CORTEX â INDUSTRIAL SYSTEM CONTROLLER

Brake Letoff Control

Instruction Manual

Model CORTEX-E00

CAROTRON

Driven by Excellence

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SOLID STATE STARTERS, SYSTEM INTERFACE
CIRCUITS AND ENGINEERED SYSTEMS

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1 General Description

Model CORTEX-E00 is a microprocessor based brake let-off control. Tension is regulated by controlling braking torque through varying levels of material roll diameter and line speed. Multiple options are available for obtaining diameter information.

In the simplest mode of diameter compensation, the Cortex calculates the let-off diameter by monitoring the line and let-off speed signals.

A second mode of diameter compensation allows an external diameter signal to be input into the Cortex such as from a sonic device or a lay-on roll that measures diameter. This method is also helpful when accurate diameter information is required with minimal operator interface.

A third method of diameter compensation is to provide a pulse signal proportional to revolutions of the let-off roll. These pulses can be calibrated for one count per turn of the roll and used in conjunction with material thickness, core diameter and max diameter to calculate roll diameter.

This method can provide very accurate diameter information, but requires operator input for starting parameters such as core diameter, max diameter and material thickness.

In its most basic mode of operation, the Cortex provides open loop diameter compensation to obtain constant tension. Closed loop tension control can be obtained by use of a loadcell sensor.

2 Specifications

2.1 Electrical

A.C. Input
Internally fused at 0.3 Amps
• 115 VAC ± 10%, 50/60 Hz ± 2 Hz
• 230 VAC ± 10%, 50/60 Hz ± 2 Hz

Analog Inputs (4)
• Voltage inputs: 10 VDC max
• Current inputs: 20 mADC max
• Nominal +10VDC supply @ 5.0mA

Digital Inputs (6)
Sink Mode
• Vil=3.0 VDC max @ 2.7mA
• Vih=5.0 VDC min to 30.0 VDC max @ 2.5mA
Source Mode
• Vil=3.0 VDC max @ 0.7mA
• Vih=5.0 VDC min to 30.0 VDC max @ 1.0mA
Digital Input Reference
• Internal: Nominal +24 VDC supply @ 200mA
• External: 5.0 - 30.0 VDC

Frequency Inputs (2)
• Frequency: 32kHz max, zero crossing square wave
• Voltage: 12 VDC max
• Sinking current required: 1.5mA min
• Nominal +12VDC supply @ 300mA

Relay Outputs (4)
Form-C contact:
• 3 A @ 115 VAC
• 3 A @ 30 VDC

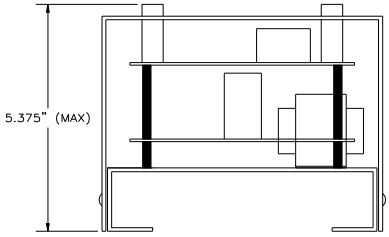
Analog Output
• 10 VDC max (voltage mode)

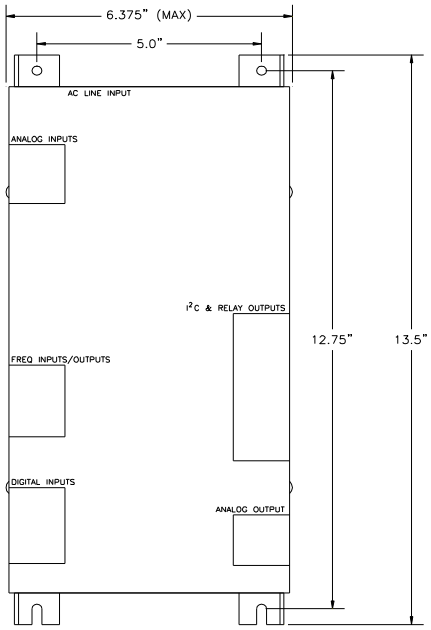
• 20 mADC max (current mode)
• External Voltage Reference -10.0 to +10.0 VDC

Frequency Output
• External Voltage Reference: 0 to 16.0 VDC
• Output Frequency: 2kHz max, zero crossing square wave
• Output current: 50mA max

I²C Expansion Bus
• Nominal +12 VDC supply @ 300mA

2.2 Physical





3 Installation

The Cortex should be installed in accordance with the National Electric Code and any applicable local or state codes.

WIRING PRECAUTIONS:

Use shielded cable for all analog, digital, and frequency inputs and outputs. Connect the shield to circuit common at the receiving end only. Please note that there are 6 different isolated sections on the Cortex. This allows unisolated drives, tachometers, etc... to be connected directly to the unit without the need for an isolation card. Each isolated common is designated on the included drawings with a unique number to distinguish one section from the others.

Any relays, contactors, motor starters, solenoids, etc. located in close proximity to or on the same A.C. line as the Cortex controller should have a transient suppression device in parallel

with the coil to minimize interference with the unit.

TERMINAL CONNECTIONS:

TB1 (AC line input)
Terminals 1 and 4 are used for the AC line input. Either 115 or 230VAC input can be connected to these terminals. If 115VAC input is used, place a jumper between terminals 1 & 2 and also between terminals 3 & 4. If 230VAC input is used, place a jumper between terminals 2 & 3.

TB2 (Analog inputs)
There are 4 analog inputs on the Cortex, 2 voltage and 2 current. Terminals 1 and 6 provide the +10VDC supply and the common connection respectively. Terminals 2 and 4 are the voltage inputs and terminals 3 and 5 are the current inputs.

TB3 (Frequency output)
Terminal 2 is the frequency output signal and terminal 3 is the common. An external voltage up to 16 VDC must be supplied at terminal 1.

TB4 (Frequency inputs)
Terminal 2 is the frequency #1 input, and terminal 3 is the frequency #2 input. Terminals 1 and 4 provide a nominal +12VDC supply and the common connection respectively.

TB5 (Digital inputs)
Terminals 1 through 6 provide the six digital inputs, and terminal 7 provides the common connection. When configured with the INTERNAL reference, terminal 8 provides a nominal +24VDC level to be used with the digital inputs. If desired, an external signal up to +30 VDC can be used by selecting EXTERNAL reference. Terminal 8 then becomes an input for the external voltage signal.

TB6 (I^2C Bus)
This expansion port can be used to supplement the Cortex with additional inputs and outputs along with other interface options. Terminal 1 is the SDA or signal data line and terminal 4 is the SCL or signal clock line. Terminals 2 and 3 provide a +12VDC signal and circuit common respectively.

