BCSE 1000 HARDWARE MANUAL

THIS MANUAL CONTAINS:

INTRODUCTION TO GRAIN TEMPERATURE MONITORING SYSTEMS
BCSE 1000 INTERFACE HARDWARE INSTALLATION INSTRUCTIONS
BCSE 1000 NETWORKING INSTALLATION INSTRUCTIONS

SPECIAL NOTE

READ THIS ENTIRE BOOKLET BEFORE PROCEEDING WITH THE INSTALLATION

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INTRODUCTION
TO GRAIN TEMPERATURE
MONITORING SYSTEMS

1. GRAIN TEMPERATURE SYSTEMS AND THEIR USE

Stored grain is constantly threatened by the hazards of mold activity, insect infestation and moisture migration. When grain goes out of condition, regardless of the cause, there is almost always a rise in temperature in the critical areas.

1.1. HAZARDS

1.1.1. Molds

All stored grain is infected to a certain extent with various types of grain storage molds. The correct conditions of moisture and temperature will stimulate their activity. The optimum temperature is about 85°F (30°C) for most prevalent species. The growth of storage mold lowers the usefulness of grain and grain products by the development of off-odors and various types of kernel discoloration. If there are a high percentage of damaged kernels, often caused by "turning", the grain is more likely to go out of condition.

1.1.2. Insects

Insect activity is also directly related to temperature and moisture content of the stored grain. Generally speaking, the dampest and warmest part of the bulk, and not the average, is the determining factor with respect to insect growth and reproduction. Infestation can be controlled by fumigants, but reduction in fumigant cost is possible if storage temperature can be maintained at a lower level. Most insects thrive in temperatures above 70°F (21°C), particularly in high-moisture grain. Insects not only consume the grain, causing damaged kernels, but generate heat and ultimately develop a temperature in the grain which may cause further serious damage. Below 50°F (10°C), most insects become dormant and may die of exposure to low temperatures after a few weeks.

When warm grain is put in storage, it is essential to reduce the temperature of the grain as soon as possible. When this cannot be done within a matter of weeks, it is wise to treat the grain with an insecticide if there is any possibility of insect infestation. If the grain is to be stored for any length of time before the temperature is reduced, further fumigation may be necessary.

1.1.3. Moisture

The moisture in a mass of grain stored at uniform moisture content may move within the mass because of differences in grain temperature. During the winter, the grain next to the bin wall becomes cooler than that at the center of the mass. Convection air currents pick up moisture from the warm areas and transfer it to cooler parts of the grain mass. The increase in moisture content may cause a corresponding increase in the respiration of the grain and associated micro-organisms, and this oxidation of the grain carbohydrates produces added moisture and heat. Heating from one cause may trigger another, which will contribute to the total heat produced; the combined action may result in serious damage, unless the heated grain is removed, or the temperature reduced. When sufficient moisture is concentrated in the top layer of the stored grain, it may mold and cake. This often occurs, even in grain which was considered to be of safe moisture content when it was stored.

1.2. **HOT SPOTS**

A *hot spot* is a location in grain mass that has experienced an active rise in temperature due to one of the hazards identified above. Consideration must be given to the duration and temperature compared to the surrounding grain in the same storage structure.

