KT REMOTE CABLE SWITCH INSTALLATION INSTRUCTIONS

SPECIAL NOTE

READ THIS ENTIRE BOOKLET BEFORE PROCEEDING WITH THE INSTALLATION

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1. INTRODUCTION

Grain Temperature Monitoring Systems perform the process of Data Access, which reads data from a device and returns it to another device that requested it. More specifically, first the data is requested, and then it is returned to the device to be read. Typically there will be hundreds or even thousands of Sensing Points and one Central Electronic Measuring Instrument to read them all. There will also be significant distance in between. It is a complicated and tedious process to cope with such distances and great number of points.

The *KT Remote Cable Switch* simplifies this problem by temporarily connecting one small group of Sensing Points at a time. It forms a system of interconnected switches, which correctly organizes and sequences through the all the sources of signals. This is the basis of the concept of Switching.

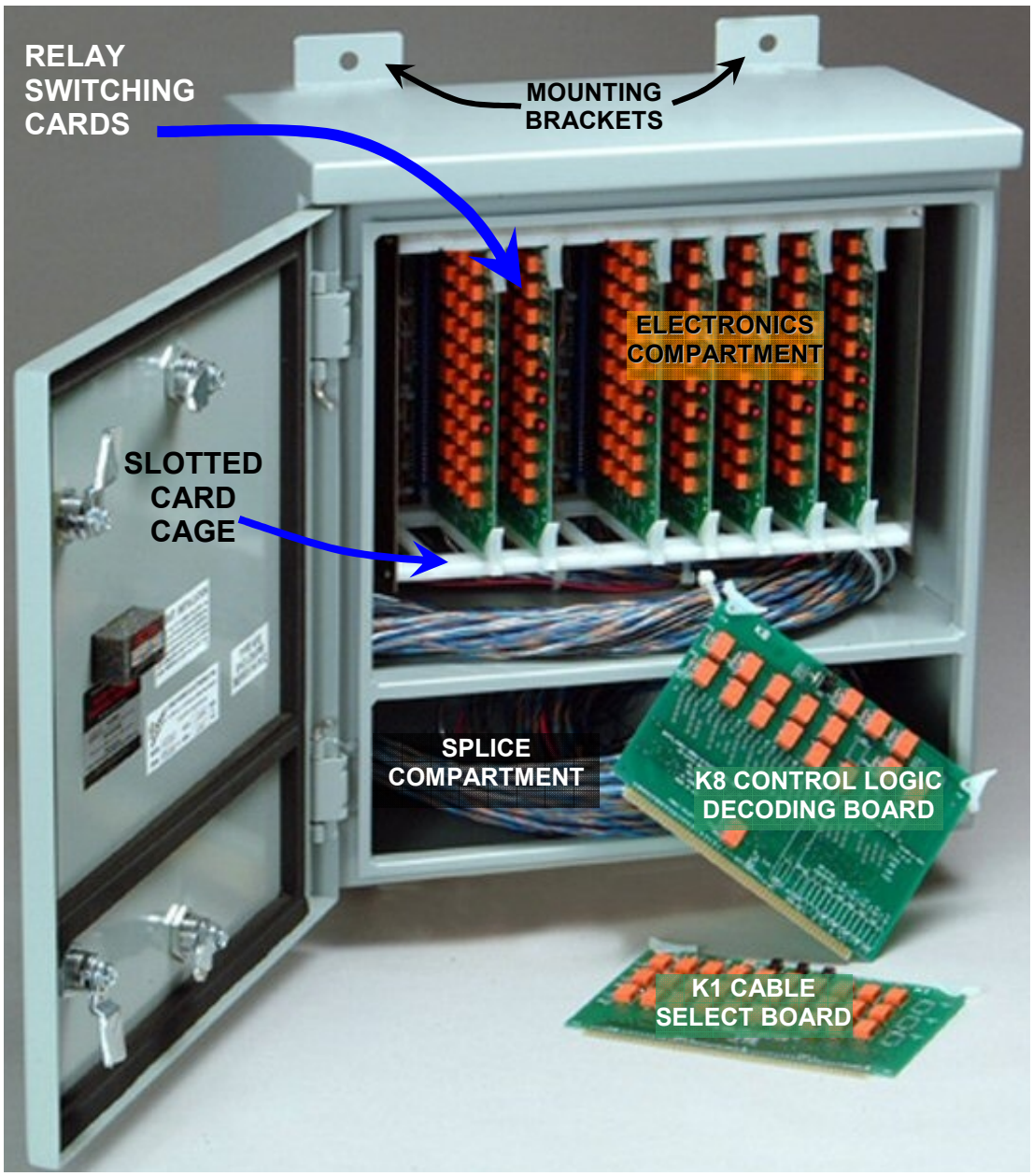


Figure 1 KT Remote Cable Switch, Pre-Installation

1.1. DESCRIPTION

The *KT Remote Cable Switch* is a large weatherproof enclosure divided into two compartments (refer to Figure 1). The bottom compartment is dedicated to wire splice connections. All wires from outside the box enter through this *Splice Compartment*. Electrical Conduit is attached here. The top compartment is sealed from moisture and dust. It is set apart to protect electronic components that are used to switch signals. Access to the interior is provided by a hinged, locking door.

The sealed, top *Electronics Compartment* is occupied by a cage frame that holds the *Relay Switching Cards* in slots. All cards plug into a back plane board that inter-connects all boards. A *KT Remote Cable Switch* must have only one *K8 Control Logic Decoding Board,* which is always in the first position that is closest to the hinge. The number of *K1 Cable Select Boards* may be changed from 1 to 8 in order to scale the system to the number of *Temperature Cables*.

The main function of the *KT Switch* is to acts as a bridge between one selected *Temperature Cable* and the *Interface*, so thermocouple signals can be passed from the source to destination. Once the Cable has been switched in, thermocouple signals arrive at the Interface as a group for reading.

Here are some features and highlights of the *KT Remote Cable Switch*:

Dimensions= 17" (432mm) Height
16" (406mm) Width
8.25" (210mm) Depth
Capacity = 24 Cables or 504 Sensing Points (TCs)
Enclosure = NEMA 4 or 4X Water tight (intended for extremely wet or corrosive environments)
Input Power = 6W @ 12 VDC
Control Interface = Parallel Binary Logic
TC Type = Type T (Copper Constantan)

1.1.1. The *KT Switch* uses a *Parallel Binary Logic* that lends itself easily to interfacing with Programmable Logic Controllers and many other controllers.
1.1.2. The *KT Switch* easily adapts to most existing temperature systems for add-on or renovation.
1.1.3. *Relay Switching Cards* plug-into slotted cage rack for ease of troubleshooting and repair.
1.1.4. Standard enclosure is made from heavy gauge steel with baked enamel finish.
1.1.5. An optional 304 Stainless Steel 4X enclosure is available by special order.
1.1.6. Positive contact precious-metal relay switching gives greater reliability and is more durable than solid state switching.
1.1.7. False readings are eliminated by isolation; only one *KT Switch* can be energized at a time.
1.1.8. The KT enclosure has a separate splice compartment from the electronics, sealed with an epoxy barrier to ensure that the switching remains in a clean, dust and moisture free environment.
1.1.9. Enclosure top has drip-shield / rain hood protecting door gasket.
1.1.10. All of the relay contacts and the card edge connectors are made from gold for reliable low level switching.
1.1.11. Edge connections of the *Relay Switching Cards* are bifurcated (split into two parts) and have a positive lock connection to ensure excellent contact even in high vibration conditions.

2. CONCEPTS

The following general discussion may help you to better understand what is happening in the use of the *KT Switch*.

2.1. SWITCHES & SWITCHING SYSTEMS

Switches are electromechanical devices that control routing and operation of a signal path. Switching is a method that uses temporary connections, rather than permanent, to route information between *Sensing Points* and the *Central Measuring Instrument*. Even though a *KT Switch* is internally made up of several *Relay Switching Cards* each having many electromechanical relays (53 internal mounted on cards), it is just referred to as a single device.

Electromechanical relay-type switching systems operate on the premise that all paths are open until one path is directed to connect. A command to connect is called *Selection*. When internal control relays are open, all *Sensing Points* are isolated. Thus there is no way to turn on another *Switch* or *Cable* to give a false reading.

2.2. ELECTRICAL BUS

A Grain Temperature Monitoring System employing *KT Remote Cable Switches* makes use of the *Electrical Bus* idea in many ways. An Extension Cable or TC Common Cable can be thought of as a Bus.

It was said that one small group of *Sensing Points* connects at a time. This group is called a *Temperature Cable*. Parallel signal paths emerge from *Sensing Points* on the *Cable* to form an *Electrical Bus.* This is an important concept to understand in how the *Data Access* process works.

A *Bus* is a set of hardware lines (conductors) used for data transfer among the components of a system. A bus is essentially a shared highway that connects different parts of the system and enables them to transfer information.

The bus consists of specialized groups of lines that carry diverse types of information. One group of lines carries data; another carries memory addresses (locations) where data items are to be found; yet another carries control signals.

Buses are characterized by the number of bits they can transfer at a single time, equivalent to the number of wires within the bus.

Symbolic representation of a *Bus*: The thick line is the *Bus*, which represents three wires and is much easier to work with when making or reading schematics. The slash through the bus arrow and the "3" means that the *Bus* represents 3 wires. See Figure 2, which illustrates how a simple 3-line *Bus* named “Z”, is drawn. It also gives and example of thermocouple lines as a *Bus*.

