Usage Agreement

By purchasing, obtaining, or in any way using a Xandem TMD demo system, you agree that: (1) the system is for demonstration and testing purposes only and Xandem Technology, LLC will not be held responsible for any consequences of using the system (2) you will never reverse engineer or provide the system to another entity with the purpose of reverse engineering it (3) the system may not be certified by your country's governmental regulations, and you are fully responsible for all usage and testing of the system in this regard.

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

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: (1) Reorient or relocate the receiving antenna. (2) Increase the separation between the equipment and receiver. (3) Connect the equipment into an outlet on a circuit different from that to which the receiver is connected. (4) Consult an experienced wireless technician for help.

Introduction

Congratulations on purchasing your Xandem Tomographic Motion Detection (TMD) kit! This document provides specifications and will guide you through the process of configuring your system.

A Xandem TMD system has two kinds of devices. The “nodes” are the devices that surround the area where motion is to be sensed. The “processing unit” or “PU” devices have normally-closed contacts that can be used to easily integrate the TMD kit with other systems, as shown in Figure 1.

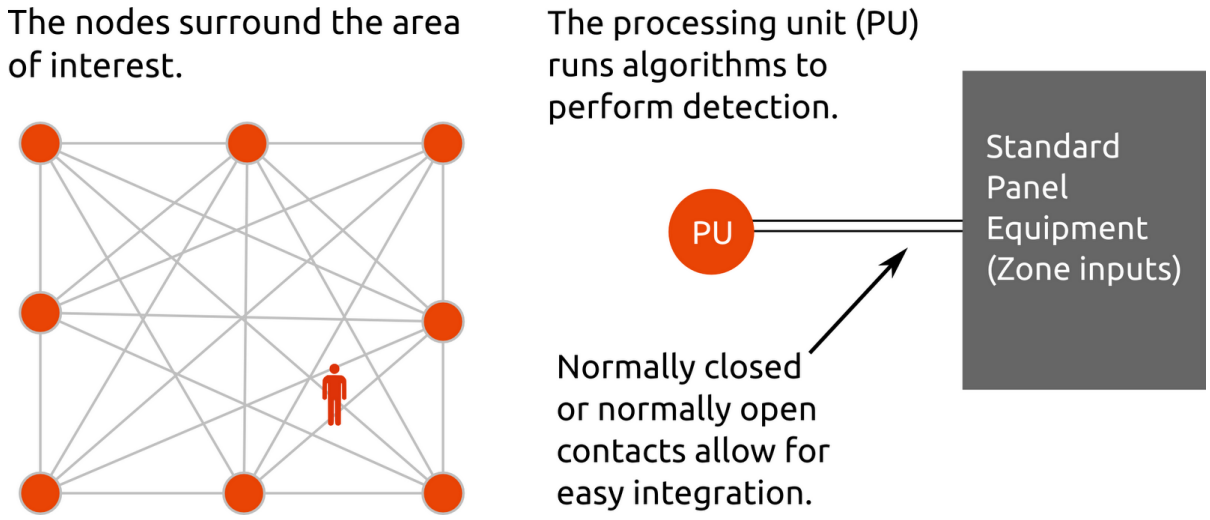


Figure 1: Xandem TMD architecture.

When the TMD system detects motion within the area surrounded by nodes, a normally-closed relay on the processing unit is opened. This is the standard way in which most security and automation panel equipment is triggered.