TB7 (Relay Contacts)

Relay #1 contacts:	Normally closed	Terminal 1
	Normally open	Terminal 2
	Wiper	Terminal 3
Relay #2 contacts:	Normally closed	Terminal 4
	Normally open	Terminal 5
	Wiper	Terminal 6
Relay #3 contacts:	Normally closed	Terminal 7
	Normally open	Terminal 8
	Wiper	Terminal 9
Relay #4 contacts:	Normally closed	Terminal 10

Normally open.....Terminal 11
Wiper.....Terminal 12

TB8 (Analog Output)

Terminal 3 is the analog output signal. When configured as a voltage output, the common connection should be connected to terminal 4. When configured as a current output, the current return signal should be connected to terminal 5. If desired, an external voltage signal can be applied to trim the analog output. This is achieved by applying the signal to terminal 1 and configuring the output reference to EXTERNAL. Terminal 2 provides an extra common connection.

4 Operating Modes

Off Mode

The Cortex inputs and outputs are disabled.

Manual Mode

In the manual mode, the torque reference output of the Cortex must be adjusted manually to achieve the desired tension. The PID and inertia functions are disabled in this mode.

Auto Mode

In the auto mode, the torque reference output of the Cortex is automatically controlled to achieve a constant tension level. With a loadcell, closed loop tension control with diameter compensation is available. The Cortex can also provide for open loop control with diameter compensation if a loadcell is not desired.

Stall Mode

The Cortex outputs the set Stall Torque level.

Run Mode

When the Run Mode is initially entered, the Cortex outputs the Initial Run Torque level as the line increases in speed. When the line acceleration is complete or a programmed time period has elapsed, the output ramps to the Manual torque level (in the Manual mode) or to the level commanded by the Auto Tension setpoint (in the Auto mode).

Stop Mode

When the Stop mode is initially entered, the Cortex continues operation as described in the Run Mode. When the line reaches Zero Speed or a programmed time period has elapsed, the Stall Mode is entered and the output ramps to the Stall Torque setpoint.

E-Stop Mode

When the Estop mode is entered, the torque output immediately goes to its maximum level. The Stall and Run inputs must be released to exit this mode.

5 Programming & Adjustments

INTERFACE

The Cortex contains an RS232 communication port for serial communication to and from the unit. This communication port is used in conjunction with a handheld programmer, panel mount programmer, or a personal computer to configure the Cortex's operating parameters. A standard 9 pin communication cable is required to connect the Cortex to a PC. When power is applied, the unit goes into an initialization process and then displays the first monitoring screen. Please refer to drawing D11928 in Section 8 for visual representation of the menu structure.

MENU

After the initial power up, the display will show the first monitoring screen and may contain items such as line speed, let-off speed, diameter, and operating mode. The user can scroll through the monitoring screens and the QUICK MENU by using the 'D' and 'E' keys. The 'D' key will take you to the previous screen and the 'E' key will take you to the next screen. The last monitoring screen displays the setpoint, loadcell feedback, and other PID values. The values range from 0.00-1.00, which correspond to 0-100%.

When viewing the last monitoring screen showing the PID values, pressing the 'E' key will take you back to the first monitoring screen if the PASSWORD ENABLE parameter is set to 'yes'. If the password enable is not on, the QUICK MENU will be displayed. The QUICK MENU contains parameters that may require changing frequently. The softkeys are used to navigate through the menu and set values. When the NEXT softkey is pressed at the last QUICK MENU screen, the display will return to the first monitoring screen. To gain access to the QUICK MENU when the password protection is on, press the 'ENTER' key while at one of the monitoring screens. Enter the QUICK MENU password when prompted.

The MAIN MENU is accessed by pressing the 'ENTER' key. If the PASSWORD ENABLE selection is set to 'yes', the menu password has to be entered to gain access. Otherwise, the MAIN MENU screen is displayed and 8 options are given allowing the inputs, outputs, and functionality of the Cortex to be defined. Once an option is chosen, the appropriate menu screen is displayed. When in the menu, the top 5 keys (A,B,C,D, and E) act as 'soft keys'. The function of each soft key is indicated by the text immediately above each key in the bottom row of the display. The softkeys are used to navigate through the menu and set options. Please note that some parameters cannot be modified unless the unit is in the OFF mode. The following contains a description of each menu screen and the function of each parameter.

MAIN MENU

1-I/O .....Configures the inputs and outputs.
2-BRAKE.....Configure the Brake parameters.
3-OPTIONS ..... Configure the operating, PID, and accel/decel parameters.
4-TENSION .....Configure the tension and torque settings.
5-DISPLAY ..... Set monitoring preferences.
6-SYSTEM ..... Set security passwords.
7-FILE ..... Load and Save user configurations.
8-EXIT ..... Return to the monitoring screens.

1. I/O (INPUTS/OUTPUTS)

CONFIGURE I/O

The analog, digital, and frequency inputs can be configured by pressing the INPUTS softkey. Likewise, the analog, frequency, and relay outputs are configured by pressing the OUTPUTS softkey. The MAIN softkey will take you back to the MAIN menu.

INPUTS

The digital inputs can be configured by pressing the DIGITAL softkey and the analog and frequency inputs are configured by pressing the ANALOG/FREQ softkey. The PREV softkey will take you back to the I/O menu.

DIGITAL INPUT VOLTAGE

Selects the source of voltage used on the digital input section. An internal unregulated nominal voltage of +24VDC is the factory preset and is accessed at TB5 terminal 8. If desired, an external voltage can be used by selecting external and applying the voltage at TB5 terminal 8.

DIGITAL INPUT LOGIC

Selects the type of logic for the external devices used on the digital inputs. The factory preset is SOURCE which sets the digital inputs low and the external input device must SOURCE or drive the input high when activated. An example of this is simply a switch connected to a digital input and the voltage source at TB5 terminal 8. The SINK selection sets the digital inputs at a high state and the external input device must SINK or pull down the input when activated. An example of this is simply a switch connected to a digital input and the common terminal at TB5 terminal 7.

DIGITAL INPUTS 1 - 6

Each digital input may be configured to provide various functions. Digital inputs 1-6 are programmable and can perform the functions listed below. The FUNC softkey allows the user to scroll through a list of unused functions. Each digital input may also be configured to be on (active) when the external device or switch is in the open or closed position. Normally open switches should be configured as ‘CLOSED=ON’ and normally closed switches should be configured as ‘OPEN=ON’. The TYPE softkey allows configuration. The factory preset is ‘CLOSED=ON’.

Off
The input has no function.

Stall
This input selects whether the Cortex is in the Off or Stall modes.

Run
This input selects whether the Cortex is in the Run or Stop modes.

Auto/Manual
The input selects whether the Cortex is in the automatic or manual modes.

Bit 1, Bit2, Bit3
These input functions can be used to select and load a user defined parameter set. When all are used, up to 8 different configurations are possible. Bit 1 has a binary weight of 1, bit 2 has a binary weight of 2, and bit 3 has a binary weight of 4. Refer to PARAMETER LOADING under the OPTIONS section for more information.