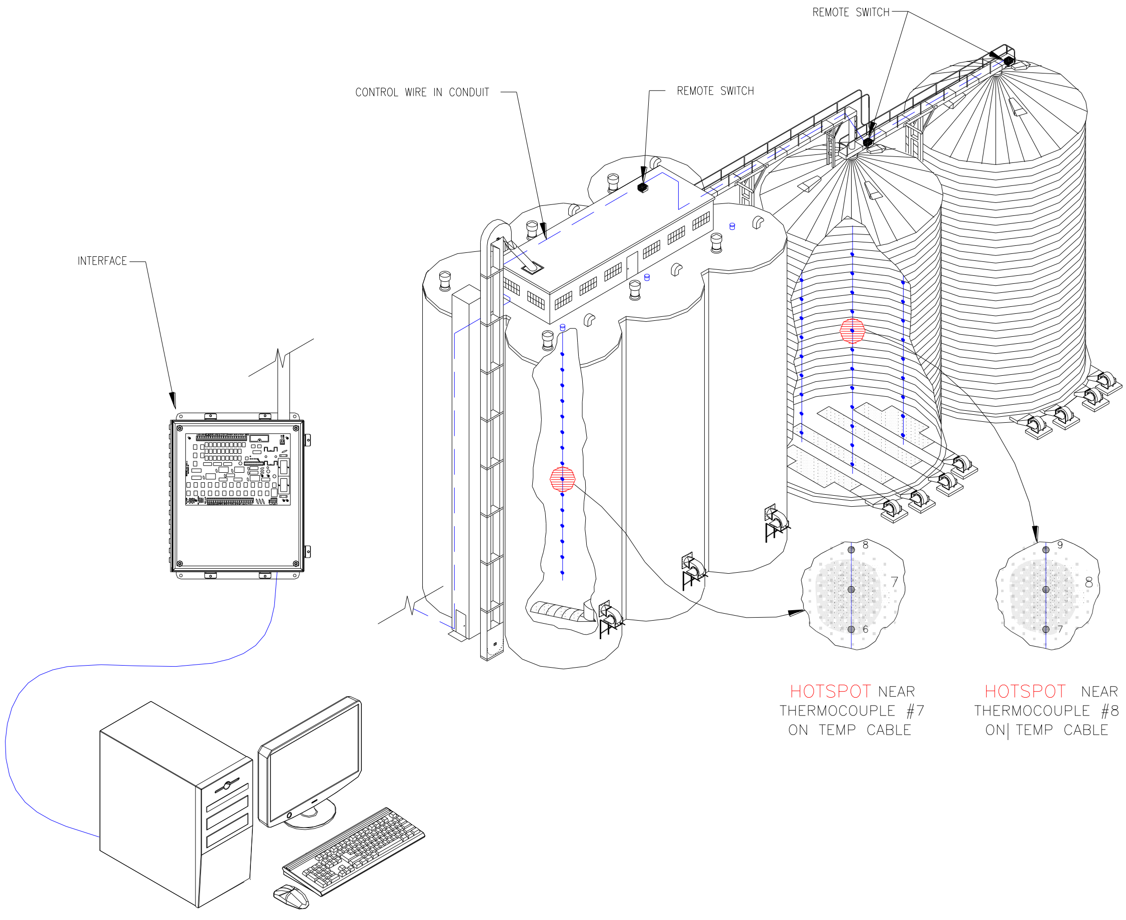


Figure 1 Several hot spots in a Grain Storage Structure

2. BACKGROUND & KEY CONCEPTS

Grain Temperature Monitoring Systems are typified by many *Sensing Points* and one *Central Driving & Read-Out Device* (electronic measuring instrument) with significant distance in between. It is not cost-effective for each *Sensing Point* to have its own dedicated read-out device. Here are some important concepts used in modern monitoring systems:

2.1. LEADWIRE SYSTEM

A straightforward and reliable type of system used in the past is called a *Leadwire System*. In its most-basic form, separate pairs of wires from each of the *Sensing Points* (thermocouples) are routed back to the *Central Read-Out Device* (instrument). If each *Sensing Point* is given its own dedicated pair of conductors, it results in a lot of duplication of wire & cable runs. Modifications to these types of systems are difficult and the redundancy unnecessarily adds to the cost and complexity.

2.2. REMOTE SWITCHING — Eliminates Redundancy

The problems associated with *Leadwire Systems* can be minimized by carefully distributing *switching devices* around the facility in strategic locations. This technique is called *Remote Switching*, which eliminates redundant wires by sharing runs of wires that all *switching devices* would have in common to deliver signals back to the *Central Read-Out Device* (instrument). A *Thermocouple-Common Cable* is a group of conductors that serve as a major path that interconnects all the *switching devices* in parallel. It acts as a means by which signals are carried from one place to another. When a single *switching device* is selected, it gets the chance to send signals back to the instrument. Effectively all the other *switching devices* are not part of the system. In this way temperatures from many *Sensing Points* can use the same wires at different times if there is coordinated timing of the *switching devices*. The interaction of the *Interface* and the *Remote Cable Switches* (*switching devices*) provides coordinated timing.

2.3. SECTIONS

Anywhere there is a natural grouping of cables, such as on the roofs of tanks or interiors of Head-Houses, is an often-used location for a *switching device*. A *Section* is a particular grouping of cables within relatively close proximity of a *Remote Cable Switch*. Each *Switch* handles just the *Temperature Cables* (maximum of 24) in its *Section*, not all cables in the facility.

2.4. CABLE SELECT — BALANCING HARDWARE versus SYSTEM READ-TIME

There must be a balance to the combination of how much hardware is necessary with the total time taken to read all the temperatures in the system. The compromise is to read just one *Temperature Cable* at a time. The *Remote Cable Switch* is called as such because it sends all the signals from *Sensing Points* (thermocouples) on an individual *Temperature Cable* back to the *Interface* for read-out.

2.5. THERMOCOUPLES

A Thermocouple is made when two dissimilar (unlike) conductive metal wires are electrically joined together at both ends, making a continuous loop or circuit. This junction will produce a predictable and repeatable voltage in direct relation to its exposure to heating and cooling. The smaller the voltage the thermocouple generates, the lower the temperature. This is the essential operating principle of all thermocouple-based monitoring systems. Refer to Figure 2.

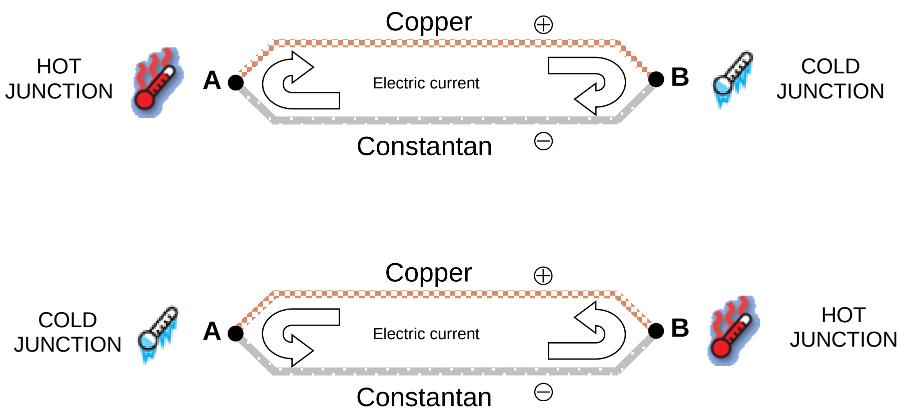


Figure 2 Thermocouple Circuit

2.5.1. Thermocouple Type

The choice of dissimilar metals in the *Thermocouple Junction Wire*, determines the “Type”. The *BCS ETHERNET Temperature System* uses type “T”, which is made from copper and constantan metals. They are the most practical for temperatures below 600°F (315°C) because they are affordable and easy to work with. Once twisted together so that the metals contact, the junction can be soldered, crimped, or welded. It is the metal-to-metal contact that makes the thermocouple junction, not the solder.

