LONWORKS™ 78kbps Self-Healing Ring Architecture

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Introduction

Echelon's TP/XF-78 Twisted Pair Control Module and TPT/XF-78 Twisted Pair Transceiver Module provide a simple, cost effective method of adding LONWORKS technology to machine controls, process controls, building management systems, fire and security devices, and general purpose control systems. Twisted pair wiring is an excellent medium for LONWORKS control networks because it is reliable, inexpensive, supports high speed communications, and simple to install and repair in the event of faults.

The actual performance of the network under different fault conditions will vary according to the method by which the TP/XF-78 Control Module and TPT/XF-78 Transceiver Module are connected to the twisted pair wire. Two wiring methods are typically employed: bus and loop. This document describes the benefits and limitations of each of these two wiring methods.

By way of introduction, the TP/XF-78 Control Module consists of a miniature circuit card containing a Neuron® 3150 Chip, EPROM socket, transformer isolated 78kbps differential Manchester communication transceiver, and connectors for power, I/O, and the two wire network data bus. The TP/XF-78 Control Module requires only +5VDC, an EPROM, and user-supplied application electronics to form a complete node.

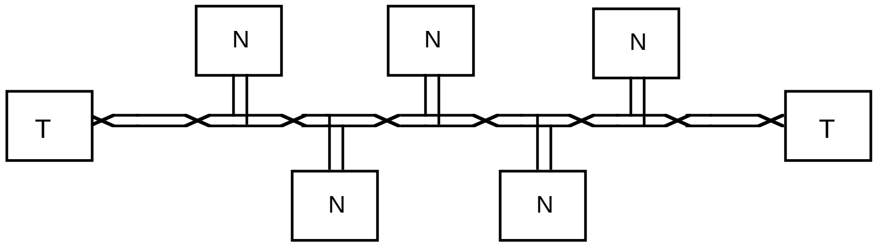
The TPT/XF-78 Transceiver Module consists of a module containing a transformer isolated 78kbps differential Manchester communication line interface and connectors for power, the Neuron Chip communication port lines, and the two wire network data bus. The TPT/XF-78 Transceiver Module is a complete network transceiver, and aside from requiring +5VDC and a Neuron Chip node, is otherwise self-contained.

Bus Wiring

A LONWORKS bus topology entails wiring nodes in parallel along the length of a twisted wire pair, and terminating each end of the bus with the proper termination network (figure 1). This method of wiring is suitable for applications in which the following assumptions apply:

1 The typical fault mode is an open circuit;

2 It is not necessary for all nodes to communicate with one another in the event of a circuit fault.

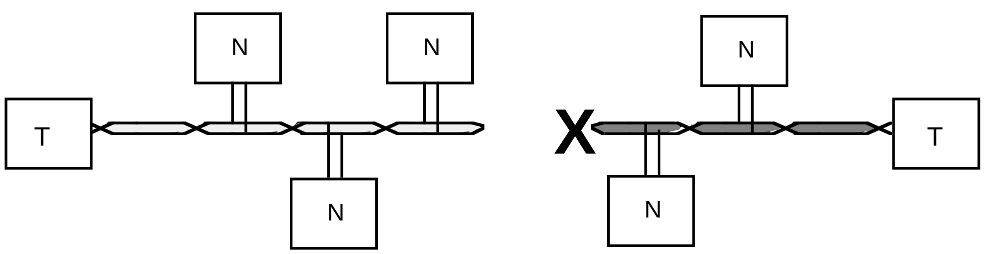


T = Termination Network
N = Neuron Chip Node

Figure 1 Typical 78kbps Bus Wiring

In normal operation, all of the nodes can receive packets from, and transmit packets to, any other node via the twisted pair wire. The termination network suppresses signal ringing and insures stable network performance over the specified wire distance and number of nodes.

In the event of an open circuit fault, the twisted pair bus will be split into two pieces (figure 2). In this case, packets will be unable to reach every node in the network because the open circuit will block packet transmissions across the fault. Only those nodes that are directly connected on each side of the open fault will be able to communicate with one another, assuming the absence of excessive reflections and ringing due to the loss of both network terminations.



T = Termination Network
N = Neuron Chip Node

Figure 2 Typical 78kbps Bus Wiring with Open Fault

There are situations in which it is desirable to maintain network communications in the event of a circuit fault. In these cases, it is important that the fault condition be identified and that the system take some corrective action to automatically restore network communications with all of the nodes. This situation can be handled using loop wiring.