Memory Reset
The memory reset function is used to manually reset the integral and diameter memories. This function will only reset the diameter memory when the revolution counter and the material thickness are used to determine the diameter. If a diameter signal or let-off speed signal are used for diameter info, the memory reset function will have no affect on these signals. If this function is not assigned to a digital input, the memory reset function will automatically be performed when the Cortex enters the OFF mode.

E-Stop
The E-Stop function commands the Cortex to immediately output the maximum torque level. The unit must be cycled back to the OFF mode to reset the unit.

VOLTAGE 1 INPUT, **CURRENT 1 INPUT**,
VOLTAGE 2 INPUT, **CURRENT 2 INPUT**,
FREQUENCY 1 INPUT, FREQUENCY 2 INPUT

Each of the 4 analog inputs (2 voltage, 2 current) and 2 frequency inputs can be configured to provide certain functions. The FUNC softkey scrolls through a list of available functions. Please note that if an input function is not displayed as you scroll through the list, it is already assigned to a different input. The function must be first unassigned before it can be reassigned to a new input.

After a function has been chosen, the CAL softkey allows the Cortex to calibrate the input. The Cortex can automatically measure the minimum and maximum levels by choosing AUTO. The Cortex will prompt you to input the minimum signal level and then press OK. It will then prompt you to input the maximum signal level. Again when this is done, press OK. Note: The calibration routine can only be run when the unit is in

the OFF mode.

The Cortex also allows the user to manually set or adjust these minimum and maximum signal levels by pressing the MAN softkey. The levels are displayed and can be modified by pressing the SET softkey. Note that the 4 analog input levels have a resolution of 12 bits. The values can range from 0 to 4095 and correspond to an analog level of 0 to 10VDC or 0 to 20mADC. The frequency input levels are in Hertz and can range from 0 to 32,000 Hz.

Furthermore, the AVG softkey allows adjustment of the windowed or sliding average routine that is performed on the incoming signal. The size of the window is adjustable from 1 (no averaging) up to 255.

The following input functions are available as analog or frequency:

Off
The input has no function.

Auto Tension
The auto tension function is used to set the desired tension level when running in the auto mode. If this function is not assigned to an input, an internal setting may be used.

Manual Torque
The manual torque function is used to set the torque level output when running in the manual mode.

Stall Torque
The stall torque function is used to set the torque level output when in the stall mode.

Init Run Torque
The init run torque function is used to set the torque level output when the RUN mode is initially entered. This level is maintained until the line finishes accelerating or the Run Delay Timer expires.

Line Speed
The line speed function is used to monitor the line speed. This allows the Cortex to perform the Zero Speed and Line at Speed functions, and in some cases the diameter calculations.

Diameter
An external signal representing the diameter of the let-off roll is one method of providing diameter information to the Cortex. The signal should be at its minimum level when at Core and at its maximum when at the maximum diameter.

Loadcell
When closed loop tension control is desired, a buffered loadcell signal must be supplied to measure the tension.

The following input functions are available only as frequency inputs:

Let-Off Speed
This signal function can be used to monitor the speed of the let-off roll. When combined with the line speed information, the Cortex can calculate the diameter of the let-off roll.

The following input functions are available only on frequency input 2. Please also note that the calibration function is disabled when either of these functions are selected since they are simply counting pulses.

Revolution
A third option of determining the diameter is to provide a pulse per revolution input signal. The Cortex, when provided with the pulses per revolution and material thickness data can compute the diameter.

OUTPUTS
The analog and frequency outputs can be configured by pressing the ANALOG/FREQ softkey. Likewise, the relay outputs are configured by pressing the RELAY softkey. The PREV softkey will take you back to the I/O menu.

ANALOG REFERENCE
Selects the reference source of voltage for the digital to analog converter. The factory preset is INTERNAL and selects a DC voltage level that allows an output up to 10VDC or 20mADC. If desired, an external voltage can be used to trim the output by selecting EXTERNAL. The external voltage should be applied to TB8 terminal 1.

ANALOG OUTPUT
Selects whether the analog output is voltage or current. The output is at TB8 terminal 3 regardless of the selection. However, the common or return connection should be made to terminal 4 for voltage and terminal 5 for current. The factory preset is VOLTAGE.

ANALOG OUTPUT BIAS
This menu screen is used to set a bias level for the analog output. The '+' and '-' softkeys are used to adjust the level up and down. The RES softkey will toggle the resolution between a coarse and fine adjustment. The factory preset is 0%.

ANALOG OUTPUT GAIN
This menu screen is used to set the gain level for the analog output. The '+' and '-' softkeys are used to adjust the level up and down. The RES softkey will toggle the resolution between a coarse and fine adjustment. The factory preset is 100%.

FACTORY OFFSET
This parameter is used to zero the internal amplifier connected to the digital to analog output. This parameter is set at the factory and should not require re-adjusting.

FACTORY GAIN
This parameter is used to set the gain of the digital to analog signal to 10 VDC or 20 mADC. This parameter is set at the factory and should not require re-adjusting.

FACTORY BIAS
This parameter is used to bias the analog output to zero. This parameter is set at the factory and should not require re-adjusting.

RELAY #n FUNCTION (n = 1 - 4)
Each relay output may be configured to provide various functions. Below is a description of each function:

Off
The relay has no function and is de-energized.

On
The relay has no function and is energized.

Zero Speed
This function monitors the line speed input and is energized when the speed is below the adjustable ZERO SPEED SETPOINT and de-energized above it.

Line at Speed
This function monitors the line speed input and is energized when the speed is not accelerating.

Run
This function energizes the relay when in the RUN mode.

Stall
This function energizes the relay when in the STALL mode.

E-Stop
This function can be used to indicate an emergency stop condition. This function de-energizes the relay when in the E-STOP mode.

Tension Out of Range
In the automatic mode, as the diameter of the let-off roll decreases, the torque output of the Cortex also decreases to keep the tension constant. However, when in the manual mode, it is possible to command the full torque level when the diameter is at or near Core. This produces tension well beyond the 100% level.

The Tension Out of Range function energizes when the tension is above 110% and de-energizes when the tension is below 90%.

FREQUENCY OUTPUT

This menu allows the user to select the function of the frequency output and to set the level of the maximum output. Pressing the FUNC key scrolls through a list of functions that are described below. The SET softkey allows the 100% frequency output level to be defined in Hertz. The frequency output range is 0 to 2000 Hz.

Off
The frequency output is disabled.

Tension
The frequency output will be proportional to the material tension.

Diameter
The frequency output will be proportional to the let-off diameter.

Line Speed
The frequency output will be proportional to the line speed input signal.

Let-Off Speed
The frequency output will be proportional to the let-off speed.

Torque
The frequency output will be proportional to the torque output signal of the Cortex.

2. BRAKE DATA

BRAKE TORQUE

The 100% torque level of the brake is entered here. This value should be less than or equal to the nameplate torque rating of the brake.

