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Part Number 82231-01
Revision B, 1991

# TK83 Balance Master 2

## Manual

BENTLY
Nevada

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# Introduction

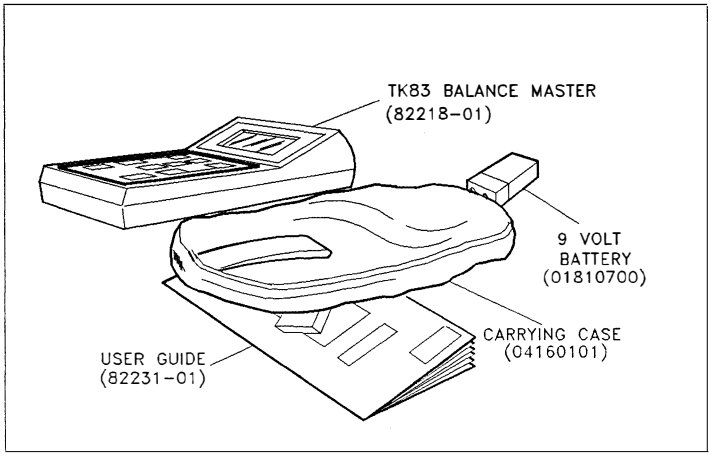
The TK83 Balance Master 2 is a hand-held vibration diagnostic instrument. It is useful in detecting overall vibration, imbalance, and misalignment in rotating machinery. It measures and displays unfiltered (direct) vibration, DC (gap) voltage, speed, one and two times (1X and 2X) rotative amplitude and phase. Signals from displacement, velocity, acceleration and Keyphasor transducers are accepted.

# WARNING

**Attempting to balance when unknown vibration sources exist is dangerous and potentially destructive. Conduct tests to determine vibration sources.**

# Features

- Hand-held, Lightweight, Portable
- High Accuracy
- Single 9 Volt Battery Powered
- English/Metric Units and Scale Factors
- Shock & Water Resistant
- Wide Input Voltage Range
- Extra/missing Keyphasor check
- Built in Integration
- Adjustable Scale Factors
- Fast Settling Time
- Auto Keyphasor Threshold
- Data Memory

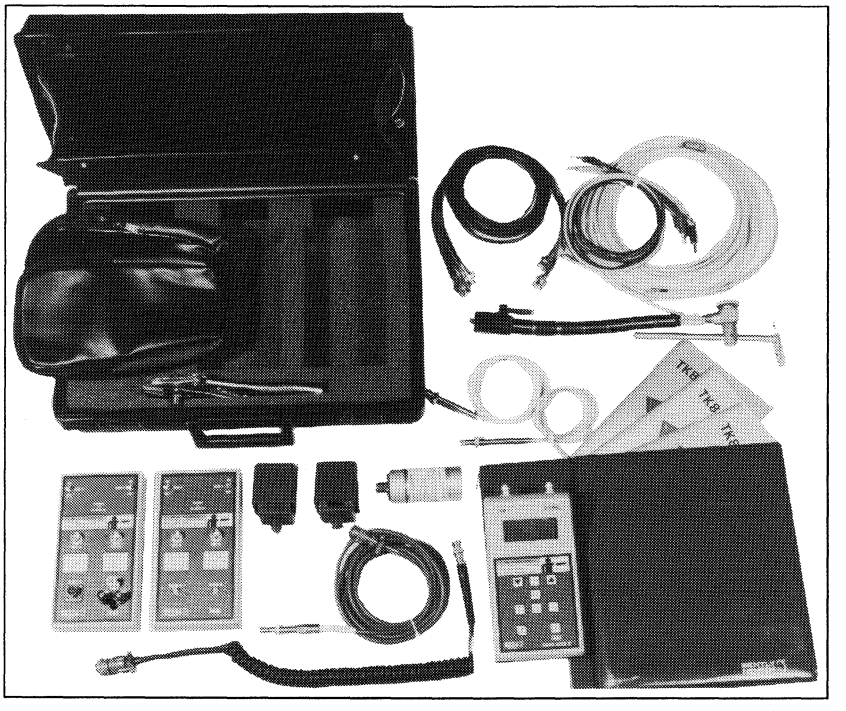





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# Accessories

## Field Balancing Package P/N 82997-01

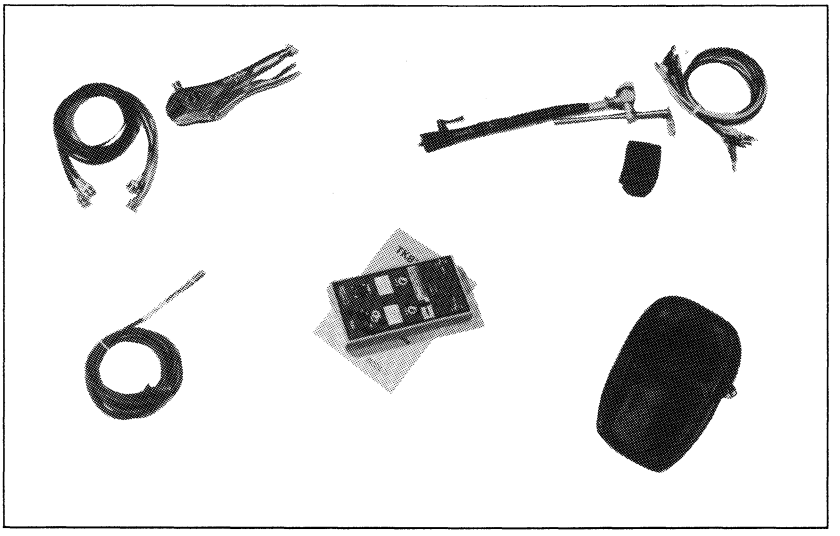


- TK83 Balance Master 2
- TK84 Optical Interface Package
- TK85 Dual Proximitor Package
- Velocity Package
- Transport Case
- TK Clipboard
- Manuals