Self-Healing Ring Wiring

A LONWORKS loop topology entails wiring nodes in parallel along the length of a 200 meter twisted wire pair, and terminating each end of the bus at an Intelligent Switch that includes suitable termination networks, two Neuron Chips, and a relay bus switch (figure 3). In normal operation of the loop the Intelligent Switch is open, and the network communications flow in a manner identical to the bus topology. In the event of an open fault, however, an application program causes the Intelligent Switch to close, effectively reconnecting the network to nodes on both sides of the open fault. Communications continue with all nodes in spite of the open fault condition.

The role of the Intelligent Switch is critical to the detection and correction of an open fault condition. Since the Intelligent Switch is normally open and the loop is not completed, an open fault on the wiring will be detected as a communication failure with those nodes that become isolated from the rest of the network. This fault condition can then be reported as a wiring failure to maintenance personnel. It is only after the detection of this fault condition that the Intelligent Switch closes, healing the loop and re-establishing communications with all nodes.

If the Intelligent Switch were absent and the network wired as a loop, an open fault condition would not be detected. This is because the network signals would still reach all of the nodes without interruption by traversing around both sides of the loop and avoiding the open fault. The open fault would therefore go undetected, and maintenance personnel would not be notified of the problem. If a second open fault subsequently occurred, communications would be lost with all of the nodes between the two open faults, and automatic self-healing would not be possible.

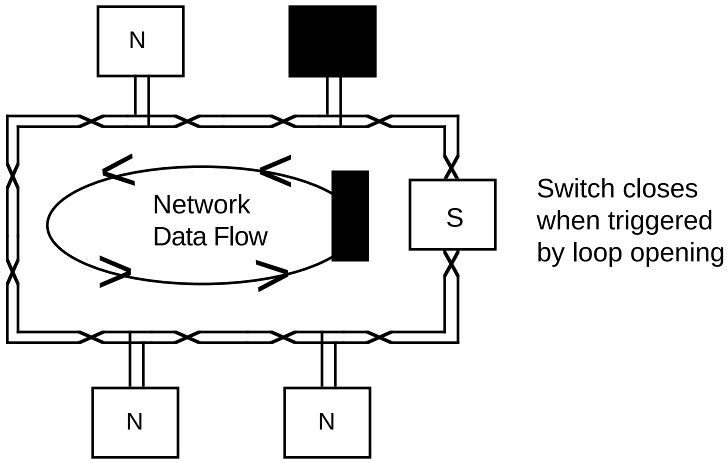
The loop/Intelligent Switch method of wiring is suitable for applications in which the following assumptions apply:

1 The typical fault mode is an open circuit;

2 It is necessary for all nodes to communicate with one another at all times, even in the event of a circuit fault.

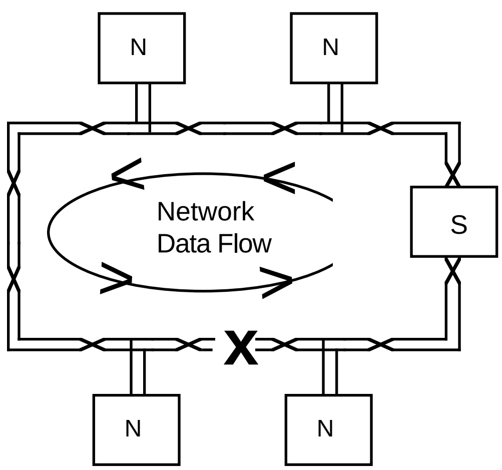
In normal operation, all of the nodes can receive packets from, and transmit packets to, every other node via the twisted pair wire. In the event of an open circuit fault, the twisted pair bus will be split into two pieces (figure 4). This condition causes an application program to trigger the Intelligent Switch, causing the loop to be closed and restoring communications to all of the nodes.

One of the advantages of the loop architecture is that it will automatically restore communication in the event of an open circuit condition. This self-healing design is especially important in applications where every node must be able to communicate with every other node at all times. Typical applications include fault alarm networks, machine controls, fire and security alarms, and process controls.



N = Neuron Chip Node
S = Switch & Termination Node (Closes Loop When Activated)

Figure 3 Typical 78kbps Loop Wiring



N = Neuron Chip Node
S = Switch & Termination Node (Closes Loop When Activated)

Figure 4 Typical 78kbps Loop Wiring with Open Fault

The Intelligent Switch itself is made of the following components shown in the Intelligent Switch box in figure 5. The operation of the Intelligent Switch in the event of an open fault proceeds according to the following steps:

1 Master Neuron Chip opens the Intelligent Switch.

2 Master Neuron Chip sends a packet to the slave Neuron Chip. Since the Intelligent Switch is open, this packet must traverse the entire twisted pair loop in order to reach the slave NEURON CHIP.

