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Tele-Trak 3000 System
Users Manual

3000 Series Transmitters
and
RD-3000 Receiver/Demodulator

These devices comply with Part 15 of the FCC Rules. Operation is subject to the following conditions: (1) these devices may not cause harmful interference, and (2) these devices must accept any interference received, including interference that may cause undesired operation.
(47 CFR 15. 19 (a) (3))

The user is cautioned that changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment. (47 CFR 15.21)
1102 FCC ID: HWN-1102

Binsfeld Engineering, Inc.
4571 W. MacFarlane
Maple City, MI 49664

(231)334-4383
FAX:(231)334-4903
www.binsfeld.com

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Binsfeld 3000 Series Transmitter

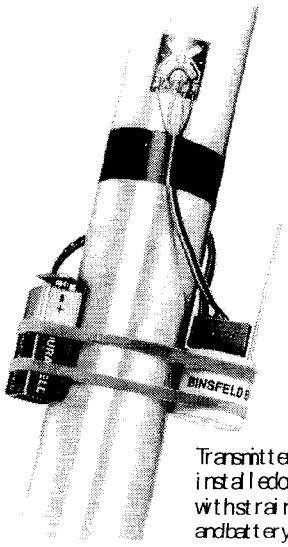
SYSTEM DESCRIPTION

Telemetry is a method of transferring data by radio transmission from transducers to readout or recording devices. Using this technique, static and dynamic data is obtainable from moving elements without the use of direct coupling methods.

Torque, voltage, and temperature data can be obtained from a rotating shaft with the Binsfeld 3000 series transmitters and the RD-3000 Receiver/Demodulator.



RD-3000 Receiver/Demodulator with Panel Meter



Transmitter installed on shaft with strain gage and battery

The Binsfeld 3000 series transmitters are typically powered by a 9V battery. The battery and transmitter are strapped to the moving element. The transmitter is 1.5" diameter x 1.5" high and weighs 2.5 ounces. When mounted on a rotating shaft, the transmitter and battery are typically taped 180 degrees apart to minimize unbalance. Run time with the recommended lithium battery is approximately 10 hours. For longer run times multiple batteries can be connected in parallel.

SYSTEM DESCRIPTION (cont.)

The **Binsfeld F-3000** transmitter converts the signal obtained from torque, pressure, or other strain gage sensors to an FM signal which is transmitted in the 49.83 - 49.90 MHz band.

The **Binsfeld V-3000** transmitter converts the voltage signal obtained from other sensors to an FM signal which is transmitted in the 49.83 - 49.90 MHz band.

The **Binsfeld T-3000** transmitter converts the signal obtained from an RTD temperature sensor to an FM signal which is transmitted in the 49.83 - 49.90 MHz band.

This FM signal from the transmitter is broadcast to a receiving antenna located within 5' of the transmitter. The signal is then fed directly or via coaxial cable to the RD-3000 Receiver/Demodulator. An FM receiver in the RD-3000 is set at the transmitter frequency and converts the radio signal to an audio data signal. The transmitted data signal is demodulated to a voltage signal where balance and gain adjustments are available.

The output of the receiver/demodulator is a voltage signal which can be recorded on an oscillographic instrument or read by meters or process instrumentation. The output voltage is also displayed on an LCD digital meter mounted on the front panel of the RD-3000. A filter can be turned on to reduce dynamic frequency response. The filter is used to eliminate signal noise by responding to average rather than actual signal levels. With the filter off, the response time exceeds the capability of most direct-write recorders.

GENERAL INFORMATION

3000 SERIES TELEMETRY TRANSMITTER

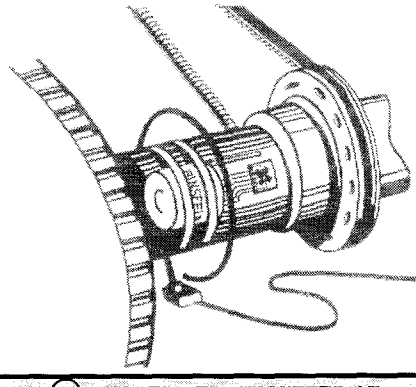
The 3000 Series includes three transmitters:

F-3000 - strain gage applications
V-3000 - to transmit voltage data
T-3000 - temperature applications

The rugged epoxy-encapsulated transmitters are 1.5" diameter x 1.5" long and weigh 2.5 ounces. There is a two-wire battery cable with a clip for attachment to a nine volt lithium battery. The transmitter will run for 10 hours with a nine volt lithium battery before instability becomes noticeable. Longer running times can be obtained by using parallel batteries. Transmitting linearity is ±0.5% of range (typical).

There are four additional sensor wires for the V-3000 and F-3000 transmitters and two additional wires for the T-3000 transmitter.

HOW TELEMETRY WORKS

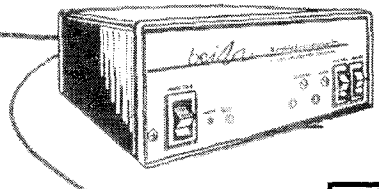


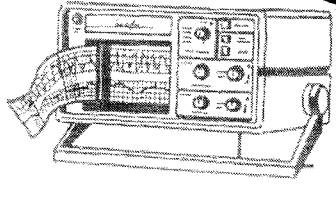
(1) BINSFELD TRANSMITTER AT REMOTE SENSOR LOCATION

1. Transmitter provides excitation for most sensors and converts output to frequency data signal.
2. Frequency data is transmitted as a radio frequency.

(2) BINSFELD RD-3000 RECEIVER/DEMODULATOR

1. Picks up radio signal.
2. Built-in 49 MHz receiver converts radio signal to an audio frequency signal. Switchable speaker allows you to hear this audio signal as a tone that goes up and down with positive and negative sensor inputs.
3. Demodulator circuitry converts audio signal to a voltage signal for output.





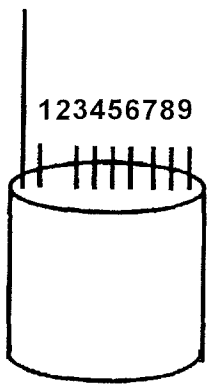
(3) CHART RECORDER OR READOUT DEVICE

1. Accepts voltage signal from RD-3000 demodulator to control pen position on chart.
2. Can record trace at different chart speeds and signal gains to best capture data.
3. Provides a hard copy of static and dynamic data vs. time.

F-3000 Telemetry Transmitter

The F-3000 includes a four wire ribbon cable to attach to the sensor element, such as a transducer or strain gage. There are also three short wires (red, green and white) for calibration connections. An internal regulator provides 5 volts DC to the strain gage bridge.

