## FEATURES

- **16 Inputs to LON network (78K FT)**
- **10 universal analog and 6 digital inputs, 12 bit A/D**
- **0-10V, 0-5V, 4-20mA, 1 or 2 K RTD, 10K thermistor**
- **4 inputs allow custom scaling with range module**
- **10K thermistor inputs include linear conversion**
- **User definable base & range for each analog input**

## APPLICATIONS

- **Multi point monitoring for LON BAS systems**
- **Laboratory multi pressure and flow monitoring**
- **Temperature monitoring for multi sensor large areas**
- **Central plant flow, temperature and pressure monitoring**

## DESCRIPTION & OPERATION

The MALNI was designed as a 16 input to LON network interface that incorporates an Echelon Neuron processor and FTT-10A transceiver to communicate with the twisted pair LON Free-Topology network. Each of the 16 inputs reports their data to an individual LON network variable (SNVT) within the MALNI network address. Standard network manager tools such as LON maker or Tridium can configure the MALNI and may bind any of the network variable values to any other device on the LON network.

All of the inputs are converted to 0 to 5VDC (corresponding to 0 to 100% of signal) before being converted to a binary 10 bit value by the A/D converter. Digital inputs are converted as 5VDC being off and 0VDC being on.

During the configuration, the user enters unit type, such as: digital, percent, voltage, and 10K thermistor, (C), RTD, for each input. For Custom input, additional start (base) and endpoint (range) along with units per volt into the A/D are entered for each input selection to specify partial ranges. The MALNI automatically converts the signal to reverse or direct by the user selection of + or - units per volt. The selection of 10K signals the MALNI that the specified input is a non-linear 10K thermistor and to linearize the temperature range of -29 to 104.5°C (-20 to 220°F).

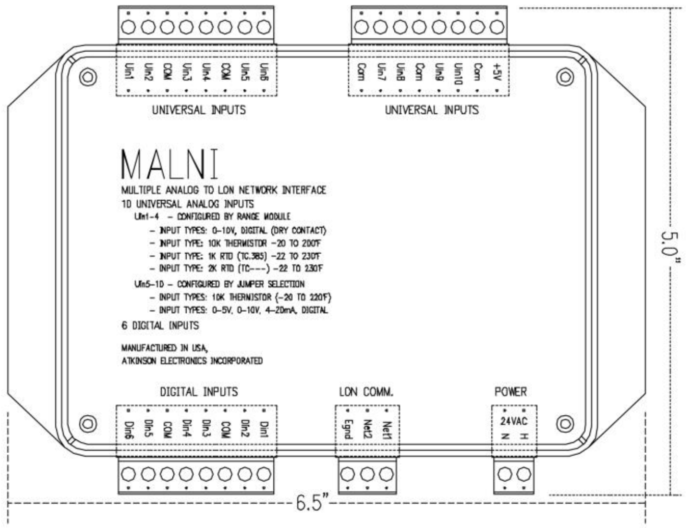
Analog inputs Uin1 thru Uin4 utilize a range module to configure the input and allow the amplification of the input signal to 0 to 5VDC to improve the accuracy. Analog inputs Uin5 thru Uin10 incorporate an individual selection jumper to select 0-10V, 0-5V, 4-20mA or a 10K thermistor for each input. The six digital inputs incorporate a pullup resistor so that a closed contact provides a 0V input and an open contact is 5V.

The MALNI module incorporates an on-board isolation transformer so any 24VAC power source may be used. All of the inputs are measured to a common. If electrical isolation or buffering is required to connect to existing signals being used by other control devices, then analog buffering modules such as the SBM or optical isolation modules such as the DISM-E are available.

