Minerva Company
P.O. Box 1536
Dahlgren, Virginia 22448-1536
MinervaCo@mindspring.com

Minerva – Roman goddess of wisdom, technical skill, and invention

TX3 ±50 gee
Wireless Accelerometer
and
RX3 Data Receiver

User's Manual

Contents

Quick Start

1) Insert two new CR2025 or CR2032 lithium coin cell batteries into the RX3 receiver's battery holder, with the positive (+) sides up.

2) Plug one end of the serial cable into the RJ-45 to DB-9F adapter, and plug the adapter into a DB-9 serial port on the PC or laptop computer.

3) Turn on the PC to make the serial port active (power its data pins).

4) Plug the other end of the cable into the RJ-45 modular jack on the RX3 receiver. If the serial port is active (the PC is turned on), the LED should flash two times to indicate it is ready to receive with its default settings of 115.2 kBaud and RF data parity ON.

   (**NOTE:** If the LED doesn't flash, press and hold the RX3 silver button for at least 3 seconds to restore its default settings. The LED should light while pressing the button to indicate the RX3 is ON, and it should flash two times when the button is released to show the default settings.)

5) Insert two new CR2025 or CR2032 lithium coin cell batteries into the TX3 wireless accelerometer's battery holder, with the positive (+) sides up.

6) Turn on the TX3 by using a toothpick to slide the small top switch (switch #1) to the right, “ON” position. The other three switches should be in the left, “OFF” position.

7) Check that the TX3 is ON and transmitting by momentarily pressing it's silver button. The TX3 LED should light while pressing the button to indicate the TX3 is ON. Observe the RX3 LED. Two and a half seconds after releasing the TX3 button, its settings should be transmitted to the RX3, and should flash on its LED.

8) Run the RX3.EXE data acquisition program to acquire the data. You will need to specify the serial COM port the RX3 is plugged into, eg COM1 or COM2. Applications not requiring uninterrupted samples may use either the Windows version of the program, or the DOS version running in a Windows command window. For uninterrupted, ±5 µsec sample accuracy though, the PC must be booted to DOS and the DOS version of the program must be used.

1 TX3 Wireless Accelerometer and RX3 Data Receiver Overview

TX3 is a miniature wireless accelerometer sensor based on the Analog Devices ADXL250 ±50 gee micromachined accelerometer. This is a dual axis, low noise iMEMS® device with low power consumption and a wide dynamic range. Typical S/N is 80 dB, allowing resolution of signals as low as 10 mg, while still providing a ±50 gee full-scale range.

Each TX3 sensor has four sliding control switches. There is an ON/OFF switch, a switch for mechanical and electrical self-test of the accelerometer IC, and a switch for each X and Y axis to select 2x scaling for a ±25 gee full-scale range. There is also a settings button used to enter the ID and Mode of the sensor. An LED lights when this button is pressed.

TX3 offers 16 different modes of operation, allowing up to 15 different TX3 sensors to be used simultaneously. The optimum mode for a given application depends on the desired sample rate and data resolution, the bandwidth of the signal being measured, and the number of TX3 sensors used.

Mode 0 (Oversampling Mode) transmits X and Y accelerometer data with 12-bit effective resolution (from 16x oversampled 10-bit data), at a uniform rate of ~330 samples/second. This mode is used for higher resolution, 12-bit data from a single TX3 sensor.

Mode 1 (Maximum Sample Rate Mode) transmits X and Y accelerometer data with 10-bit resolution at a uniform rate of ~1,050 samples/second. This mode is used for fast, 10-bit data from a single TX3 sensor.

Modes 2-15 (Poisson Mode) are used when multiple TX3 sensors are used simultaneously. In these modes, TX3 sensors sample and transmit X and Y accelerometer data with 10-bit resolution at (Poisson) random time intervals. The optimum mode to use corresponds to the number of sensors. For example, when three TX3 sensors are used simultaneously, all three sensors should be set to Mode 3. The average data rate is also a function of the mode. In this example, the average data rate of each sensor is at least 115 samples/second.