F-3000 Transmitter



F-3000 Transmitter

Pin 1 - ----
Pin 2 - Clipped for key
Pin 3 - ----
Pin 4 - Strain gage output (HI) (green)
Calibration input (green)
Pin 5 - Strain gage output (LO) (white)
Calibration input (white)
Pin 6 - Strain gage input (0 V) (black)
Pin 7 - Strain gage input (+5 V) (red)
Calibration input (red)
Pin 8 - 9 volt positive (battery clip)
Pin 9 - 9 volt common (battery clip)

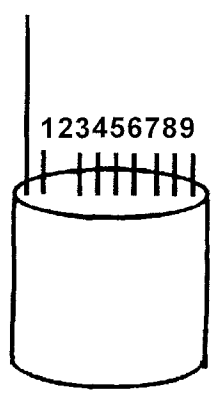
V-3000 Telemetry Transmitter

The V-3000 includes a four wire ribbon cable to attach to the sensor element. Using pin 1 (white wire) as common, the output of the de-modulator will go positive or negative depending on the polarity of the input signal applied to pin 3 (black wire), pin 4 (green wire), or pin 5 (red wire).

V-3000 Transmitter

Pin 1 - Voltage input (LO) (white)
Pin 2 - Clipped for key
Pin 3 - ±100mV input (HI) (black)
Pin 4 - ±1V input (HI) (green)
Pin 5 - ±5V input (HI) (red)
Pin 6 - ----
Pin 7 - ----
Pin 8 - 9 volt positive (battery clip)
Pin 9 - 9 volt common (battery clip)

V-3000 Transmitter



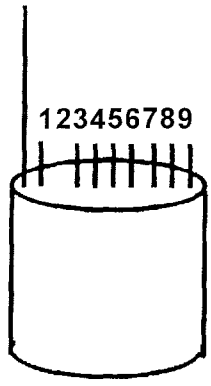
T-3000 Telemetry Transmitter

The T-3000 includes two wires (white and green) to attach to the RTD sensor element.

T-3000 Transmitter

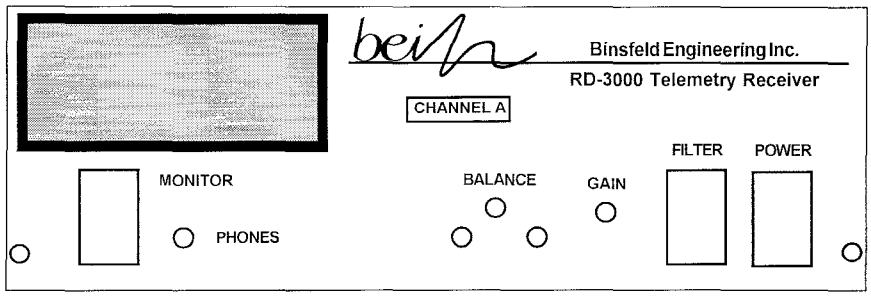
Pin 1 - Sensor input (LO) (white)
Pin 2 - Clipped for key
Pin 3 - ----
Pin 4 - Sensor input (HI) (green)
Pin 5 - ----
Pin 6 - ----
Pin 7 - ----
Pin 8 - 9 volt positive (battery clip)
Pin 9 - 9 volt common (battery clip)

T-3000 Transmitter



RD-3000 Receiver/Demodulator

The RD-3000 Receiver/Demodulator receives the FM signal from the 3000 series transmitters, decodes the audio frequency (data) signal from the FM carrier and then converts it to a dynamic DC voltage output (nominally ± 2VDC full scale). This DC voltage can then be used to deflect a recorder or meter. The amount and direction of deflection will be proportional to the torque, temperature or other sensor signal from the corresponding 3000 series transmitter.



RD-3000 Front Panel Layout

The **MONITOR** switch turns on an internal speaker so that the demodulated audio (data) signal from the transmitter can be heard. The internal speaker is adequate for tuning the system in most environments. However, the RD-3000 also includes an earphone connector for verifying signal reception in noisy environments.

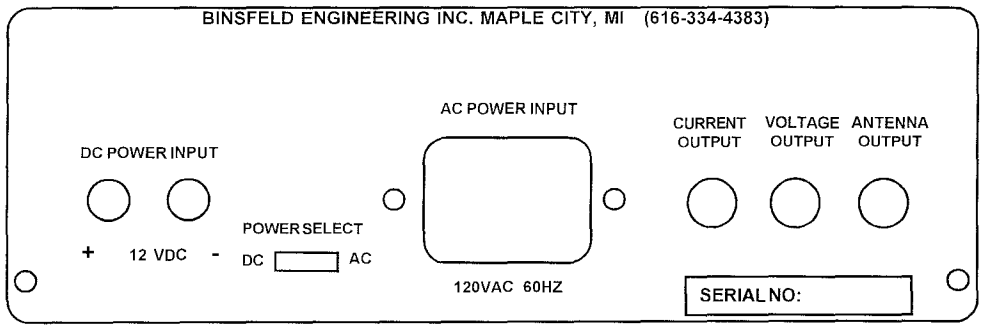
The RD-3000 is crystal controlled and therefore does not require any RF tuning although it must be matched to the transmitter frequency.

On the front panel is the BALANCE control that consists of two LED's, one on each side of a balance adjustment screw. Balance is accomplished at zero sensor load by turning the screw toward the unlit LED until both LED's flicker.

The GAIN adjustment screw is used to reduce the level of the DC output, if required. The FILTER switch activates an internal low-pass filter to reduce signal noise by looking at average load values.

RD-3000 Back Panel

There are two BNC CONNECTORS on the back panel. The BNC marked ANTENNA INPUT is for connecting the receiver antenna directly or via a coaxial cable. The BNC marked VOLTAGE OUTPUT is for connecting the readout or recording device and provides a nominal ± 2 VDC signal proportional to the sensor load. An optional third BNC marked CURRENT OUTPUT is for connecting to a readout device designed to accept a 4-20 mA signal.



RD-3000 Back Panel Layout

For the DC power option, which allows operation of the RD-3000 from a 12 volt DC supply, there are two binding posts for power connection. A power select switch is also provided for switching between DC power and 110 VAC power.

The RD-3000 Receiver/Demodulator is 2.5" high, 7.5" wide, and 9.5" deep and weighs 3.0 lbs.

