



Micro Thermo Standard Wiring Guide

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1 Introduction

1.1 *Using this document*

This guide is intended for Micro Thermo Technologies engineering department. It is not a complete user guide, but rather a detailed cable selector guide for MT Alliance nodes and sensors installation.

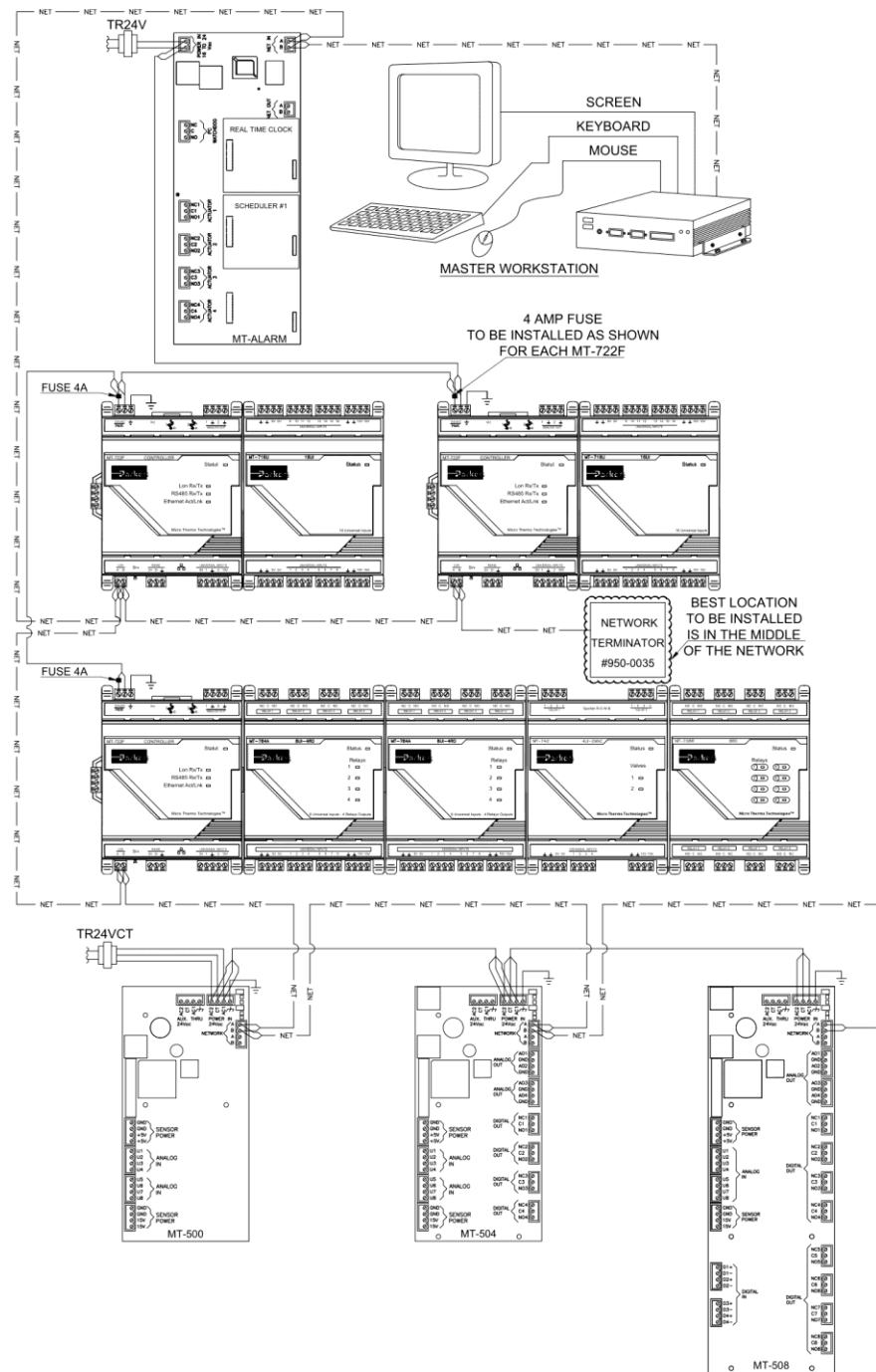
1.2 *Conventions used in this document*

Text is used for emphasis or to highlight MT Alliance terms as found on the interface.

