potentiometer (R48). An Emergency stop will also de-energize the spindle contactor after the delay.

J3 and J4 are for future use. J3 pin 1 is identical to J1 pin 16 (active low output to generate External Slidehold). J3 pin 2 is an active high External Slidehold. J4 are Doors Closed signals which will change with the Doors Closed LED (D10). J4 pin 1 is active high (sourcing) and J4 pin 2 is active low (sinking).

**Indicators (LEDs)**

The LEDs on the 2000-1B are slightly different than the 2000-1A:

- There is only one green LED (D10) for the doors. It will be on only if all doors are closed and all circuitry is indicating doors closed.
- There is a separate red LED for each door circuit (one for the normally open of each door and one for the normally closed of each door). The red LED will be on if that circuit is indicating a door open condition.
- There is a yellow LED for each door. This indicates a fault condition in a door circuit (i.e. one circuit indicating door open but the other indicating door closed). This LED will flash whenever the door is opened or closed because the two circuits do not change state at the exact same instant. The flash is normal.
- There are two red LEDs for the External Slidehold outputs. D16 indicates the status of J1 pin 16 and J3 pin 1. D17 indicates the status of J3 pin 2. The LEDs light when the output is active. J1 pin 16 and J3 pin 1 are active low. J3 pin 2 is active high. J3 is for future use.
- A green LED has been added for the status of the spindle solid state relay. It will light when the output for the spindle contactor is on. In other words, it will light when all the doors are open and will go out 5-10 seconds after a door is opened.

## Emergency Stop Circuit Overview

The Emergency Stop (E-stop) circuit is designed to stop the moving functions of the machine when a fault is detected.

### Basic Hardware Operation Description: Normal Operation (No Fault)

When the CPU (1400) issues an enable E-stop command to the Mill Interface (1040), the Mill Interface pulls Panic line (pin 15) down (to ground or about zero volts) which activates K20 on the Power Distribution (1100-1). With K20 contacts closed, 120 VAC is allowed to flow though fuse F14 out 1100-1 TB2-26 to the overload relay switch contacts (number of relay(s) vary for different models and configurations) and the E-stop switch (normally closed) then returns to 1100-1 TB1-10. From this point a wire is contacted to 1100-2 TB1-25 and on the 1100-1 to the coils of K1 and K2, activating K1 and K2.

K1 and K2 normally closed contacts open. One side of these contacts is connected to ground. The other side to the fault lines (1100-1 TB1-2, TB1-3, TB-4, TB1-5, TB1-6, TB1-7), by opening the contacts the 10VDC (8 to 12 VDC) fault lines will allow the Axis Amplifiers or Spindle Drive and Controller PCBA to operate. K2 normally open contacts are connected to 120 VAC through fuse F17 and outputs (1100-1 TB1-8) to the control input on the Amplifier Chassis. This control input activates the solid-state relays on the Amp. Chassis closing the contacts and allowing power to the bridge rectifiers to power up the Amplifiers.

The connection to the 1100-2 (TB1-25) has three paths on the board. The first connects to the coil of K33 and activates the relay closing the contacts and allowing the 120 VAC input power to the Turret Motor. The second supplies 120 VAC to Spindle Forward, Spindle Reverse and Orientation circuits. The third connects through the normally closed contacts of K3 and provides power to the Drawbar and Slide Motor Reverse circuits. This third path also provides a safety function by removing power for the Drawbar and Slide Motor Reverse circuits when the Spindle Forward (K3) is activated.

This is the normal operation of the E-stop circuit providing power to all the circuits involved and allowing the fault lines to stay up (10VDC).

**Fault Condition**

When there is a fault, the E-stop circuit shuts down the machine. It accomplishes this by removing the power to each device. First, the power to K1 and K2 is removed connecting all the fault lines to ground. This informs the Amplifiers and the Controller Boards that they are in E-stop. It also removes the control voltage to the Amplifier Chassis, which removes the power to the Amplifiers. The 120 VAC to the 1100-2 is removed and this causes K33 to open its contacts and stop the Turret Motor. Power is removed from Spindle Forward, Spindle Reverse, Orientation, Drawbar and Slide motor Reverse circuits.

Functional Block and Wiring Diagrams are at the end of this section.

**Basic Software Operational Description**

There are many possible combinations of software functions. The computer board CPU(1400) communicates with the Computer Interface (1030), which communicates with the other boards, Axis Controllers (1010), Spindle controller (1010) and the Mill Interface (1040), or vice versa.

If the CPU initiates an E-stop condition then it disengages the panic line.

The Axis Controllers declares an E-stop to the CPU upon detecting the Fault line down (if cold started) or if the controller detects a problem in operation of the axis, such as the following error being too large.