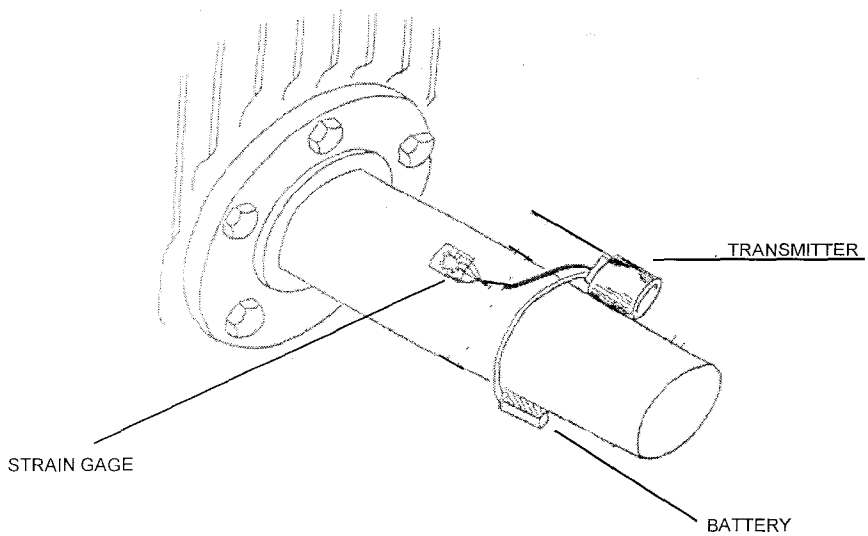
F-3000 Set Up Procedure

1. Attach sensor or strain gage(s) to shaft or device being measured. (See Appendix B for strain gage installation.) Be sure shaft and/or sensor is unstrained when attaching as this is the zero load reference. For torque, a 350 ohm full bridge gage is recommended, such as CEA-06-250US-350, available from Measurements Group. A complete Strain Gage Kit is also available from BEI.

2. Strap transmitter and 9 volt battery to shaft or device being measured. For best results, orient transmitter so antenna lies away from shaft. To secure transmitter, use glass strapping tape, hose clamps, or other methods or devices as appropriate.

3. Solder ribbon cable to gage or sensor. Attach transmitter battery clip to battery.

F-3000 Set Up



F-3000 Set Up Procedure (cont.)

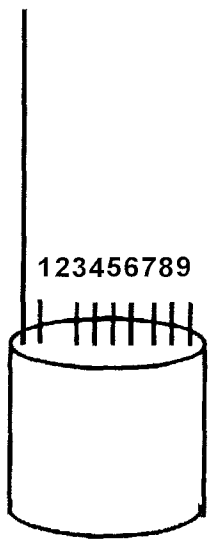
4. Connect harness to transmitter pins. NOTE: For long term installations, applications with excessive vibration, dirty or wet environments, and where low level signals are compromised by noise it is recommended that you solder sensor leads and battery leads directly to the transmitter pins, thereby eliminating the harness.

5. The receiving antenna is typically within 5' of the transmitter. For shaft diameters larger that 18" or if you are experiencing a loss of signal once per revolutions, a hoop-shaped antenna can be fashioned from 1/4" copper tubing and shaped around the shaft, in the rotational plane of the transmitter. Anchor with insulated clamp, or use the A-101 Magnetic Mount Antenna.

6. Connect receiving antenna directly or via coaxial cable to the RD-3000 ANTENNA INPUT.

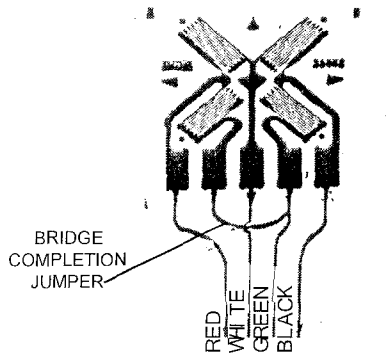
Transmitter Pin Outs

Pin 1 - ----
Pin 2 - Clipped for key
Pin 3 - ----
Pin 4 - Strain gage output (HI) (green)
Calibration input (green)
Pin 5 - Strain gage output (LO) (white)
Calibration input (white)
Pin 6 - Strain gage input (0 V) (black)
Pin 7 - Strain gage input (+5 V) (red)
Calibration input (red)
Pin 8 - 9 volt positive (battery clip)
Pin 9 - 9 volt common (battery clip)



F-3000 Transmitter

Connection Diagram
for
Torque Strain Gage



7. Turn on the RD-3000 Receiver for a 15 minute warm-up. Use the internal speaker (MONITOR switch) or earphone to verify reception of the transmitter signal (constant high-pitched tone).

F-3000 Set Up Procedure (cont.)

8. Rotate transmitter through complete range of motion to verify strong signal reception in all orientations.

9. Connect recorder or other voltage readout device to VOLTAGE OUTPUT on rear panel of RD-3000.

10. Set FILTER switch on front of RD-3000 to ON (top portion of switch depressed)

11. Adjust balance control with screwdriver so that both balance lights appear to be on. At this point, the system is balanced and the recorder or other readout device should indicate zero (or 4 mA for current output).

12. Apply shunt calibration resistance (e.g. from a resistance decade box) between short red and green (or red and white) leads of F-3000 harness. (Refer to Appendix C for calibration resistor calculations). The meter and/or chart pen will move upscale or downscale in proportion to the value of the calibration resistor.
NOTE: Calibration resistance should be no lower than 87.5k ohms for a 350 ohm full bridge gage with a standard F-3000 transmitter.

13. Adjust gain of chart recorder for required deflection. For example, if using a calibration resistor of 160k ohms = 20,000 in-lbs, adjust gain of recorder to deflect 20 millimeters when 160k ohms is applied across calibration leads. The center of the chart is usually considered the zero or balanced position.

14. System is now ready to record data. Start with FILTER switch ON. To obtain maximum dynamic response, set FILTER switch to OFF. Use filter to integrate torsional vibration to obtain average torque values and to reduce noise effects.

INSTALLATION PROCEDURE

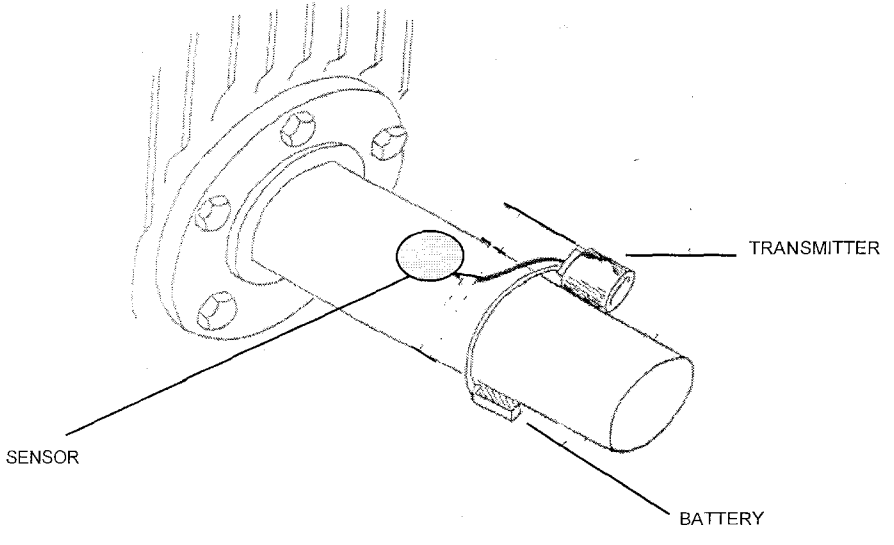
V-3000 Set Up Procedure

1. Attach sensor to shaft or device being measured.

2. Strap transmitter and 9 volt battery to shaft or device being measured. For best results orient transmitter so antenna lies away from shaft. To secure transmitter use glass strapping tape, hose clamps, or other methods or devices as appropriate.