2 System Overview

Figure 1 shows an example of a typical Alliance installation including three MT-500 nodes, three MT-700 nodes and one MT-Alarm node.

Figure 1 Example of a Free Topology installation



3 Power

3.1 Transformer for MT-500 nodes

A 24Vac center tap transformer is recommended for most common installations. Where long wire runs are used, or line voltage drop is expected, a 32Vac center tap transformer is a better choice. Allow 3VA per board.

Warning! Do not connect boards other than the MT-5xx and MT-Alarm on the same transformer.

3.2 Transformer for MT-700 nodes

Use a 24Vac transformer. Consumption of a node depends on the cluster of modules connected to the MT-722 (Main Controller). Refer to the "MT-700 Power requirements" document to calculate the consumption of a node.

Warning! Do not connect anything other than MT-722 modules or MT-ALARM on the same transformer. Do not use a 32Vac transformer

Warning! For UL compliance, it is required to insert a 4A fuse in series with the AC power input of each MT-722 (see the Installation manual for more details about fuse type)

Warning! Do not connect or disconnect (hotswap) any MT-700 module with the 24V power on.

3.3 Supplying the MT-ALARM Node

The power for the MT-ALARM board can be supplied from a dedicated 16Vac or 24Vac transformer. This board can also share the transformer of a MT-700 node, or a 32Vac CT transformer used on a MT-500 board by using one of the secondary wires and the center tap (to obtain 16Vac).

Warning! Do not power the MT-Alarm board with 32Vac

3.4 Power cable type

Use 3-18AWG stranded twisted pair unshielded or equivalent Belden #8770

Other sizes may be used, see below for details.

3.5 Power wiring for MT-500

Use a 3-18AWG cable to connect the power to the POWER IN connector on each MT-500. Due to wire resistance, a limited number of nodes may be attached on a run of wire. The voltage drop through the wire is proportional to the current that is drawn through it. The longer the wire, the less nodes it can support. Once the limit is reached, start a new cable run from the transformer. See the following tables.

TABLE 1 Number of MT-500 per Length of 18AWG Wire using a 32VCT transformer

Length (m)	Length (ft)	Max Number of Nodes
48	156	11
55	182	10
63	208	9
71	234	8
83	273	7
95	312	6
119	391	5
190	625	4
238	781	3
286	937	2

Note: Measuring the 24Vac or 32Vac with a multimeter will not give an accurate reading of the power loss. Measuring the 15V Sensor Power on a board will indicate if the power is adequate. As nodes are added, the 15V Sensor Power will drop. If it drops below 13Vdc, the MT-500 will not operate properly. Temperature readings will start to drift. These values were found using MT-500 boards. If MT504, MT508 or MT512 boards are used, wire lengths should be shortened according to their respective power draw (see table 4).

TABLE 2 Number of MT-500 per Length of 16AWG Wire using a 32VCT transformer

Length (m)	Length (ft)	Max Number of Nodes
76	249	11
88	290	10
100	331	9
114	373	8
132	435	7
152	497	6
189	621	5
303	994	4
379	1243	3
455	1491	2

3.6 Power draw of MT Boards

See 70-PHW-1016 Summary of Power Requirements for Micro Thermo Boards

3.7 Power wiring for MT-700

Use 2-16AWG stranded twisted pair unshielded

TABLE 3 Maximum load per Length for 16AWG cable
(using a 24Vac/100VA transformer)