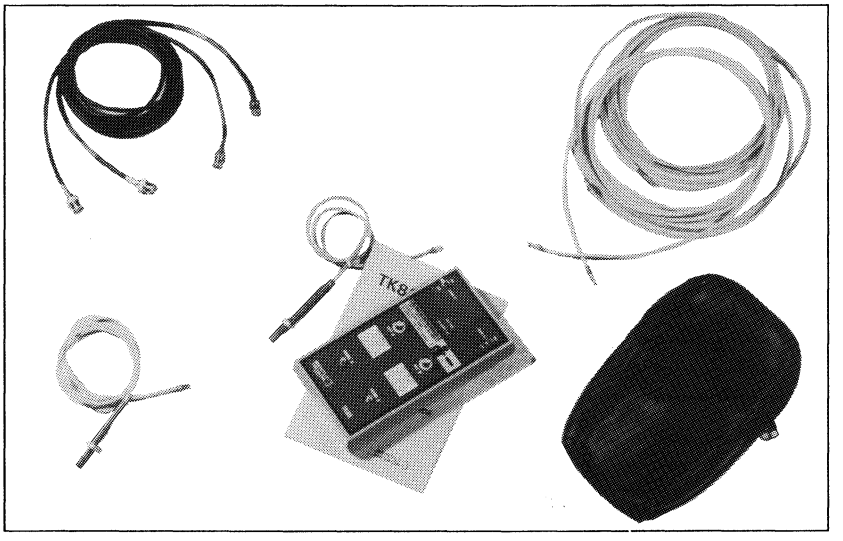
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## TK84 Optical Interface Package P/N 82608-01



- TK84 Optical Interface
- Optical Transducer
- Keyphasor Mounting Kit
- Manual

## TK85 Dual Proximity Package P/N 82609-01

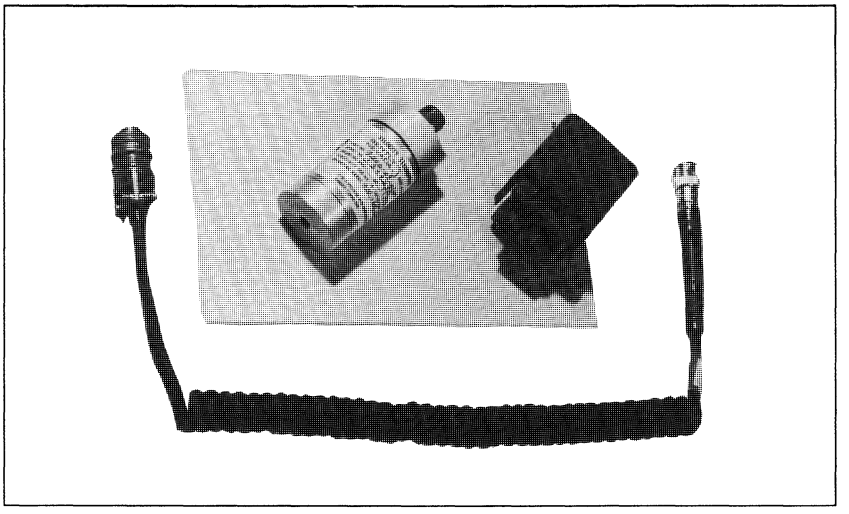


- TK85 Dual Proximitor
- Eddy Current Probes
- Probe Extension Cables
- Manual



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### TK Velocity Package P/N 82611-01



- Velocity Seismoprobe
- Magnetic Base
- Cable
- Manual

## Ordering Information

### TK83 Balance Master 2 82320-01

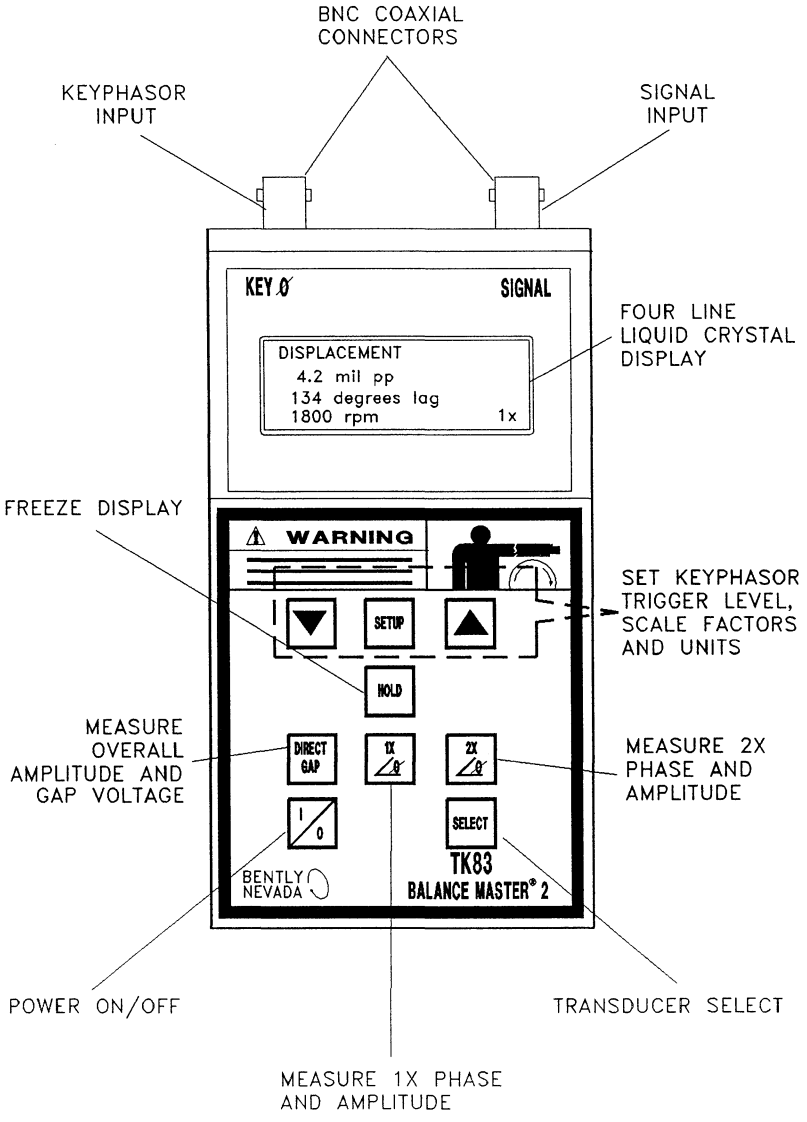
Includes:

| Component | Part Number |
|---|---|
| TK83 | 82218-01 |
| Carrying Case | 04160101 |
| Nine Volt Alkaline Battery | 01810700 |
| User Guide | 82231-01 |