3. Solder appropriate harness leads to sensor. Make sure that the negative sensor lead is connected to the white wire and the positive sensor lead is connected to the black (±100mV), green (±1V), or red wire (±5V). Attach transmitter battery clip to battery.

V-3000 Set Up



4. Connect harness to transmitter pins. NOTE: For long term installations, applications with excessive vibration, dirty or wet environments, and where low level signals are compromised by noise it is recommended that you solder sensor leads and battery leads directly to the transmitter pins, thereby eliminating the harness.

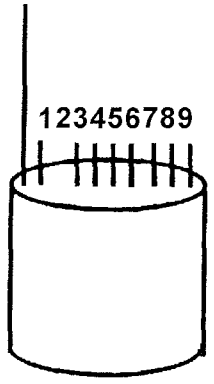
V-3000 Set Up Procedure (cont.)

5. The receiving antenna is typically within 5' of the transmitter. For shaft diameters larger that 18" or if you are experiencing a loss of signal once per revolutions, a hoop-shaped antenna can be fashioned from 1/4" copper tubing and shaped around the shaft, in the rotational plane of the transmitter. Anchor with insulated clamp, or use the A-101 Magnetic Mount Antenna.

6. Connect receiving antenna either directly or via coaxial cable to RD-3000 ANTENNA INPUT.

V-3000 Sensor Inputs

Pin 1 - Voltage input (LO) (white)
Pin 2 - Clipped for key
Pin 3 - ±100mV input (HI) (black)
Pin 4 - ±1V input (HI) (green)
Pin 5 - ±5V input (HI) (red)
Pin 6 - ----
Pin 7 - ----
Pin 8 - 9 volt positive (battery clip)
Pin 9 - 9 volt common (battery clip)



V-3000 Transmitter

7. Turn on the RD-3000 Receiver for a 15 minute warm-up. Use the internal speaker (MONITOR switch) or earphone to verify reception of the transmitter signal (constant high-pitched tone).

8. Rotate transmitter through complete range of motion, if possible, to verify strong signal reception in all orientations.

V-3000 Set Up Procedure (cont.)

9. Connect recorder or other voltage readout device to VOLTAGE OUTPUT on rear panel of RD-3000.

10. Set FILTER switch on front of RD-3000 to ON (top portion of switch depressed).

11. Short the green and white (input) leads of transmitter harness together (0 volt reference). Adjust balance control with screwdriver so that both balance lights appear to be on. At this point, the system is balanced and voltmeter and/or recorder should indicate zero (or 4 mA for current output).

12. To calibrate, separate the green and white transmitter leads and apply a known DC voltage across them. The V-3000 is configured as per customer specifications or ±1V full scale. NOTE: Calibration voltage should not exceed the full scale input of transmitter. The meter and/or chart pen will move upscale or downscale in proportion to the value of calibration voltage applied.

13. Adjust gain of chart recorder for required deflection. For example, if using a 1 volt calibration input, adjust gain of recorder to deflect 10 millimeters when the calibration voltage is applied to the green and white leads.

14. System is now ready to record data. Start with the FILTER switch ON. To obtain maximum dynamic response, set FILTER switch to OFF. The filter can be switched on to obtain average values and to reduce noise effects.

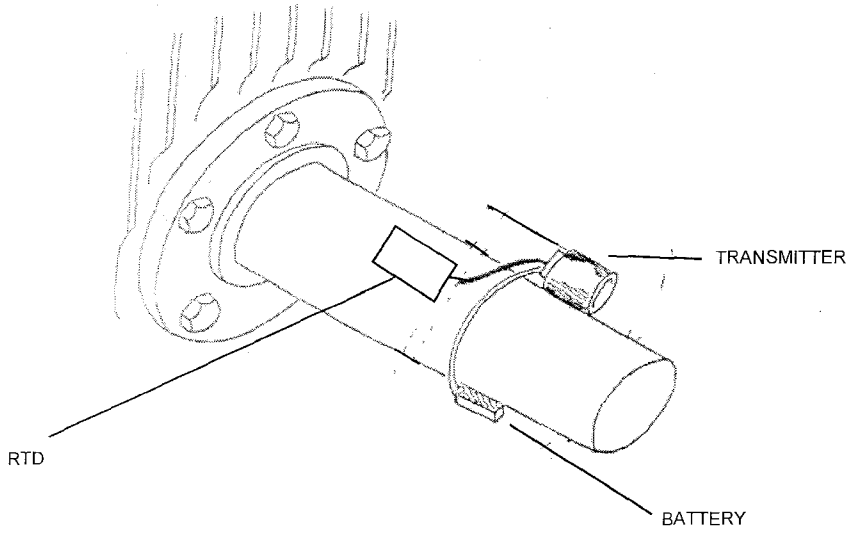
T-3000 Set Up Procedure

1. Attach RTD sensor to shaft or device being measured.

2. Strap transmitter and 9V battery to shaft or device being measured. For best results orient transmitter so antenna lies away from shaft. To secure transmitter use glass strapping tape, hose clamps, or other methods or devices as appropriate.

3. Solder green and white wires to sensor. Attach transmitter clip to battery.

T-3000 Set Up



4. Connect harness to transmitter pins. NOTE: For long term installations, applications with excessive vibration, dirty or wet environments, and where low level signals are compromised by noise it is recommended that you solder sensor leads and battery leads directly to the transmitter pins, thereby eliminating the harness.

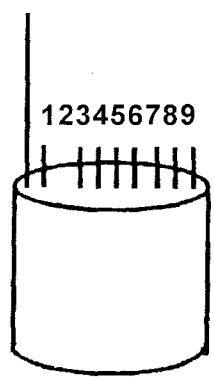
T-3000 Set Up Procedure (cont.)

5. The receiving antenna is typically within 5' of the transmitter. For shaft diameters larger that 18" or if you are experiencing a loss of signal once per revolutions, a hoop-shaped antenna can be fashioned from 1/4" copper tubing and shaped around the shaft, in the rotational plane of the transmitter. Anchor with insulated clamp, or use the A-101 Magnetic Mount Antenna.

