





General Rules

- **Use Dedicated Power with Networked Systems – DO NOT USE UNIT POWER**
- **Use Separate Power for all Relays**

– Both of these precautions help eliminate the potential for noise on the communication lines.

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General Rules --continued

- **Use a Transformer with Adequate Power**

- SZ Series Stats 8 VA max
- SZ/SL Series Controllers 5 VA max
- 2100 Series Controllers 15 VA max
- QD1010/QD1011a 1 VA max
- QD2020i/ie 6 VA max

- **Maintain Power and Comm. Polarity**

- +24V to +24V to +24V... & -24V to -24V to -24V ...
- A to A to A... & B to B to B... & Ref to Ref to Ref...

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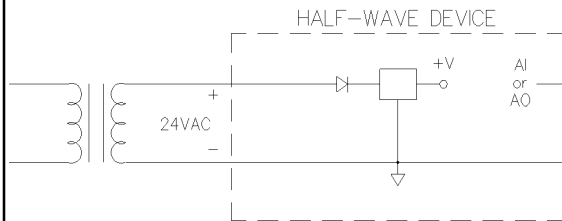
General Rules --continued

- **Use Separate Power for Controllers and Actuators NOT Manufactured by TCS**

- All SZ/SL Controllers are Half-wave Rectified
- Other Manufacturer's may be Half- or Full-wave

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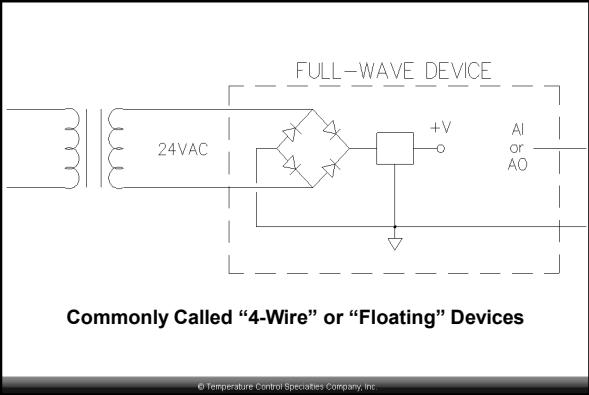
Half Wave vs. Full Wave Rectification



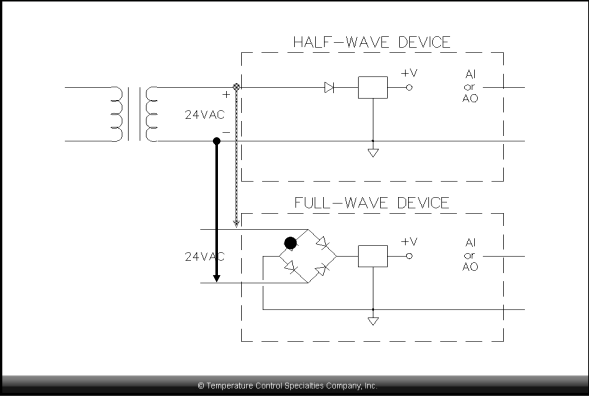
Commonly Called "3-Wire" Devices

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Half Wave vs. Full Wave Rectification--continued



Half Wave vs. Full Wave Rectification--continued

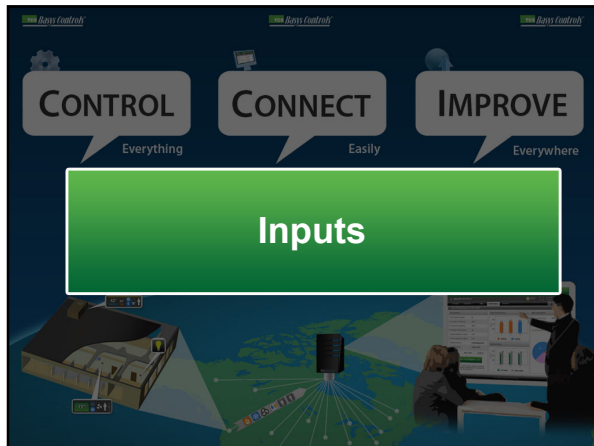


General Rules --continued

- **Use Separate Power for Controllers and Actuators...**
 - ... if Half-wave, You Could Share a Transformer
 - ... if Full-wave, Must use Separate Transformers
 - ... if Not Sure use Separate Transformers

A transformer is an inexpensive insurance policy.