Hardware Specifications

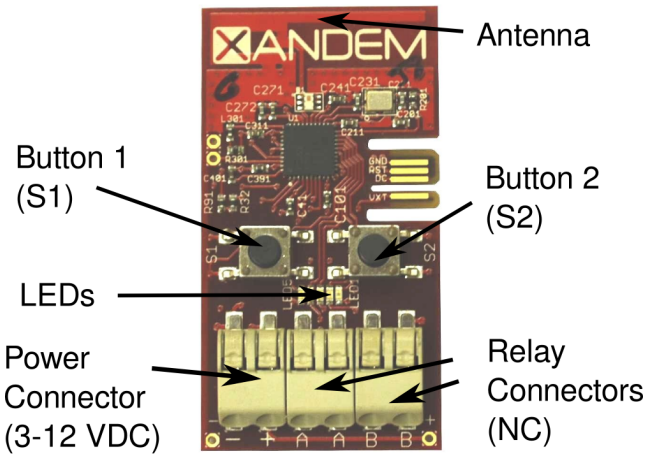


Figure 2: A TMD processing unit

Specification	**Node**	**Processing Unit**
Supply voltage	3-12 Volts	3-12 Volts
Current consumption (typical)	34-50 mA	34-50 mA
Power usage (typical)	100 mW	100 mW
Integration contacts	None	Normally closed
Max RF transmit power	4.5 dBm	None
Transmit distance (typical)	No obstructions: 70 meters Medium obstructions: 35 meters Heavy obstructions: 20 meters	None
RF frequency	Minimum: 2.405 GHz Maximum: 2.480 GHz Channel bandwidth: 5MHz Number of channels: 16	Minimum: 2.405 GHz Maximum: 2.480 GHz Channel bandwidth: 5MHz Number of channels: 16

Table 1: Xandem TMD specifications.

Installation Instructions

1. Wire power to each node and processing unit. Use batteries at a convenient location before permanent wiring and deployment.
2. If you need to change the number of nodes, the channel, or PAN, use the configuration instructions in this document to program each node and processing unit.
3. After completion of configuration, verify that all nodes blink mostly green and little red. Red LEDs indicate missed packets, but some amount of red is normal as long as there are more green than red blinks. If excessive red LEDs are blinking:
    a. verify that all nodes have power.
    b. verify that all nodes are set to the same channel.
    c. verify that each node is configured with the correct ID.
    d. verify that each node is configured with the correct number of total nodes.
    e. verify that all nodes are within range of each other.
    f. verify that all nodes are set to the same PAN.
    g. verify that other equipment is not interfering with the Xandem system. Try changing to another channel if necessary.
    h. verify that the TX power of each node is set correctly.
4. Verify that the processing unit has green LEDs illuminated. Green LEDs on the PU indicate that all nodes are reporting correctly. If even one node is not reporting correctly, the green LEDs will be off. If green LEDs are not illuminated on the PU:
    a. verify that the PU and all nodes are powered correctly.
    b. verify that all nodes are in range of each other and the PU.
    c. verify that the PU and all nodes are set to the same channel.
    d. verify that the correct number of nodes is set in the PU.
    e. verify that the PAN is set the same on the nodes and PU.
    f. verify that other equipment is not interfering with the Xandem system. Try changing to another channel if necessary.
    g. verify that the TX power of each node is set correctly.
5. Deploy and install the nodes around the area of interest.
6. Walk test with the processing unit and verify that motion is detected correctly within the area of interest. Set the sensitivity of the processing unit accordingly. Walk or move vehicles around the outside of the area to make sure the threshold is not set so low that motion outside the perimeter causes false triggering.
7. Connect the processing unit to a panel or other equipment using the normally-closed (NC) contacts on connector A (see Figure 2). The connector is labeled at the bottom of the circuit board.
8. Verify steps 3 and 4 once all nodes are deployed if LED indicators show a problem.

Tips and Best Practices

- Use battery packs to configure the nodes and processing unit at a table before installing devices in any permanent locations.

- When setting sensitivity thresholds, carry the PU with a battery pack as you walk around the sensing area, adjusting the threshold as necessary. Walk or move vehicles around the outside of the area to make sure the threshold is not set so low that motion outside the perimeter causes false triggering.

- To avoid false alarms, try setting the threshold at a high value upon installation. Test the system, and if it's not sensitive enough, decrease the threshold until it is. It's better to approach the optimum threshold from higher thresholds, and work your way to lower values to avoid false triggering.

- Avoid placing nodes directly behind metal objects. This will cause some of the radio waves to reflect away from the interior of the network which decreases performance and creates possible sensitivity outside the area of interest.

- Place nodes at 2-4 feet off the ground, and do not place nodes directly on the ground. Ground placement will cause poor antenna performance, and less energy will travel through people as they walk through the network.