Each sensor should also be assigned it's own unique ID number. The sensor ID is used to tag the data packets from each sensor in order to distinguish between them. In the above example, the three sensors should have their IDs set to 1, 2, and 3, respectively.

RX3 is used to receive the data from one or more TX3 sensors. It receives the data packets, screens them for RF parity errors (if enabled), and sends them to a PC or laptop computer via serial cable. There is no ON/OFF switch on the RX3 receiver; it turns on automatically when its cable is plugged into an active (powered) serial data port. The settings button is used to set the serial baud rate and RF data parity setting. For optimum performance, the RX3 receiver should be left at its default settings of 115.2 kBaud and RF data parity ON. The LED on RX3 lights when the settings button is pushed, and is also used to flash the current RX3 and TX3 sensor settings.

All TX3 sensors and RX3 receivers use a single, shared RF channel at 916.5 MHz in the U.S. and Canadian Industrial, Scientific, Medical (ISM) band. TX3 sensors are FCC certified for unlicensed, low-power transmitter operation, and the RX3 receivers comply with FCC standards for receivers and Class B digital devices. They may be used in both residential and industrial environments, subject to the interference limitations in the FCC Compliance section. The line-of-sight range has been tested to greater than 100 yards, although this varies with any obstacles, the propagation environment, and antenna orientation.

The data is acquired with a PC or laptop computer and either displayed on the screen or saved to disk. A serial cable and RJ-45 to DB-9F adapter are provided to allow connection to a DB-9 serial data port on the computer. No other special data acquisition equipment or boards are required. Because a PC is used as an inexpensive, real-time data acquisition system, it's system resources must be dedicated to the task of acquiring the data. A Microsoft DOS® program is provided for this real-time data acquisition. For applications where ±5 µsec timing accuracy is not required, a Microsoft Windows® data acquisition program is also provided.

2 TX3 Description & Operation

(Sketch 1)

1. Analog Devices ±50 gee micromachined accelerometer.
2. DIP switches
3. Settings button
4. LED
5. Transmit antenna
6. Battery holder

Detail 1: Accelerometer with positive X & Y acceleration axes arrows
Description of accuracy, resolution.

Detail 2: DIP switch settings

1. OFF-ON
2. Self-Test
3. Double X-Sensitivity
4. Double Y-Sensitivity

Detail 3: ID and Mode Settings Button & LED
ID and Mode entry.
ID change only (1-15, within 2.5 seconds)
Flash TX3 settings on RX3 (press button once)
Reset to default (Mode=0) settings (press and hold button for > 2.5 sec)
ID and Mode settings are saved in non-volatile flash memory, and will be retained even with the batteries removed.

TX3 Mode Settings						
			Resolution[3] (gees)		X/Y Sample rate (Hz)	
Mode	Number of TX3s	Bits	Normal	Double	Actual[4]	Effective[5]
0[1]	1	12[2]	0.032	0.016	330	330
1	1	10	0.128	0.064	1,050	1,050
2	2	10	0.128	0.064	422	230
3	3	10	0.128	0.064	211	115
4	4	10	0.128	0.064	141	77
5	5	10	0.128	0.064	106	58
6	6	10	0.128	0.064	84	46
7	7	10	0.128	0.064	70	38
8	8	10	0.128	0.064	60	33
9	9	10	0.128	0.064	53	29
10	10	10	0.128	0.064	47	26
11	11	10	0.128	0.064	42	23
12	12	10	0.128	0.064	38	21
13	13	10	0.128	0.064	35	19
14	14	10	0.128	0.064	33	18
15	15	10	0.128	0.064	30	16

[1] default
[2] effective, from 16x oversampling
[3] typical
[4] average packets transmitted per second
[5] average packets received without collisions

Detail 4: Antenna

Do not pull.

For maximum range, should be extended straight out from TX3, and oriented broadside and parallel with the RX3 (receiver) antenna.