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# TOPVIEW

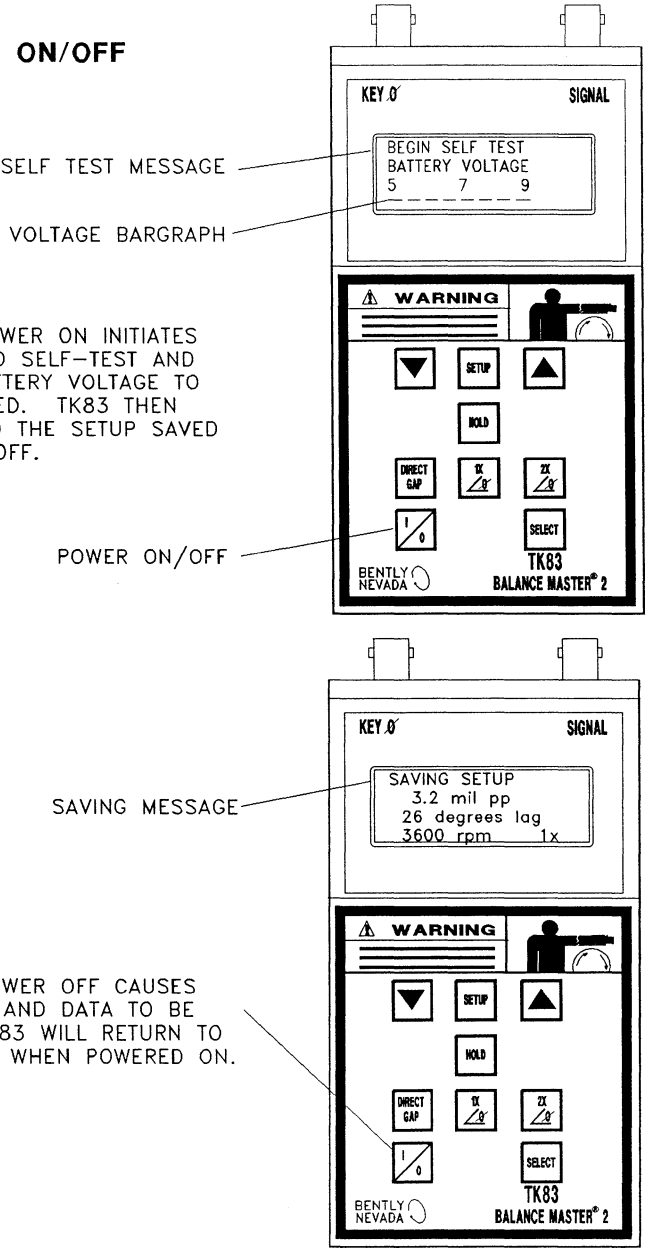





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## CONTROLS

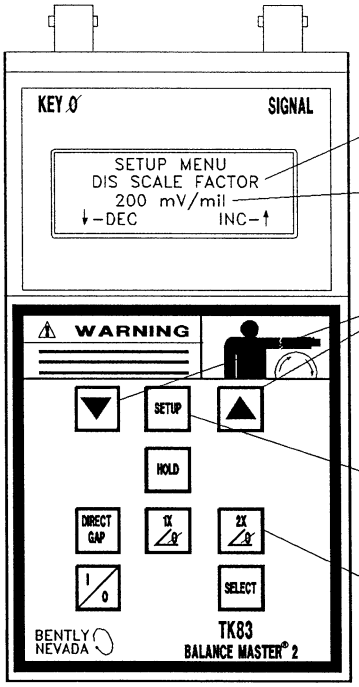
### ON/OFF






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# SETUP




SETUP SELECTION

SCALE FACTOR VALUES

PRESS AND HOLD ARROW KEYS TO INCREASE OR DECREASE VALUE.

REPEATED PRESSING OF SETUP KEY SELECTS BETWEEN KEYPHASOR THRESHOLD, TRANSDUCER SCALE FACTORS OR UNITS SETUP MENUS. SELECTION RANGE IS SHOWN BELOW FOR EACH MENU.

PRESS ANY FUNCTION KEY TO EXIT SETUP

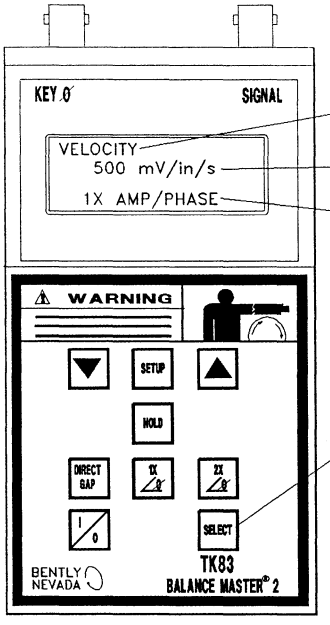
| | |
|---|---|
| SETUP MENU<br>KØ THRESHHOLD 50%<br>↓–DEC INC–↑ | KEYPHASOR SELECTIONS ARE 25, 50 OR 75% POINT OF THE KEYPHASOR SIGNAL. (SEE THE KEYPHASOR SIGNAL PROCESSING IN THEORY OF OPERATION.) |
| SETUP MENU<br>DIS SCALE FACTOR<br>200 mV/mil<br>↓–DEC INC–↑ | DISPLACEMENT SCALE FACTOR RANGES ARE FROM 5 mV/mil TO 9999 mV/mil (0.2 mV/um to 393.7 mV/um). |
| SETUP MENU<br>VEL SCALE FACTOR<br>500 mV/in/s<br>↓–DEC INC–↑ | VELOCITY SCALE FACTOR RANGES ARE FROM 5 mV/in/s TO 9999 mV/in/s. (0.2 mV/mm/s to 393.7 mV/mm/s). |
| SETUP MENU<br>ACC SCALE FACTOR<br>100 mV/g<br>↓–DEC INC–↑ | ACCELERATION SCALE FACTOR RANGES ARE FROM 5 mV/g TO 9999 mV/g. |
| SETUP MENU<br>ENG/MET OPTION<br>ENGLISH SELECTED<br>↓↑ – TOGGLE | EITHER ARROW WILL TOGGLE BETWEEN ENGLISH OR METRIC SCALE FACTORS. |