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General Practices – Inputs

- **Use Shielded, Twisted-pair Cable**
... Use the RED & BLACK Sensor Wires (*clip white*)
- **Ground Shield at One End ONLY**
... Preferably at the Sensor
- **All Wire Has Resistance...**
... Use the RTD Zero Pots to Fine Tune Readings
a Couple of Degrees by Adjusting Them Slightly
(Only After all Other Inaccuracies are Eliminated)

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General Practices – Inputs --continued

- **DO NOT RUN Near High Voltage Wiring**
... Fans, Variable Speed Drives, Ballasts
- **If Must Run Near High Voltage Wiring,**
... Stay at Least 2' to 3' Away if Parallel
... Cross Wiring Perpendicular to Each Other

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Analog Inputs - Resistive

<p>100 Ω Platinum RTD Resistance Change is Linear with Temperature</p> <p>Resistance @ 32 °F 100 Ω Temp. Coefficient 0.216 Ω /°F</p> <p>Example Resistances - 70 °F => 108.21 Ω 110 Ω => 78.3 °F</p>	<p>1000 Ω Platinum RTD Resistance Change is Linear with Temperature</p> <p>Resistance @ 32 °F 1000 Ω Temp. Coefficient 2.16 Ω /°F</p> <p>Example Resistances - 70 °F => 1082.1 Ω 1110 Ω => 78.3 °F</p>
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NOTE: You Must "Break the Circuit" to Measure/Check an RTD

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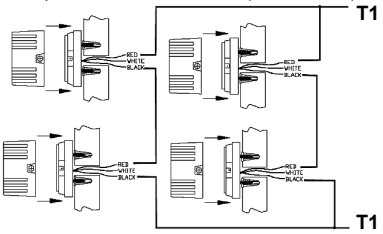
Averaging Platinum RTD Sensors

- **Single Sensor vs. Multiple Sensors**
 - ...Continuous Averaging Probe (*return or mixed air*)
 - ...Combination of Single Point Sensors (*4, 9, 16, etc.*)
$$\frac{1}{R_1} + \frac{1}{R_2} + \dots + \frac{1}{R_n} = \frac{1}{R_T}$$
- **Wiring Options**
 - ...By Hand (*series / parallel wiring of sensors*)
 - ...Install an Averaging Kit (*wired in series*)
 - *Examples on Following Slides*

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Averaging Platinum RTD Sensors-- continued

- **Series / Parallel Wiring of Sensors**
must be a square number of sensors (4, 9, 16, etc.)

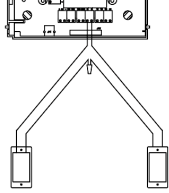


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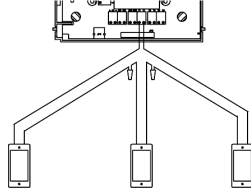
Averaging Platinum RTD Sensors-- continued

- **Averaging Kit** (*wired in series*)

2 Zones = TS3020



3 Zones = TS3030



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Analog Inputs - Current

4-20 mA Transmitters/Transducers

4 to 20 mA Signal is Linear to the Selected Span

For example – a 20°F to 120°F => 4mA @ 20°F, 20mA @ 120°F
0.16 mA/°F

a 40°F to 90°F => 4mA @ 20°F, 20mA @ 90°F
0.32 mA/°F

Used For: Temperature, Humidity, Pressure, CO₂, CO, Light Level, etc.

NOTE: "S" Series Controllers Provide DC Power for 4-20 mA Inputs

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Measuring 4-20 mA Inputs

- **To verify a 4-20 mA signal, you can...**
 - Measure the mA Directly by Breaking the Circuit and Inserting an Ammeter (*Difficult to do*)
 - Measure the Voltage Across AI and Ground, Then Compare it to Expected Values (*See Below*).

Input Impedance / Expected Voltages
for TCS Products Having 4-20 mA Inputs

SZ Series Devices	250 Ω	1 to 5 V
All Other Products	100 Ω	0.4 to 2 V

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Wiring a 4-20 mA Input (Loop Powered Transmitter)

• Temperature Sensor
 • Humidity Sensor
 • Pressure Sensor
 • And Others...

NOTE: Set meter to read DC voltage.

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Wiring a 4-20 mA Input (Self-Powered Transmitter)

• CO₂ Sensor
 • And Others...

NOTE: Set meter to read DC voltage.