Length		Max Load (VA)	
meters	feet	Distributed	End of cable
30		140	70
	100	140	70
60		80	40
	200	80	40
	300	58	29
100		54	27
	400	46	23
150		40	20
	500	40	20
	600	34	17
200		32	16
	800	28	14
250		26	13
300		22	11
	1000	22	11

4 FTT10 network (also called Data, NET or LonWorks)

4.1 Cable type for FTT10

Use 2-18AWG stranded twisted pair unshielded

Other recommended cables:

	Belden: 8461	Belden: 8471
Description	1 twisted pair, unshielded	1 twisted pair, unshielded
Conductor size	AWG #18	AWG #16
Stranding	AWG #26 x7	AWG #29 x19
Conductor material	Tinned copper	Tinned copper
Lay length (twists /ft)	2 inches (6)	2 inches (6)
Inductance	N.A.	0.19 uH /ft
Capacitance	22 pF /ft	33 pF /ft
DC resistance	5.86 ohms /1000ft	4.49 ohms /1000ft
Nominal outside diameter	.234 inch	.274 inch
Acceptable alternate suppliers	General Cable (Carol): C2830A	General Cable (Carol): C2405A
	-	Windy City Wire: 104500
	West Penn Wire: 224	West Penn Wire: 225
	Daburn: 3029	Daburn: 3030

A more general list of approved LonWorks cables can be found in Echelon document "Junction box and wiring guideline for twisted pair LonWorks networks" (005-0023-01).

For marine applications or harsh conditions where the network has to cope with high electrical noise level, it is recommended to use armored cable. AmerCable Gexol 37-102-610-BS has proven to perform well in such conditions.

4.2 Data wiring for Free Topology (FTT-10 and FT-X)

A twisted pair cable ensures communication between nodes, and with the PC. See the table for Echelon approved wire types. For proper system operation, the maximum node-to-node distance as well as the maximum total wire length must be respected.

Cable	Maximum device-to-device distance (Feet)	Maximum total Wire length (Feet)
Belden 85102	1640	1640
Belden 8471	1312	1640

The maximum number of Free Topology nodes on a network is 64. The PC and routers also count as nodes. It is recommended to keep the number of node to 50 when designing the network. This will allow room for future additions. These limits apply to Case Controllers, MT-700, MT-500 and other Micro Thermo Free Topology nodes.

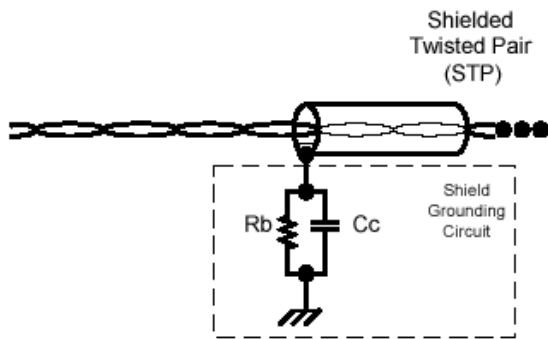
When using a shielded twisted pair (not recommended), the cable shield must be grounded at one end using a capacitor and a resistor. A large resistor will bleed off any static electricity in the shield. The capacitor will prevent DC and 50/60 Hz ground paths from being conducted through the shield. Typical values for Rb and Cc are as follows:

$$C_c = 0.1\mu\text{F}, 10\%, \text{Metalized Polyester}, \geq 100\text{V}$$

$$R_b = 470\text{k}\Omega, 1/4\text{W}, \pm 5\%$$

The cable shield must be grounded at least once per segment, and preferably at each node. Grounding the shield at every node (using a resistor and capacitor) will assist in suppressing 50/60Hz standing waves.

Figure 2 Shielded Data Cable



Ready-made grounding kit 950-0036 is sold by MTT

The data link is not polarity sensitive. Note that the MT-500 boards have two DATA connectors. Either one may be used (it is preferred to use the same if there are only 2 cables). The same applies to the POWER connectors.

4.3 Network Termination

The network must be terminated in an appropriate fashion. The following table shows the network terminator to use for free topology (FTT-10 and FT-X).