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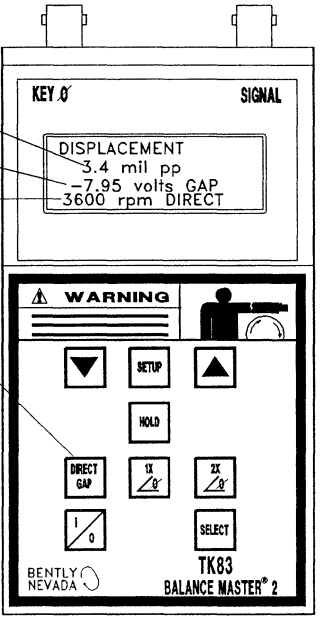
# TK83 HAND HELD BALANCE MASTER 2

## SELECT




PRESS SELECT KEY TO CHANGE TRANSDUCER SELECTION BETWEEN DISPLACEMENT, ACCELERATION, INTEGRATED ACCELARATION, VELOCITY, OR INTEGRATED VELOCITY.

## DIRECT/GAP




PRESS DIRECT/GAP KEY TO MEASURE UNFILTERED (DIRECT) MAGINITUDE. GAP VOLTAGE IS DISPLAYED ONLY FOR DISPLACEMENT TRANSDUCERS.

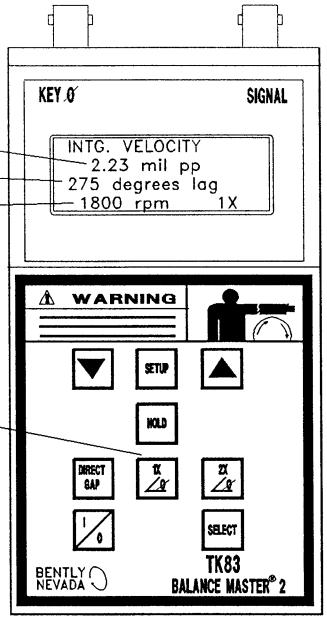
PRESSING KEY SHOWS SCALE FACTOR AND UNITS.

KEYPHASOR IS NOT NECESSARY TO MAKE DIRECT MEASUREMENTS.



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# 1X OR 2X AMPLITUDE and PHASE




FILTERED AMPLITUDE

PHASE ANGLE

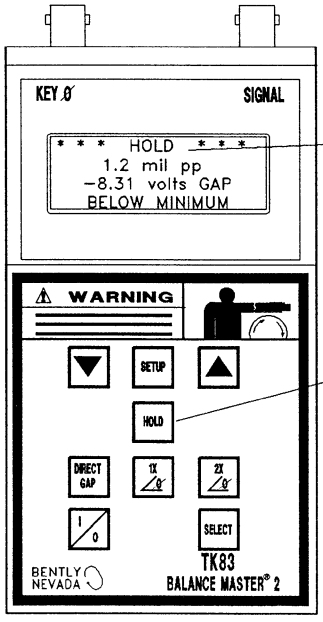
MACHINE SPEED

PRESS AND RELEASE THE 1X OR 2X KEY TO SELECT AMPLITUDE AND PHASE MEASUREMENT OF THE ONCE OR TWICE PER TURN COMPONENT OF VIBRATION.

SCALE FACTOR AND UNITS ARE SHOWN WHILE KEY IS DEPRESSED.

WITH NO KEYPHASOR THE AMPLITUDE AND PHASE READOUTS ARE BLANKED.

## HOLD




THE MESSAGE "HOLD" WILL ALTERNATELY FLASH WITH THE TRANSDUCER TYPE WHEN IN THE HOLD MODE.

PRESS HOLD KEY TO FREEZE DISPLAY. VALUES REMAIN UNTIL HOLD IS PRESSED AGAIN.

DISPLAY VALUES ARE STORED WHEN POWER IS TURNED OFF AND RETURN WHEN POWER IS TURNED ON.



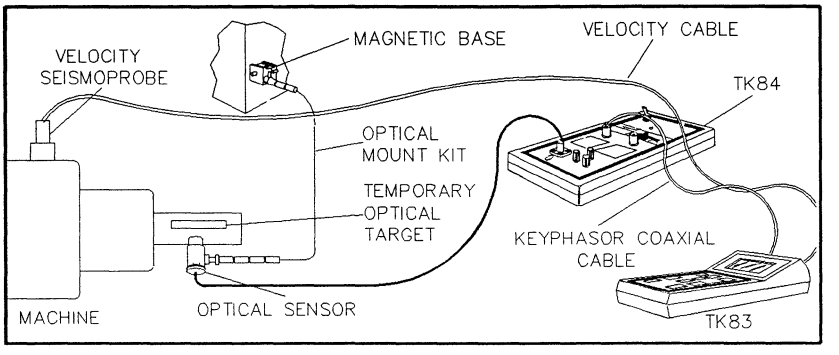
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# Operation

Illustrations of typical installations using the TK83 and accessories follow:

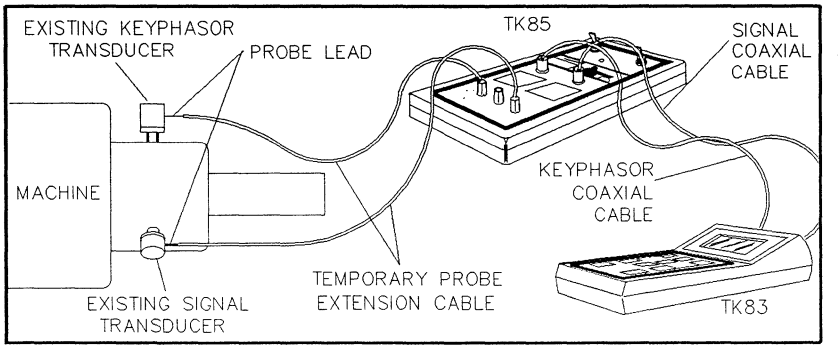
## Temporary Seismic Transducer and Optical Keyphasor

A TK84 will power a temporary optical Keyphasor transducer. Use a case mounted transducer to measure vibration.