A Simple Bus

A Thermocouple Bus with 3 Copper (Cu) wires sharing 1 Constantan (Con)

Figure 2 The Symbol for an *Electrical Bus*

2.3. HOW BUSES ARE USED IN A GRAIN TEMPERATURE SYSTEM

Different types of information travel on Buses which are adapted to suit a particular purpose. Temperature data transfers on one type of Bus which is specially configured to carry thermocouple voltages. Another type of Bus delivers a coded number, which in turn gives a physical location holding the temperature data. The concept of a Bus is used two ways when accessing data. Selection sets up the device in the proper way and Retrieval sends back the readings.
Figure 3 shows the basic components connected to a KT Switch using one of its 24 inputs and the one output.

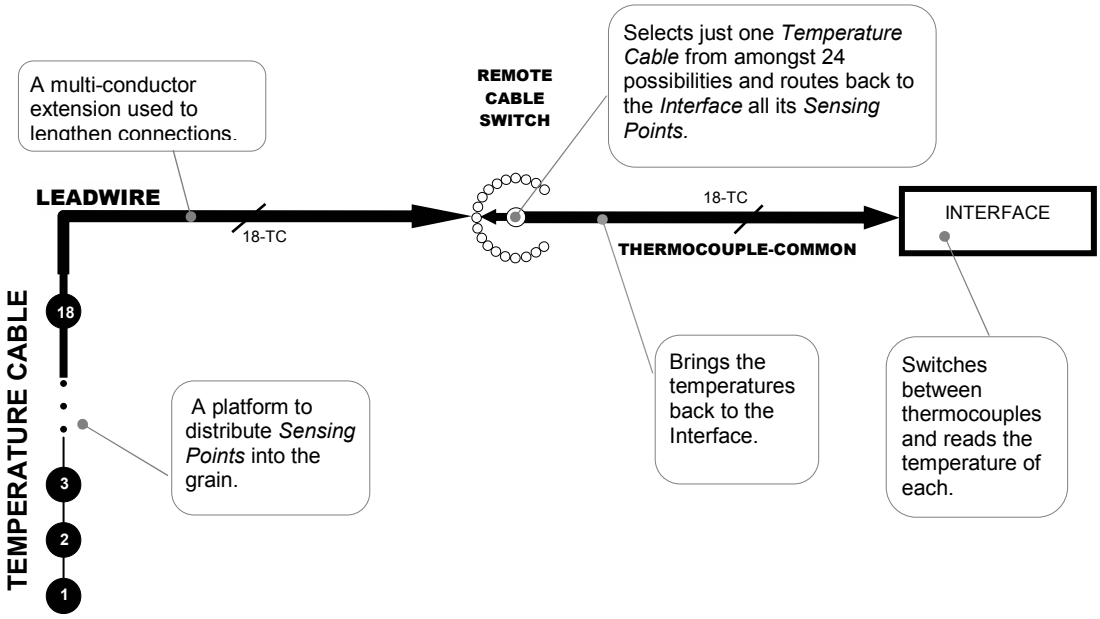


Figure 3 Representation of KT Switch connection Temperature Cable and Interface

2.3.1. SELECTION BUS

Selection is the initial contact made between the *Interface* and a *KT Remote Cable Switch* in preparation for transferring data. These lines are the *Control Wiring*.

2.3.1.1. Switch Select

A *Select* command determines which *KT Switch* gets permission to be the sender of information at any time. A Single Dedicated Wire goes to each *KT Switch* for this purpose.

2.3.1.2. Cable Select

Commands are sent out on a 5-line *Control Bus* in the form of a binary code. This is done for the purpose of selecting a particular *Temperature Cable*. A *KT Switch* takes this code and makes the switching hardware pick out the *Cable* of interest. The bus technique is a more complicated method of selection than just a simple enable line, but it saves on redundant wiring, electrical components, connections and labor.

2.3.2. RETRIEVAL BUS

A *Bus* is the route on which the temperature signals travel to the *Interface*. These lines are the *Leadwire & Thermocouple-Common Cable*.

3. SWITCH LOCATIONS

Leadwires, conduit and electronic hardware can be kept to a minimum by carefully distributing switching devices around the facility in strategic remote locations. These locations often include the roofs of tanks, interiors of head houses that are situated at a distance from the Central Electronic Measuring Instrument that can be accessed via a system of switches. See Figure 4. Often groups of Cables in close proximity have their Leadwires conveniently funneled at one point. Where they come relatively close is a good place to locate a KT Remote Cable Switch. Each KT Switch handles just the 24 Cables connected to it; not all the cables in the facility.

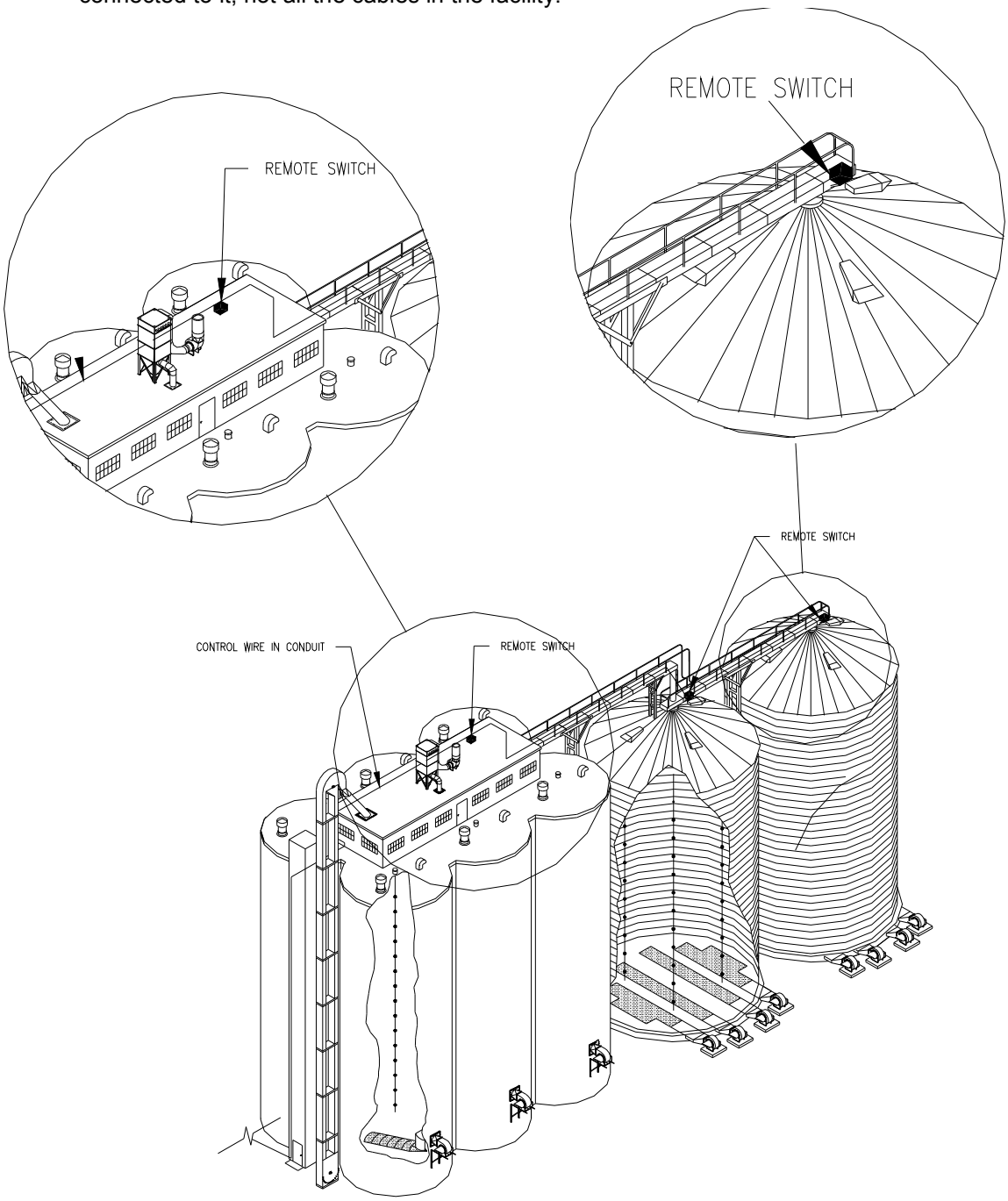


Figure 4 KT Remote Switch Locations

4. SECTIONS

A Section is a distinct part of the elevator that can be considered separately from the whole of the elevator. More specifically, a *Section* is a particular grouping of cables (often associated with a tank or bin) within relatively close proximity of a *KT Remote Cable Switch*.

5. INSTALLATION

The *KT Remote Cable Switch* should be mounted using its *External Mounting Brackets* (See Figure 1). The Installer should check the system drawings sent with each job and determine the proper location of each *KT Switch*. Each Switch should be easily accessible and free from obstruction. A fully loaded *KT Switch* consists of eight K1 Boards and one K8 Board. These boards and their capabilities will be discussed in detail later.

6. CONNECTIONS

Make sure electrical power is OFF to the Computer and the BCSE Interface before making connections. Figure 5 below, shows a block diagram of all Input and Output connections to a KT Remote Cable Switch System. Each *KT Switch* is connected to DC Power, Control Cable, Thermocouple-Common Cable and Leadwires. The following sections will look at the types of wiring one by one and describe how each subsystem affects the total system.