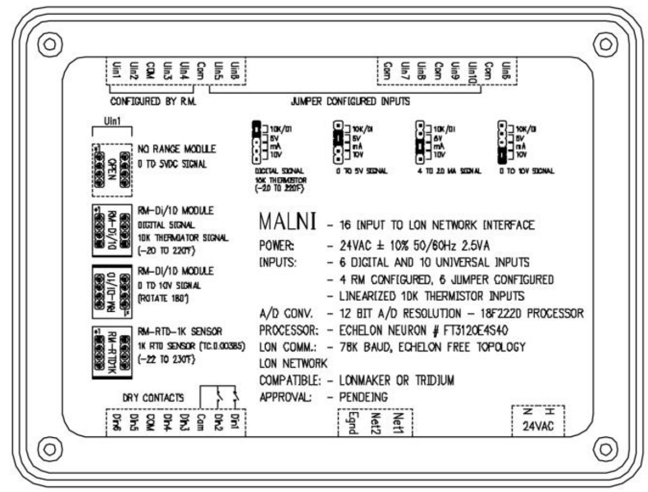

## SPECIFICATIONS

| | |
|---|---|
| SIZE: | 7.3" L x 4.75" L x 2.37" H |
| MOUNTING: | PVC plastic enclosure with 2 screws |
| POWER: | 24VAC ±/- 10% 60Hz 2.5VA |
| TRUNK I/0: | Echelon Free Topology twisted pair |
| PROCESSOR: | Echelon Neuron |
| INPUTS: | 16 total inputs: 10 Analog, 6 digital<br>(6) Universal Analog – Jumper select:<br>0-10VDC, 4-20mA, 0-5VDC,<br>10K thermistor, and<br>digital contact closure<br>(4) Universal Analog – Range module:<br>For 0-10VDC, 4-20mA, 0-5VDC<br>10K thermistor<br>Digital contact closure<br>1K or 2K RTDs (-30 to 110°C),<br>or signal scaling<br>(6) Digital or binary inputs<br>Dry contact or open collector<br><br>10K thermistor inputs are linearized for -29 to 104.5°C (-20 to 220°F) |
| A/D CONVERSION: | 10 Bit resolution for 0-5VDC |
| LON CONFIGURATION: PROPERTIES: | Total of 64 |
| LON NETWORK: COMPATIBILITY: | LONmaker or Tridium |
| TEMPERATURE: | -40 TO 70°C |