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Digital Inputs – Contact Closure

Relay / Switch
Simple On/Off Signal
 Can be Momentary or Continuous
(depending on application and programming)

Digital Input is SHORTED, CLOSED, ON, or LOW
 Digital Input is OPEN, OFF, or HIGH

Used For: Door Closure, Pressure Switch, Photocell, Occupancy, etc.

NOTE: Digital Inputs are Dry Contacts ONLY...
 ... Powering the DI Will Damage the Controller
 ... if Using Powered Signal, Use an External Relay to Isolate DI

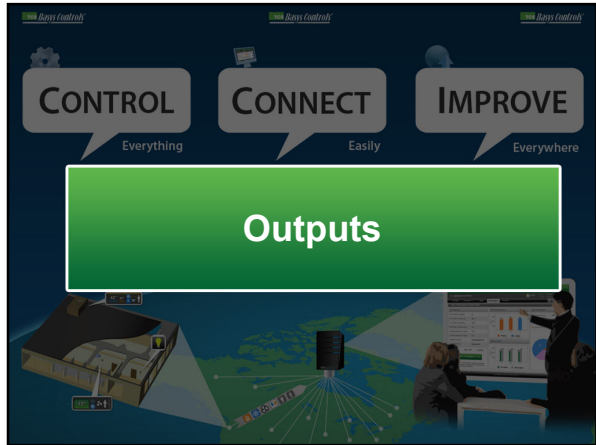
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Wiring a Digital Input *--continued*

Note: If all the controllers are powered with the same transformer...
... you may use the same set of contacts directly into up to 6 controllers.

Even in this case, we still recommend using a relay with multiple, separate contacts at the controller (or a peanut relay).

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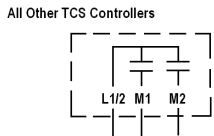
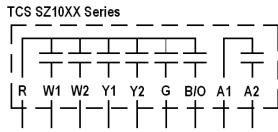


General Practices – Digital Outputs

- **Output Relays Rated at 24VAC @ 2 A**
... if Power Exceeds this use a Pilot Relay
- **Digital Outputs are Dry Contact (Not Powered)**
... Power can be Supplied to External Relays by Running Power to the "R" Terminal
- **2 sets of Power MUST NOT go to 1 Relay,**
Either, use a Separate Transformer to Power "R"
or, Operate the 2nd Unit Through External Relay

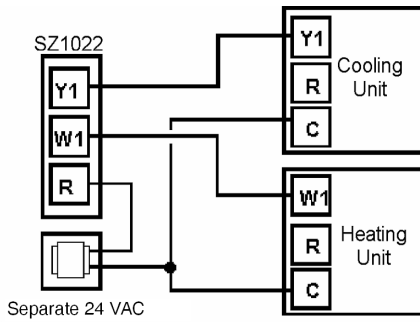
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Wiring Digital/Relay Outputs



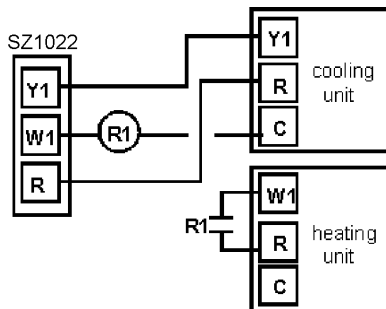
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Wiring Digital/Relay Outputs -- continued



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Wiring Digital/Relay Outputs -- continued



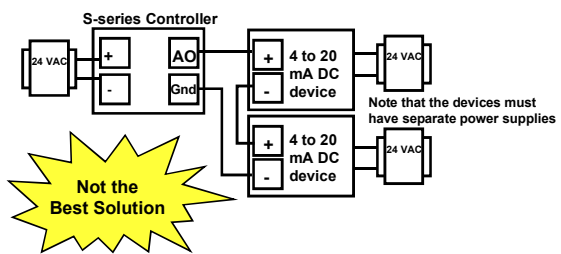
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General Practices – Analog (4-20 mA) Outputs

- Analog Outputs **Should Not** be Powered
- We use “Current Source” Outputs
 - ...Current is Pushed from the Controller Back to Ground
- Analog Outputs can be Shared
 - ... as a Current Signal
 - ... as a Voltage Signal (*preferable*)

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Sharing an Analog Output as a Current Signal

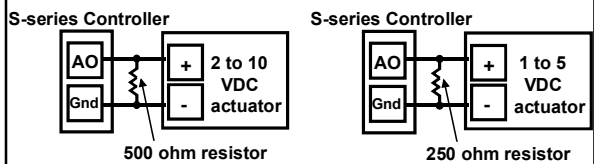


Note: Total Impedance for all Devices **MUST** be **LESS THAN** 600 ohms.
 If total impedance exceeds 600 ohms, the output **WILL NOT** reach max. value (20 mA).