- Avoid placing nodes within 3 meters of appliances that run water such as dishwashers, toilets, large water pipes, and washing machines. The moving water may cause false detections if a node is placed too close.

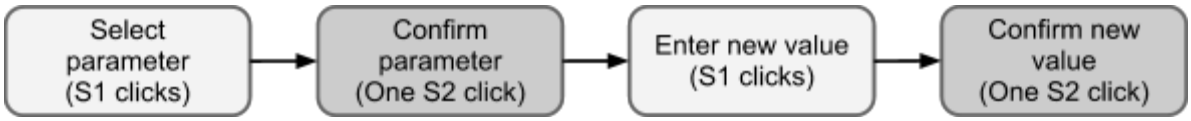
- The PU must be able to communicate with all nodes in the network. In some cases, this may require placing the PU near the area being sensed by the nodes and running a longer signal wire from the PU to the panel.

- Microwave ovens can cause interference to Xandem TMD systems. Avoid placing nodes and processing units within about 5 meters of microwave ovens.

Configuration

Configuring the devices is done with a series of button clicks located on the devices. Figure 2 shows the location of the buttons and the contacts of the relay on the processing unit.

- **Setting a parameter:** A configuration parameter is selected (see Table 2) by clicking S1 a certain number of times, and then confirming the selection by clicking S2. The LEDs will display a particular code to verify your selection. After the parameter is selected, the new value is set by another series of S1 clicks, followed by a second confirmation click of S2. The parameters are saved in memory, so even if the device is turned off, the configuration remains when power is restored.



- **Reading a parameter:** To find out the current value of a parameter, click S1 the number of times needed (see Table 2) to select the desired parameter, then click S2 twice. LEDs will blink the number of times that match the value of the given parameter. For example, if you choose Channel (4 clicks) it will blink 3 times if the channel is set to 3.

- **Resetting to factory default values:** Click S1 ten times, then click S2 to confirm. Click S1 another ten times then click S2 to confirm. A successful reset will be followed by 10 LED blinks.

- **Note:** If at any time you are unsure as to how many times you have clicked the button, turn the power off then back on, wait for the device to return to normal operation, and begin the process again.

The following table can be used to quickly reference how many clicks are required to set each configuration. See the documentation below for details.

Number of S1 clicks	Node	Processing Unit	LED Verification	Factory Defaults
1	LED Indicators	LED Indicators	Green	On
2	Number of Nodes	Number of Nodes	Orange	8
3	Node ID	Motion Threshold	Green, Orange	ID = 1 or Thresh = 2
4	Channel	Channel	Red	1
5	TX Power	N/A	Red, Green	25
6	PAN	PAN	Red, Orange	1
10	Factory Reset	Factory Reset	Yellow, Orange	

Table 2: Parameter selection guide

Node Configuration

LED Indicators
LEDs can be enabled or disabled on each node. When the green light blinks on a node, it means the node is transmitting. If a red light blinks, it means that a reception from another node has failed. Some amount of flickering red is normal, but if a node has more red light than green blinking, there may be a problem with interference or node configuration.

To enable or disable the LED indicators:

1. Click S1 one time.
2. Click S2 one time to confirm you want to set the LED.
3. The green LED should be illuminated.
4. Click S1 one time to disable LED indicators, or two times to enable them.
5. Click S2 one time to confirm the new setting.

Node count
Each node must be programmed with the total number of nodes in the sensing network. Processing units do not count as nodes.

To program the node count:

1. Click S1 two times.
2. Click S2 one time to confirm you want to set the Node Count.
3. The orange LED should be illuminated.
4. Click S1 N times, where N is the number of total nodes in the sensing network.
5. Click S2 one time to confirm the new setting.

Node ID
Each node must be programmed with a unique ID in the range from 1 to the total number of nodes in the sensing network. For example, if you are programming an 8 node network, you would program the first node ID as 1, the second as 2, all the way up to the 8^{th} node.

To program the node ID:

1. Click S1 three times.
2. Click S2 one time to confirm you want to set the Node ID.
3. The green and orange LEDs should be illuminated.
4. Click S1 N times, where N is the node ID you wish to set for this particular node.
5. Click S2 one time to confirm the new setting.