LET-OFF ENCODER PPR (Pulses Per Revolution)

The number of pulses per revolution of the let-off speed encoder or the revolution counter is entered here. This parameter is only required if the let-off speed or revolution input functions are defined.

LET-OFF GEAR RATIO

The gear ratio of the let-off core to the brake is entered here.

3. OPTIONS

1-OPERATING PARAMS .....Configure operating parameters.
2-PID..... Configure the PID parameter options.
3-ACCEL/DECEL ..... Configure accel and decel times.
4-MAIN..... Return to the MAIN MENU.

1. OPERATING PARAMETERS

CORE DIAMETER
The core diameter is entered here. Press the UNITS softkey to scroll to the desired units.

MAX DIAMETER
The maximum diameter is entered here. Press the UNITS softkey to scroll to the desired units.

MATERIAL THICKNESS
The thickness of material is entered here. Please note that this is only required if a revolution pulse input is used to measure the let-off diameter. Press the UNITS softkey to scroll to the desired units.

RUN DELAY MODE
When initially entering the RUN mode, the Initial Run Torque level is output. This parameter selects when the Manual Torque (manual mode) or the Auto Tension (auto mode) level is activated. If TIMER is selected, the RUN DELAY TIMER must expire before the new level is activated. If the LINE AT SPEED function is selected, the new level is activated when the line finishes accelerating. If EITHER is selected, either of the above conditions will activate the new level.

STOP DELAY MODE
When initially entering the STOP mode, the output continues operate as it did in the RUN mode. This parameter selects when the STALL mode is entered and the Stall Torque level is applied. If TIMER is selected, the STOP DELAY TIMER must expire before the STALL mode is entered. If the LINE AT ZERO SPEED function is selected, the STALL mode is entered when the line reaches zero speed. If EITHER is selected, either of the above conditions will cause unit to enter the STALL mode.

LINE AT SET SPEED SENSITIVITY
This parameter adjusts the sensitivity level of the LINE AT SPEED function. A high level of sensitivity will detect when the line has finished accelerating quickly. A low level of sensitivity takes longer to detect when there is no acceleration. If during acceleration, the Line at Set Speed function activates before the line has finished accelerating, lower the sensitivity level.

ZERO SPEED SETPOINT
This parameter sets the level of line speed at which the zero speed relay energizes and de-energizes. A small hysteresis level is also provided to prevent ‘chattering’ of the relay.

RUN DELAY TIMER
See RUN DELAY MODE above for explanation.

STOP DELAY TIMER
See STOP DELAY MODE above for explanation.

WK2 COMPENSATION RESPONSE
The WK2 function monitors the line speed signal and senses any deceleration. The Cortex in turn will increase the torque output to decelerate the let-off. This parameter sets the rate at which the WK2 function responds. The factory preset is 0%.

WK2 COMPENSATION LEVEL
This parameter sets the level of the WK2 function response. Increasing this value increases the effect on the output. The factory preset is 0%.

PARAMETER LOADING
The Cortex allows up to 10 unique user defined parameter sets to be defined for use. By using the Bit 1, Bit 2, and Bit 3 digital input functions, 8 of these users sets can be selected and loaded into memory. This parameter selects the loading method used. If OFF MODE is selected, the specified user set will be loaded when the unit enters the OFF mode. If INSTANTLY is selected, any change in the bit selection will cause an immediate load of the indicated parameter set.

2. PID

PROPORTIONAL GAIN
This parameter sets the proportional response. Increasing this value increases the gain (increases the response rate). The factory preset is 40%. The RES softkey toggles the resolution of the + and - keys from coarse to fine.

INTEGRAL TIME
This parameter sets the integral response. Increasing this value increases the time (decreases the response rate). The factory preset is 60%. The RES softkey toggles the resolution of the + and - keys from coarse to fine.

DERIVATIVE RESPONSE
This parameter sets the rate at which the derivative responds. The factory preset is 0%.

DERIVATIVE LEVEL
This parameter sets the level of the derivative response. Increasing this value increases the effect on the output. The factory preset is 0%.

DEADBAND
This parameter sets a window in the response loop where the output is not affected by small changes in the dancer. Increasing this value increases the window. The factory preset is 50%.

PID TRIM RANGE
This parameter determines the sensitivity of the PID portion of the control loop.

3. ACCEL/DECEL TIMES

AUTO ACCEL TIME
This parameter sets the acceleration time when in the auto mode.

AUTO DECEL TIME
This parameter sets the deceleration time when in the auto mode.

MANUAL ACCEL TIME
This parameter sets the acceleration time when in the manual mode.

MANUAL DECEL TIME
This parameter sets the deceleration time when in the manual mode.

4. TENSION

TORQUE/TENSION MODE
If the auto/manual function is not assigned to a digital input, this internal setting controls the operation of the Cortex. Auto puts the unit in the auto tension mode, while manual puts the unit in the manual torque mode.

AUTO TENSION
In the auto mode, this setpoint controls the tension placed on the web. This internal setpoint may also be defined as an external analog or frequency input. Press the UNITS softkey to scroll to the desired units.

STALL TORQUE
This parameter sets the level of the torque in the STALL mode. This internal setpoint may also be defined as an external analog or frequency input. Press the UNITS softkey to scroll to the desired units.

INIT RUN TORQUE
This parameter sets the level of the torque in the INIT RUN TORQUE mode. This internal setpoint may also be defined as an external analog or frequency input. Press the UNITS softkey to scroll to the desired units.

MANUAL TORQUE
In the manual mode, this parameter sets the level of the torque when running. This internal setpoint may also be defined as an external analog or frequency input. Press the UNITS softkey to scroll to the desired units.

TENSION TRIM RANGE
This parameter determines the sensitivity of the diameter compensated torque portion of the control loop.

5. DISPLAY

MAX LINE SPEED
Optional menu parameter. Used only when a line speed signal is applied to the unit. The Cortex monitors the line speed per one of its analog or frequency inputs. The line speed can be displayed as a percentage or in other useful units such as Feet/Min, Yards/Min, & Meters/Min. In order to display properly, the unit must first be calibrated with the 100% line speed value. Press the UNITS softkey to scroll through a list of predefined units and then press SET to enter the maximum line speed.

LET-OFF UNITS
Optional menu parameter. This parameter is used to select the units in which the let-off speed is displayed. If a let-off speed signal is not provided to the Cortex, the unit will calculate the let-off speed and display it as a percentage. However, if a signal is supplied, the option of displaying in RPM is available.

6. SYSTEM

CORTEX-E00
This menu screen displays the model number and the software versions.

PASSWORD ENABLE
This option allows the user to turn the password protection on or off. When turned on, the user must enter a password before access is given to either the main menu or the quick menu. The menu that is displayed depends on which password was entered.

MENU PASSWORD
The user can set the menu password at this screen.