## Existing Proximity Probes Only

Use a TK85 Dual Proximitor with existing eddy current probes to complete the signal and Keyphasor transducer system.

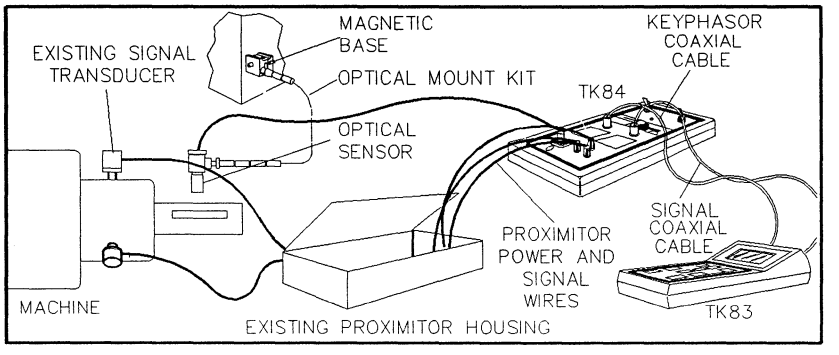





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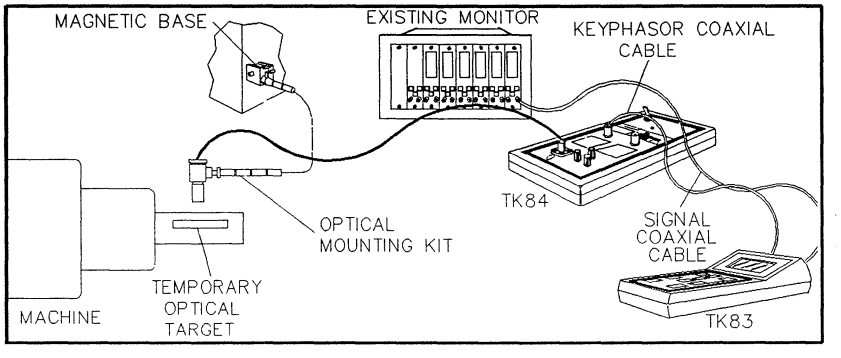
## Existing Proximity Probes and Proximitors Only

Use a TK84 Optical System for powering a signal Proximitor and a temporary optical Keyphasor transducer. If you use a probe and Proximitor as a Keyphasor transducer, you may use the TK84 to supply Proximitor power.




## Existing Monitoring System with No Keyphasor System

If the monitor does not have a Keyphasor system, install a temporary Keyphasor transducer (such as the TK84 Optical System) and connect to the TK83. Take the signal directly from the monitor.

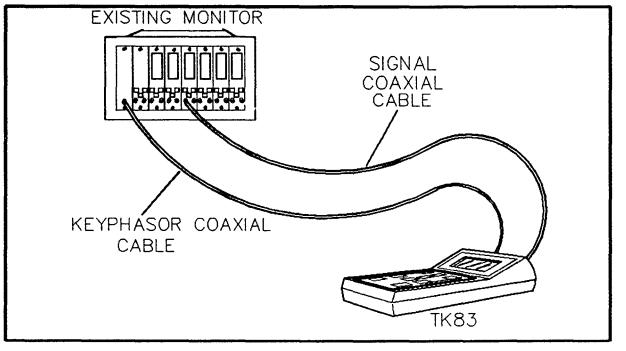





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## Existing Monitoring System with Keyphasor System

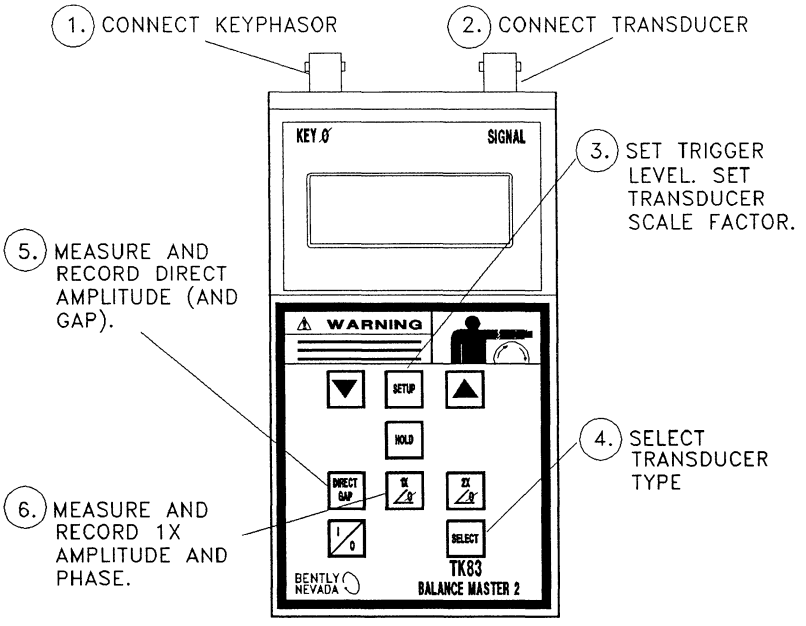
Connect Keyphasor system and vibration signals directly to the TK83 if they are available at a monitor front panel.