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Converting a Current Output (4-20 mA) to a Voltage

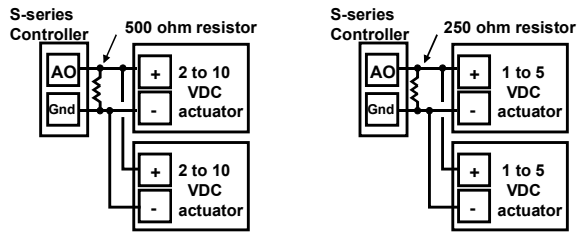
**** Use Resistor to Convert to Voltage Signal ****



Note: 500 ohm Resistor is Included with All Controllers with Modulating Outputs

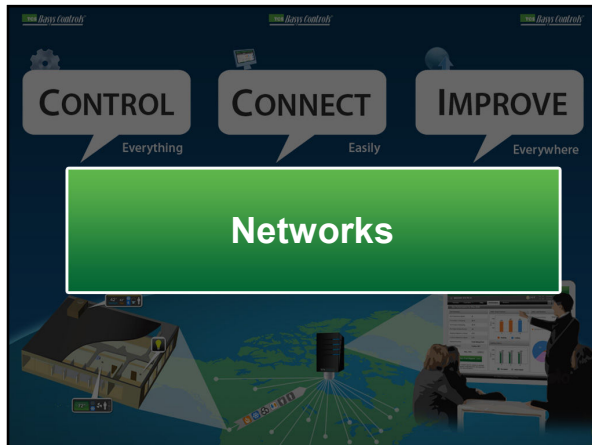
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Sharing an Analog Output as a Voltage Signal



Note: Total Impedance is Not an Issue When Sharing as a Voltage Signal

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General Practices – Networks

- **Supports all Common Configurations**
 - Star, Daisy Chain, Tree, Bus, Hybrid, etc.
- **Integrity of Comm. Wiring Must be Maintained or the Network Will not Work**
 - ... A to A to A, B to B to B, Ref. to Ref. to Ref.
- **Minimize Potential Causes of Noise**
 - Avoid Power Wires, Frequency Drives, Ballasts
 - Leave as Little Exposed Wire as Possible
 - Ground the Shield at **ONE** End

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General Practices – Networks -- continued

- **Each Device Has Unique Address** (*not 248*)
- **Baud Rate MUST be the Same Across the Entire Network** (*Stats, Controls, Comm. Devices*)
- **Install Terminating Resistor at Both Ends as Required**
- **See “Support Resources”**
 - “FAQ Superstats™” Catalog page 355
 - “Network Wiring and Setup” page 390
 - “Troubleshooting Network Wiring” page 396
 - “Checkout & Troubleshooting” on Product Ins.

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Checking the Network Communication Bus

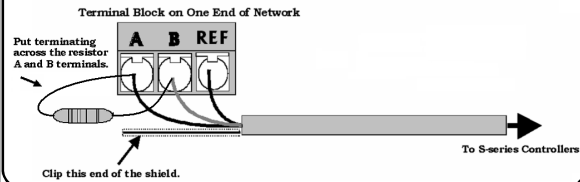
- **Avoid Noise by Grounding the Shield – AT ONE END ONLY**
- **Check the Voltages on the Comm. Bus**
 - Measure the Voltage Across the Specified Points, Then Compare it to Values Shown Below
 - Note: These values do not guarantee network communication.*

A to B	0 VAC	1 to 4 VDC
A to REF	0 VAC	0 to 1 VDC
B to REF	0 VAC	2 to 5 VDC
A or B to Shield	0 VAC	0 VDC