QUICK MENU PASSWORD
The user can set the quick menu password at this screen.

TIME IN USE
The Cortex provides a real-time clock to keep track of how long a unit has been

powered up.

FORCE A REINITIALIZATION
Choosing this option reinitializes the Cortex and loads the factory presets into all of the user parameter sets. Warning! Any custom configuration data contained in the current or user sets will be lost.

ANALOG INPUT STATUS
This status screen displays the level of the two voltage inputs and the two current inputs in volts and milliamps.

FREQ INPUT STATUS
This status screen displays the level of the two frequency inputs in Hertz. If frequency input #2 is configured as a revolution counter, the screen will display the number of pulses as it counts down.

DIGITAL INPUT STATUS
This screen displays the internal status of the six digital inputs as on or off. The state takes into account the configuration of the digital input (closed=on or open=on).

RELAY OUTPUT STATUS
This screen displays the status of the four relay outputs as on or off. A relay is energized when in the 'on' state and is de-energized when in the 'off' state.

SIGNAL OUTPUT STATUS
This status screen displays the level of the analog output in percentage and the frequency output in Hertz.

SET START DIAMETER
As described earlier, one method to measure the let-off diameter is to provide a pulse or pulses for every revolution of the let-off. The Cortex counts these pulses. When combined with the material thickness, this data can be used to calculate the diameter. If the diameter is mistakenly reset before an entire roll is depleted, this menu screen may be used to preset the diameter to the actual diameter on the let-off. This will allow the unit to operate properly and provide the desired tension on the remaining portion of the roll.

7. FILE

FILE MENU
The Cortex allows the user to save up to 10 different configurations. This menu screen allows you to either load or save a configuration. The MAIN key returns you to the MAIN MENU. The monitoring screen that displays the operating mode also displays the current configuration set. For example, if user setup #0 is loaded, the display will show 'USER 0'. A 'USER x' indicates that a user set has

been modified but not saved. Furthermore, if the factory presets are loaded, it will be indicated with 'FACTORY'.

LOAD USER SETUP
To load a previously saved configuration, press the CHANGE key until the user set number is displayed. Pressing the OK key will load the selected configuration into memory. The CANCEL key returns you to the previous menu.

SAVE USER SETUP
To save the current setup to a user configuration location, press the CHANGE key until the desired location is displayed and then press OK. The CANCEL key returns you to the previous menu.

6 Adjustment Procedure

WARNING!

The Cortex has 6 sections that are electrically isolated from each other. Any section that is connected to an un-isolated device (such as an un-isolated DC drive) can have high voltage potentials between earth ground and any point in the circuit and between other sections. All test instruments should be isolated from earth ground to prevent damage to the instrument or the control. Any instrument connected to the circuit is floating at potentials that approach the AC line voltage and should be handled with care.

STEP 1. SETUP INPUTS
Enter the MAIN MENU and select the I/O section and then INPUTS. Under the DIGITAL section, configure each digital input for the desired function and type of input. Next, under the ANALOG/FREQ section, configure each input for the desired function.

After a function has been assigned to an input, use the CAL softkey to calibrate the input. Initial calibration should be performed in the AUTO mode. If calibrating the line speed, the Cortex will prompt you to input the signal corresponding to 0% line speed and then press OK. Next, run the line up to 100% speed and again press OK. Make a note of the surface speed before stopping the line.

Any other input functions that are assigned should be calibrated at this time. Please note that if used, the revolution function on the frequency 2 input does not need calibrating.

The let-off speed input utilizes a unique calibration routine that differs from all the others. The let-off speed input must be supplied to the Cortex as a frequency from an encoder or similar type device. Since it is difficult to run an undriven brake at full surface speed to calibrate the input, the Cortex will calculate the expected frequency level by using the MAX LINE SPEED, LET-OFF ENCODER PPR, LET-OFF GEAR RATIO, and CORE DIAMETER parameters. Therefore, before calibrating this input function, ensure that all of these parameters are

programmed to reflect the system. If needed, this frequency level may be fine tuned by entering the calibration section and manually adjusting this level.

STEP 2. SETUP OUTPUTS

To calibrate the analog output, temporarily set the Stall Torque level to 100%. Note that this adjustment will either be an external or internal setting depending on the setup in Step 1.

Under the I/O section, choose OUTPUTS and then ANALOG. Configure the analog output's reference source and output type. Activate the STALL digital input to put the Cortex into the STALL mode. Next, adjust the ANALOG OUTPUT BIAS until the minimum desired output is achieved. Adjust the ANALOG OUTPUT GAIN until the desired 100% output level is achieved. The factory settings are programmed to give a 0 to 10VDC level. Enter the RELAY/FREQ section and define the desired function of the relay outputs. Likewise, program the function and maximum level of the frequency output.

STEP 3. PROGRAM OPTIONS

At the MAIN MENU, enter the BRAKE section. The BRAKE TORQUE parameter should correspond to the amount of torque the brake produces when the Cortex output is at 100% (performed in Step 2). If the LET-OFF SPEED or REVOLUTION inputs functions are used, set the LET-OFF ENCODER PPR value. Also enter the brake to let-off gear ratio.

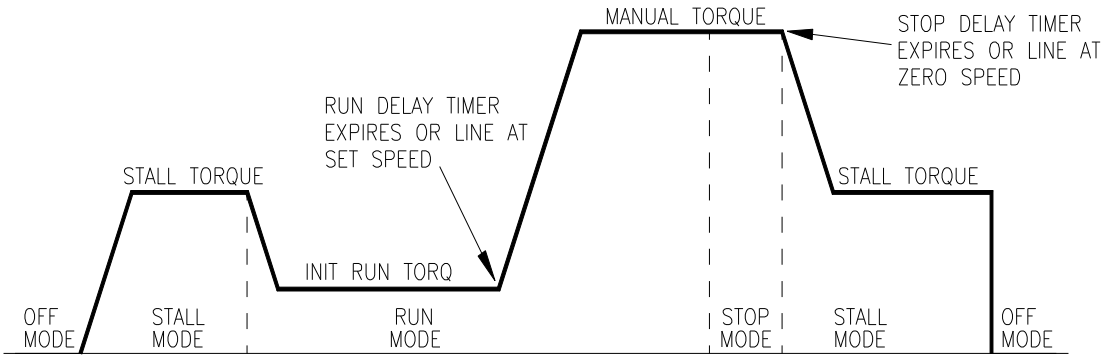
At the MAIN MENU, enter the OPTIONS section. In the OPERATING PARAMS section, configure the options per your system. Many of these parameters are optional and may not be required. Please refer to the descriptions earlier to determine if they apply to your system. Enter the ACCEL/DECEL section and set the desired auto and manual accel/decel times.