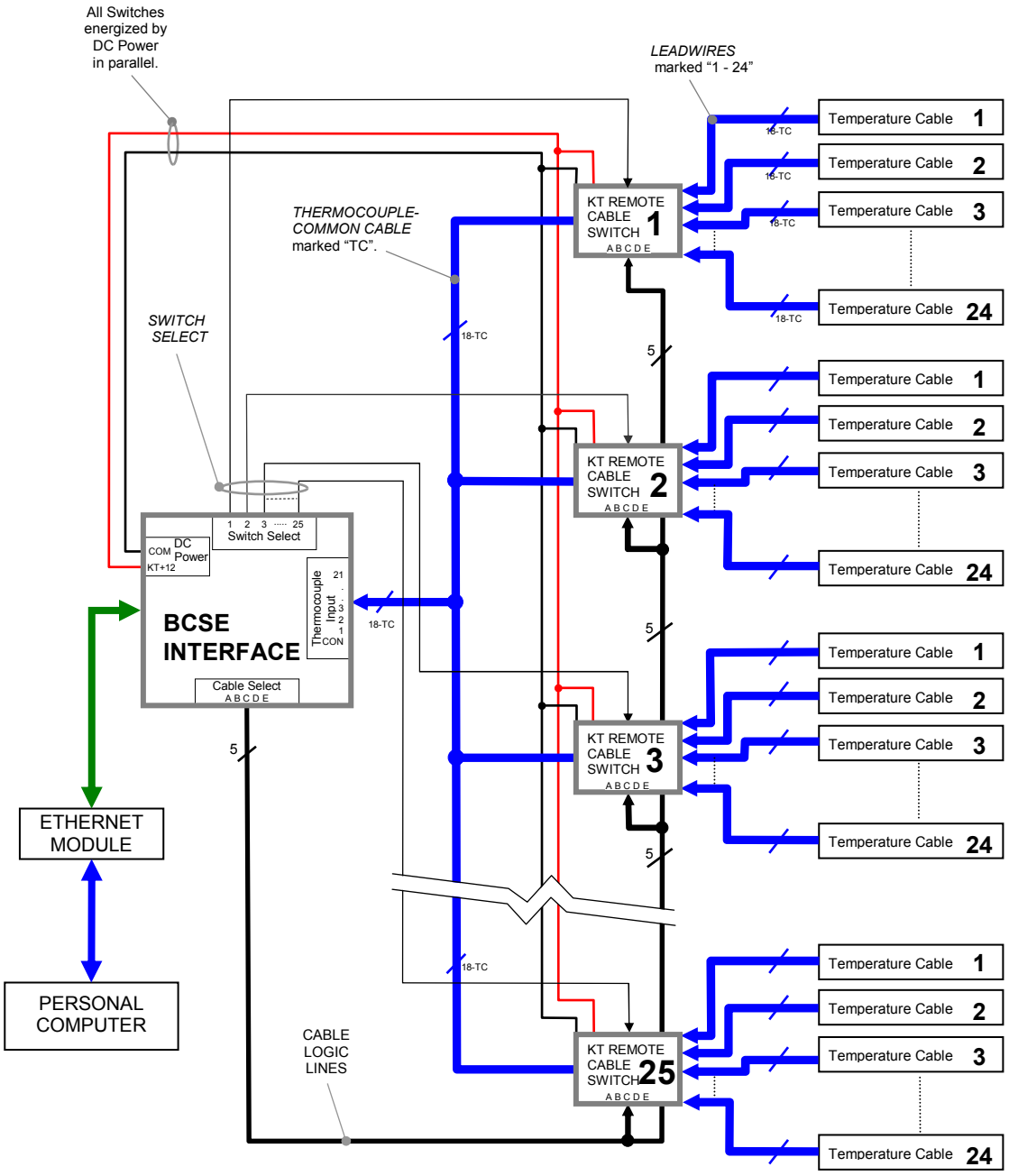


Figure 5 Composite Block Diagram of Connections to a KT Remote Cable Switch System.

6.1. INPUTS

The *KT Remote Cable Switch* is electrically driven and needs two kinds of inputs: Power and Control.

6.1.1. DC Power

Nominally +12 Volt Direct Current Power comes from the *Interface* on separate 18 AWG wires for internal electromechanical relays. They are:

- ⊕12 Volt SUPPLY, RED insulation, is the positive conductor.
- ⊖RETURN, BLACK insulation, is the negative conductor.

All *Switches* get *Supply* and *Return* conductors in parallel (electrically side by side).

6.1.2. Control Bus

Control Inputs are necessary to operate a *KT Switch* correctly, so that only one data pathway is made at a time from source to destination. In order for this to occur, relays in a *Switch* need to open and close at the right time and in the right order. Another word for these types of control inputs is *Control Data.*

You will come into contact with terms such as *Control Logic*, which is the electronic circuitry that generates, interprets, and uses Control Data. *Logic* describes how the *KT Switch* will behave when it is given certain inputs.

Control Cable — are further divided up into Switch Select Wire and Cable Select Wires.
The *Switch Number* and *Cable Number* are essential pieces of information for the KT Switch to work and are present on the *Control Bus*.

6.1.2.1. *Switch Select — a simple enable line*

Selection of a whole KT Switch is a straight forward use of the Single Dedicated Wire. Each Switch in the system must be assigned a unique number from 1 to 25. Figure 6 shows necessary connections for *Switch Selection*.

- Voltage applied to a single *Switch Select* line is a prior condition for *Cable Selection.*
- The circuit is completed by the Black DC Power Return Wire that runs back to the Interface.

Switch Select lines determine which *KT Switch* accepts the *Cable Select* Logic Codes. Other *KT Switches* are essentially offline and ignore the Logic Codes.

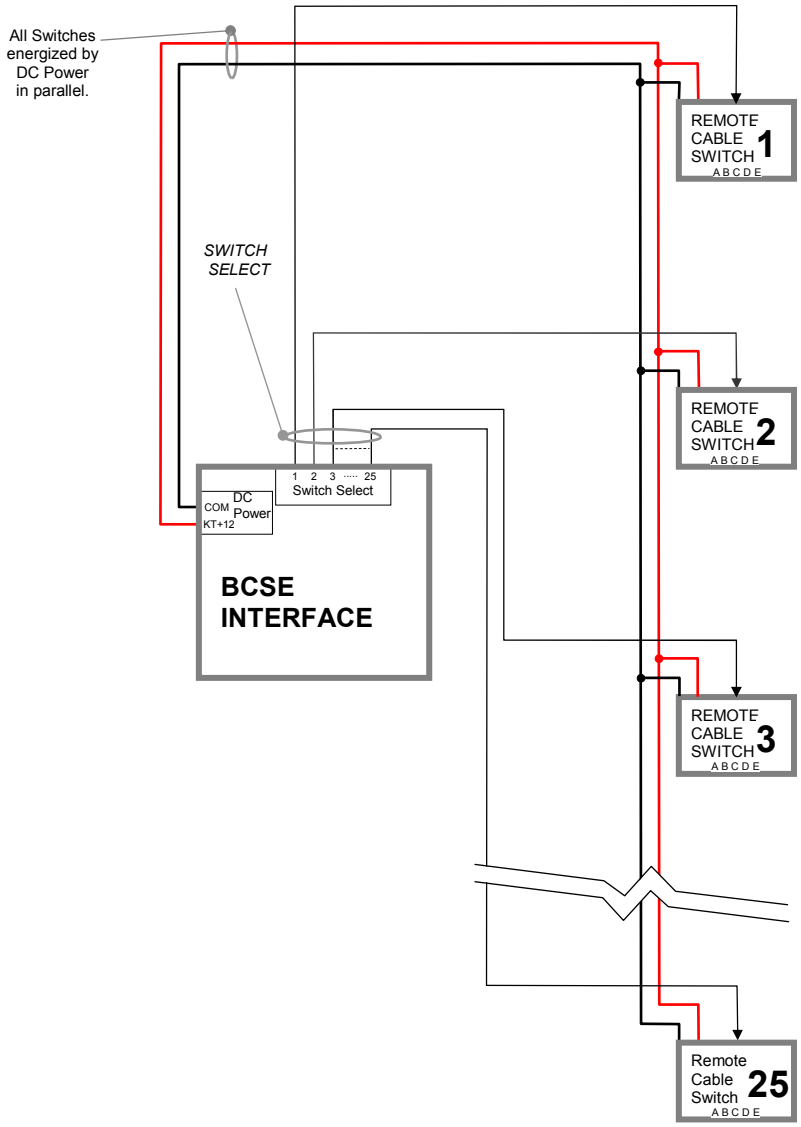


Figure 6 A simplified view of the *DC Power* and *Switch Select* portion of the Control Wiring.

6.1.2.2. *Cable Selection — a more complex technique*

Cable Selection is a way to single-out a particular *Temperature Cable* using a more complex technique than just an enable line. It would be too difficult to handle the quantity of dedicated wires necessary to do *Cable Selection* the same way. Using a *Control Bus* and *Cable Logic Codes* results in far fewer control lines, but is more technically advanced. Figure 7 below, shows a block diagram of *Cable Select* connections.

- Voltages applied in coded form to *Cable Logic Lines: A, B, C, D and E* determine which *Cable* is selected.
- The circuit is completed by the Black DC Power Return Wire that runs back to the Interface.