2.5.2. “T”-Type Junction Metals

2.5.2.1. Copper

Simple copper wire is used as the positive lead.

2.5.2.2. Constantan

An alloy of 57% copper and 43% nickel is used as the negative lead. The resistance remains constant over a wide range of temperatures.

2.5.3. Thermo-Electric Voltage

Call the two junctions of dissimilar metals in this circuit, A and B. When one junction has a different temperature from the other, an electromotive force (voltage) is generated. The common abbreviation for ThermoCouple is TC. This voltage is very small and requires sensitive equipment to measure it.

2.5.4. Hot And Cold Junctions

Direct electric current will flow in one direction if the temperature at (A) is higher than (B). The current will flow in the opposite direction if the temperature at (B) is higher than (A). No voltage will exist, and no current will flow when the temperature of junctions (A) and (B) are the same.

3. DESCRIPTION OF THE COMPONENTS

This section describes the components of a Grain Temperature Monitoring System, their basic functions, and relationships. A basic system is represented in the block diagram figure below.

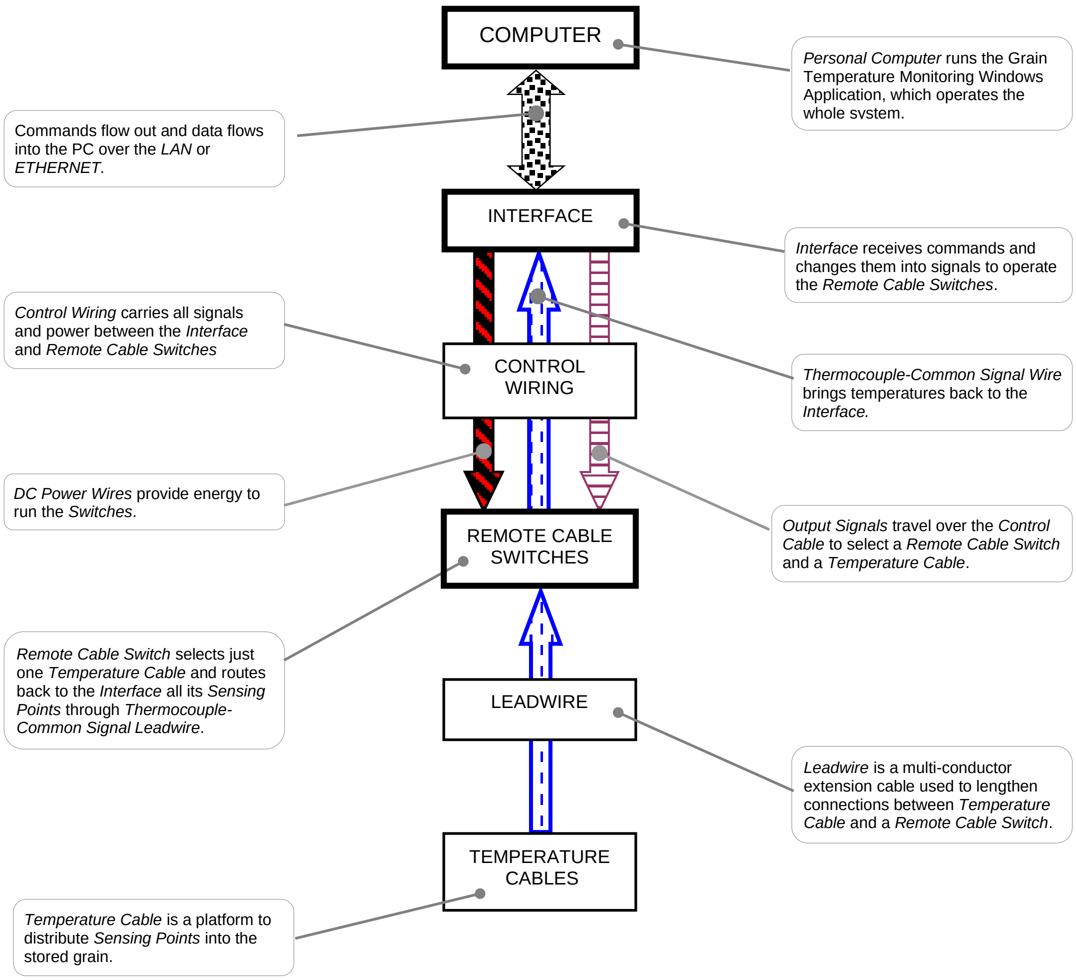


Figure 3 Block Diagram of Grain Temperature Monitoring System

3.1. TEMPERATURE CABLES

The purpose of a *Temperature Cable* is to provide a platform so that *Sensing Points* can be suspended down into the stored grain. They are usually supported by some structure under the roof of the silo or bin. For larger bins more cables are added in predetermined patterns based upon the tank diameter. Cables are made up of several components. Refer to manual 'Temperature Cable' located on the www.rolfesatboone.com website.

3.2. LEADWIRE

Leadwire is a multi-conductor extension cable used to lengthen connections between Temperature Cables and a Remote Cable Switch. Temperature signals of a single Temperature Cable are channeled through a Remote Cable Switch. Leadwire is used because it is less costly than Thermocouple Junction Wire. Modern electronic instruments are designed such that the length of the extension wire will not affect the temperature reading. Refer to manual 'Leadwire' and 'Temperature Cable' located on the www.rolfesatboone.com website.

3.3. **REMOTE CABLE SWITCH**

One of the most effective ways to balance the combination of how much hardware is necessary to install with time taken to read all the temperatures in the system is to read an entire Temperature Cable at one time. The Remote Cable Switch is called as such because it selects just one Temperature Cable. All the Sensing Points it has are routed back to the Central Read-Out Device through Leadwire. Refer to manual 'Model KT Multiplexer' located on the www.rolfesatboone.com website.