Channel
The frequency channel of each node can be changed, but all nodes in the sensing network must be set to the same channel. The processing unit for the network must also be set to the same channel so that it can “hear” the nodes. See Table 3 for channel center frequencies.

To change the channel of a node:

1. Click S1 four times.
2. Click S2 one time to confirm you want to set the Channel.
3. The red LED should be illuminated.
4. Click S1 N times, where N is the channel you wish to change to. Valid Channels are from 1-11.
5. Click S2 one time to confirm the new setting.

Channel 1 begins at frequency 2.480 GHz and moves toward lower frequencies in 5MHz steps at each channel.

Channel 1	2480 MHz	Channel 9	2440 MHz
Channel 2	2475 MHz	Channel 10	2435 MHz
Channel 3	2470 MHz	Channel 11	2430 MHz
Channel 4	2465 MHz	Channel 12	2425 MHz
Channel 5	2460 MHz	Channel 13	2420 MHz
Channel 6	2455 MHz	Channel 14	2415 MHz
Channel 7	2450 MHz	Channel 15	2410 MHz
Channel 8	2445 MHz	Channel 16	2405 MHz

Table 3: Chanel center frequencies

Transmit power

The total transmit power of each node can be configured. Higher transmit power results in longer transmission distances, but also may cause more interference to neighboring devices.

To change the transmit power of a node:

1. Click S1 five times.
2. Click S2 one time to confirm you want to set the TX Power.
3. The red and green LEDs should be illuminated.
4. Click S1 N times, where N is the transmit power level you would like to change to. Valid levels are 1-25, with 1 being the lowest transmit power and 25 being the highest.
5. Click S2 one time to confirm the new setting.

PAN

PAN stands for personal area network, and is a same-channel filtering mechanism. Nodes and processing units that are on the same channel but have different PANs will not communicate, but may still interfere with each other. All nodes in the sensing network, including the processing unit must be set to the same pan. In most cases, this does not need to be changed from factory defaults. If you are trying to use multiple systems on the same channel, the PAN must be different in each system, and nodes from each system should be separated by as much physical space as possible. It may be helpful to reduce the TX power on each node to reduce the amount of same-channel interference.

To change the pan of a node:

1. Click S1 size times.
2. Click S2 one time to confirm you want to set the PAN.
3. The red and orange LEDs should be illuminated.
4. Click S1 N times, where N is the PAN you wish to change to. Valid PANs are from 1-255.
5. Click S2 one time to confirm the new setting.

Factory Reset
To reset the nodes to factory defaults:
1. Click S1 ten times.
2. Click S2 one time to confirm the reset setting.
3. The yellow and orange LEDs should be illuminated.
4. Click S1 ten more times.
5. Click S2 for a final confirmation to reset. This will be followed by 10 blinks.

Processing Unit Configuration

LED Indicators
LEDs can be enabled or disabled on each processing unit. When the green light is on, it means the PU is receiving data from all configured nodes in the network. If the green LED is The red LED indicates that motion is currently being detected.

To enable or disable the LED indicators:
1. Click S1 one time.
2. Click S2 one time to confirm you want to set the LED.
3. The green LED should be illuminated.
4. Click S1 one time to disable LED indicators, or two times to enable them.
5. Click S2 one time to confirm the new setting.

Node count
The PU must be programmed with the total number of nodes in the sensing network.

To program the node count:
1. Click S1 two times.
2. Click S2 one time to confirm you want to set the Node Count.
3. The orange LED should be illuminated.
4. Click S1 N times, where N is the number of total nodes in the sensing network.
5. Click S2 one time to confirm the new setting.

Threshold (Sensitivity for motion detection)
The PU has an adjustable motion detection threshold. Lower threshold values will trigger easier than larger values. Good threshold values are highly dependent on the node density of the sensing network. For example, 8 nodes surrounding an area of 1000 square feet will have lower thresholds than 8 nodes in a space of 200 square feet.