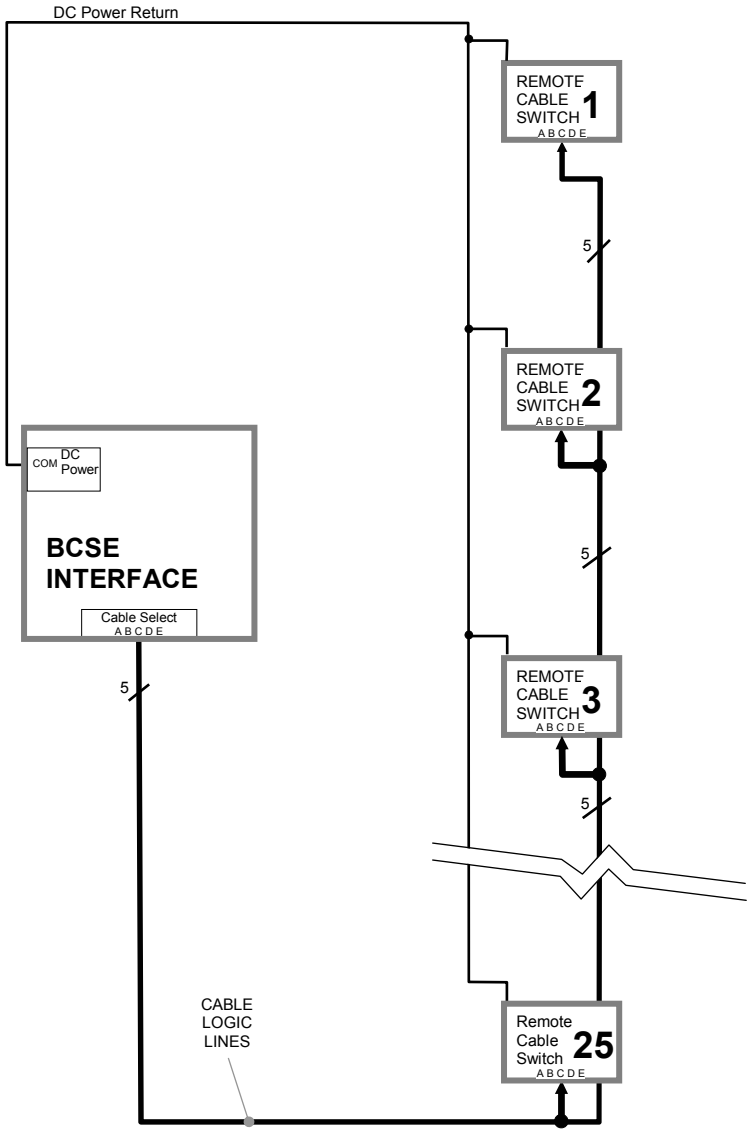


Figure 7 A simplified view of the Cable Select portion of the Control Bus.

- *Cable Numbers and Cable Logic Codes*
  Each *Temperature Cable* in the *KT Switch* is assigned a unique *Cable Number* (from 1 to 24). Any *Cable Number* can be represented by a code instead. When a *Temperature Cable* is selected by a code, this process is known as *Cable Logic*. Codes convert numerals (familiar to humans) into another form useful to electronic devices like the *KT Switch*. That code relates to a physical location in the *KT Switch* holding the temperature data. Another way to think of codes is that they are instructions about how to change the *Relay Switching Cards, thus* preparing the hardware to retrieve data. Every unique relay configuration corresponds to a unique Cable Number. When all relays move to the correct combination of positions, this is called *Decoding*.

- *Binary Coding*
  It should be mentioned that lines on the *Control Bus* can have only two possible voltage levels (distinct states), on and off. It comes from binary system (1 means ON; 0 means OFF).

- *Cable Logic Lines: A, B, C, D and E*
  Commands from the Interface in the form of *Cable Logic Codes* are sent out on a 5-line Control Bus. Five individual lines (known as A, B, C, D and E) appear at each *KT Switch* in the system in binary form. The combination of the 5 wires and the 2 values they can assume, define what the KT Switch does. Table 1 presents the values necessary on each *Logic Line* to connect to a particular *Cable Number*.

Table 1. CABLE SELECT LOGIC CODES

	LOGIC LINES				
CABLE №	**A**	**B**	**C**	**D**	**E**
1	0	0	0	0	0
2	1	0	0	0	0
3	0	1	0	0	0
4	1	1	0	0	0
5	0	0	1	0	0
6	1	0	1	0	0
7	0	1	1	0	0
8	1	1	1	0	0
9	0	0	0	1	0
10	1	0	0	1	0
11	0	1	0	1	0
12	1	1	0	1	0
13	0	0	1	1	0
14	1	0	1	1	0
15	0	1	1	1	0
16	1	1	1	1	0
17	0	0	0	0	1
18	1	0	0	0	1
19	0	1	0	0	1
20	1	1	0	0	1
21	0	0	1	0	1
22	1	0	1	0	1
23	0	1	1	0	1
24	1	1	1	0	1

0= NO VOLTS
1= APPLIED VOLTS

6.2. OUTPUT - Thermocouple-Common Cable

Thermocouple-Common Cable is the only output from the *KT Switch* and carries the actual thermocouple signals that will be processed by the *Interface*. Thermocouple signals are just passed through to the *Switch* unchanged. Figure 8 below, shows a block diagram of *Thermocouple-Common Data Bus* connections.

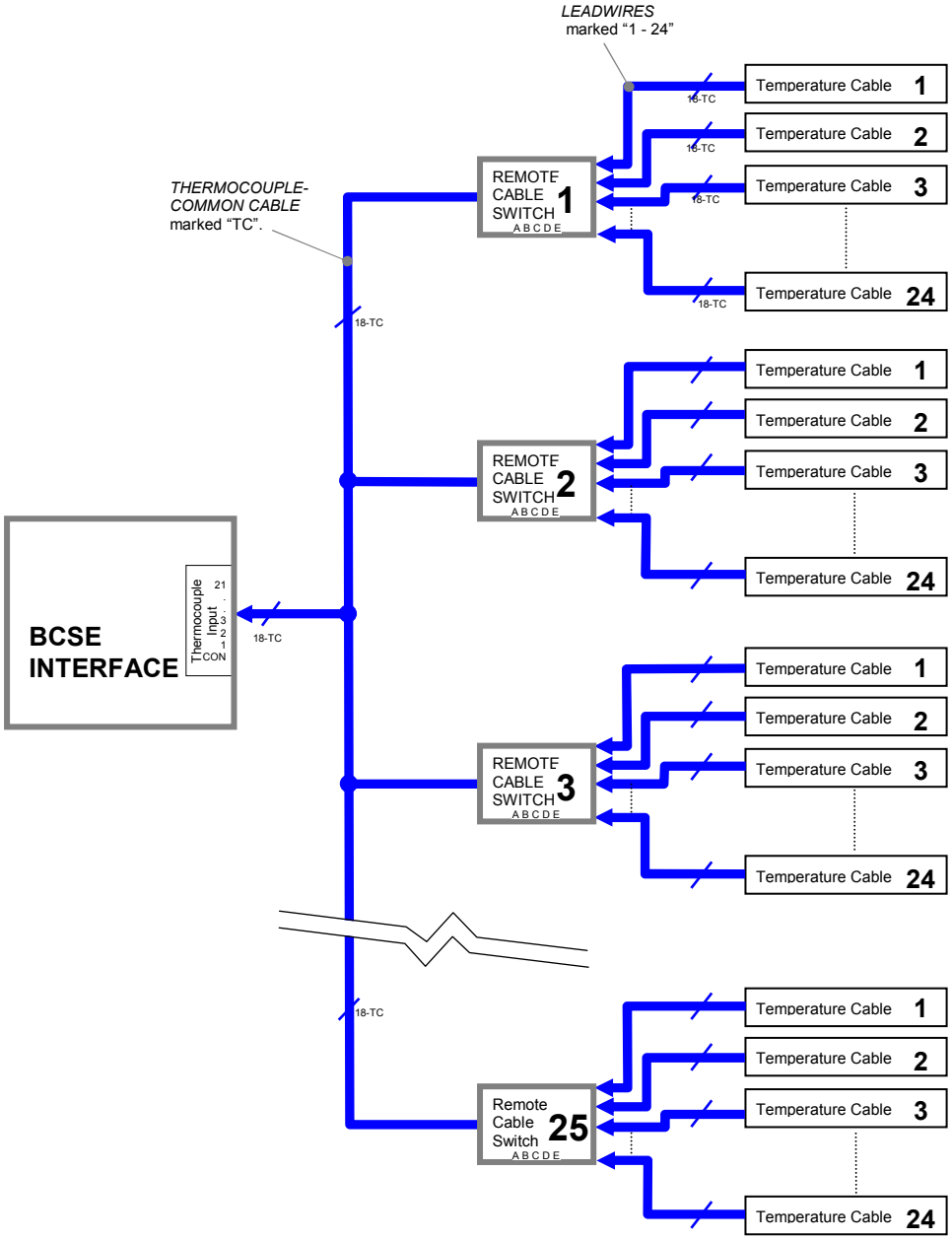
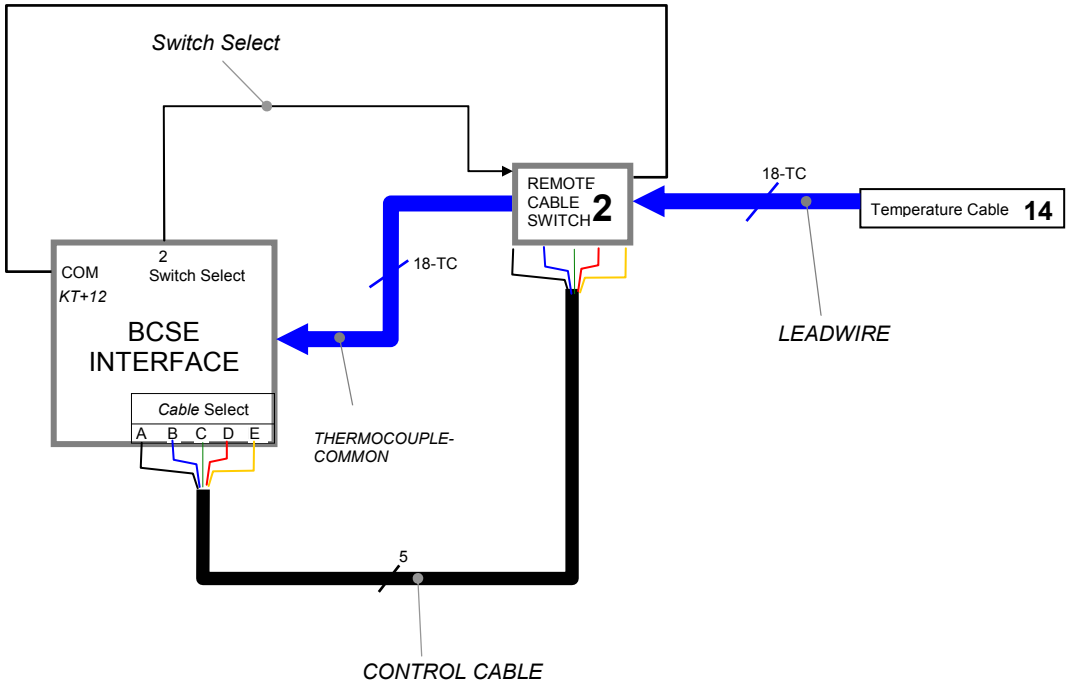