3.4. **CONTROL WIRING**

Control Wiring runs from the *Interface* to the first switch and between all subsequent switches. It carries all the input and output signals and power, for the *Interface* to communicate to the switches and for the switches to communicate back to the *Interface*. The other leadwire is used to bring the switch select and cable select logic to the switch.
<u>Control Cable</u> — are further divided up into Switch Select Wire and Cable Select Wires.
<u>Thermocouple-Common Signal Wires</u> — the control wire also contains a thermocouple signal wire that is common to all Switches. This is because switching of the thermocouples of a cable, are done in the Interface via one leadwire.
<u>DC Power Wires</u> — in most cases the control wiring also includes the power wires to run the switches. The black 18 AWG is common for the power supply and the red 18 AWG is +12volts DC from the power supply at the Interface. Refer to manual 'Temperature Cable' located on the www.rolfesatboone.com website.

3.5. **INTERFACE**

The Interface is a boundary between the Personal Computer and the Grain Temperature Monitoring System that have very different types of electrical signals and power that do not mix. To connect between these two hardware devices, there must be interface circuits to provide compatibility between linear and digital systems. The purpose of the Interface is to provide the appropriate output signals for section selection, cable selection and thermocouple selection. In most systems the power to run the switches also comes from the Interface. In the case of PC based systems, the Interface performs the functions of the Instrument through software commands from the computer. These signals can be generated mechanically through switches and relays or through electronic components like IC's and processors.
The Interface combines all functions that used to be performed by multiple devices in older systems. It now takes the place of the Instrument, Potentiometer, and Power Supply. An Interface has traditionally been in a central location such as an office or control room. That was because it was dependant on Input / Output Expansion Cards plugged into the PC motherboard and the limited distance transmission standards like RS-232 could go. Now that ETHERNET cabling and protocol is used, the PC and Interface can be much farther apart, freeing up the possibilities of where the Interface can be located.

3.6. **PERSONAL COMPUTER**

A Personal Computer runs the ROLFES @ Boone Grain Temperature Monitoring Windows Application, which operates the whole system. The PC commands the Interface to perform operations such as driving the Switches and being a Read-Out Device and Graphical User Interface on the PC Monitor. The BCS ETHERNET Temperature System puts data on the LAN or ETHERNET.

BCSE 1000 INTERFACE HARDWARE INSTALLATION INSTRUCTIONS

1. INTRODUCTION

An *Interface* is a boundary between the *Personal Computer* and the *Grain Temperature Monitoring System*. These two types of hardware systems are very different in the kinds of electrical signals each has and are therefore not compatible. To exchange information between them, there must be buffer circuits to provide separation and compatibility between linear and digital circuits.

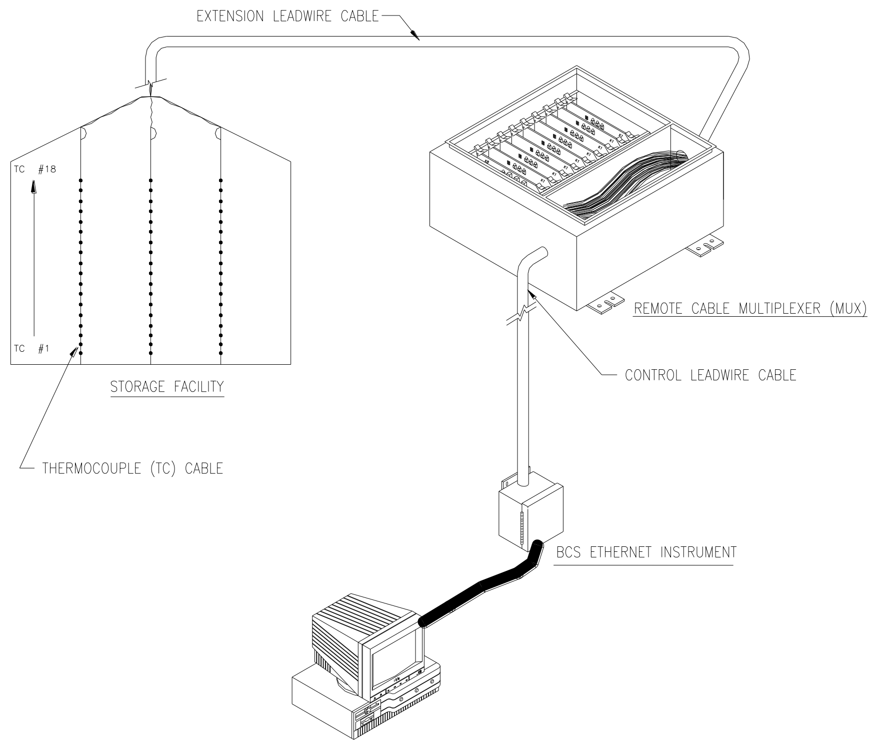


Figure 1 Typical BCSE 1000 Temperature Detection System

1.1. PURPOSE

The purpose of the *BCSE 1000 Interface* is to provide the appropriate output signals to the *KT Remote Cable Switch* for *Switch Selection* and *Cable Selection*. As part of a PC-based system, the *Interface* performs the functions of an Instrument through software commands from the ROLFES @ Boone Grain Temperature Monitoring Windows Application. Interface receives software commands and changes them into signals that can operate the *KT Switches*. The DC power to run the *Switches* is also converted from AC power at the *Interface*.

1.2. COMBINES MULTIPLE DEVICES INTO ONE

The Interface combines all functions that used to be performed by multiple devices in older systems. It takes the place of an Instrument, Potentiometer, and Power Supply.