TABLE 4 Network Termination

	Location	Model Number
Free Topology	Place on the network (preferably close to center)	FTNT-2 MTT # 950-0035

Warning! If power is accidentally connected to the data network, the terminator and the electronic modules will be damaged.

4.4 Network Recommendations and Troubleshooting Tips

Even when the recommended cable is used and is properly terminated, some precautions should be taken for reliable communication.

- Network cable should not be routed close to high voltage wires and noise generating equipment. When the cable runs parallel to power line wires, keep a minimum distance of 8 inches for >400Vac, and 3 inches for 120Vac. Shorter distance is acceptable for cable crossing the power line wires at a right angle. Use the same minimum distance with VFD, lighting ballasts, motors and power switching devices. These rules also apply for electronic modules connected to the network.
- At cable ends, do not remove cable sheath more than necessary (2 inches is usually sufficient). Do not untwist the wire pairs more than necessary.
- If a VFD is interfering with network operation, make sure that the proper filters and/or chokes for EMI damping are installed (see drive manufacturer installation manual). Even with the VFD properly grounded, ground loops can exist and be a source of noise. Some sections of the network cables and/or nodes may have to be relocated.
- Noise on High Voltage cables can “jump” conductors leading you to find noise where you wouldn’t expect to see it.
- Nodes using the FTT-10A transceiver may be protected with a magnetic shield Echelon Model 51001R or MTT 220-0044
- The common mode choke LonWorks filter (“life saver”) may also be used to reduce noise. P/N 180-0028 is available at MTT.
- Belden type 8471 is the preferred cable for FTT. Shielded cable should be avoided.
- Do not mix different cable types on the same network segment.
- Do not exceed allowed number of nodes (64) on a single cable.
- Use the Network Analyzer tool in MT-Alliance to determine the health of the network. A score of 0 to 10 indicates a trouble free network. A score of 10 to 20 is good. A score over 20 is a sign of a weak network and should be improved. This tool can also spot a node that is "talking" too much.
- For Belden 8471 The Max Node-To-Node Distance of Network Wire that can be used is 400m (1312ft.). The Max Wire Length is 500m (1640ft.). Virtually all other cables have a lower quality, so keep that in mind when using Belden 8461 or a Belden 8471 Equivalent.
- Generally speaking, resistance measurement at the end of a cable run should be under 58 ohms (when the termination resistor is 52 ohms). A resistance measurement over 65 ohms is unacceptable. Try to tighten each terminal screw on the wire path or remove wire from the segment. For instance, Belden 8471 adds 4.49 ohms per 1000 feet, which equates to 0.0049 ohms per foot. If you times that by 312 (to get 1312ft - the max node-to-node distance) and add the original resistance for 1000 feet, it will get you a resistance of 5.89088. So, if 1312 feet of Belden 8471

equates to 5.89088 ohms, you should not have anything over 57.89088 ohms of resistance on a Network Length of 1312 feet when using a 52 ohm resistor. If this is true, for any network that has over 58 ohms, network wire should be removed. If a technician considers the resistance on a network when commission a Project, many problems will be eliminated down the line.

- Having a resistor to place in the network as you're troubleshooting, along with cable markers helped calculate and find bad segments with ease.
- After an optimal cable length has been determined with the resistor at one end of the network, it is standard practice to move the termination resistor to the center of the segment. The goal is to generally maintain the same amount of resistance on all ends.
- An abnormal resistance reading can also be caused by noise on the network. Noise causes the multimeter to give false readings.
- Abnormal resistance has also been seen on the network when blown-in-insulation was falling or hitting the wire.
- Adding routers is a good way to improve the network performance and/or reliability. A router is the only way to create a new Segment.
- Additional information can be found in the "LonWorks Installation Handbook"(ISBN 978-0-615-37794-0).

5 Relay Contact Output

Use unshielded cable according to the rating of the load.