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# OPERATING SUMMARY




7. USE ACCEPTABLE READINGS TO DETERMINE THE BALANCE SOLUTION.

NOTES

1. UNSTABLE SPEED OR AMPLITUDE READINGS CANNOT BE RELIED ON. WAIT FOR STABLE READING.
2. THE KEYPHASOR TRIGGER LEVEL IS ADJUSTED WHEN THE DIRECT/GAP, 1X OR 2X KEYS ARE PRESSED, OR A KEYPHASOR ERROR IS DETECTED. REPEATED OCCURRENCE OF ERRORS SUGGESTS A NOISY KEYPHASOR OR NOT ENOUGH AMPLITUDE. ATTEMPT SETTING THE KEYPHASOR THRESHOLD USING THE SETUP KEY TO STABILIZE THE KEYPHASOR.
3. DATA VALUES MAY BE RETAINED BY PLACING THE TK83 IN THE HOLD MODE. VALUES WILL BE RETAINED WHEN POWER IS TURNED OFF.



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# Theory Of Operation

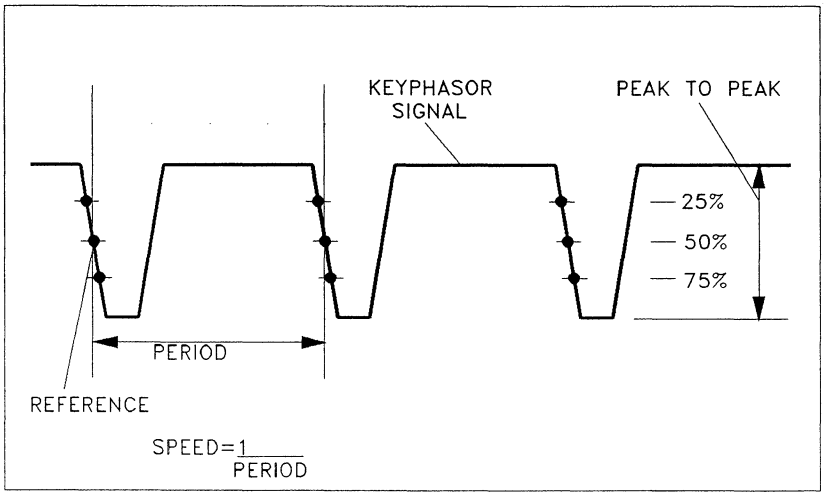
The TK83 measures machine speed, overall vibration amplitude, gap voltage, and the one times (1X) and two times (2X) rotative speed amplitude and phase components.

## Keyphasor Signal Processing

The TK83 computes speed from the time period between successive Keyphasor pulses. The reference point for this period is on the falling edge of the Keyphasor waveform. The reference is user-set at 25, 50 or 75% of the peak to peak amplitude. The instrument also uses the reference point as the zero-degree reference for phase measurements of the 1X or 2X vibration components.

The internally-set reference voltage corresponds to 25, 50, or 75% of the waveform. The instrument compares the reference voltage to the incoming Keyphasor signal voltage. When the Keyphasor voltage falls below the reference voltage, the TK83 computes the speed and notes the start of another period.

The instrument calculates the reference voltage from the peak to peak magnitude of the Keyphasor signal. It makes this calculation when the user presses the DIRECT/GAP, 1X, or 2X key, or when the instrument senses a Keyphasor error. A Keyphasor error occurs when successive Keyphasor periods differ by more than 12 1/2%.





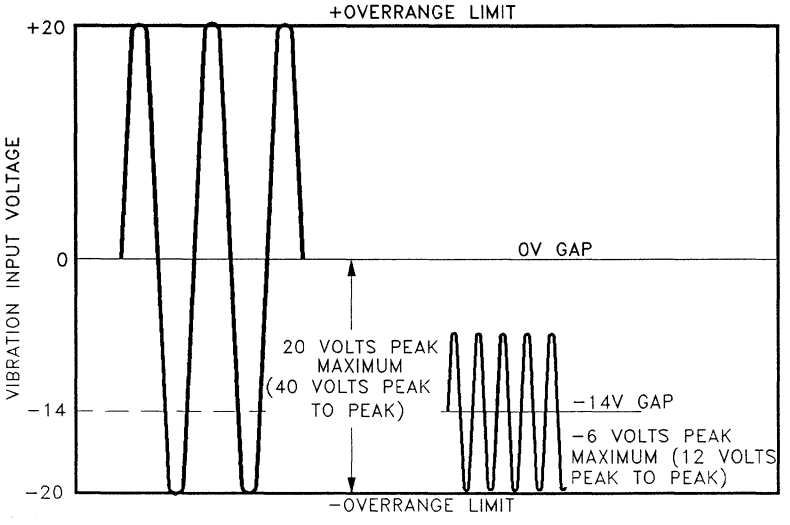

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To calculate the reference voltage, the instrument first samples the Keyphasor signal voltage for one second at a very high rate. The highest and lowest values sampled determine the peak to peak magnitude. The TK83 then determines the voltage that corresponds to the 25, 50, or 75% user-set reference point, and sets the voltage internally.

To ensure reliable measurements, the Keyphasor voltage must be at least 1 volt peak to peak, and have a pulse width of at least 50 μsec or 1% of the Keyphasor period.

## Vibration Signal Voltage Range

The vibration input voltage range is +20 to -20 volts. The combined gap and vibration signals cannot exceed this value or an OVERRANGE message will appear. A displacement transducer with -14 gap volts can only have -6 volts of peak vibration before the OVERRANGE message. A transducer with no dc voltage can have 20 volts peak vibration before the OVERRANGE indication. The scale factor is only used to compute the display value. Changing the scale factor will not affect the overrange input.