1.3. MORE LOCATION POSSIBILITIES

Interfaces have traditionally been in a central location such as an office or control room. That was because it was dependent on digital Input / Output Expansion Cards plugged into the PC motherboard and the limited distance transmission standards like RS-232 could go. Now that ETHERNET cabling and protocol is used, the PC and Interface can be much farther apart, freeing up the possibilities of where the Interface can be located. **However, the interface shall only be installed in Non-Hazardous locations. Hazardous locations are defined by the National Electrical Code in Article 500, under special occupancies**. The *BCSE 1000 Interface* Temperature System puts data on the LAN or ETHERNET so that anywhere a network can link to is now a location to install the *BCSE 1000 Interface.*

2. ENCLOSURE COMBINATIONS

BCSE 1000 Interface can be enclosed in one box if ordering the product new from the factory or it can be a combination of the existing legacy BCS 1000 Interface along with a smaller enclosure holding the Ethernet module board. The latter will be the case if the customer wants to upgrade to ETHERNET communications.

2.1. SINGLE ENCLOSURE

All components fit in a single box. AC Line power, ETHERNET, and Switch Control Wire are all that is needed for connections.

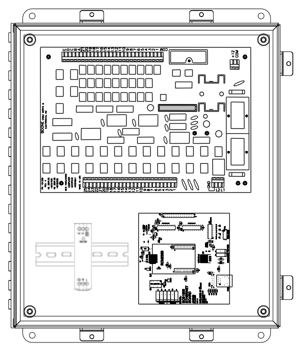


Figure 2 BCSE 1000 Board, +12V Power Supply, and Ethernet Board in Single Enclosure

2.2. SEPARATE ENCLOSURES

The Ethernet module board is in its own enclosure connected to the Interface by an 8-foot [2.4 meter] Round, Black, *BCS CABLE*. Connections are the same as for the single enclosure, just separated. The Upgrade Kit is basically a smaller enclosure and cable.

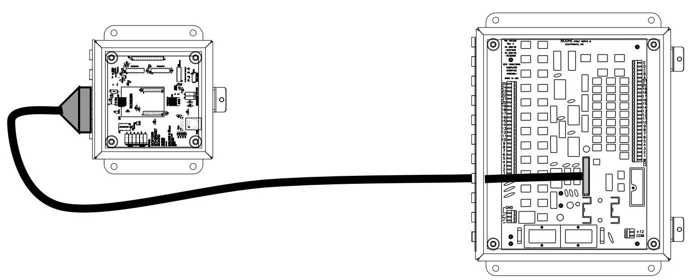


Figure 3 BCS1000 Interface Board with Ethernet Upgrade Kit in Separate Enclosures

3. CONNECTIONS

Make sure electrical power is OFF to the Computer and the *BCSE 1000 Interface*.

IMPORTANT NOTICE - MAKE CERTAIN the Protective Earth Ground Conductor from the 120 / 240 VOLT AC Line Supply, is connected to the to the GND terminal of the *BCSE 1000 Interface*.

In the *BCSE 1000 Interface* enclosure there are 4 terminal strips. Refer to Figure 4.

3.1. INPUTS

The Output of one device is also the Input to another device. Connections that are considered “Inputs” to the *Interface* are from the point of view of the *Interface*.

3.1.1. <u>AC Line Supply</u>

This is the connection to the general-purpose alternating current (AC), 3-wire, single-phase, *Mid-Point Neutral*, electric power distribution system, also referred to as the Mains. The *BCSE 1000 Interface* can be powered from one of two commonly supplied voltages. One terminal strip is for the 120 VAC (or 240 VAC, specify when ordering) connections marked L1, L2 and GND.

3.1.1.1. <u>GROUND, GND</u>

Connect the GREEN wire (or Green with yellow stripe) from Ground to the connector designated “GND”. Also known as the Earth Wire, it connects the case or enclosure of equipment to earth ground as a protection against insulation failures. Electromagnetic interference filters and surge protectors dispose of unwanted electric charges via the earth wire.

3.1.1.2. <u>L1, LIVE WIRE ONE</u>

This is the energized connection to the alternating current from the electrical panel or power grid. It is also called *Line,* Phase, Active, or Hot. Connect the BLACK (often used in N. America) wire to the connector designated “L1”.

3.1.1.3. <u>L2, LIVE WIRE TWO</u>

This wire should be treated as energized.

- 240 VAC Configuration
  If your *BCSE 1000 Interface* was configured for 240 VAC, a second live conductor from the electrical panel or power grid is brought to the connector designated “L2”. *Mid-Point Neutral* is <u>not</u> used in this situation.
- 120 VAC Configuration
  If your *BCSE 1000 Interface* was configured for 120 VAC, then it is assumed the interface is supplied as a 3-wire, single-phase, *Mid-Point Neutral* set up. Connect the second WHITE (often used in N. America) wire from Neutral, to the connector designated “L2”.

3.1.2. <u>Thermocouple-Common Cable</u>

The *Control Wire* also contains the *Thermocouple-Common Cable* that is common to all Switches. Switching of the thermocouples of a cable, is done in the Interface via one leadwire, not in the Switch.
The second terminal strip is labeled CON, 1 through 21. The CON stands for the *Constantan* of the 18 or 21 TC Leadwire for the TC signals coming from the switches. Use the TC color code when wiring the TC Leadwire in from 1 to 18 or 21 depending on the number of thermocouples per cable.

3.2. OUTPUTS

Connections that are considered "Outputs" from the *Interface* are from the point of view of the Interface.