For example, use 2-16AWG for a 200' run with a 0.5A to 1A solenoid.

If 24VAC or 32VAC is required it should come from a separate dedicated transformer

Warning! Pull a dedicated unshielded control cable for AC power. Many states do not accept that AC control power share the same shielded multiconductor cable as the sensor signal wires.

6 Sensor Wiring

6.1 Sensor cable type

Use shielded 4-22AWG stranded or shielded 2-18AWG (Belden 5502FE or equivalent)

Other sizes may be used, see below for details.

6.2 Thermistor

When the thermistor element senses a high temperature, its resistance is low (NTC). Added resistance from the wiring can affect accuracy. Use the table below for the maximum allowable length according to the higher monitored temperature.

TABLE 5 Max 2 conductor cable length to be used for a temperature reading error of less than 0.1°C

Length vs. wire size at max monitored temperature	16 AWG (feet)	18 AWG (feet)	20 AWG (feet)	22 AWG (feet)	24 AWG (feet)
0°C / 32°F	2000	2000	2000	2000	2000
25°C / 77°F	2000	2000	2000	1000	500
50°C / 122°F	1000	1000	500	400	200
100°C / 212°F	200	100	50	50	20

The thermistor is not polarity sensitive. When many thermistors use the same common wire, it shortens the max cable length allowed.

TABLE 6 Max cable length to be used for 3 thermistors using the same common wire reading error of less than 0.1°C

Length vs. wire size at max monitored temperature	18 AWG (feet)	20 AWG (feet)	22 AWG (feet)
0°C / 32°F	2 000	2 000	2 000
25°C / 77°F	1 000	1 000	600
50°C / 122°F	400	200	200
100°C / 212°F	50	10	
0-10V (err <1%)	15 000	10 000	6 000

When a 4 conductor cable is used for 2 or 3 thermistors, the following color code is recommended:

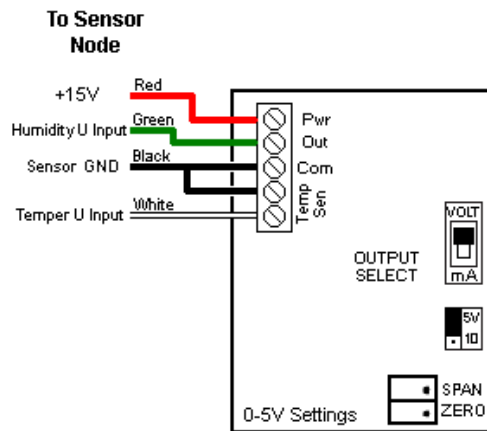
- Black – Common (SGND) (or Signal 1 return)
- White – Signal 1
- Green – Signal 2
- Red – Signal 3 (or Signal 2 return)
- Shield – Earth Ground at the node end only

Shielded cable is not necessary, but if used, the shield should be connected to the mechanical Ground of the node. Connection to earth ground must be made at a single point to avoid ground loops. Do not use GKT telephone cable (it is brittle and frequently damaged by rodents).

A humidity sensor usually needs power to operate. If it does not drain more than 10mA, it can be powered from the MT-500 node.

For sensors with power input, the following color code is recommended:

- Red - 15V Humidity power (or 5V Pressure transducer power)
- Green - Humidity 0-10V Signal
- White or yellow – Temperature Signal
- Black GND – Temperat-humid GND
- Shield – Earth Ground at the node end only



See sensor specifications for the recommended voltage to use.

6.3 4-20mA Transmitter

4-20mA Transmitters work with any cable type and length of cable. The shunt resistor must be placed at the node input. If the shunt resistor is left at the transmitter terminal, the signal becomes a voltage signal type (255 ohms = 1-5V, 523 ohms = 2-10V) and will not be protected against EMI and signal loss. Many 4-20mA transmitters can share the same common, but each of them needs a dedicated transformer.