3 If the slave Neuron Chip acknowledges the packet, return to step 2. Otherwise proceed to step 4.

4 The master Neuron Chip sequentially sends query status messages to all of the nodes on the loop. This requires that the master has a table of node addresses for the channel in EEPROM memory.

5 The master Neuron Chip pulses the I/O line labelled "Test."

6 The slave Neuron Chip executes the operation described in step 4 (sending packets to all of the nodes on the loop, reading the locations out of EEPROM.)

7 The slave Neuron Chip pulses the I/O line labelled "Complete."

8 The master Neuron Chip closes the Intelligent Switch and sends a packet to the slave Neuron Chip to request the responses received by the slave Neuron Chip under step 6.

9 The master Neuron Chip compares its list of responses with the list received from the slave Neuron Chip and reports a cable break between locations A and B.

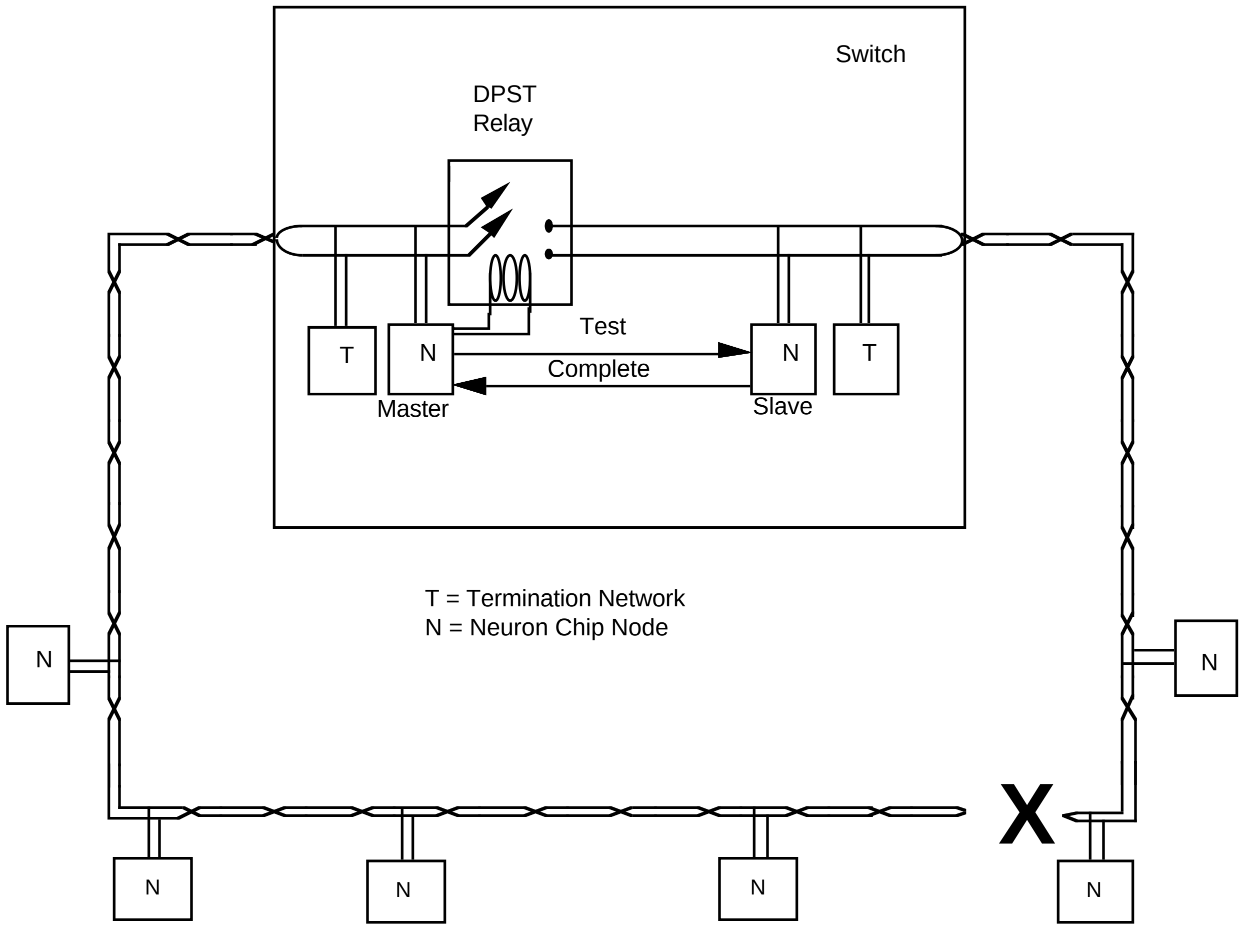


Figure 5 Intelligent Switch Block Diagram

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