3.2.1. DC Power

The Interface converts AC power into 12V Direct Current Power using its own on-board supply. This supply is dedicated to energize the Switches and is not to be confused with a different 12V, Industrial, DIN-Rail, Power Supply for the BCS1000 Ethernet Circuit Board, which is discussed in the section on "BCSE 1000 Networking Installation Instructions".
The third terminal strip marked "KT+12" and "COM" is for the power lines that run from the Interface to the switches.

3.2.1.1. KT+12

Connect the RED insulated, 18 AWG wire to the connector designated "KT+12". This is the positive 12 Volts DC output. This is otherwise known as the ⊕12 Volt SUPPLY at the *KT Remote Cable Switch*.

3.2.1.2. COM

Connect the BLACK insulated, 18 AWG wire to the connector designated "COM" and is short for COMMON. This is the negative 12 Volts DC, otherwise known as the ⊖RETURN at the *KT Remote Cable Switch*.

SUPPLY and RETURN conductors are connected in common and in parallel (electrically side by side) to all *KT Switches*.

3.2.2. Control Cable

The *Control Wiring* runs from the *Interface* to the first *Remote Cable Switch* and between all subsequent *Switches*. It includes wires used to select a particular *Switch* and a *Cable* within that switch.

3.2.2.1. Switch Selection

A fourth terminal strip labeled from 1 through 25. These numbers correspond to the *Remote Cable Switch* that is to be selected. Each switch must be assigned a designated number in the system.

3.3. BI-DIRECTIONAL I/O

Depending upon which Enclosure Combination your *Interface* has, you will be connecting one of two versions of cable. They perform the same function, and both plug into the connector designated "TB1". Connectors and Cables use pin and socket genders that will only allow correct connection.

3.3.1. Ribbon Cable

Connect the short 34-Conductor flat grey *Ribbon Cable* to "TB1".

3.3.2. Round Black BCS Cable

Connect the longer round black *BCS Cable* to "TB1"