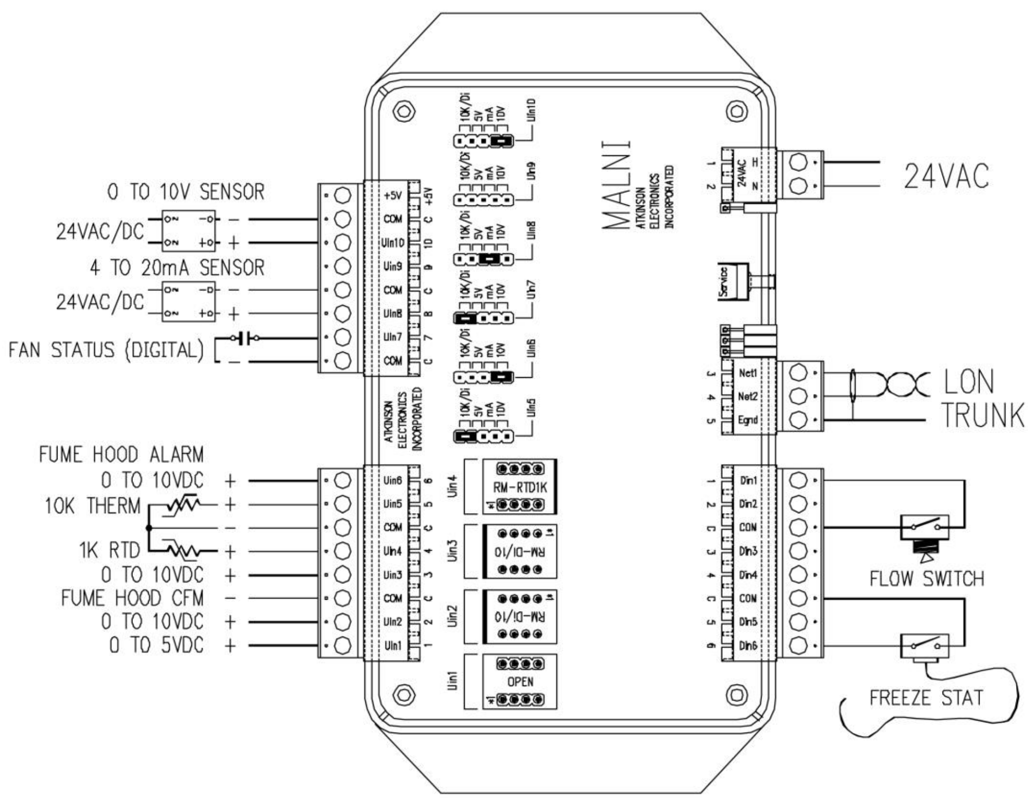
## *PHYSICAL CONFIGURATION*




## *INPUT CONFIGURATION GUIDE*




## *TYPICAL WIRING DIAGRAM*




The above application wiring diagram for the MALNI shows typical wiring for various analog and digital inputs. Each of the inputs is referenced to a negative common. A 4 position selection jumper is provided for inputs Uin5 thru Uin10. These selections are 0-10VDC, 4-20mA, 0-5VDC and 10K thermistor or dry contact. Inputs Uin1 thru Uin4 allow the insertion of a range module so that an internal amplifier may scale a partial voltage out to 0 to 5VDC for maximum A/D signal resolution. Wiring a 10K thermistor to any of the analog inputs, selecting 10K jumper and selecting the 10K during the configuration, signals the Neuron Processor and A/D converter to linearize the input signal voltage from the 10K Ohm thermistor over the range of -29 to 104.50°C. None of the other input sensors are linearized. 0V input = 0 binary counts from the A/D converter. 5V input = 4096 binary counts. Floating point decimal values are provided per the LON SNVT's selected during configuration.

## DESCRIPTION

The MALNI is a multiple analog to LON Network Interface. The MALNI consists of ten analog voltage input channels and 6 digital input channels. Each analog voltage input can be posted on a LONWorks network in a variety of ways. The purpose of the MALNI is to provide an interface between various types of analog sensors and a LONWorks distributed control network.

## SUMMERY OF OPERATION

The MALNI presents a very versatile interface to a variety of sensors, however this also requires significant set-up and calibration by a qualified technician. Depending on the type of sensor interface, some calculation may be required for proper calibration. Once configured, the MALNI continually monitors the 10 analog inputs and 6 dedicated digital inputs. Input values are immediately processed upon any change, via an internal 12 bit A/D converter, and posted to the network near instantaneously. All configuration properties are stored in EEPROM memory, thus configuration properties will not be lost upon power-down.

## ANALOG INPUTS CHANNEL 1-10

The basis for each analog input is a 0-5 volt signal. The MALNI is then (via any LON network management tool) to interpret the signal into a value corresponding to a specific sensor type, as defined by the user. The following configurations are available for each of 10 analog channels:

| Type | Input (0-5 V range) | LON Network Output |
|---|---|---|
| 0 | Un-configured | 0.0 |
| 1 | Digital Input | 1.0 or 0.0 |
| 2 | Percent | linear 0.0-100.0% |
| 3 | Voltage Linear | 0.0 to 5.0 Volts |
| 4 | 10K Thermistor | Degrees Celsius |
| 5 | RTD (1K or 2K) | Degrees Celsius (Inputs 1-4 require range module) |
| 6 | Custom | Linear custom range |

Each analog input channel of the MALNI has four corresponding SCPTs and one SNVT output. Each SCPT is stored in Eprom memory, thus configuration data is not lost upon loss of power. The # symbol represents the channel number (1-10):

| | | |
|---|---|---|
| SCPT input: | nciCh#Type | The channel's input type |
| SCPT input: | nciCh#BaseValue | The base value for custom ranges or input calibration for input types 2 thru 5 |
| SCPT input: | nciCh#BaseVolt | The base voltage value for custom ranges |
| SCPT input: | nciCh#Slope | The slope/gain for custom ranges |
| SNVT output: | nvoCh#Value | This output value posts to the LON network |

The nciCh#Type variable corresponds to the type values listed above. In most configurations, the nciCh#Type variable is the only SCPT which must be set. The nciCh#BaseValue, nciCh#BaseVolt, and nciCh#Slope SCPTs are only used in the custom range application (i.e. only if nciCh#Type = 6). The specific calibration methods for each input type will be addressed later in this document. The SNVT output, nvoCh#Value, is always a float type output variable. This is significant when considering an application which uses an analog input configured as a digital input, since the digital output to the LON network will be a SNVT float type, rather than a SNVT switch type.