Figure 8 A simplified view of the Thermocouple-Common Data Bus

6.3. AN EXAMPLE OF ONE CABLE READ

This section presents an example of what connections are made when one possible Temperature Cable is selected. Figure 9 shows the lines that are active when Cable № 14 of *KT Remote Cable Switch* № 2 is being read by the Interface. Switch Select Line № 2 is energized by the Interface. Cable Select Lines A, C, D are then energized to choose Cable № 14. Lines B & E are off as the Logic Code requires by the table in figure 9.



	LOGIC LINES				
CABLE №	**A**	**B**	**C**	**D**	**E**
14	1	0	1	1	0

0= NO VOLTS
1= APPLIED VOLTS

Figure 9 A simplified view of the Thermocouple-Common Data Bus

7. WIRING DIAGRAMS

The following sections will look at the more practical aspects and possibilities you may encounter when installing *KT Remote Cable Switches*. In any Grain Temperature Monitoring System employing *KT Switches,* there will be many combinations of the quantity of Switches and amount of Temperature Cables attached to each Switch. This part of the instructions will focus more on the most commonly used systems and using the color codes of wires to make the connections easier.

Figure 10 below shows another way to view all Input and Output connections to a System, but detailing the wire colors dedicated to each type of connection.

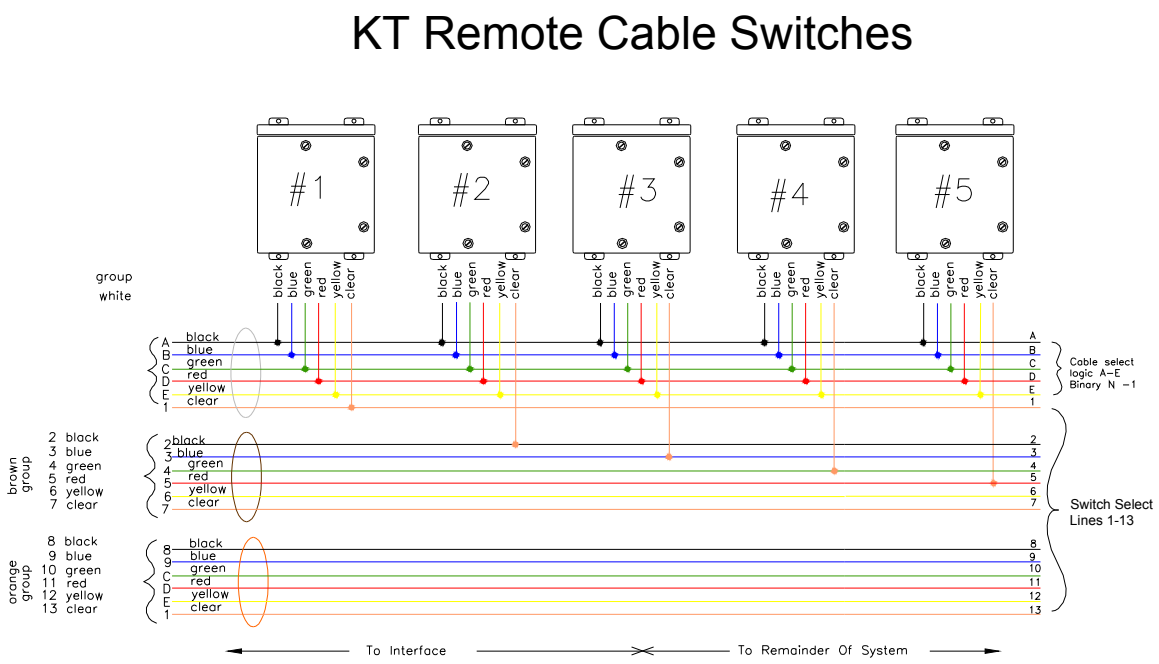


Figure 10 Switches and Their Connections by Wire Colors.

7.1. COLOR CODES

7.1.1. Cable Select & Switch Select

Table 2 describes how insulation colors of the Control Bus cable are organized.

Table 2 Logic Cable Color Codes

	Logic	Insulation Color Code	**GROUP** (Constantan Insulation Color)
Cable Select	A	Black	White
	B	Blue	White
	C	Green	White
	D	Red	White
	E	Yellow	White
Switch Select	1	Clear	White
	2	Black	Brown
	3	Blue	Brown
	4	Green	Brown
	5	Red	Brown
	6	Yellow	Brown
	7	Clear	Brown
	8	Black	Orange
	9	Blue	Orange
	10	Green	Orange
	11	Red	Orange
	12	Yellow	Orange
	13	Clear	Orange

7.1.2. OUTPUT - Thermocouple-Common Cable

Table3 Color Code Chart for *18TC Shielded Thermocouple-Common Cable*.

TC №	Leadwire Insulation Color Code	**GROUP** (Constantan Insulation Color)
1	Black	White
2	Blue	White
3	Green	White
4	Red	White
5	Yellow	White
6	Clear	White
7	Black	Brown
8	Blue	Brown
9	Green	Brown
10	Red	Brown
11	Yellow	Brown
12	Clear	Brown
13	Black	Orange
14	Blue	Orange
15	Green	Orange
16	Red	Orange
17	Yellow	Orange
18	Clear	Orange