Detail 5: Batteries

Type
expected life
turn DIP switch off when not in use.
removing - plastic knife, screwdriver, toothpick.
inserting - polarity
(To insert new batteries, insert the first coin cell into the battery holder with the positive (+) side up, then slide the second one in (also with the positive side up) on top of the first one and under the battery clip.)

3 RX3 Description & Operation

Serial cable (3') with RJ-45 connectors
Custom DB-9F adapter

Sketch 1
1. Settings button
2. LED
3. RJ-45 serial port
4. Receive antenna
5. Battery holder

RF Parity bit setting
leave it on, or you can get false settings packets which'll make the led flash up to 255 times.
RS-232 serial parity

RX3 Baud Settings		
Setting	***Baud Rate***	***Serial Data Sample Timing Accuracy[2] (µsec)***
1[1]	115.2 k	± 4.9
2	57.6 k	± 9.2
3	38.4 k	± 13.6
4	28.8 k	± 17.9
5	19.2 k	± 26.6
6	14.4 k	± 35.3
7	9600	± 52.7
8	4800	± 104.7
9	2400	± 208.9
10	1200	± 417.2

[1] default
[2] add ±0.5 µsec to get PC DOS timestamp accuracy

4 Data Acquisition Software

TX3 sensor data that is received by an RX3 receiver is sent to the PC or laptop computer via the serial cable. Two programs are provided to acquire the data: RX3.EXE, a 16-bit DOS program which runs in DOS (or in a Windows command window); and RX3_WIN.EXE, a 32-bit Windows program. The DOS program offers more accurate timing of all X/Y data samples.

The data is time-stamped as it is received by the PC. Because a PC is used as an inexpensive, real-time data acquisition system, it's system resources must be dedicated to the task of acquiring the data. DOS is a real-time operating system, but Windows is not. Windows is a multi-threaded operating system, in which background tasks frequently interrupt the task at hand.

DOS programs can be used for accurate timing, programs running in Windows (or in a Windows command window)

Run the RX3.EXE data acquisition program to acquire the data. You will need to specify the serial COM port the RX3 is plugged into, eg COM1 or COM2. Applications not requiring uninterrupted samples may use either the Windows version of the program, or the DOS version running in a Windows command window. For uninterrupted, ±5 µsec sample accuracy though, the PC must be booted to DOS and the DOS version of the program must be used.

The data is acquired with a PC or laptop computer and either displayed on the screen or saved to disk. A serial cable and RJ-45 to DB-9F adapter are provided to allow connection to a DB-9 serial data port on the computer. No other special data acquisition equipment or boards are required. Because a PC is used as an inexpensive, real-time data acquisition system, it's system resources must be dedicated to the task of acquiring the data. A Microsoft DOS® program is provided for this real-time data acquisition. For applications where ±5 µsec timing accuracy is not required, a Microsoft Windows® data acquisition program is also provided.

Latest software can be downloaded at www.mindspring.com/~???

- RX3 software for DOS®
- RX3 software for Windows®
- M-file for MATLAB 6.1+
- Other - Hyper Terminal

5 Precautions

Shock sensitive. Do not drop or expose TX3 to excessive shock or vibration.
Don't static or eletrically shock the components.
Do not use liquid cleaners on any surfaces. Only use a soft, slightly damp (cotton or other non-static) cloth.
Keep dry. Do not immerse or spray with water.
Temperature rating?
Don't pull on the antenna
Battery leakage, if stored for extended time.

6 Tips and Troubleshooting

(Problem) (Possible Causes/Solutions)
Data not being transmitted
Turn off, press button (discharge capacitors for a good reset), turn on again
Hyperterminal test

7 Technical Specifications

TX3:
- Transmit Frequency: 916.5 MHz ISM band
  - (U.S. & Canada Industrial, Scientific, Medical)
- Modulation: AM-ASK, 115.2 kbps
- Transmit Power: < 1 mW
- Transmit Range: > 100 yards, line-of-sight

- Acceleration measurement range: ±50 gees
- Resolution (Mode 0):
  - Normal (32 uV/gee) Channel Sensitivity - 12 bits (effective), LSB = ?? gees
  - High (72 uV/gee) Channel Sensitivity -
- Resolution (Modes 1-15):
  - Normal (32 uV/gee) Channel Sensitivity - 10 bits, LSB = ?? gees
  - High (72 uV/gee) Channel Sensitivity -
- Frequency response?
- Linearity (typical)? (measure with a spinning drill press?)