TC B

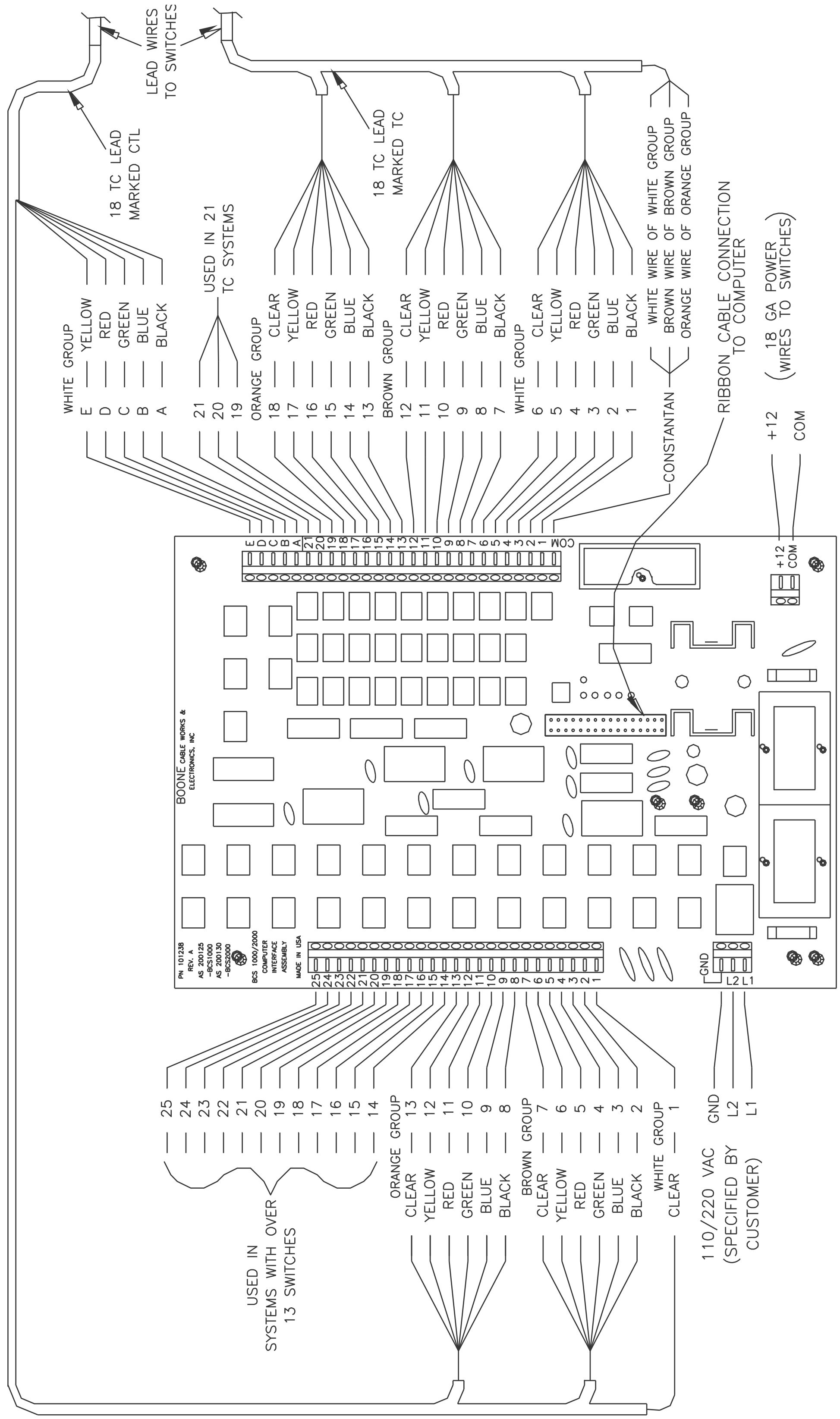


Figure 4 BCS 1000 Board Connections to Field Equipment using KT Switching

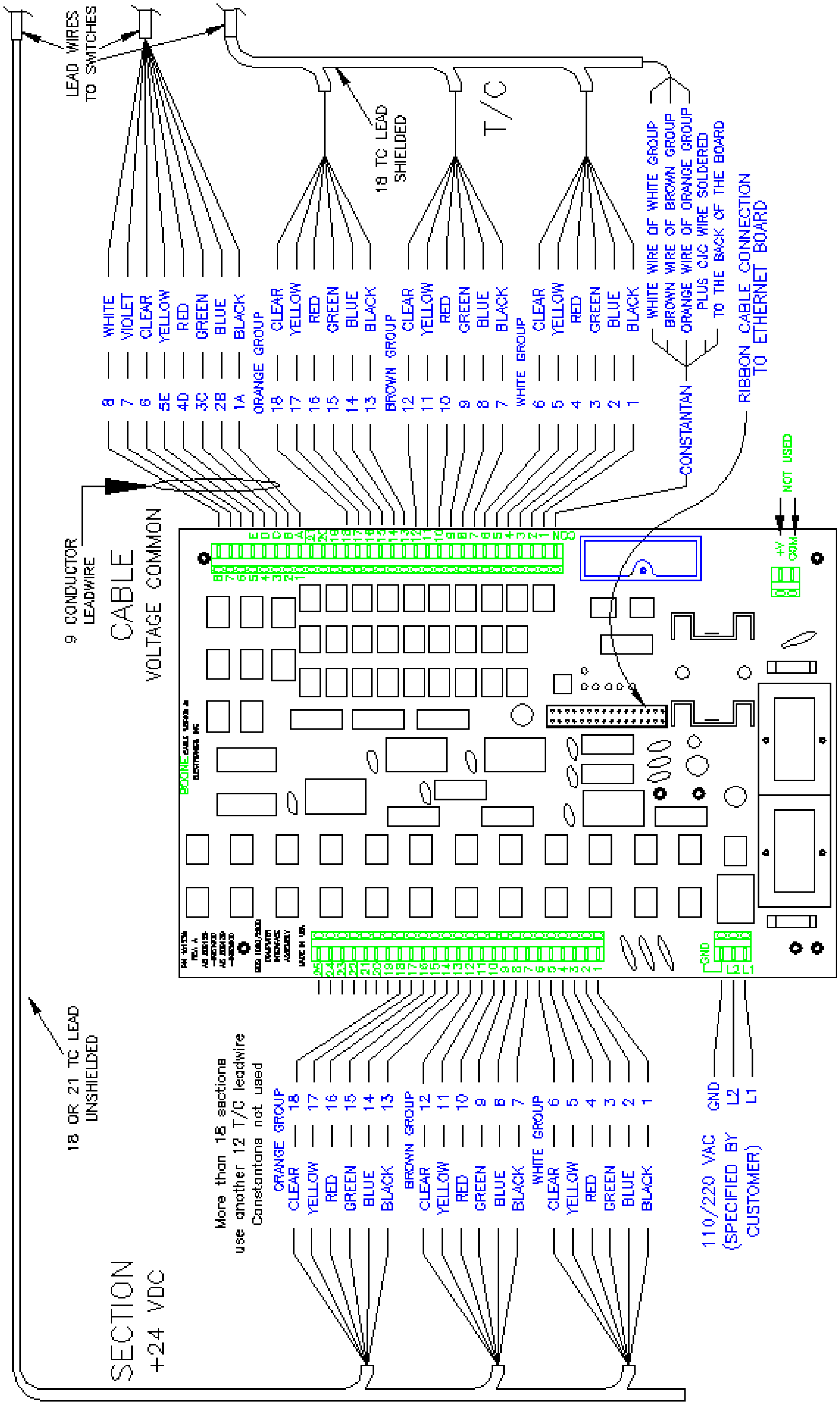
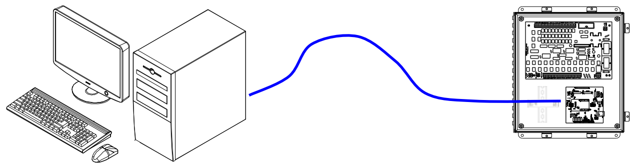


Figure 5 BCS 1000 Board Connections to Field Equipment using IICS Switching

BCSE 1000 NETWORKING INSTALLATION INSTRUCTIONS

1. OVERVIEW OF THE BCSE 1000 SYSTEM

The *BCSE 1000 Interface* Temperature System uses a Local Area Network or ETHERNET as the communications link to the PC. Commands come from the PC to the *Interface* to perform operations such as driving the Switches. The PC Monitor also acts as a Read-Out Device and Graphical User Interface showing data sent back on the ETHERNET. The whole system is operated by a PC running the ROLFES @ Boone Grain Temperature Monitoring Windows Application. Figure 1 shows required connections.