## DIGITAL INPUTS CHANNEL A-F

The dedicated digital channels do not require any user calibration. Each dedicated channel accepts a 0 to 5 volt signal, which corresponds to a LONWorks switch type SNVT of the following form (where # is the channel number A-F):

nvoCh#Value

Each digital input channel acts upon an active low, thus a low input will produce a high state for the switch type SNVT. The MALNI calculated all digital inputs (both analog and dedicated digital channels) based upon a 2.5 volt threshold. This 2.5 volt threshold is not user configurable.

## *INITIAL CHANNEL SETUP CONFIGURATION*

Each analog input channel of the MALNI must be configured before use. For the majority of applications this will consist of setting the channel type (and base value for calibration purposes). However, the MALNI has the ability to define a custom range, for which the configuration becomes a slightly more complicated process. The channel types are configured as follows:

**TYPE O – UNCONFIGURED (DEFAULT):**

This is the default configuration for all analog input channels of the MALNI. If the nciCh#Type SCPT for the channel is set to 0, the channel is considered to be un-configured. The channel's SNVT nvoCh#Value output will always be 0.0, regardless of any voltage present on the analog input. Thus, if the channel type is left un-configured, the channel will be inactive on the LON network.

**TYPE 1 – DIGITAL**

If an analog channel is set to receive a digital input, the channel will operate on the assumption that the digital input will be between 0 and 5 volts DC, and the threshold value between digital High and Low will be 2.5 volts. All digital inputs on the MALNI are assumed to be active low, thus a low input voltage will produce a HIGH digital state. The SNVT nvoCh#Value which posts to the LON network from one of these analog channels will be a float type SNVT. Thus a digital high will be a 1.0 float type, and a low will display as a 0.0 float type on the LON network. Due to SNVT limitations within the MALNI software, it is not possible to provide a switch type SNVT for digital inputs on the analog channels. However, a typical LON network management tool (LONMaker, Tridium) is able to condition this output within the network management software as the user requires. Switch type SNVT's are only available on the six dedicated digital channels (channels A-F).

**TYPE 2 – PERCENT**

A channel configured for the Percent input type will post a floating point value to the LON network which corresponds to a linear percentage of the 0-5 volt input. Zero volts input corresponds to 0.0%, while a 5 volt input will correspond to a 100.0% value posting to the LON network. This range (0-5 volts corresponds to 0 to 100%) is the only range available for this input type. If a different range is desired, the user must configure a custom range (see Type 6 - Custom).

**TYPE 3 – VOLTAGE**

If the analog input channel is configured for input type 3, the MALNI will post the direct voltage reading of that channel to the LON Network. This voltage reading will be a floating point input type, with 3 digits of precision. The 12 bit A/D converter implemented within the MALNI is accurate to within 0.12% (approximately 1/819 of a volt) across the full 5 volt input range. For Ai's 1-4 a range module is required to divide the 0-10VDC signal down to 0-5VDC for the A/D convertor.

***NOTE:*** Ai's 1-4 the RM Di/10 range module is installed with the white line toward the Ai's terminal block for 0-10VDC signals.

**TYPE 4 – 10K THERMISTOR**

If a MALNI channel is configured for a 10K thermistor input, Ai's1-4 requires a range module (RM-Di/10), Ai's 5-10 you select the 10K/Di jumper position. The jumper selection 10K/Di and/or RM-Di/10 provides the pullup resistor for the 10K thermistor or dry contact circuit (digital).

Note: the RM-Di/10 range module is installed with the white band away for the Ai's terminal block. The temperature range for the 10K thermistor is -29 to 104.5°C (-20 to 220°F). For narrower temperature ranges use TYPE 6 Custom, the LON network value for this channel definition will be in degrees Celsius, with 3 digits of precision.

**TYPE 5 – 1K & 2K RTDS**

If a MALNI channel is configured for an RTD input, Ai's 1-4 only, a RTD range module (RM-RTD1K, RM-RTD1KA or RM-RTD2K) must be used. The range module defines a fixed temperature range of -30 to 110°C (-22 to 230°F). The RM-RTDX expands a specific, relatively small voltage range into a full 0-5 volt range, which still corresponds to the initial temperature range. This allows the MALNI's 12-bit A/D converter to offer the same 0.12% full-range accuracy for the temperature range. For narrower temperature ranges use TYPE 6 Custom: with a Custom Range Module (CRM-RTD1K). The LON network value for this channel definition will be in degrees Celsius, with 3 digits of precision.