- Batteries
  - 2 x 3V Lithium coin cell batteries
  - CR2025 (? mA-H battery capacity) or CR2032 (? mA-H battery capacity)
- Current consumption
  - Average (Mode 0)
  - Average (Mode 1)
  - Average (Mode 15)
- Approximate Battery life
  - Mode 0 - 2+ hours
  - Mode 1
  - Mode 15

- Temperature
- DIP switch life: 1000 operations
- Button life
- Flash memory life
- Dimensions

RX3:
- Baud Settings table
- Accuracy (+/- 4us (RS-232 USART clock alignment), +0 to +1us program latency)

8 FCC Compliance and Advisory

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: 1) this device may not cause harmful interference, and 2) this device must accept any interference received, including interference that may cause undesired operation.

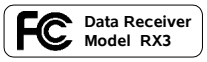
This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

Changes or modifications not expressly approved by the manufacturer could void the user's authority to operate the equipment.

TX3 FCC Certification label:

RX3 FCC Declaration of Conformity label:



9 Warranty

LIMITED WARRANTY
Minerva Company (Minerva) warrants its TX3 Wireless Accelerometers and RX3 Data Receivers (products) to be free from malfunctions and defects in materials and workmanship for six (6) months from the date of purchase, subject to the limitations stated herein. Except for the foregoing, the above products are provided “AS IS”. Any data acquisition programs (software) or updates are provided “AS IS” without warranty of any kind.

Minerva will, at its discretion, repair the product or replace it with either a new or tested reconditioned product. Proof of purchase date (e.g. a copy of the dated sales receipt) is required for warranty service. Such repair or replacement is the exclusive remedy under this limited warranty.

DISCLAIMER OF WARRANTY
This limited warranty makes no guarantee of the product's fitness for a particular use or purpose. It does not cover damage or failure caused by or attributable to abuse, unreasonable use, exposure to excessive shock or vibration, unauthorized service, or any cause not related to defects in material or workmanship.

Minerva will not be responsible for any special, consequential or incidental damages resulting from the sale, purchase, or use of this product, regardless of the cause. Liability for any special, consequential or incidental damages (including but not limited to loss of revenue or profit, downtime costs, loss of the use of the equipment, cost of substitute equipment, facilities or services, or claims of your customers for such damages resulting from the purchase, use or failure of the product), regardless of cause or for breach of any written or implied warranty is expressly disclaimed and excluded herefrom.

LIMITATION OF LIABILITY
Minerva makes no other express or implied warranty for the product. In the event that the exclusion of any implied warranty is ineffective under the law, the duration of the implied warranty will not be more than six months from the purchase date, and the maximum liability shall not exceed the purchase price of the product or software.

This warranty gives you specific rights, and you may have others which vary from state to state. This warranty is void if this product is purchased outside the USA or Canada.

LIMITATION OF LIABILITY
TO THE EXTENT NOT PROHIBITED BY LAW, IN NO EVENT WILL MINERVA

OR ITS LICENSORS BE LIABLE FOR ANY LOST REVENUE, PROFIT OR DATA, OR FOR SPECIAL, INDIRECT, CONSEQUENTIAL, INCIDENTAL OR PUNITIVE DAMAGES, HOWEVER CAUSED REGARDLESS OF THE THEORY OF LIABILITY, ARISING OUT OF OR RELATED TO THE USE OF OR INABILITY TO USE THE PRODUCTS OR SOFTWARE, EVEN IF MINERVA HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES. In no event will Minerva's liability to you exceed the amount paid by you for the Products under this Agreement. The foregoing limitations will apply even if the above stated warranty fails of its essential purpose. Some states do not allow the exclusion of incidental or consequential damages, so some of these terms may not be applicable to you.