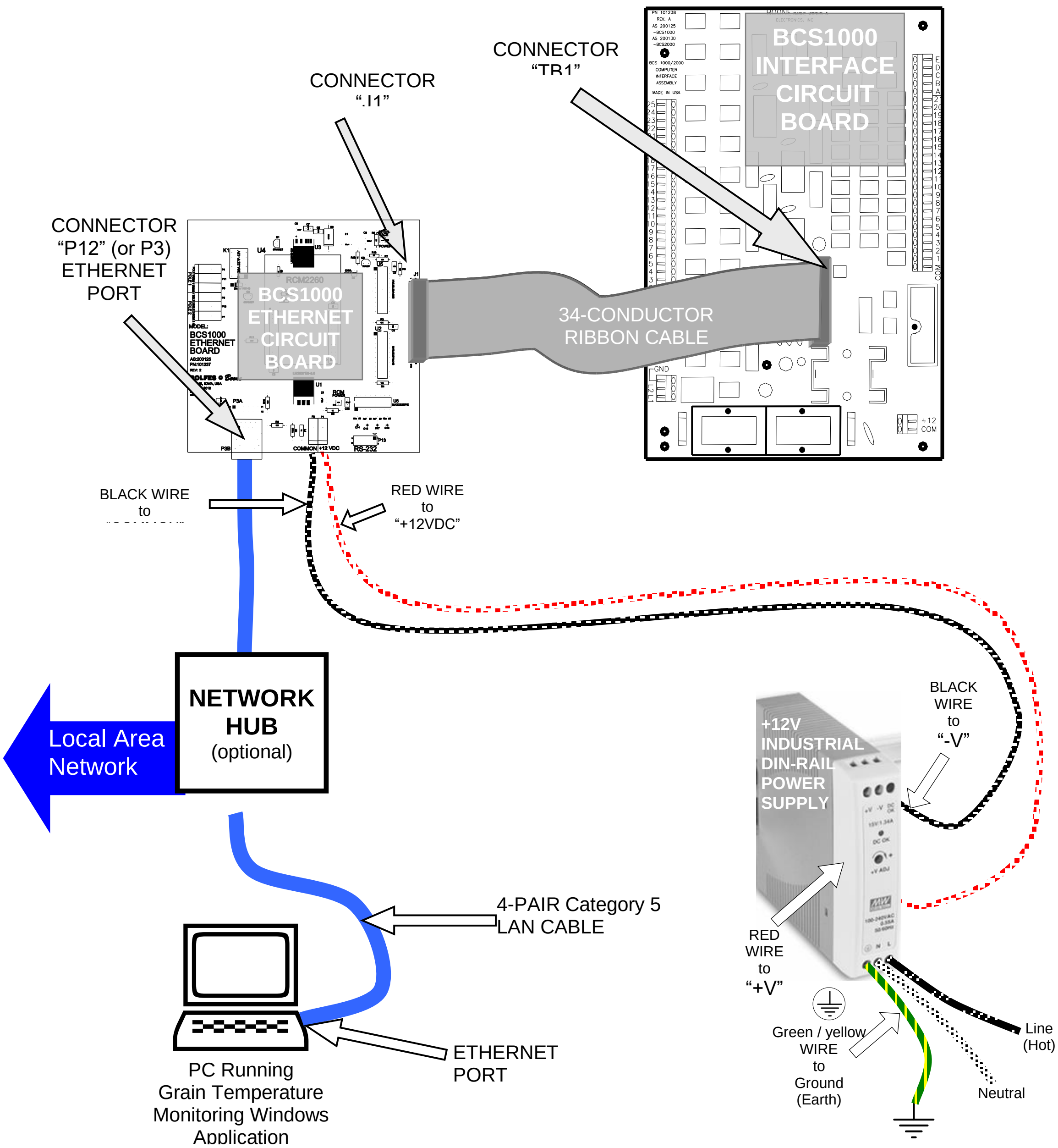


Figure 2 BCSE 1000 Basic Connections

2. CONNECTIONS

Refer to Figure 1.

2.1. TO A PERSONAL COMPUTER.

Make sure the *BCSE 1000 Interface* is powered up. When hooking up the Ethernet Module to a stand-alone desktop computer, make sure to use a CAT 5E crossover cable. On some Notebook computers you can use both crossover and straight through network cables.

2.2. TO A SWITCH OR HUB.

First hook up the interface to a computer, preferably a notebook connects the interface to a switch/hub.

2.3. TO BCS1000 ETHERNET BOARD

Make sure electrical power is OFF to the Computer and the BCS 1000 Computer Interface. Refer to Figures below.

2.3.1. <u>Ribbon Cable</u>

Connect the 34-Conductor Ribbon Cable from the CONNECTOR designated “J1” on the BCS1000 ETHERNET BOARD to the CONNECTOR designated “TB1” on the BCS1000 INTERFACE BOARD.

2.3.2. <u>DC Power Supply</u>

A +12V, Industrial, Din-Rail, Power Supply runs the BCS1000 Ethernet Circuit Board.

2.3.2.1. BLACK WIRE

Connect the BLACK WIRE to the connector designated “COMMON” on the BCS1000 ETHERNET BOARD to the connector designated “-V” on the Supply.

2.3.2.2. RED WIRE

Connect the RED WIRE to the connector designated “+12VDC” to the connector designated “+V” on the Supply.

2.3.3. <u>LAN Cable</u>

Connect the 4-PAIR Category 5 LAN CABLE to the connector designated “P12” (or P3) ETHERNET PORT on the BCS1000 ETHERNET BOARD. Connect other end of the LAN CABLE to a NETWORK HUB (optional) or directly to the ETHERNET PORT of the PC.

2.3.4. <u>AC Line Voltage</u>

The +12V INDUSTRIAL DIN-RAIL POWER SUPPLY requires AC Line Voltage for input power to the connectors on the front of the POWER SUPPLY.

2.3.4.1. GROUND

Connect the Green WIRE with yellow stripe from Ground (Earth), to the connector designated: ⏚

2.3.4.2. NEUTRAL

Connect the white WIRE from Neutral, to the connector designated “N”.

2.3.4.3. LINE

Connect the black WIRE from AC Line Voltage (Hot) supply to the connector designated “L”.