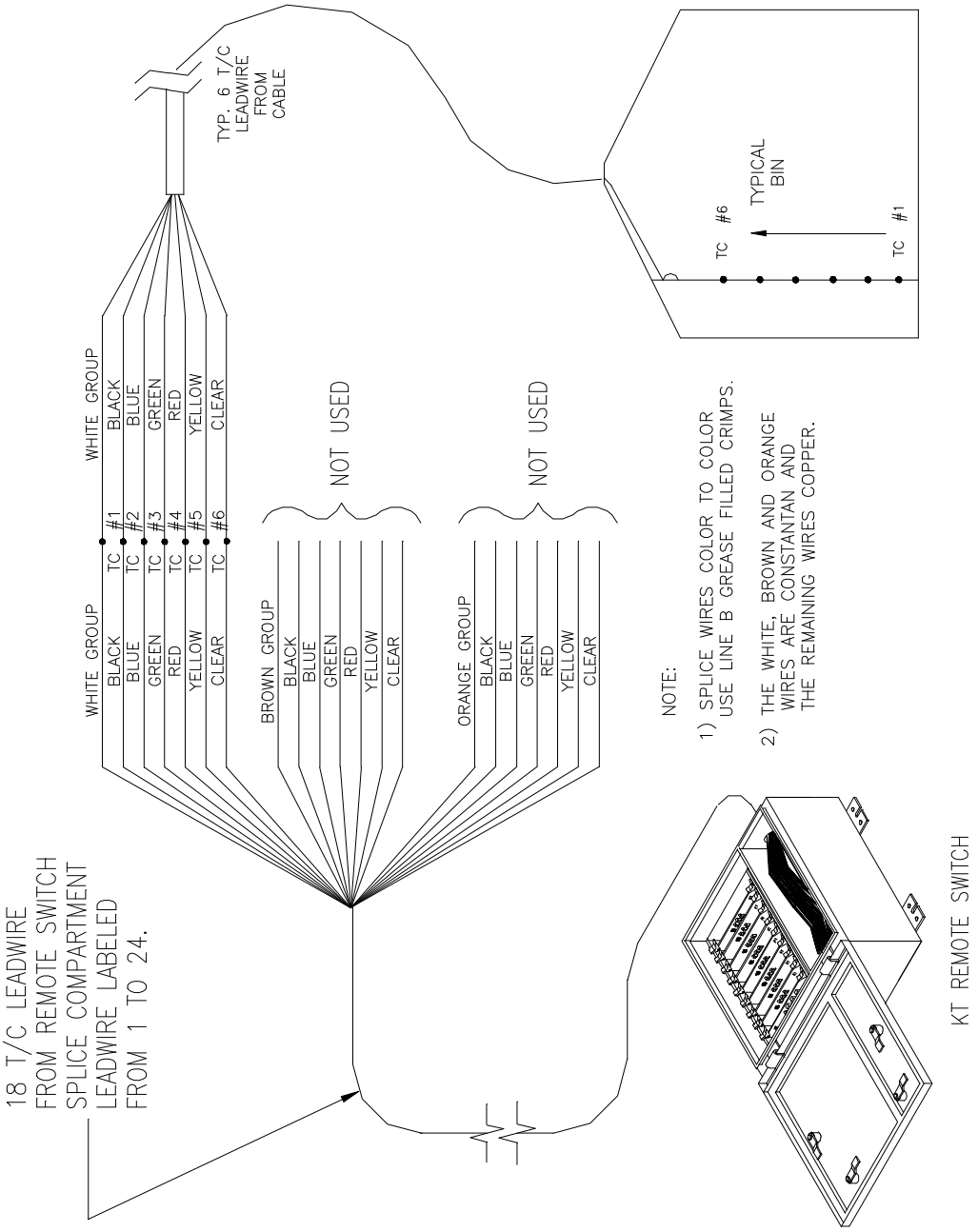


Figure 11 WIRING OF 18-TC KT Remote CABLE SWITCH TO 6-TC CABLE

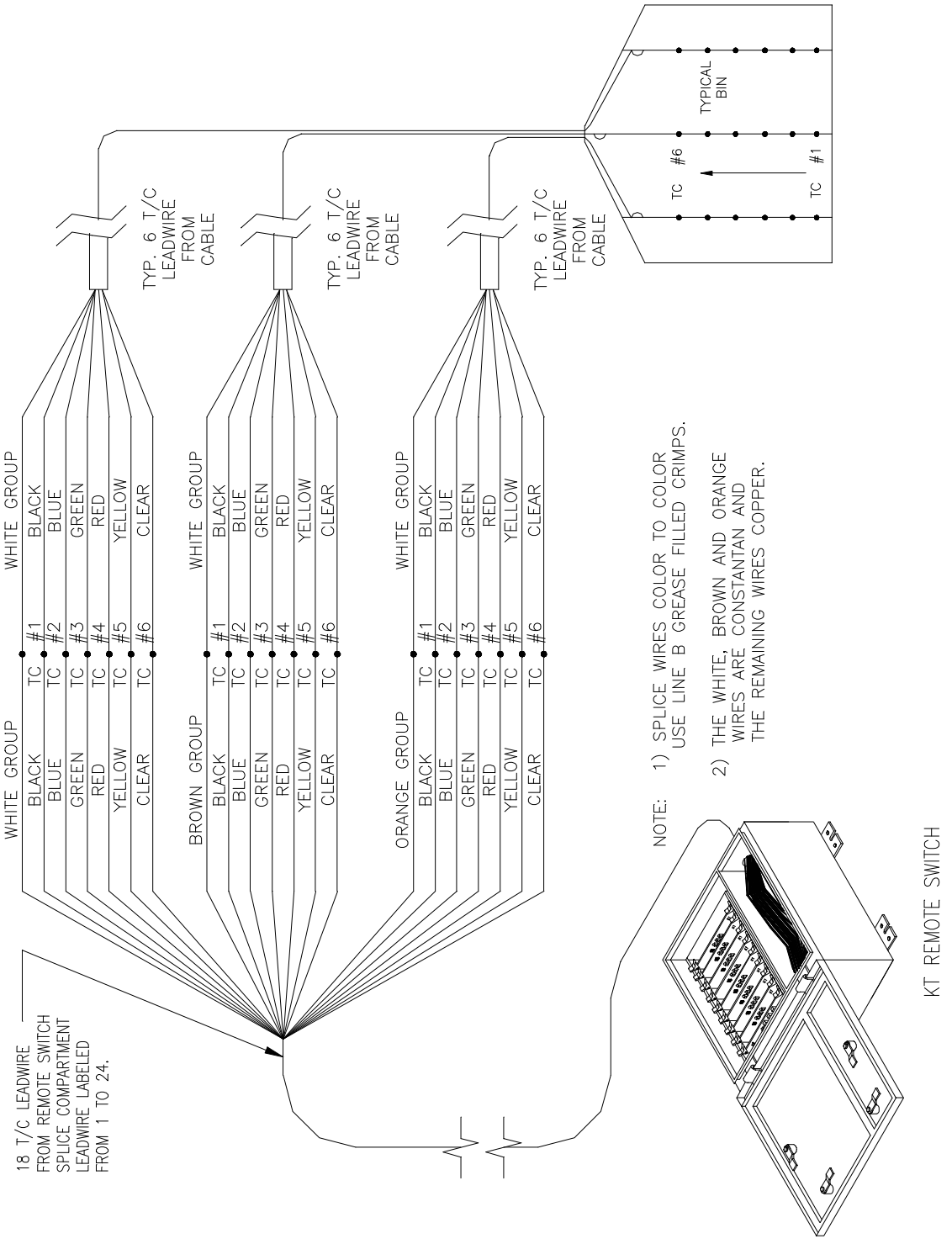


Figure 12 Wiring of 18-TC KT Remote Cable Switch To Three 6-TC Cables (6-TC Special)