***EXAMPLE:*** The user desires a 1K RTD (T.C. 0.00385) input to display a temperature range of -30 to 110°C. This corresponds to an RTD voltage of 1.2177 to 1.7089 volts. The standard RM-1KRTD range module will expand the voltage range to 0 to 5 volts. When the RTD input is 1.4633 volts, this will be expanded to 2.5 volts. The MALNI will retrieve the appropriate value from a look-up table, and post this value to the LON Network.

**TYPE 6 – CUSTOM**

The custom range is the most versatile and most difficult range to configure properly. The custom range is intended for use when a non-standard sensor input is used, or a non-standard output range is required to be posted on the LON network. To configure a custom range the user is required to enter additional configuration information. This additional information is used by the nciCh#BaseValue, nciCh#BaseVolt, and nciCh#Slope SCPT variables. These variable will allow a user to define any custom linear range within the follow constraints:

- The input voltage range must be between: 0 to 5 volts (No jumper or RM-Di/10), 0 to 10 volts with jumper or RM-Di/10.
- The MALNI cannot interpret negative voltage values.

The output range must be a floating point value between:

- -32768 to 32768 for no decimal precision
- -3276.8 to 3276.7 for 1 decimal precision
- -327.68 to 327.67 for 2 decimal precision
- -32.768 to 32.767 for 3 decimal precision

The floating point output value can be of any type desired by the user. This will be called the unit for the remainder of this section. Examples of various units which may be desired for a custom range are temperature (degrees C, degrees K), pressure (mmHg, inches H2O, kPa), velocity (m/sec, mph, ft/sec), or any other custom value. The user must also know the linear gain of the sensor, in the form of units/volt. This linear sensor gain is the slope of the custom range curve.

To configure the custom range input channel, the user must know one point of the desired linear response curve. This one point is entered into the SCPTs for nciCh#BaseValue, nciCh#BaseVolt. The user must also know the linear gain of the sensor, in the form of units/volt. This linear sensor gain is the slope of the custom range curve, and is used for the SCPT value of nciCh#Slope. The MALNI uses these three configuration points to calculate the custom range to be used for this channel. If the values for the configuration SCPTs are negative the MALNI will still construct the appropriate linear range. However, it is important to note that while the MALNI will accept a custom voltage reference point (nciCh#BaseVolt) which is negative, and will calculate an accurate lookup table, the MALNI can only accept real voltage inputs which are positive, between 0-5 volts. Thus, the MALNI nvoCh#Value output SNVT will only post these values (corresponding to 0-5 volts) to the LON network.

Note, if a custom range is defined (input type 6) and later changed to a different input type (input type 0-5), the additional configuration properties do not reset to zero. Each SCPT will preserve its previous value in EEPROM memory, until specifically reconfigured by the user. However, this data is only used for the custom range, and will not affect the operation of the analog channel for any other input type.

***Example 1:*** Custom range with a known slope, positive reference points.

The user desires to use a unique type of fluid level sensor which produces a linear 1 volt response for each 5 feet of fluid depth. The fluid tank is never below 30 feet, and the user desires to zero the sensor at this point. Thus, the unit is the depth in feet.

The initial data point is known: 0 volts at 30 feet depth
nciCh#BaseVolt = 0
nciCh#BaseValue =30

The slope (gain) of the sensor is known: 5 feet/volt
nciCh#Slope = 5

When the analog channel is configured in this manner, the LON network will display the following values at these sample points:

nvoCh#Value = 30.00 at -3 to 0 volts (capped at 0 volts)
nvoCh#Value = 30.00 at 0 volts
nvoCh#Value = 40.00 at 2 volts
nvoCh#Value = 48.78 at 3.756 volts
nvoCh#Value = 50.00 at 4.0 volts
nvoCh#Value = 55.00 at 5.0 to 5.3 volts (capped at 5 volts)

Note, in the above example that values below 0 volts and above 5 volts will be clamped at the minimum or maximum value allowed by the 0-5 volt range. Also note, the changing level of decimal precision as the output value varies.