STEP 4. OPERATIONAL CHECKS

Manual Mode

Activate the Stall digital input. The output should ramp to the Stall Torque setpoint at the Manual Accel rate. Activate the Run digital input. The output level should ramp to the Initial Run Torque setpoint as controlled by the Manual Accel/Decel rates. The output should remain at this level until the Run Delay Timer expires or the Line at Speed function is satisfied. The output should then ramp to the Manual Torque setpoint as controlled by the Manual Accel/Decel rates.

When the Run digital input is released, the unit will continue to output the Manual Torque level until the Stop Delay Timer expires or the Line reaches Zero Speed. The output should then ramp to the Stall Torque setpoint as controlled by the Manual Accel/Decel rates. When the Stall digital input is released, the output goes to zero.



Auto Mode (Open Loop Control)
Activate the Stall digital input. The output should ramp to the Stall Torque setpoint at the Auto Accel rate. Activate the Run digital input. The output level should ramp to the Initial Run Torque setpoint as controlled by the Auto Accel/Decel rates. The output should remain at this level until the Run Delay Timer expires or the Line at Speed function is satisfied. The output should then ramp the torque to a diameter-based level to provide the desired tension. As the let-off diameter decreases, the output torque level should decrease to provide for constant tension.

If desired, the WK2 response and level parameters can be adjusted so the Cortex can provide inertia compensating torque to the let-off during decelerations of the line speed. This torque compensation is also diameter-based. This means that the level of compensation is reduced as the diameter decreases. Initially set the WK2 COMP. LEVEL arbitrarily at 50%. Adjust the WK2 COMP. RESPONSE parameter until a smooth level of compensation is achieved. As the response level is adjusted, it may be necessary to adjust the magnitude of the compensation with the level parameter. Continue to adjust both parameters until the desired effect is achieved.

When the Run digital input is released, the unit will continue to output the diameter-based torque level until the Stop Delay Timer expires or the Line reaches Zero Speed. The output should then ramp to the Stall Torque setpoint as controlled by the Auto Accel/Decel rates. When the Stall digital input is released, the output goes to zero.

Auto Mode (Closed Loop Control)
The closed loop tension control works very similar to the open loop control described above. The difference being that a loadcell is used to provide tension feedback information when in the RUN mode.

If the control does not provide tension properly, adjustments will have to be made in order to fine tune the operation. Most applications will only require adjusting the INTEGRAL RATE, DEADBAND, & PROPORTIONAL GAIN parameters. The DERIVATIVE RESPONSE and DERIVATIVE LEVEL parameters should only be adjusted in applications where the tension responds too slowly.

STEP 5. PASSWORD (OPTIONAL)

The password option prevents unauthorized access to the MAIN MENU and QUICK MENU

screens. The option is controlled by the PASSWORD ENABLE screen. The MENU PASSWORD and QUICK MENU PASSWORD screens allow a custom password to be entered.

STEP 6. FILE (OPTIONAL)

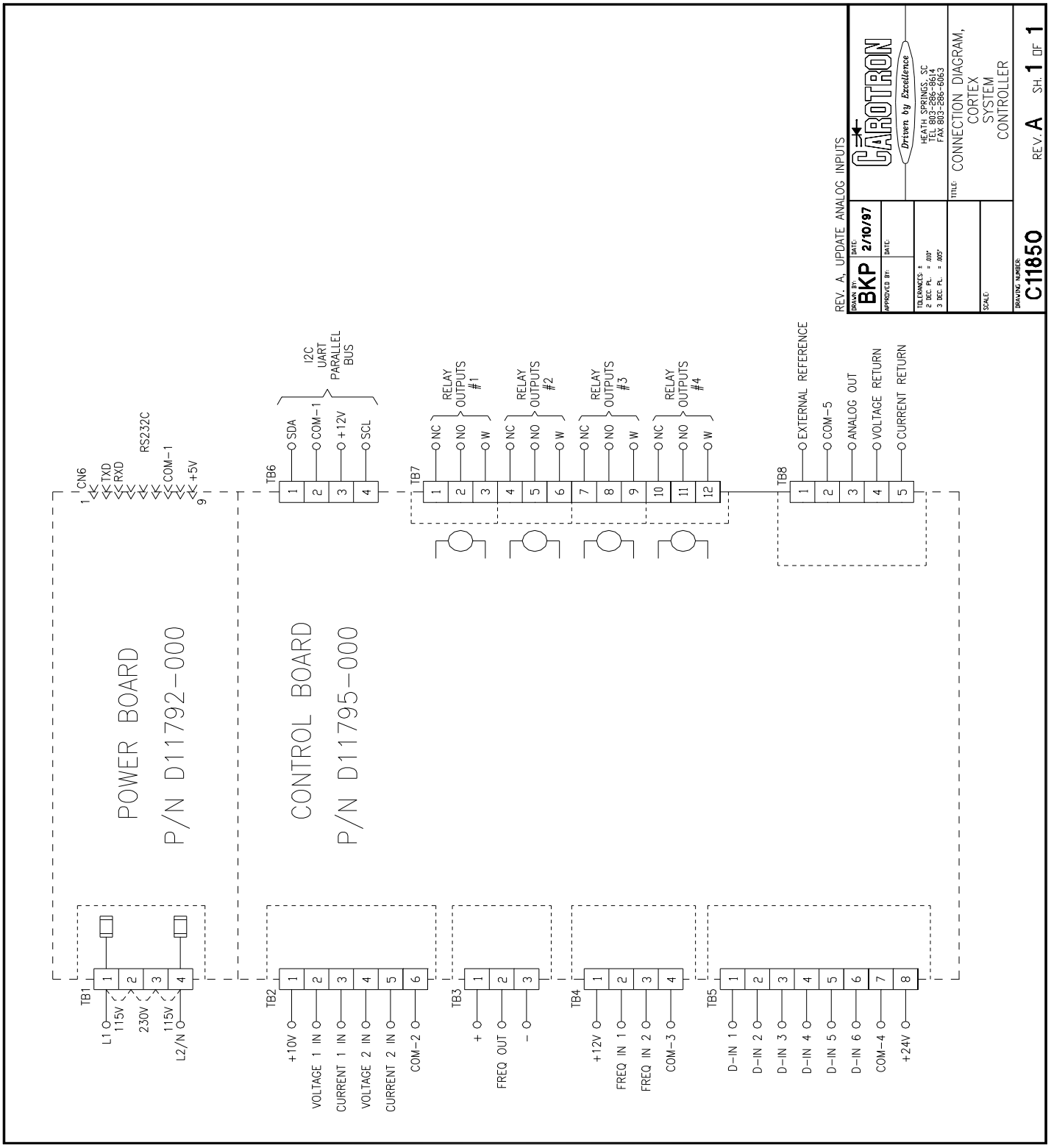
The Cortex allows up to 10 different configurations to be stored in memory for later recall. The SAVE option allows you to choose a location (0-9) to store the current configuration. Once saved, the configuration can be recalled by using the LOAD option from the menu or with a bit pattern/load signal on the digital inputs. The menu LOAD option also will allow you to reload the factory presets.