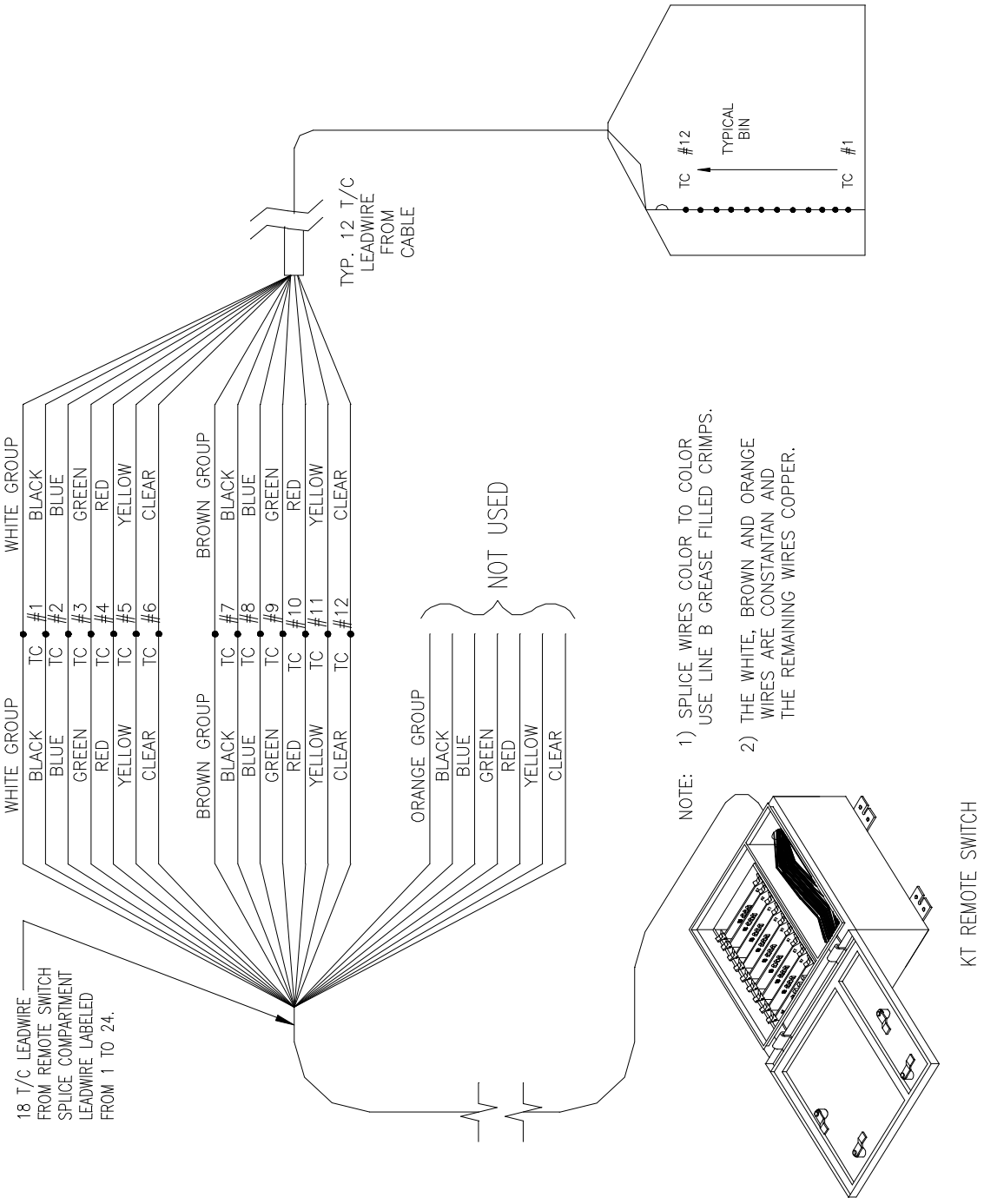


Figure 13 WIRING OF 18-TC KT Remote CABLE SWITCH TO 12-TC CABLE

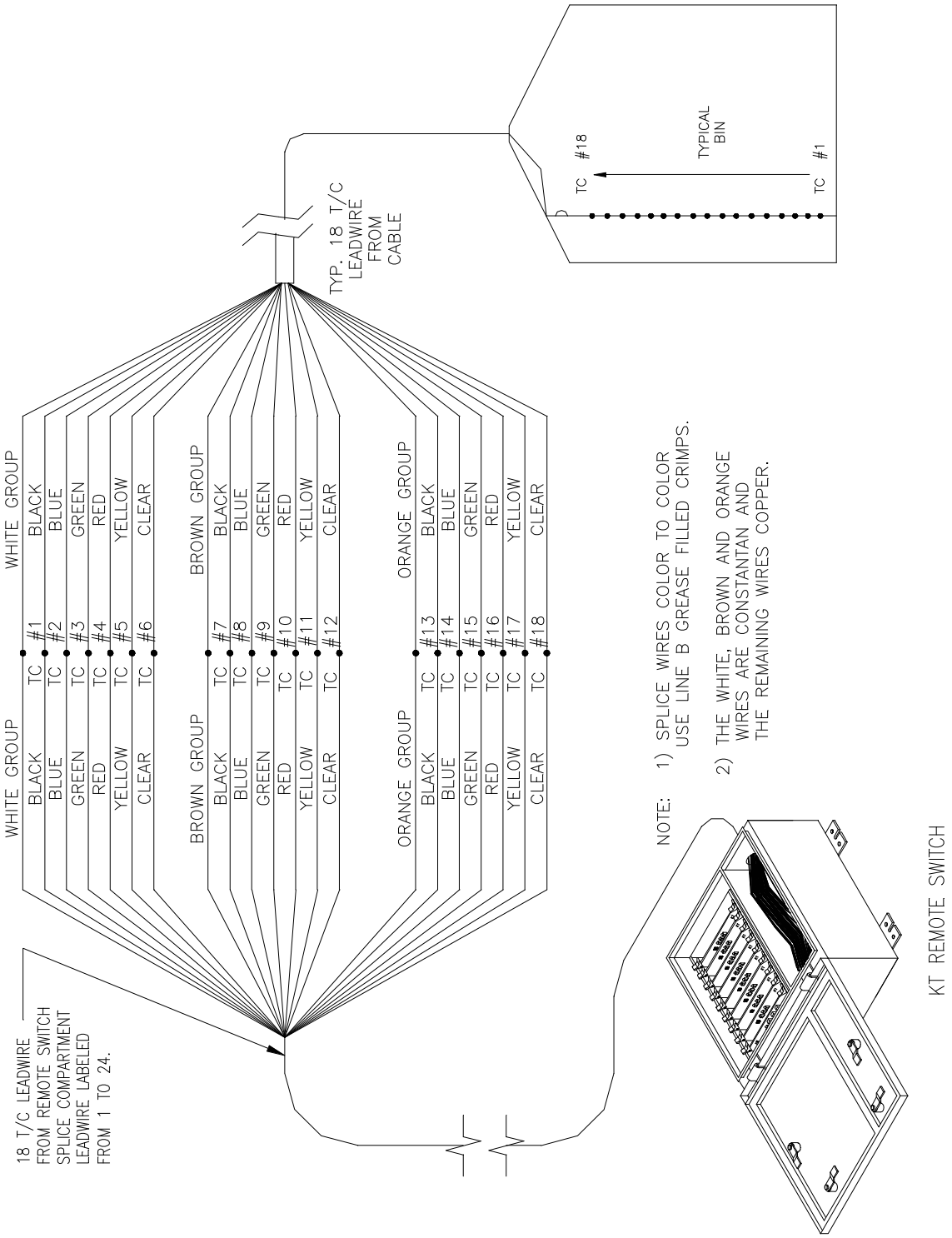


Figure 14 Wiring of 18-TC KT Remote Cable Switch to 18-TC Cable

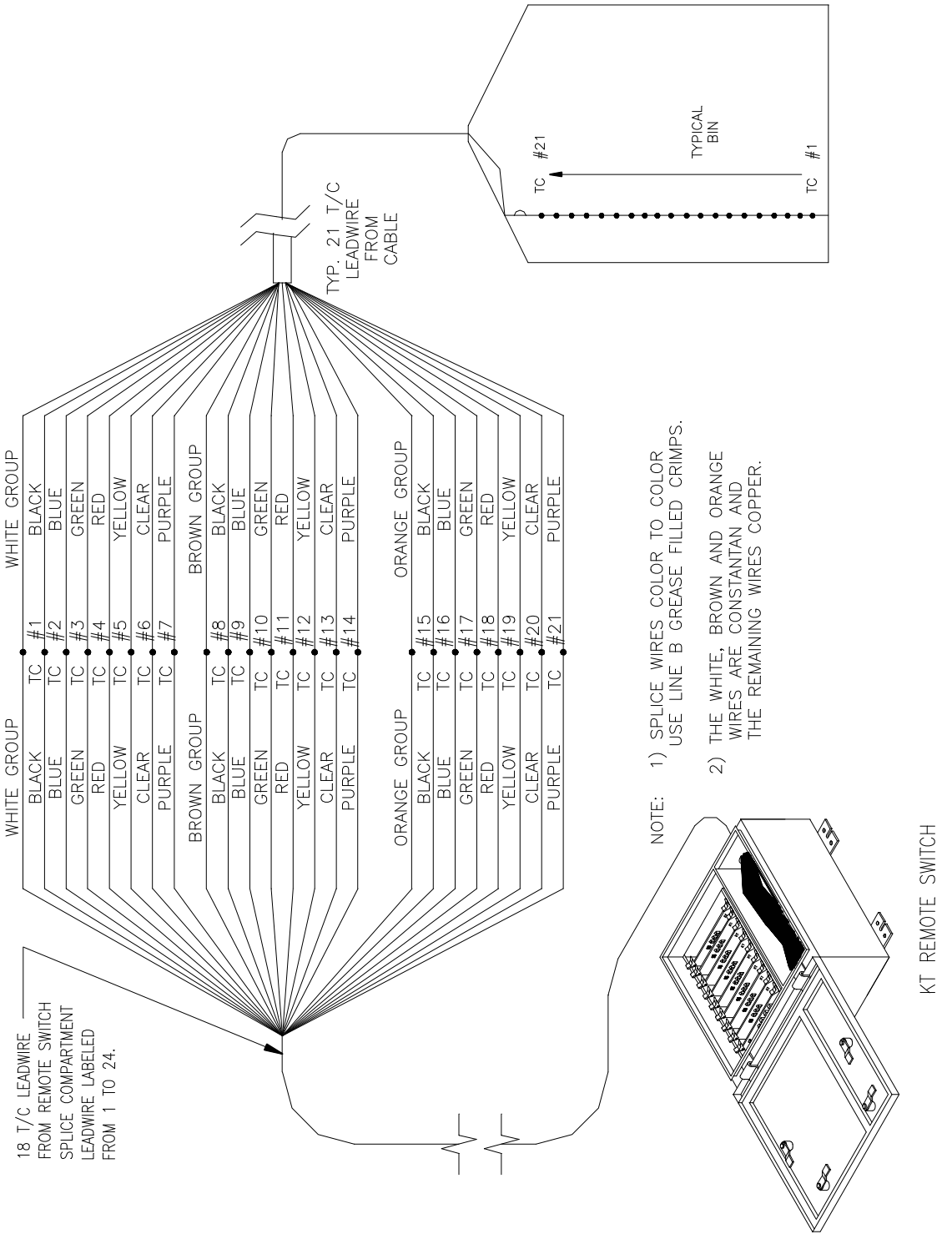


Figure 15 Wiring of 21-TC Kt Remote Cable Switch to 21-TC Cable

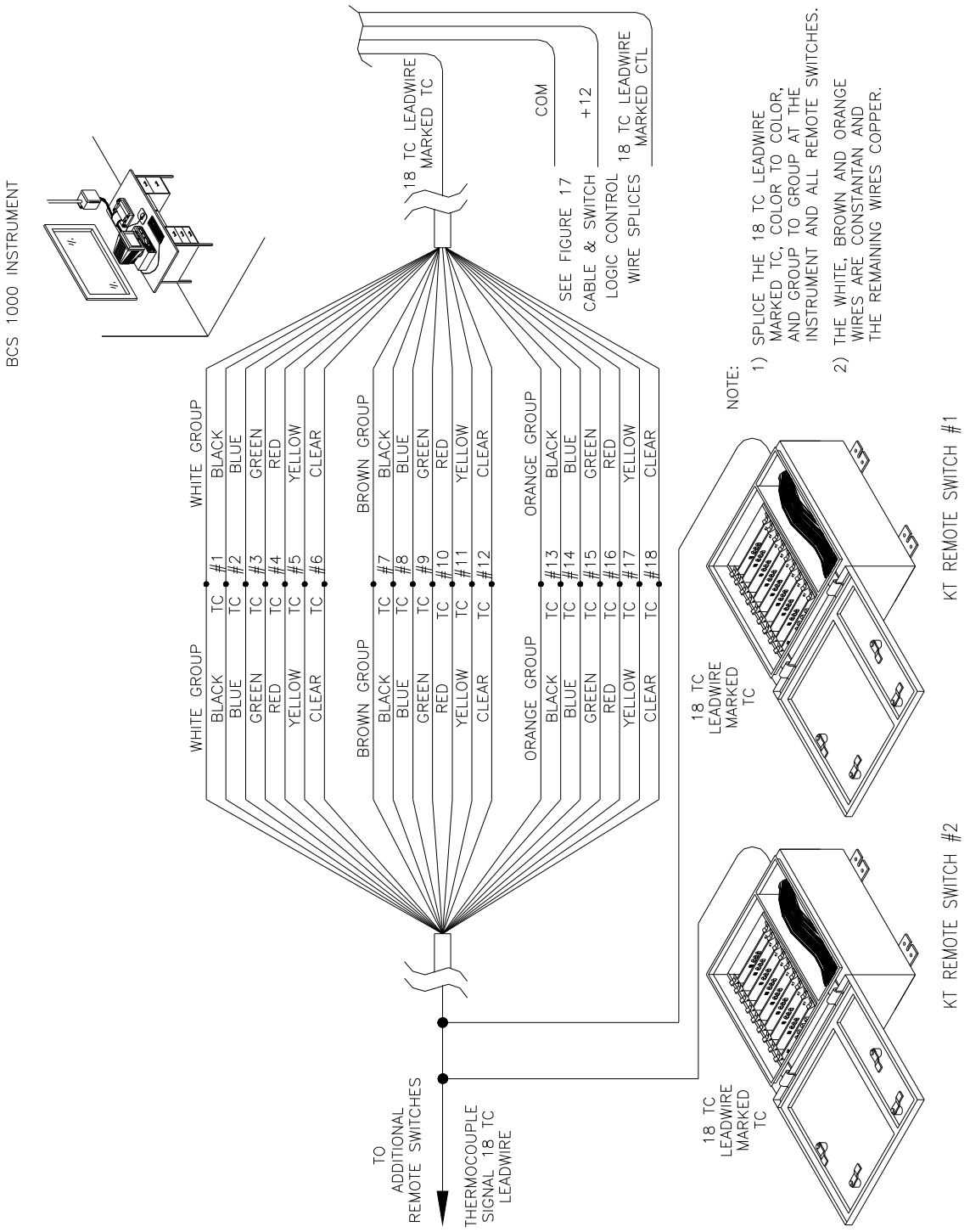


Figure 16 Thermocouple Signal Control Wire Splices

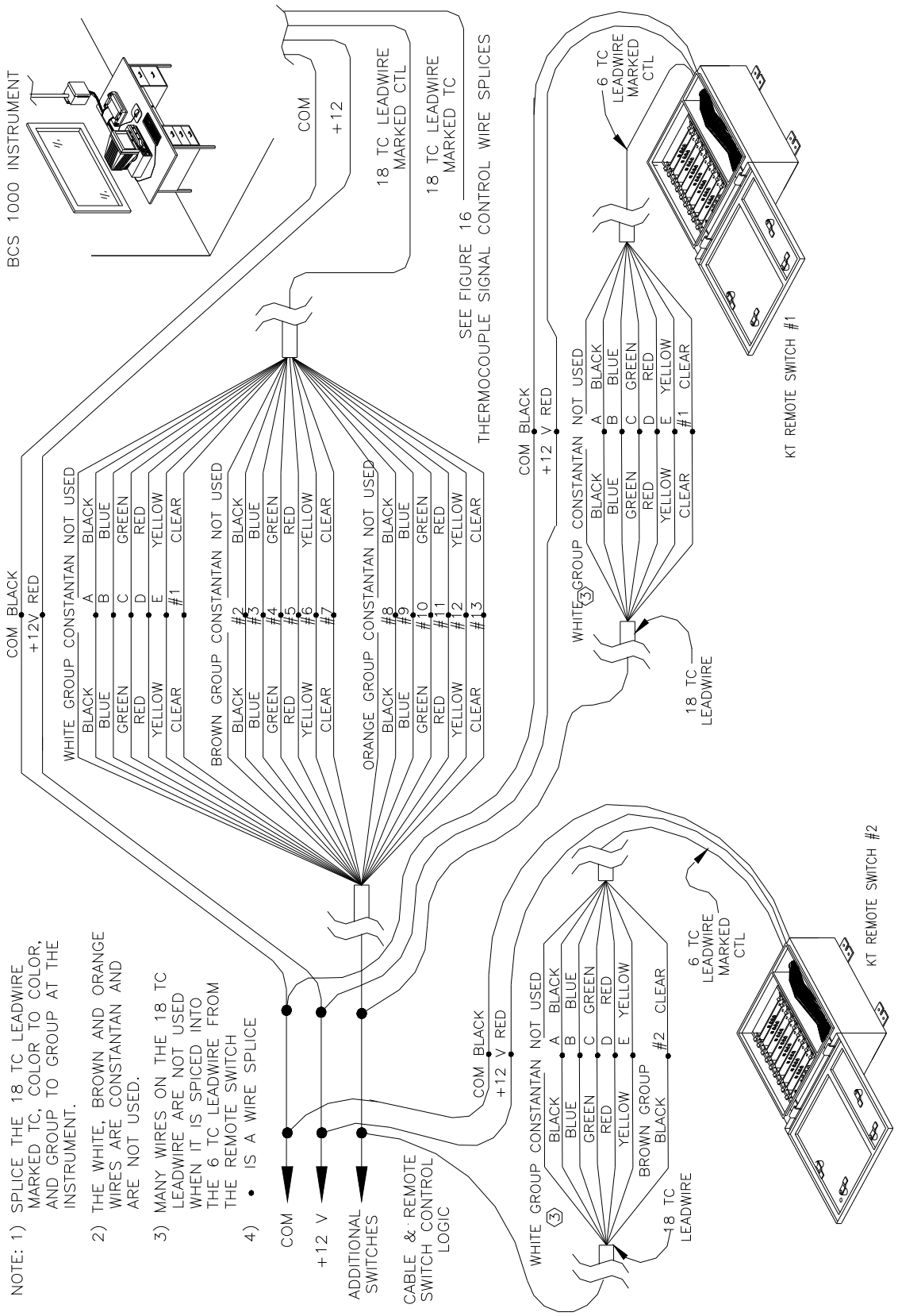


Figure 17 Cable & Switch Logic Control Wire Splices

8. KT REMOTE CABLE SWITCH THEORY & TROUBLESHOOTING

By putting the cable relays onto plug in boards you allow flexibility in sizing the system to the locations requirements.

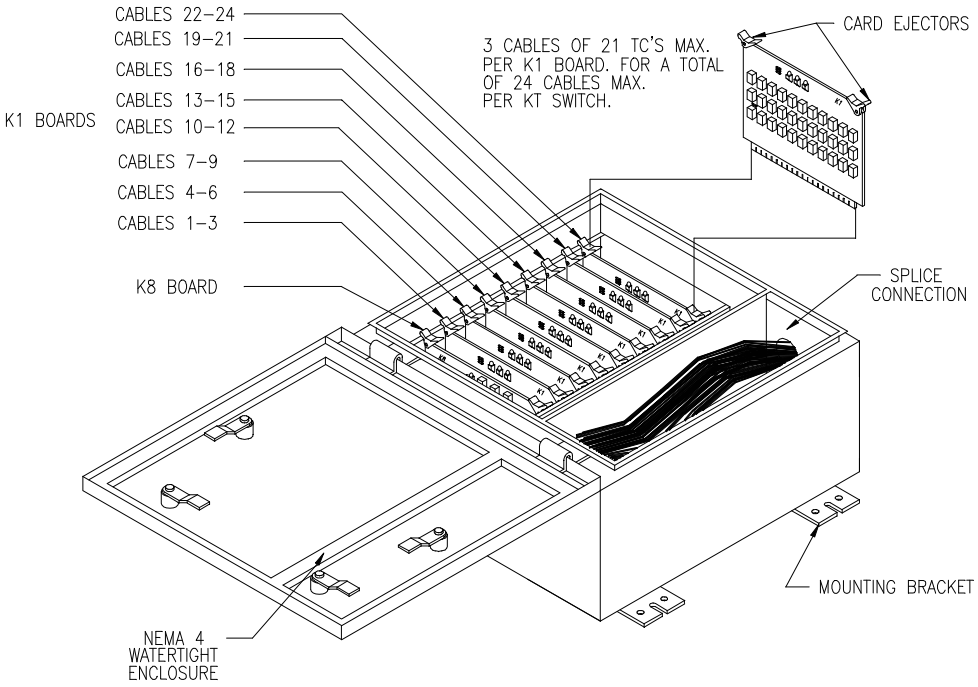


Figure 18 KT REMOTE CABLE SWITCH

8.1. K1 Cable Select Board

8.1.1. Circuit Theory

Each K1 Board can select one of three cables. Selection of a cable is identical for all three, so we will explain the operation of cable A as being typical of all three.

In our example the K8 has energized cable A. Nominally 12 volts is applied to the coils of the bottom row of relays K1 to K11. When the relays are actuated, cable A is routed into the leadwire, through the eleven relays. The leadwire is run to all *KT Remote Cable Switches* and the instrument. The instrument then must select one of the 21 TC's and display the temperature.

The actual voltage across the relays can be read at test points A, B and C (right side of LED's). This voltage should be between 11 and 14 volts for the relays to operate accurately.

8.1.2. Trouble Shooting the K1 Board