6. Connect receiving antenna either directly or via coaxial cable to RD-3000 ANTENNA INPUT.

T-3000 Transmitter

Pin 1 - Voltage input (LO) (white)
Pin 2 - Clipped for key
Pin 3 - ----
Pin 4 - Voltage input (HI) (green)
Pin 5 - ----
Pin 6 - ----
Pin 7 - ----



T-3000 Transmitter

7. Turn on the RD-3000 Receiver for a 15 minute warm-up. The internal speaker (MONITOR switch) or earphone to verify reception of the transmitter signal (constant high-pitched tone).

8. Rotate transmitter through complete range of motion, if possible, to verify strong signal reception in all orientations.

T-3000 Set Up Procedure (cont.)

9. Connect recorder or other voltage readout device to VOLTAGE OUTPUT on rear panel of RD-3000.

10. Set FILTER switch on front of RD-3000 to ON (top portion of switch depressed).

11. Adjust balance control with screwdriver so that both balance lights appear to be on. At this point, the system is balanced and the recorder or other readout device should indicate zero (or 4 mA for current output). This should be accomplished with RTD at a reference temperature such as 0 °C. As an alternative, use a decade resistance box to apply 100 ohms across the green and white RTD input leads on transmitter.

12. Apply calibration resistance (e.g. from a resistance decade box) across green and white leads of T-3000 harness to simulate a full scale deflection. (Obtain calibration value from RTD data sheet. See Appendix D.) The meter and/or chart pen will move upscale in proportion to the value of calibration resistor.

13. Adjust gain of chart recorder for required deflection. For example, if using a calibration resistor to simulate a change of 200 °C, adjust gain of recorder to deflect 20 millimeters when the calibration resistance is applied to the green and white leads.

14. System is now ready to record data. Start with FILTER switch ON. To obtain maximum dynamic response, set FILTER switch to OFF.

TROUBLESHOOTING GUIDE

NOTE: The temperature environment, particularly excessive heat or cold, will affect the batteries and electrical components in the telemetry system. Normal operating range is 0-160 degrees F (-18 - +71 degrees C). For applications outside this temperature range contact BEI.

SYMPTOM: Low RF power (tone signal sounds weak or "noisy")

PROBLEM	SOLUTION
Transmitter and/or receiving antenna shorted to ground.	Make sure antennas are not touching or lying close to metal. Antennas should be as far as possible from metal (i.e. shaft). Use insulated standoffs if necessary.
Transmitter antenna not correctly positioned.	Move antennas closer together.

SYMPTOM: Intermittent or erratic signal

Battery voltage too low.	Measure voltage across battery terminals under load, i.e., with transmitter connected. Replace battery if less than 7.5V.
Loose connection on wire harness.	Check each wire on harness for continuity. Wiggle each wire to check for intermittent connection(s).
Contaminant on transmitter pins and/ or harness sockets.	Inspect pins and sockets for debris. Clean and de-grease if necessary. For applications in harsh environments solder sensor wires directly to transmitter pins. Note: Sensor, pin and battery connections can be violated by exposure to water, dirt or chemical sprays. Environmental protective coatings, such as polyurethane, RTV or Measurements Group M-Coat J, will minimize these effects.

TROUBLESHOOTING GUIDE

SYMPTOM: No signal

Wiring error.	Check sensor wiring. If harness was modified after shipping, make sure battery polarity and voltage are correct. WARNING: If battery polarity is reversed or excessive voltage applied, voltage regulator may be destroyed. Refer to pin diagram in transmitter section of this manual for proper connections.
Voltage error.	Applying more than 15 volts DC to transmitter may damage internal voltage regulator. Operating transmitter with less than 7.5 volts DC will result in signal loss or erroneous data.
Sensor error (improper sensor connection or defective sensor).	Verify system operation with dummy bridge for strain transmitter, known voltage for voltage transmitter, or a known resistance for temperature transmitter.
Poor or shorted connections.	Check continuity at connections, including solder joints. Sensor, pin and battery connections can be violated by exposure to water, dirt or chemical sprays. Environmental protective coatings, such as polyurethane, RTV or Measurements Group M-Coat J, will minimize these effects.
Demodulator errors.	Make sure receiver antenna is connected to receiver/demodulator antenna input and power cable is plugged into an active outlet and power switch and lights are on.
No output to recording device.	Make sure cable is properly connected between receiver/demodulator and recording device. Also check cable for continuity and short circuits.

APPENDIX A: Product Data Sheets

F-3000 TELEMETRY TRANSMITTER SPECIFICATIONS

RF SECTION

Carrier Frequency:	49.83 - 49.90 (crystal controlled)
RF Output:	Less than 10,000 uV/m @ 3 meters
Transmit Range:	5 feet

SIGNAL CONDITIONING SECTION

Bridge Resistance:	120 ohm minimum, must be FULL BRIDGE
Sub-carrier Frequency:	4000 Hz center frequency
Sub-carrier Deviation:	±1000 Hz maximum (±1500 Hz with reduced linearity)
Bridge Output:	1 mV/V for 1000 Hz deviation
Bridge Excitation:	5 volts DC, regulated
Bridge Current Drain:	14 mA (with 350 ohm full bridge sensor)

OVERALL

Total Current Drain:	38 mA (with 350 ohm bridge)
Operating Temperature:	0-160 °F
Power Source:	9 volt battery (7.5 volt minimum, 12 volt maximum)
Size:	1.5" inches diameter by 1.5" inches tall (plus pins and antenna)
Weight:	2.5 ounces

V-3000 TELEMETRY TRANSMITTER SPECIFICATIONS

RF SECTION

Carrier Frequency:	49.83 - 49.90 (crystal controlled)
RF Output:	Less than 10,000 uV/m @ 3 meters
Transmit Range:	5 feet

SIGNAL CONDITIONING SECTION

Sub-carrier Frequency:	4000 Hz center frequency
Sub-carrier Deviation:	±1000 Hz maximum (±1500 Hz with reduced linearity)
Input Range:	±100 mV, ±1V, ±5V or customer specified

APPENDIX A: Product Data Sheets

V-3000 TELEMETRY TRANSMITTER SPECIFICATIONS (cont.)