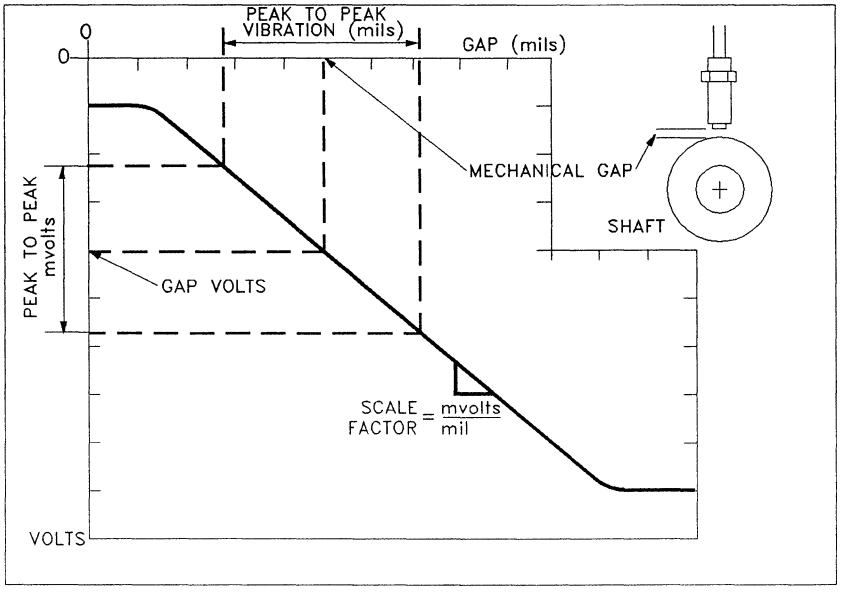

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## Direct/Gap Signal Processing

When you press the DIRECT GAP key, the TK83 measures the overall vibration magnitude and gap voltage. To make this measurement, it samples the vibration signal at a very high rate. This ensures that it samples voltages at the highest and lowest points. The difference between the highest and lowest values is the overall (peak to peak) magnitude.

The instrument expresses acceleration or velocity measurements as zero to peak (pk), and computes them as one-half the peak to peak value (pp). It computes the gap voltage as the average of all the samples. Since gap voltage is only significant for eddy current displacement probes, the instrument displays it only when you select displacement.

When you select velocity or acceleration, an electronic integrator switches into the signal path. The instrument measures overall vibration after it integrates the signal.




The displayed vibration value is computed from the sampled signal and the transducer scale factor. Scale factor is the ratio of vibration amplitude to the corresponding voltage output of the transducer. Scale factors for the three transducer types (displacement, velocity, and acceleration) are set separately and are maintained in memory. English unit scale factors are in memory; metric units are computed from them.



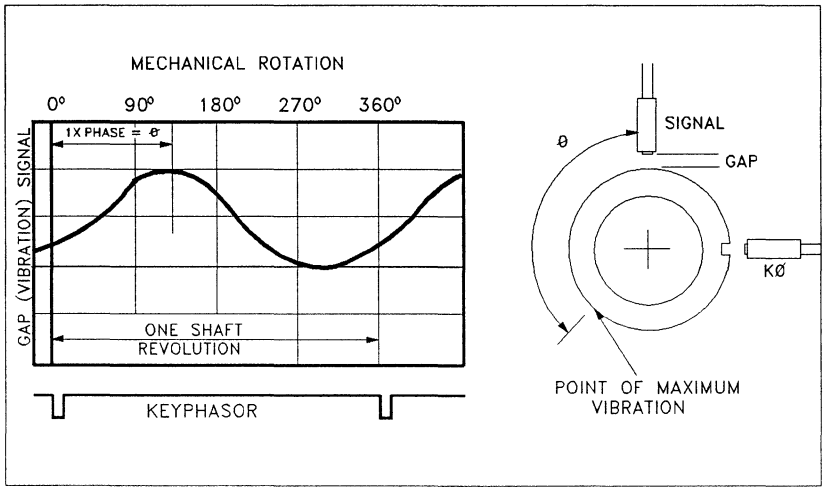
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## Filtered Vibration Processing

Vibration includes frequency components related to machine running speed. The 1X and 2X components are measured by subdividing the Keyphasor period into smaller times. The vibration signal is then sampled at these times. The amplitude and phase are computed from the samples using a mathematical discrete Fourier transform (DFT). Integrated velocity and acceleration values are computed using the machine speed.

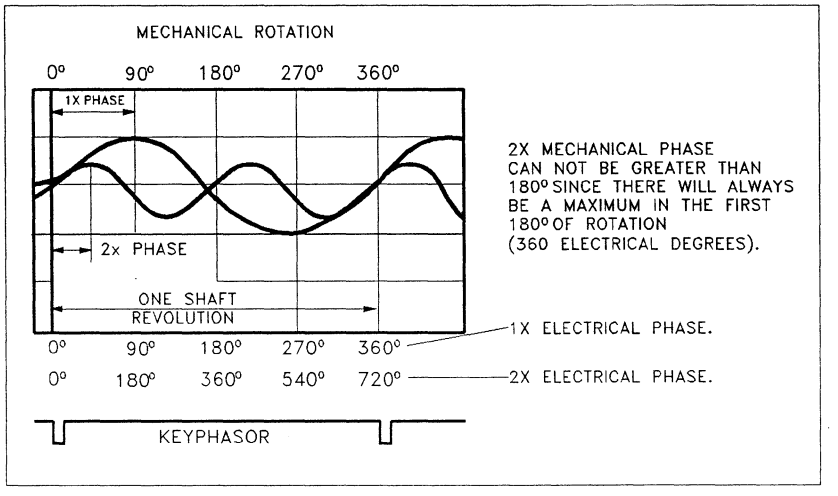
## Phase

Phase is the electrical angle from the Keyphasor to the positive peak of vibration. The 1X electrical and mechanical angles are the same. The 2X electrical angle varies from 0 to 360 degrees but occurs in the first 180 degrees of mechanical rotation.






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# Problems

## Keyphasor Error Messages

Keyphasor error messages replace speed readings on the display. BELOW MINIMUM occurs when machine speed is too slow or keyphasor amplitude is too low. KΦ ERROR occurs when the keyphasor period changes by more than 12 1/2%.

## Shifting Phase Readings

A change in the Keyphasor waveform gives a different triggering point. This results in an apparent phase change. Press the DIRECT/GAP, 1X or 2X key just before taking a reading to give more consistent results.