If the threshold is set too low, motion on the outside of the sensing network may trigger a motion detection. If the threshold is set too high, motion may not be detected when motion occurs within the area of interest. An installer can use the following equation to get an approximate threshold:

$$\text{Approximate Threshold} = \text{round}[\ 1000*(\text{nodes/square feet})\ ] + 2.$$

Keep in mind that this equation is an estimate only, and may not provide accurate thresholds for all environments. Installers will need to experiment with the system to find the best threshold for each installation.

As an example for the case of 8 nodes over 1000 square feet, 8/1000 = .008, which results in a threshold of approximately 12.

To program the threshold:

1. Click S1 three times.
2. Click S2 one time to confirm you want to set the Threshold.
3. The green and orange LEDs should be illuminated.
4. Click S1 N times, where N is the desired threshold. Valid threshold values are from 1-16.
5. Click S2 one time to confirm.

Channel

The frequency channel of each node can be changed, but all nodes in the sensing network must be set to the same channel. The processing unit for the network must also be set to the same channel. See Table 3 for channel center frequencies.

To change the channel:

1. Click S1 four times.
2. Click S2 one time to confirm you want to set the Channel.
3. The red LED should be illuminated.
4. Click S1 N times, where N is the channel you wish to change to. Valid Channels are from 1-11.
5. Click S2 one time to confirm the new setting.

PAN

PAN stands for personal area network, and is a same-channel filtering mechanism. Nodes and processing units that are on the same channel but have different PANs will not communicate, but may still interfere with each other. All nodes in the sensing network, including the processing unit must be set to the same pan. In most cases, this does not need to be changed from factory defaults. If you are trying to use multiple systems on the same channel, the PAN must be different in each system, and nodes from each system should be separated by as much physical space as possible. It may be helpful to reduce the TX power on each node to reduce the amount of same-channel interference.

To change the pan:

1. Click S1 size times.
2. Click S2 one time to confirm you want to set the PAN.
3. The red and green LEDs should be illuminated.
4. Click S1 N times, where N is the PAN you wish to change to. Valid PANs are from 1-255.
5. Click S2 one time to confirm the new setting.

Factory Reset
To reset the nodes to the factory defaults (see Table 2):

1. Click S1 ten times.
2. Click S2 one time to confirm the reset setting.
3. The yellow and orange LEDs should be illuminated.
4. Click S1 ten more times.
5. Click S2 for a final confirmation to reset. This will be followed by 10 blinks.

Frequently Asked Questions

How far can the devices transmit?
The distance that each node can transmit is dependent on the environment. Some typical environments are summarized below.

- No obstructions - line of sight: 70 meters is typical
- Medium obstructions: 35 meters is typical
- Heavy obstructions and walls: 20 meters is typical

While each node can transmit up to these distances, all nodes and the processing unit must be in range of each other.

How many nodes should I use for a particular area?
The detection performance of the system improves as the density of nodes (nodes per square feet/meter) increases. If you notice a "dead spot" where the system is not detecting motion as well as other areas, try moving or adding nodes so that more links cross through that area.

How close does the processing unit need to be in relation to the nodes?
The processing unit must be able to "hear" each and every node. The processing unit should be placed somewhere near the node network, then wired to a panel or other interface device.

What frequency does the system use?
Xandem TMD operates on between 2.405GHz and 2.480GHz, depending on the channel selected. The channel can be changed to avoid interference with other devices that may be using the same frequencies.

Are the radio waves used by TMD harmful to humans or animals?
The amount of radio power used by Xandem TMD is extremely low. An entire TMD system with all nodes broadcasts about 500 times less wireless power than a single cell phone, and less total power than a wireless router.

Will other wireless equipment and Xandem TMD interfere with each other?
In some cases, yes, but Xandem has carefully developed our products to be robust in the presence of other devices using the 2.4GHz spectrum. In cases where interference is an issue, the channel can be changed to

an open frequency, just like a cordless phone.

Can the system run on batteries or does it need to be hard wired?
Each node consumes about 34-50mA of current and can run for 3-5 days on two AA batteries (longer with larger batteries).

Will the system detect motion when a rodent or pet moves?
Not unless the animal is large. The system can be easily set to avoid triggering when small pets or rodents move within an area. As the weight and size of the animal increases, thresholds should be increased as well to avoid triggering. Nodes should be placed such that pets can't come closer than about 1 meter.