OVERALL

Total Current Drain:	24 mA
Operating Temperature:	0-160 °F
Power Source:	9 volt battery (7.5 volt minimum, 12 volt maximum)
Size:	1.5" inches diameter by 1.5" inches tall (plus pins and antenna)
Weight:	2.5 ounces

T-3000 TELEMETRY TRANSMITTER SPECIFICATIONS

RF SECTION

Carrier Frequency:	49.83 - 49.90 (crystal controlled)
RF Output:	Less than 10,000 uV/m @ 3 meters
Transmit Range:	5 feet

SIGNAL CONDITIONING SECTION

Sub-carrier Frequency:	4000 Hz center frequency
Sub-carrier Deviation:	±1000 Hz maximum (±1500 Hz with reduced linearity)
Sensor:	Pt 100 RTD (100 ohms @ 0 °C, alpha 0.00385, two-wire RTD)

OVERALL

Total Current Drain:	25 mA
Operating Temperature:	0-160 °F
Power Source:	9 volt battery (7.5 volt minimum, 12 volt maximum)
Size:	1.5" inches diameter by 1.5" inches tall (plus pins and antenna)
Weight:	2.5 ounces

APPENDIX A: Product Data Sheets

RD-3000 RECEIVER DEMODULATOR SPECIFICATIONS

RF SECTION

FM Receiver:	Fixed frequency 49 MHz band (0.5 uV sensitivity)

DEMODULATOR SECTION

Number of Channels:	One
Carrier Frequency:	Input nominally centered at 4000 Hz
Linear Deviation:	±1000 Hz from center (carrier) frequency; Usable to ±1500 Hz with reduced linearity
Volts Output:	Adjustable from 0 to ± 2V for a deviation of ±1000 Hz
Current Output (Option):	Standard 4 to 20 mA for +1000 Hz deviation. Maximum load is 360 ohms.
Frequency Response:	Sine-wave modulation, deviation amplitude of ±1000 Hz Within 1 dB for dc - 1000 Hz (mod. freq.) Within 3 dB for dc - 1600 Hz (mod. freq.)
Step Response:	Within 5% of final value in less than 1 ms.
Slow Response:	Within -3 dB at 3 Hz with LOW PASS filter on.
Output Non-linearity:	Expressed as % of the dc output generated between frequency limits, referenced to a straight line between limits:

4.0 kHz to 4.5 kHz	Less than 0.10%
4.0 kHz to 5.0 kHz	Less than 0.39%
3.0 kHz to 4.0 kHz	Less than 0.44%
3.5 kHz to 4.5 kHz	Less than 0.53%
3.0 kHz to 5.0 kHz	Less than 0.96%

Output Zero (Volts):	Adjustable over full ± deviation range
Output Ref. (mA) (Opt.):	4.0 mA with VOLTAGE OUTPUT at zero volts (balanced condition)
Output Noise (Ripple):	Less than 1% full scale at 4000 Hz
Stability:	Within 0.1% of full output with a frequency input 30 minutes after warm-up at 20 °C
Power Input:	120 VAC (Internal Fuse 5x20 mm) - 220 VAC optional
Power Input (Opt.):	12 VDC (Internal Fuse 5x20 mm)
Size:	2.5" H x 7.5" W x 9.5" D
Weight:	3 lbs.

APPENDIX B: Strain Gage Installation

Binsfeld Strain Gage Kit includes:

STRAIN GAGE KIT

5 Strain Gages #CEA 06-250US-350
1-1 oz. Bottle M-Coat A Polyurethane
1 Bottle M-Bond 200 Catalyst C
1 Bottle M-Prep Conditioner A
1 Bottle M-Prep Neutralizer 5A
1-1 oz. Bottle Rosin Solvent
15' #220 Grit Silcarbide Paper
15' #400 Grit Silcarbide Paper
1 PCT-2A Cellophane Tape
1 Roll M-Coat FA-2 Adhesive Aluminum Foil
5 Sheets Butyl Rubber
15' 4 Conductor Ribbon Wire AWG 26
Above products available from Measurements Group, Inc
919-365-3800

5 Containers Cyanoacrylate Adhesive
1 Scratch Brush
Teflon Tape
Tweezers
Tissue
Cotton Swabs
Glass Tape- for securing transmitter for low RPM applications
*CAUTION: The glue provided is a cyanoacrylate adhesive which may cause irritation and/or immediate bonding of eye, skin or mouth upon contact. Avoid contact with skin and prolonged or repeated breathing of vapors. Adequate ventilation is suggested.

STRAIN GAGE APPLICATION PROCEDURE:

PREPARING THE SURFACE

STEP 1: A 2" square area will be used for gaging. Scrape off any paint or other coatings and inspect shaft for oil residue. If necessary, use a degreasing solution or isopropyl alcohol to remove.

STEP 2: Rough sand the gaging area with ***220 grit paper***. Finish the sanding procedure by wetting the gaging area with ***M-Prep Conditioner A*** and sand the wetted surface with ***400 grit paper*** provided. Rinse by squirting with ***M-Prep Conditioner A.*** Wipe the area dry with ***tissue*** taking care to wipe in only one direction. Each time you wipe use a clean area of the tissue to eliminate contamination.

STEP 3: Rinse shaft this time by squirting with ***M-Prep Neutralizer 5A***. Using a clean cotton swab each time, keep wiping until tip is no longer discolored. Wipe the gaging area dry with a clean tissue, wiping in only one direction and using **clean area of tissue with each wipe.** Do not allow any solution to dry on the surface as this may leave a contaminating film which can reduce bonding. Surface is now prepared for bonding.

APPENDIX B: (cont.)

MARKING THE GAGE SURFACE

STEP 4: The gage needs to be perpendicular to the shaft axis. We recommend two methods for marking shaft:

1. Use a machinist square and permanent marker for perpendicular and parallel lines or scribes; or
2. Cut a strip of graph paper the circumference of shaft. Tape it to shaft while lining up the squares. Mark desired gage position with a prick punch or permanent marker. If the application requires thrust data, count half way around the shaft on the graph paper to mark opposite gage position, 180 degrees apart. These marks will be your alignment marks when gage is laid. In most cases, a 1-2 degree misalignment will not yield any significant error.

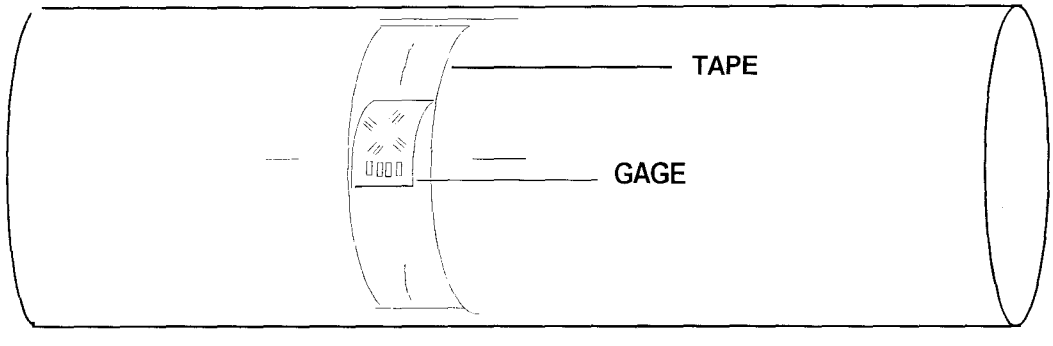
PREPARING THE GAGE FOR MOUNTING

STEP 5: Using the ***tweezers***, remove one gage from its package. Using the plastic gage box as a clean surface, place the gage on it, bonding side down. Take a 4" - 6" piece of ***PCT-2A Cellophane Tape*** and place it on the gage and terminal, centered. Slowly lift the tape at a shallow angle. You should now have the gage attached to the tape.