6.4 Voltage Transmitter (0-10V)

Voltage transmitters generally comes from a sensor that requires power. The signal itself loses accuracy on long wire lengths, especially if the power is generated from the sensor node. When both the signal return and the ground power share the same wire a voltage offset occurs. That is why the cable length is limited (see table 8) and a shielded cable is recommended.

6.5 Switches and Contacts

A switch may be connected to a node input to proof a state or to send a command. There is no accuracy issue with switches and any type of cable of any length may be used. Normally a four conductor cable is used. A dedicated common wire (Green) must be used for switches (Red). Don't share the common wire (Black) with sensors (White).

- Red – Switch Signal
- Green – Switch Common
- White or yellow – Temperature Signal
- Black GND – Temperature - humidity GND

6.6 Pressure Transducer

We recommend using shielded 3-18AWG (Black/Red/White) (Belden 8770 or equivalent)

6.7 10 conductor cable coding

For contractor that don't have their own coding for 10 conductor cable we recommend to follow this color coding for instance when extending sensor node input which has 16 inputs:

- Input 1 or 9 – Brown
- Input 2 or 10 – Red
- Input 3 or 11 – Orange
- Input 4 or 12 – Yellow
- Input 5 or 13 – Green
- Input 6 or 14 – Blue
- Input 7 or 15 – Violet
- Input 8 or 16 – Grey
- Common of the set - Black
- Common or power - White

7 EEPR Valves

7.1 Valve cable type

We recommend using shielded 4-18AWG stranded (Belden 5302FE or equivalent). The following chart indicates what size wire is required when running past 250 feet.

AWG	Maximum Wire Length	
	Feet	Meters
18	250	76
16	400	122
14	550	168

8 Revision History









REV	Description	Revised by	Date
0.2	New guide plan	RL	18-may-05
0.6	Merge version with Wiring Guide for MT products R0.5	RL	02-jun-05
0.7	Reviewed by Victor Trahan	RL/VT	07-jun-05
0.8	Formatting reviewed by Roger Legault	RL	02-mar-07
0.9	Update with d/t color code	RL	09-apr-10
1.0	Updated for MT-700 application	JR	18-feb-18






Annex 1

Wiring Diagrams for Straight Through, Cross Over and Y cables

568B wiring

Note: The hook is underneath in all cases and Pin one is always on the Left

Straight Through Cable	Color Code	Color
Pin 1	white orange	
Pin 2	orange	
Pin 3	white green	
Pin 4	blue	
Pin 5	white blue	
Pin 6	green	
Pin 7	white brown	
Pin 8	brown	

Cross Over Cable	Color Code	Color
Pin 1	white green	
Pin 2	green	
Pin 3	white orange	
Pin 4	blue	
Pin 5	white blue	
Pin 6	orange	
Pin 7	white brown	
Pin 8	brown	

The other side is a straight through cable see Straight through diagram

Annex 2

Micro Thermo Recommended Cables

Cable for Data – Belden #8461

8461 Paired - Audio, Control, and Instrumentation Cable

Total # Cond.	# Pairs				
2	1				
AWG	Stranding	Type	Insulation	Insulation Thickness (in.)	Shield
18	(7x26)	TC - Tinned Copper	PVC - Polyvinyl Chloride	.02200	Unshielded
Jacket	Jacket Thickness (in.)	Nom. OD (in.)	Nom. Cond. DCR (Ohms/M')	Nom. Vel. of Prop. (%)	Nom. Cap. (pF/ft)
PVC - Polyvinyl Chloride	.0280	.2340	5.860	66.0	22.000
Description					
Paired, 1 pair, twisted, 18 AWG, stranded (7x26) TC - Tinned Copper conductors, PVC - Polyvinyl Chloride insulation, Unshielded, PVC - Polyvinyl Chloride jacket. Applicable Specifications: UL NEC CMG, CEC C(UL) CMG. Special Application: Brilliance Audio Wire & Cable. High Conductivity Copper. BRILLIANCE is a Belden registered trademark.					