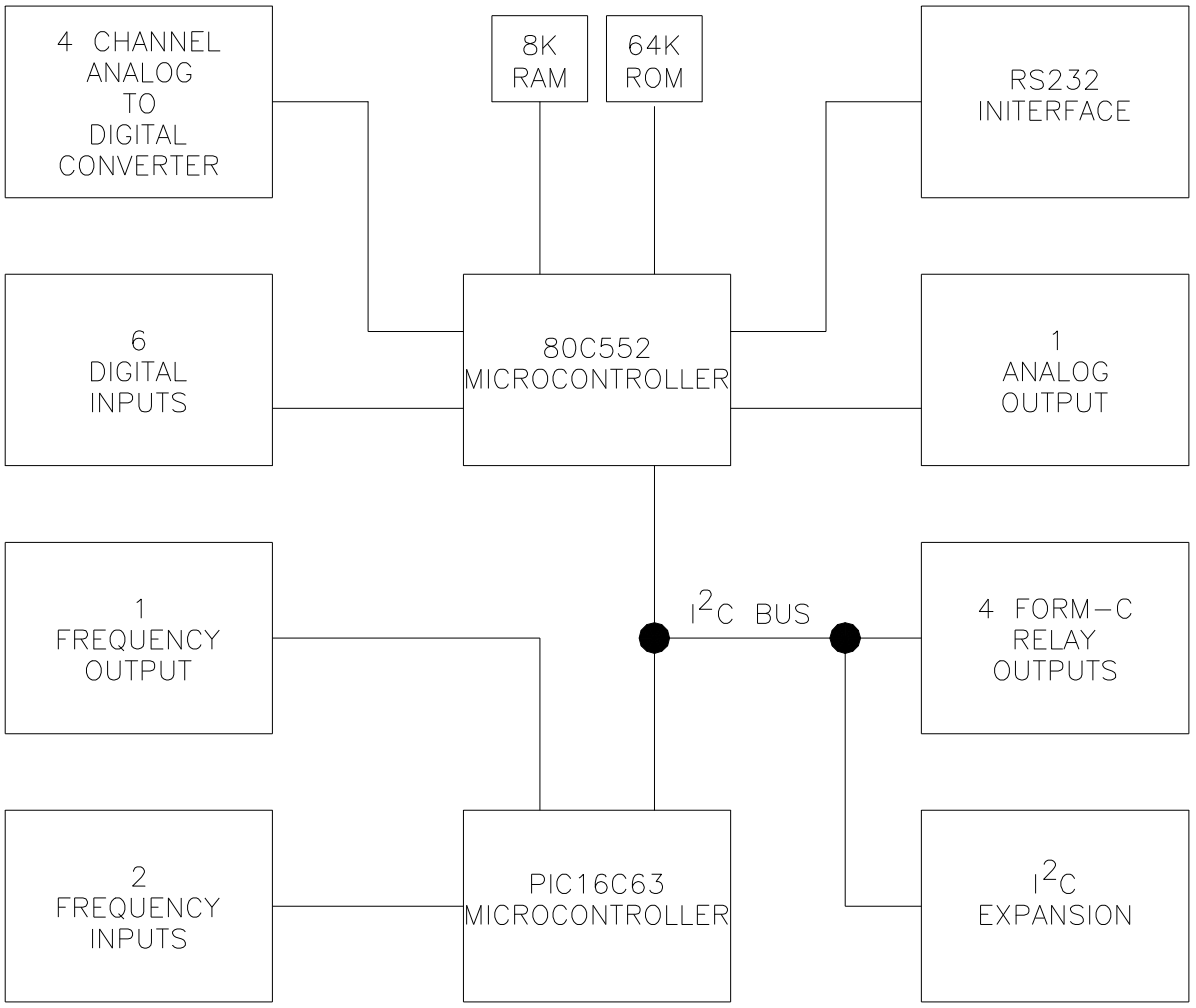
7 Spare Parts

Fuses: FU1 & FU2: 0.3 ampere, 250VAC, time-delay

Carotron FUS1006-01
Bussmann.....MDL 3/10 A
Littelfuse 313.300

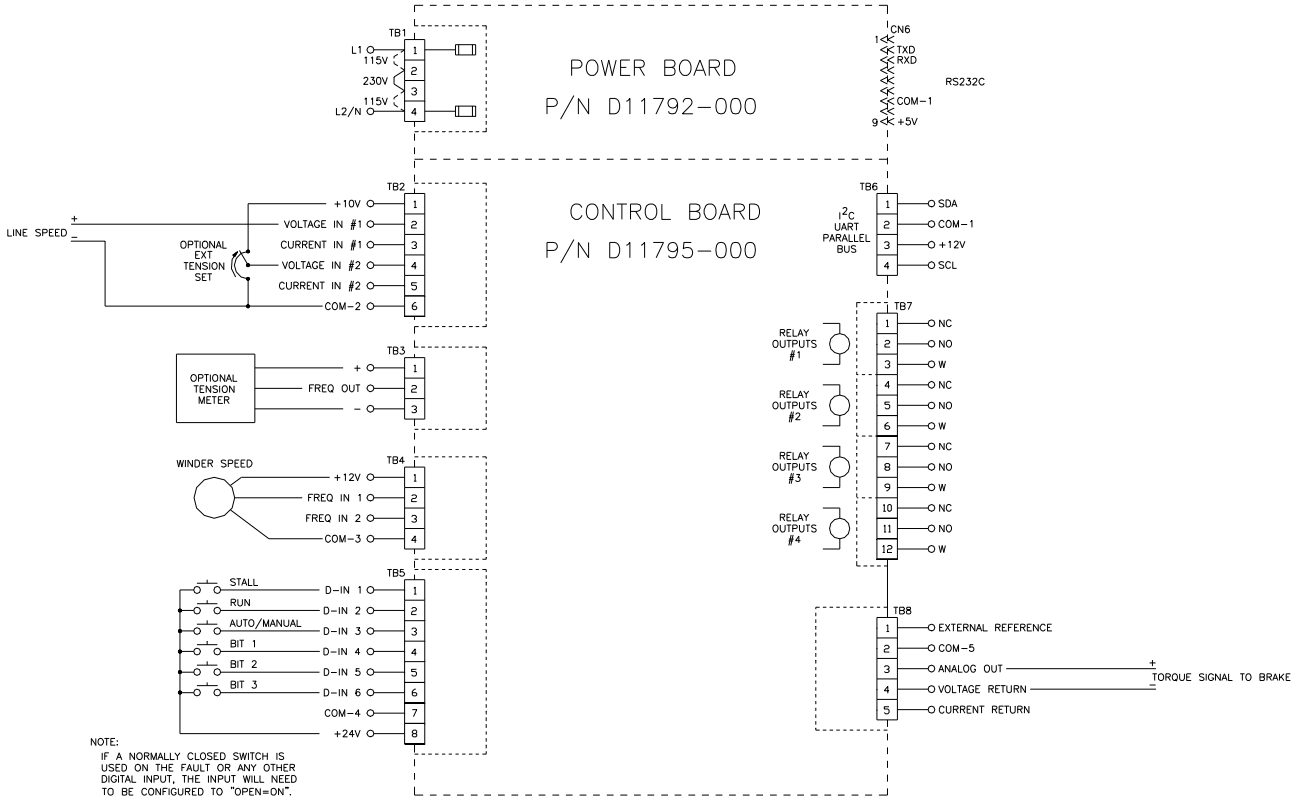
8 Prints


POWER BOARD
P/N D11792-000
CONTROL BOARD
P/N D11795-000
CN6
TXD
RXD
RS232C
COM-1
+5V
TB6
SDA
COM-1
+12V
SCL
I2C
UART
PARALLEL
BUS
TB7
NC
NO
W
RELAY OUTPUTS #1
RELAY OUTPUTS #2
RELAY OUTPUTS #3
RELAY OUTPUTS #4
TB8
EXTERNAL REFERENCE
COM-5
ANALOG OUT
VOLTAGE RETURN
CURRENT RETURN
TB1
L1
115V
230V
115V
L2/N
TB2
+10V
VOLTAGE 1 IN
CURRENT 1 IN
VOLTAGE 2 IN
CURRENT 2 IN
COM-2
TB3
+
FREQ OUT
–
TB4
+12V
FREQ IN 1
FREQ IN 2
COM-3
TB5
D-IN 1
D-IN 2
D-IN 3