POSITIONING THE GAGE

STEP 6: Using the small triangles located on the four sides of the gage, place the taped gage on the shaft, perpendicular with the shaft axis, aligned with your guide marks. If it appears to be misaligned, lift one end of tape at shallow angle until the assembly is free to realign. Keep one end of the tape firmly anchored. Repositioning can be done as the ***PCT-2A*** will retain its mastic when removed and therefore not contaminate the gaging area.

STEP 7: Gage should now be positioned. Once again, lift the gage end of the tape at a 45 degree angle to the surface until the gage is free of the surface. Continue pulling the tape until you are approximately 1/4" - 1/2" beyond the gage. Turn the leading edge of the tape under and press it down, leaving the bonding surface of the gage exposed.



APPENDIX B: (cont.)

STEP 8: Apply a very thin, uniform coat of ***M-Bond 200-B Catalyst*** to the bonding surface of the gage. This will accelerate the bonding when glue is applied. Very little catalyst is needed. Lift the brush cap out and wipe excess on lip of bottle. Use just enough catalyst to wet gage surface. Before proceeding, allow catalyst to dry at least one minute under normal ambient conditions of +75° F and 30-65% relative humidity.

NOTE:
THE NEXT THREE STEPS MUST BE COMPLETED IN SEQUENCE WITHIN 3 - 5 SECONDS. READ THROUGH INSTRUCTIONS BEFORE PROCEEDING SO THERE WILL BE NO DELAYS.

Have ready:
2" - 5" piece of ***teflon tape*** to protect thumb when applying final pressure
Adhesive
Tissues

MOUNTING THE GAGE

STEP 9: Lift the leading edge of the tape and apply one or two drops of ***adhesive*** at the gage end where the tape meets the shaft. Adhesive should be of thin consistency to allow even spreading. Extend the line of glue outside the gage installation area.

STEP 10: Holding the tape taut, slowly and firmly press with a single wiping stroke over the tape using a piece of ***teflon tape.*** This will bring the gage back down over the alignment marks on the gaging area. This forces the glue line to move up and across the gage area. A very thin, uniform layer of adhesive is desired for optimum bond performance.

STEP 11: Immediately, using the ***teflon tape*** on your thumb, apply firm pressure to the taped gage by rolling your thumb over the gage area. Hold the pressure for at least one minute. In low humidity conditions (below 30%) or if ambient temperature is below +70° F, pressure application time may have to be extended to several minutes.

Leave the cellophane tape on an additional five minutes to allow total drying then slowly peel the tape back directly over itself, holding it close to the shaft while peeling. This will prevent damage to the gages. It is not necessary to remove the tape immediately after installation. It offers some protection for the gaged surface and may be left until wiring the gage.

APPENDIX B: (cont.)

WIRING THE GAGE

STEP 12: Using the ***scratch brush***, polish the solder tabs before soldering. Tin each solder pad and lead wire with a solder dot. Trim & tin the ends of the 4 conductor ribbon wire. Solder the lead wires to the gage by placing the tinned lead onto the solder dot and pressing it down with the hot soldering iron.

STEP 13: Use the ***rosin solvent*** to clean excess solder rosin from the gage after wiring. Brush the gage pads with the solvent and dab with a clean tissue.

STEP 14: Paint the gage area with ***M-Coat A polyurethane*** and allow to air dry 15 minutes. This protects the gage from moisture and dirt. To further protect the gage, cover with a square patch of ***butyl rubber*** and then a piece of ***M-Coat FA-2 adhesive foil tape***.

APPENDIX C: Sample Calculations

These calculations demonstrate the steps required to calculate strain on a 5.0" diameter solid steel shaft using a full, four-arm Wheatstone bridge with all four arms active. Two arms are in tension and two are in compression by orientation of gage mounting. Demodulator will produce approximately 0.4 volts to the recorder or meter for this 50,000 in-lbs example.

For this example we assume:

D = 5.000 inches
T = 50,000 in-lbs (full scale)
GF = 2.0

Equation for strain:

$$\varepsilon_g = \frac{16T\,(1+\nu)}{\pi D^3 E} = \frac{16(50{,}000)(1+0.3)}{\pi(5^3)(30 \times 10^6)} = .0000883 \text{ inches/inch} = 88.3\ \mu\text{in/in}$$

Equation to determine equivalent shunt calibration resistance:

$$R_c = \frac{R_g}{(N)(GF)(\varepsilon_g)} = \frac{350 \text{ ohms}}{(4)(2.0)(88.3 \times 10^{-6})} = 495 \text{ kohms}$$

Related Equations:

$$\sigma = \frac{16T}{\pi D^3} \quad \text{and} \quad \sigma = \frac{(E)(\varepsilon_g)}{1+\nu} \quad \text{yields} \quad \varepsilon_g = \frac{16T\,(1+\nu)}{\pi D^3 E}$$