One problem that may occur on the boards is an open TC. Swap the K1 Board with another one to determine if the K1 Board is at fault.

Red Light Emitting Diodes give easy visual indication of which cable has been activated. In some cases the LED may be burnt out but the cable still activated properly. This problem can be checked by testing test points A, B and C.

8.2. K8 Control Logic Decoding Board

8.2.1. Circuit Theory

This board is designed to interface and decode the signals from the control lines from the instrument. All of the signals from the instrument are routed into the enclosure through the control wires. These wires are attached to the card cage backplane and soldered into it on the left side of the K8 board. The signals from the instrument come up into the K8 board through the left edge card connector. If the switch select line for a particular switch is at 12 volts, that switch will be selected. The five cable logic lines, when decoded, then select one of the 24 cables on the K1 boards.

8.2.2. Trouble Shooting the K8 Board

The Red Light Emitting Diode gives easy visual indication if the KT Remote Cable Switch has been activated. If the K8 is operating improperly switch it with another one to determine if the K8 Board is faulty.

8.3. Fuses

Inside the BCS ETHERNET Interface are two fuses marked F1 and F2. F1 is a 1.5 Ampere fuse on the 110/220VAC power. F2 is a 1 Ampere fuse for the power lines that go to the KT Remote Cable Switches.

A third fuse marked F3 is used when interfacing with RT Systems. It is 0.5 Ampere and fuses the power lines that go to the KT Remote Cable Switches.