## Overrange Message

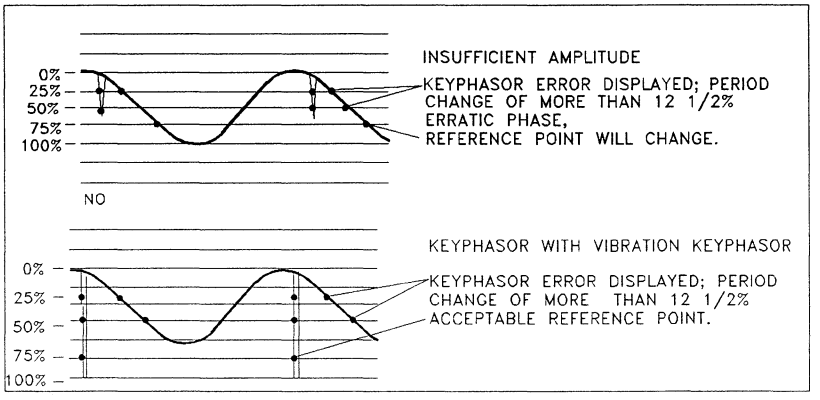
If the instrument receives a vibration signal greater than +20 volts or less than -20 volts, it displays an OVERRANGE message. Disconnect the signal. Measure the signal amplitude to ensure that peak voltages are between +20 and -20 volts.



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## Unreliable Triggering

Unreliable triggering will occur if the Keyphasor signal has a low amplitude or has a vibration signal combined with it. Symptoms include intermittent Kϕ ERROR and BELOW MINIMUM messages, and erratic phase or speed measurements. Selecting a different Keyphasor trigger percentage may correct this problem. Press the DIRECT/GAP, 1X or 2X key before taking a reading to reset the Keyphasor reference voltage. View the Keyphasor waveform on an oscilloscope if persistent triggering problems occur.




## Low Battery

The TK83 will not operate if the battery voltage drops below 5.5 volts. The instrument displays battery voltage when you turn it on. LOW BATTERY appears in the top line of the display 15 to 30 minutes before the unit automatically stops functioning. Replace the battery if the unit will not turn on. Carry a spare battery if the battery voltage is low.



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# Verification

## Self Test

A self test program checks the memory and microprocessor when the TK83 is turned on. Note any error message displayed during self test. Attempt to turn the TK83 off and then on again. If the message repeats, contact Bently Nevada for assistance.

## Operation

Check the TK83 by putting a 30 Hertz square wave of about 2 volts peak to peak into the keyphasor and signal inputs simultaneously. A stable display with no error messages shows the TK83 is functioning. Indicated speed should be 1800 rpm. The 1X amplitude should be about 27% higher than the overall amplitude. The 2X amplitude should be very small. 1X phase should be near 270 degrees.

# Specifications

## Input

**Transducer**
*Input Voltage:* -20 to +20 Volts Peak Maximum

*Input Impedance:* 1.1 Megohms typical

**Keyphasor**
*Input Voltage:* -20 to +20 Volts, 1 Volt peak to peak minimum

*Width:* 1% duty cycle or 50 μsec, whichever is greater

*Threshold:* Falling edge, adjustable to 25, 50, or 75% of peak to peak voltage

*Frequency:* 60 to 70,000 rpm (1 Hz to 1167 Hz)

**Power**
*Battery:* 9 Volt Alkaline (NEDA 1604A)

*Life:* 26 hours typical (to 5.5 volts)



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## Output

**Gap**
*Range:* -20 to +20 Volts dc

*Resolution:* 0.01 Volts

*Accuracy:* 2.35% reading ±0.10 volts

**Amplitude**
*Resolution:* Four digit plus decimal

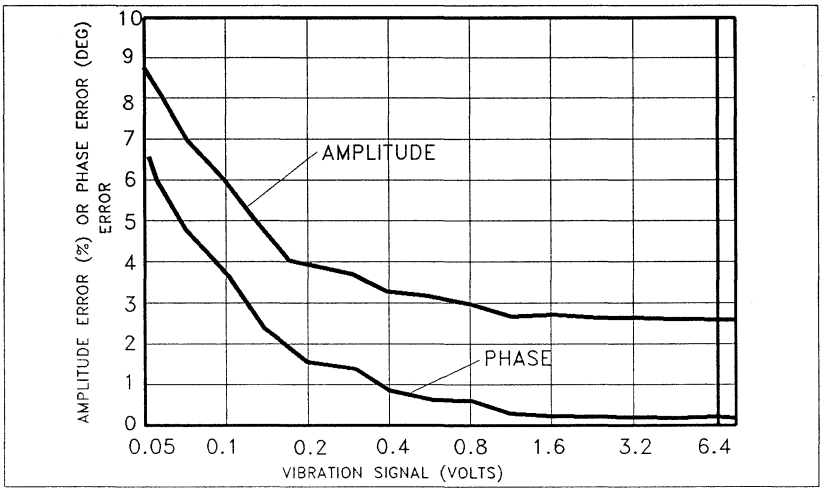
*Accuracy:*

Direct Mode: 2.35% of reading (MAX) +50mV (pk-pk MAX) equivalent noise referred to input.

Direct Integrated Mode: 2.85% of reading (MAX) +50mV (pk-pk MAX) equivalent noise referred to input.

Filtered (Filtered Integrated) Mode: 5% reading Maximum (see graph)

Filter Width: 10% bandwidth (Q = 10) Minimum




**Amplitude & Phase Error Versus Input Signal Voltage**



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**Phase**
*Range:* 0 to 359 degrees lag

*Resolution:* 1 degree

*Accuracy:* ±4 degrees maximum (see graph)

**Speed**

*Range:* 60 to 70,000 rpm (60 to 30000 in 2X mode)

*Resolution:* 1 rpm

*Accuracy:* 0.01% reading

## Environmental

**Temperature**
*Operating:* 0° to 50° C (32° to 122° F)

*Storage:* -20° to 70° C (-4° to 158° F)

**Humidity**
*Operating:* Up to 90% noncondensing



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