LEGEND

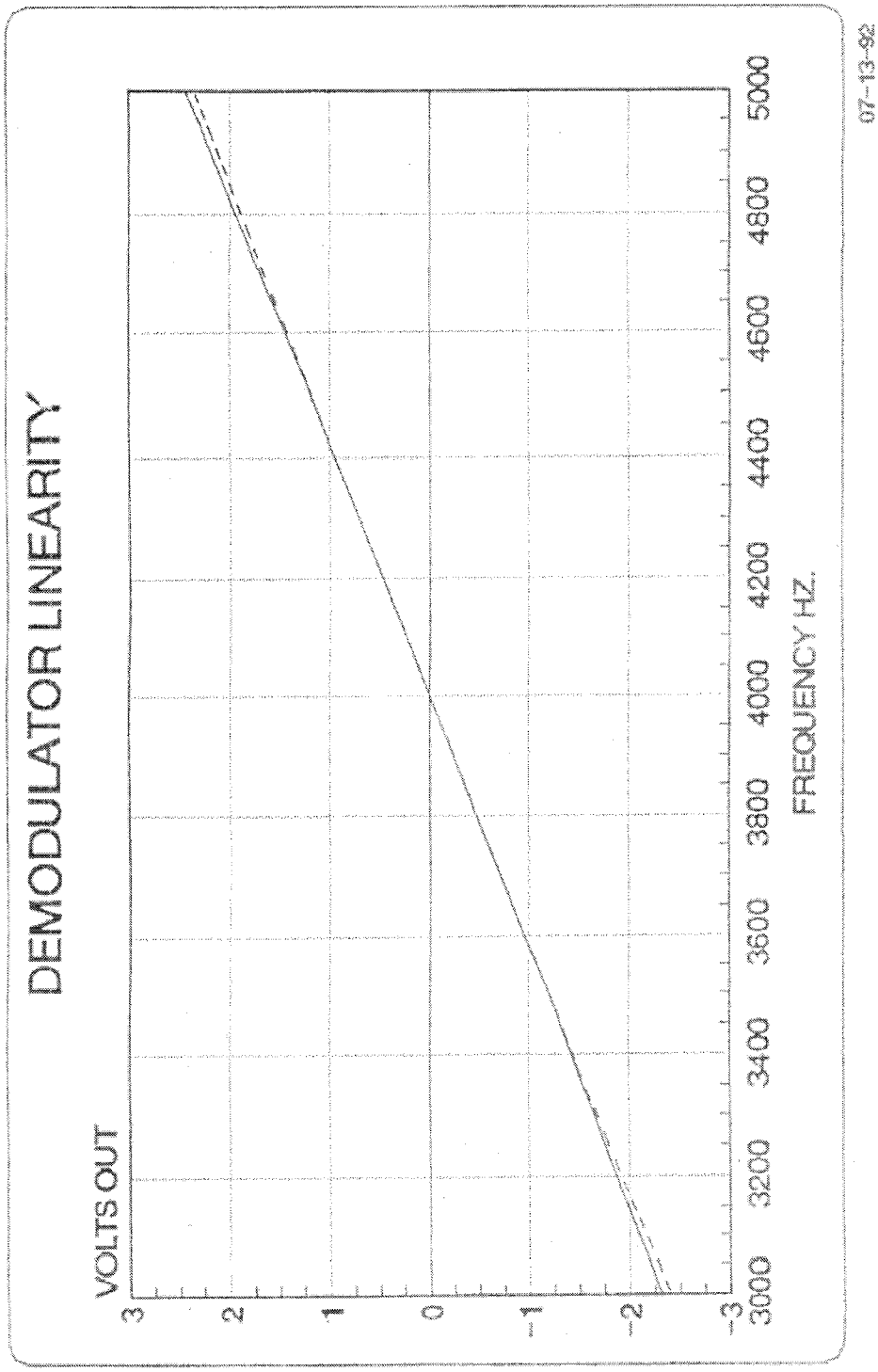
ε_g = strain on gage in/in
D = shaft diameter, inches
T = torque, inch-lb
E = modulus of elasticity (30 x 10^6 psi for steel)
ν = Poisson ratio (.30 for steel)
R_c = calibration resistance
R_g = gage resistance (350 ohms for this example)
N = number of active gages (4 for full bridge)
GF = gage factor (as specified by strain gage manf.)
σ = stress, psi

APPENDIX D: RTD Resistance

APPENDIX D: RTD Resistance (cont.)

APPENDIX D: RTD Resistance (cont.)

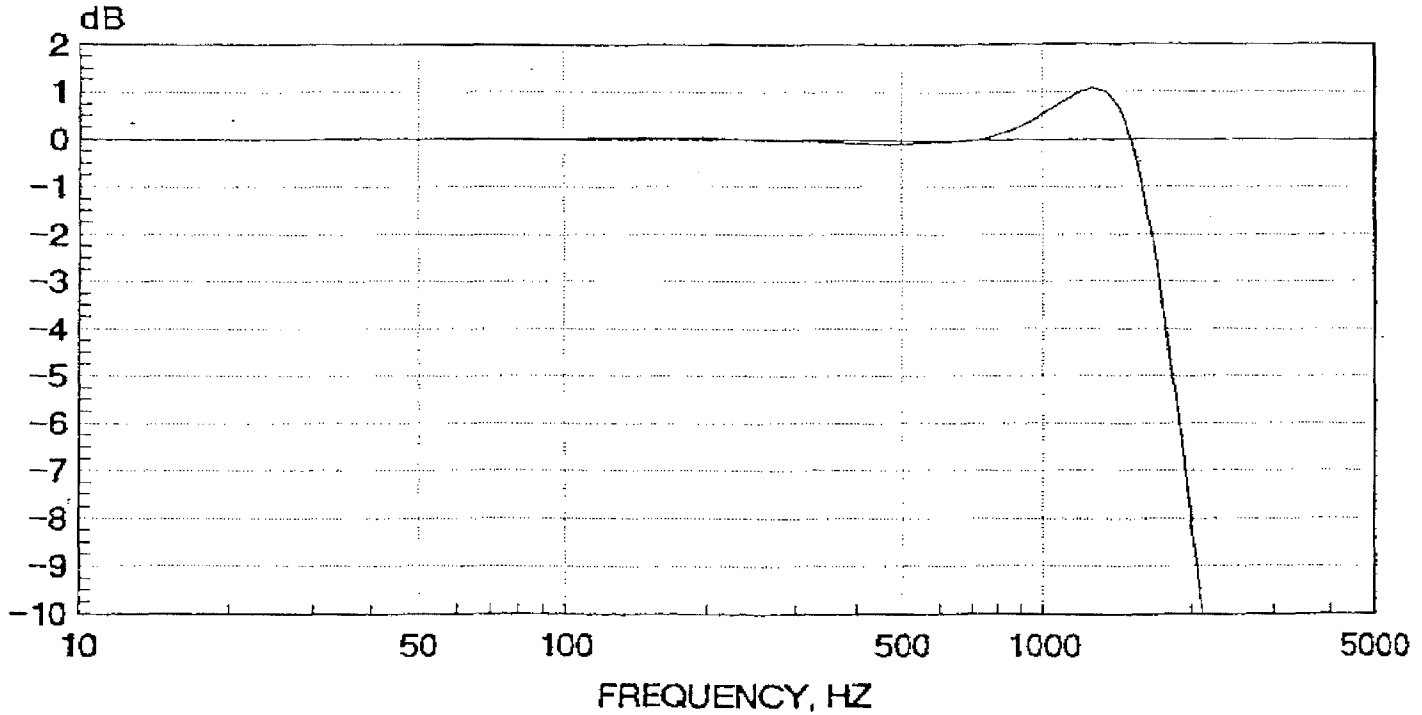
APPENDIX E: Demodulator Linearity



Demodulator output (solid line) vs Straight line (dashed line)

FREQUENCY RESPONSE

TOTAL SYSTEM



Binsfeld Engineering Inc.

RESPONSE 04-27-92

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