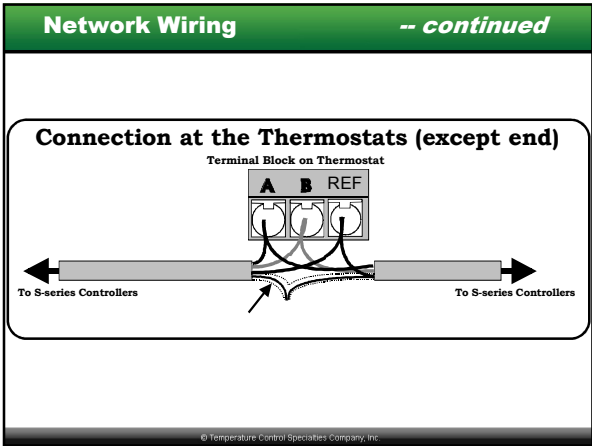
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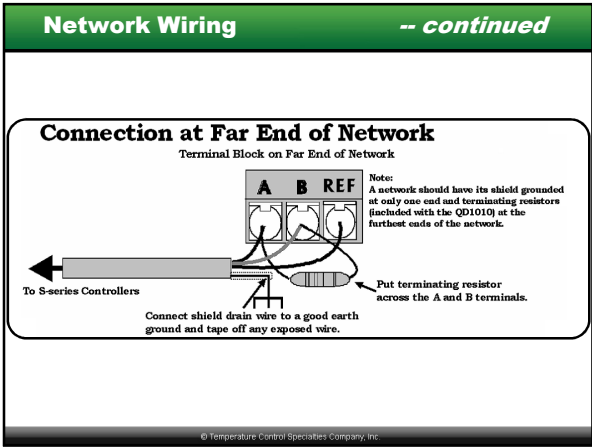
Network Wiring

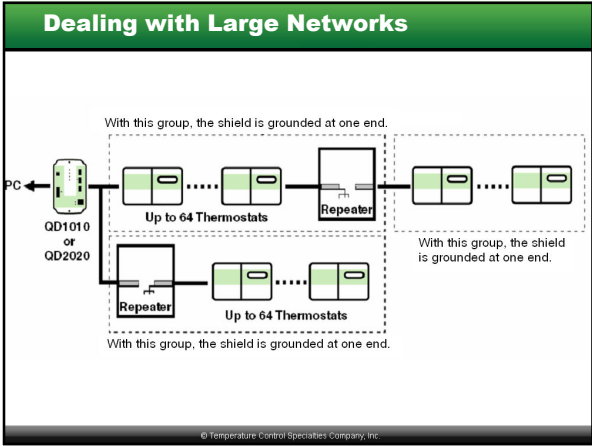
Connection at One End of Network



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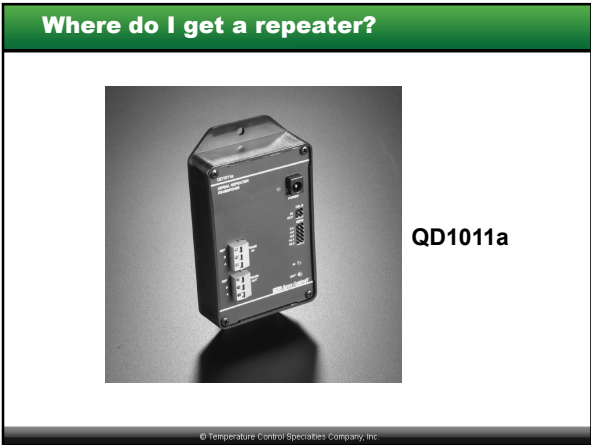




How many repeaters do I need ?

<u># Controllers</u>	<u>Length of Wire (ft.)</u>	<u># Repeaters</u>
up to 64	up to 4,000	0
up to 128	up to 8,000	1
up to 192	up to 12,000	2
up to 255	up to 16,000	3

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- Other Network Considerations**
- **Wireless vs. Wired Installation**
 - Labor Savings & Logistical Benefits
 - No Need for Isolated Power
 - Not Always Sure What is “Inside the Walls”
 - **On-site vs. Remote Access**
 - Who Needs Access and When
 - Standalone -or- Central Server
 - Analog Phone Line -or- Dedicated Internet
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Wiring Troubleshooting

- **See “Support Resources”**
 - “FAQ Superstats™” Catalog page 355
 - “Network Wiring and Setup” page 390
 - “Troubleshooting Network Wiring” page 396
 - “Checkout & Troubleshooting” on Product Ins.
- **Verify A to A, B to B, Ref. to Ref.**
 - *** DO NOT Use Shield as Ref. Wire ***
- **Verify Power Polarity**
- **Verify Isolated Transformer(s)**

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Where to Get Help or Answers

- **Instructions Sent with Product**
- **TCS Basys Controls Catalog**
- **Training & Reference Manual**
- **www.tcsbasys.com**

- **Call TCS Directly – 800-288-9383**

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