***Example 2:*** Custom range with unknown slope, positive & negative reference points. 5VDC analog input selected.

The user desires to use a unique type of temperature sensor which produces a linear response governed by a specified range:

2.493 to 3.850 volts corresponds to -12.5°C to 18.8°C

The initial data point is known: 2.493 volts at -12.5°C
nciCh#BaseVolt = 2.493
nciCh#BaseValue = -12.5

The slope (gain) of the sensor is not known and must be calculated:

Slope = Value Range / Voltage Range
Slope = [18.8 - (-12.5)] / [3.850 - 2.493]
Slope = 31.3 / 1.357
Slope = 23.066 Value/Volt

nciCh#Slope = 23.066

When the analog channel is configured in this manner, the LON network will display the following values at these sample points:

nvoCh#Value = (nciCh#Slope * input voltage) - ((2.493 * nciCh#Slope) + 12.5°C)

nvoCh#Value = -70.00 at -1 to 0 volts (capped at 0 volts)
nvoCh#Value = -70.00 at 0 volts
nvoCh#Value = -23.868 at 2 volts
nvoCh#Value = 16.635 at 3.756 volts
nvoCh#Value = 45.33 at 5.0 to 5.3 volts (capped at 5 volts)

Note, in the above example that values below 0 volts and above 5 volts will be clamped at the minimum or maximum value allowed by the 0-5 volt range. Also note, the changing level of decimal precision as the output value varies.

***Example 3:*** Custom range with negative slope, and negative reference points

The user desires to use a unique type of temperature sensor which produces a reverse acting linear response governed by a specified range:

-1.322 to -0.460 volts corresponds to -8.5°C to -14.5°C, respectively

The initial data point is known: -1.322 volts at -8.5°C

nciCh#BaseVolt = -1.322
nciCh#BaseValue = -8.5

The slope (gain) of the sensor is not known and must be calculated:

Slope = Value Range / Voltage Range
Slope = [-14.5 -(-8.5) / [ 0.460 - (-1.322)]
Slope = -6 / 0.862
Slope = -6.961 Value / Volt

nciCh#Slope = -6.961

When the analog channel is configured in this manner, the LON network will display the following values at these sample points:
nvoCh#Value = -17.702 at -3 volts (capped at 0 volts)
nvoCh#Value = -17.702 at 0 volts
nvoCh#Value = -31.624 at 2 volts
nvoCh#Value = -43.84 at 3.756 volts
nvoCh#Value = -52.51 at 5.8 volts (capped at 5 volts)

***Note:*** *The above example that values below 0 volts and above 5 volts will be clamped at the minimum or maximum value allowed by the 0-5 volt range. Also note, the changing level of decimal precision as the output value varies.*

***Example 3:*** Custom range with negative slope, and negative reference points

The user desires to use a unique type of temperature sensor which produces a reverse acting linear response governed by a specified range:

-1.322 to -0.460 volts corresponds to -8.5 °C to -14.5 °C, respectively

The initial data point is known: -1.322 volts at -8.5 °C

nciCh#BaseVolt = -1.322
nciCh#BaseValue = -8.5

The slope (gain) of the sensor is not known and must be calculated:

Slope =Value Range / Voltage Range
Slope = [-14.5 -(-8.5) / [ 0.460 - (-1.322)]
Slope = -6 / 0.862
Slope = -6.961 Value/volt

nciCh#Slope = -6.961

When the analog channel is configured in this manner, the Lon network will display the following values at these sample points:

nvoCh#Value = -17.702 at -3 volts (capped at 0 volts)
nvoCh#Value = -17.702 at 0 volts
nvoCh#Value = -31.624 at 2 volts
nvoCh#Value = -43.84 at 3.756 volts
nvoCh#Value = -52.51 at 5.8 volts (capped at 5 volts)

***Note***: *The above example that values below 0 volts and above 5 volts will be clamped at the minimum or maximum value allowed by the 0-5 volt range. Also note the changing level of decimal precision as the output value varies. Because the reference values were negative, but the MALNI can only accept a positive 0-5 volt input, it can be seen that the MALNI will never actually display the temperature values used to calculate the linear range.*