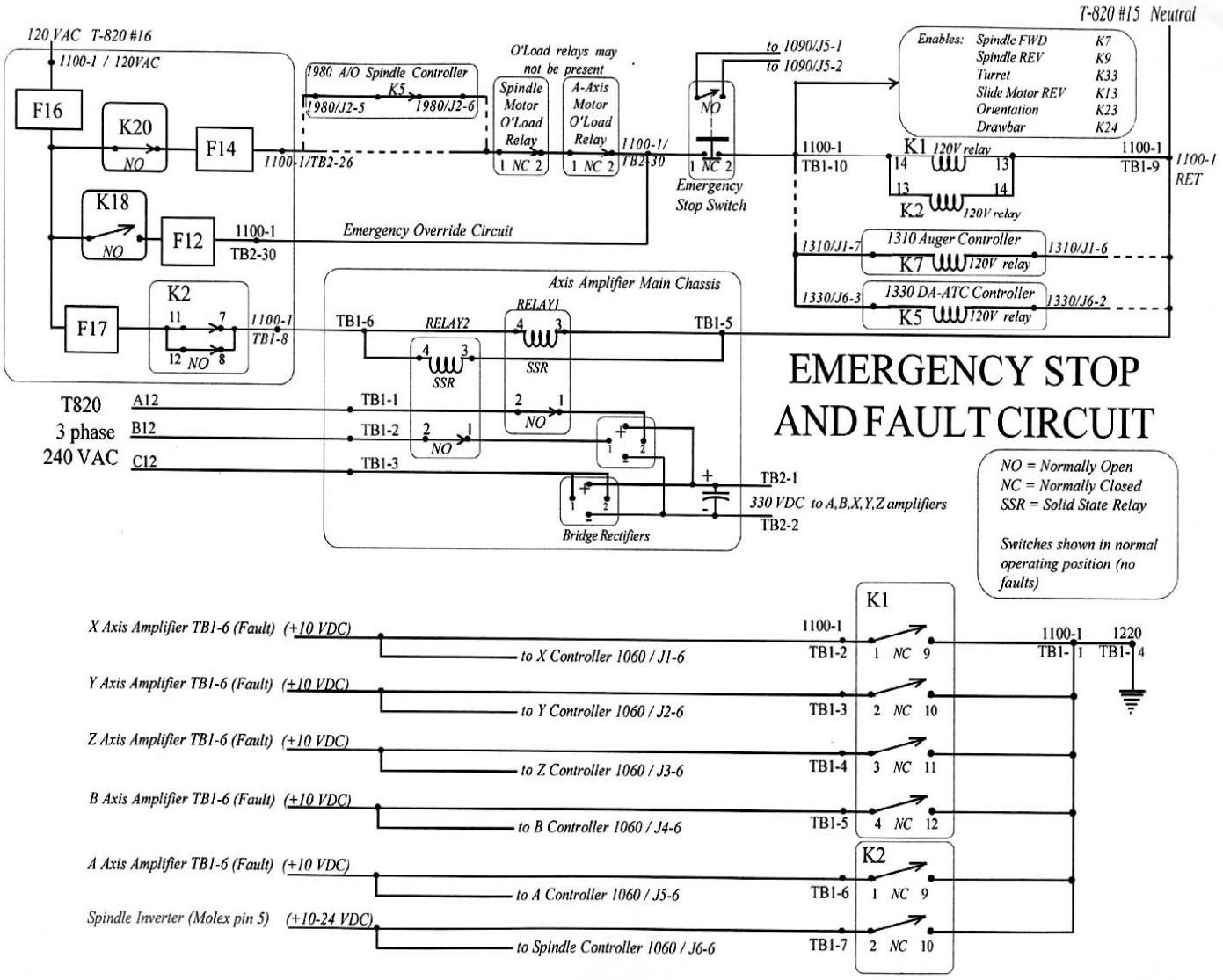
If the operator hits the E-stop switch then the switch opens the 120VAC line to the 1100-1 TB1-10 to initial the hardware E-stop and reports to the CPU though the Keyboard Interface (1090) to the Mill Interface to the Computer Interface to the CPU.

**Troubleshooting Tips**

Some possibilities for error and troubleshooting tips:

- The machine does not use K18.
- Some of the new machines do not have Overload Relays.
- For troubleshooting purposes, place a jumper between F16 and F12 this bypasses the automatic part of the circuit. Use caution when the machine is jumpered because it cannot stop itself. An AC machine must be powered up with the E-stop button pushed in, because the axis will run away if control is not up first.

## Emergency Stop and Fault Circuit



## Emergency Stop Circuitry