D-IN 4
D-IN 5
D-IN 6
COM-4
+24V
REV. A, UPDATE ANALOG INPUTS
DRAWN BY: BKP
DATE: 2/10/97
APPROVED BY:
DATE:
TOLERANCES: ± 2 DEC. PL. = .010" 3 DEC. PL. = .005"
CARLTON
Driven by Excellence
HEATH SPRINGS, SC
TEL 803-286-8614
FAX 803-286-6063
TITLE: CONNECTION DIAGRAM, CORTEX SYSTEM CONTROLLER
SCALE:
DRAWING NUMBER: C11850
REV. A
SH. 1 OF 1



DRAWN BY: BKP	DATE: 9/8/97
APPROVED BY:	DATE:
TOLERANCES: ± 2 DEC. PL. = .010" 3 DEC. PL. = .005"	CAROTRON Driven by Excellence HEATH SPRINGS, SC TEL 803-286-8614 FAX 803-286-6063
SCALE:	TITLE: CORTEX BLOCK DIAGRAM
DRAWING NUMBER: C11949	REV.- SH. 1 OF 1

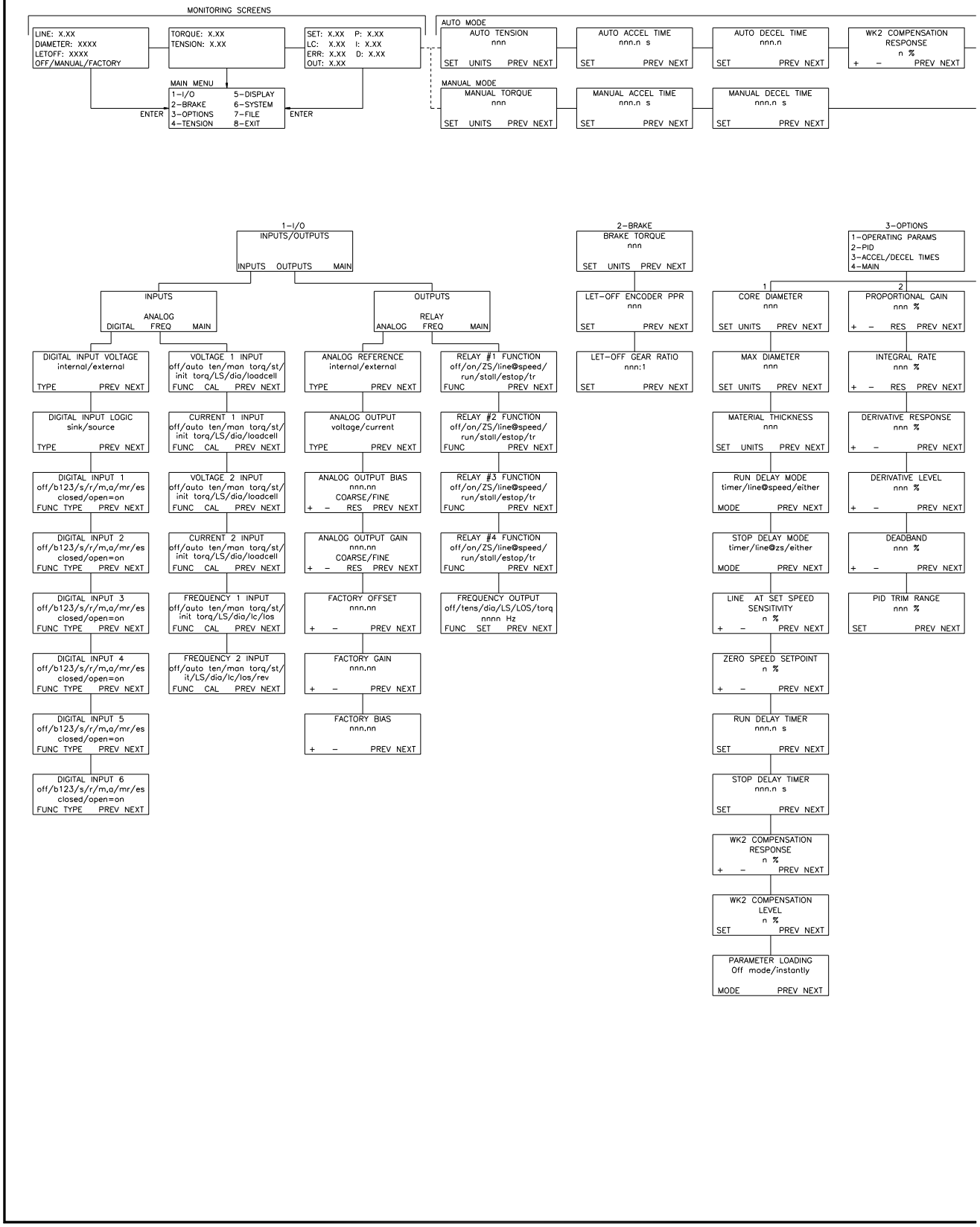
FACTORY PRESET CONFIGURATION

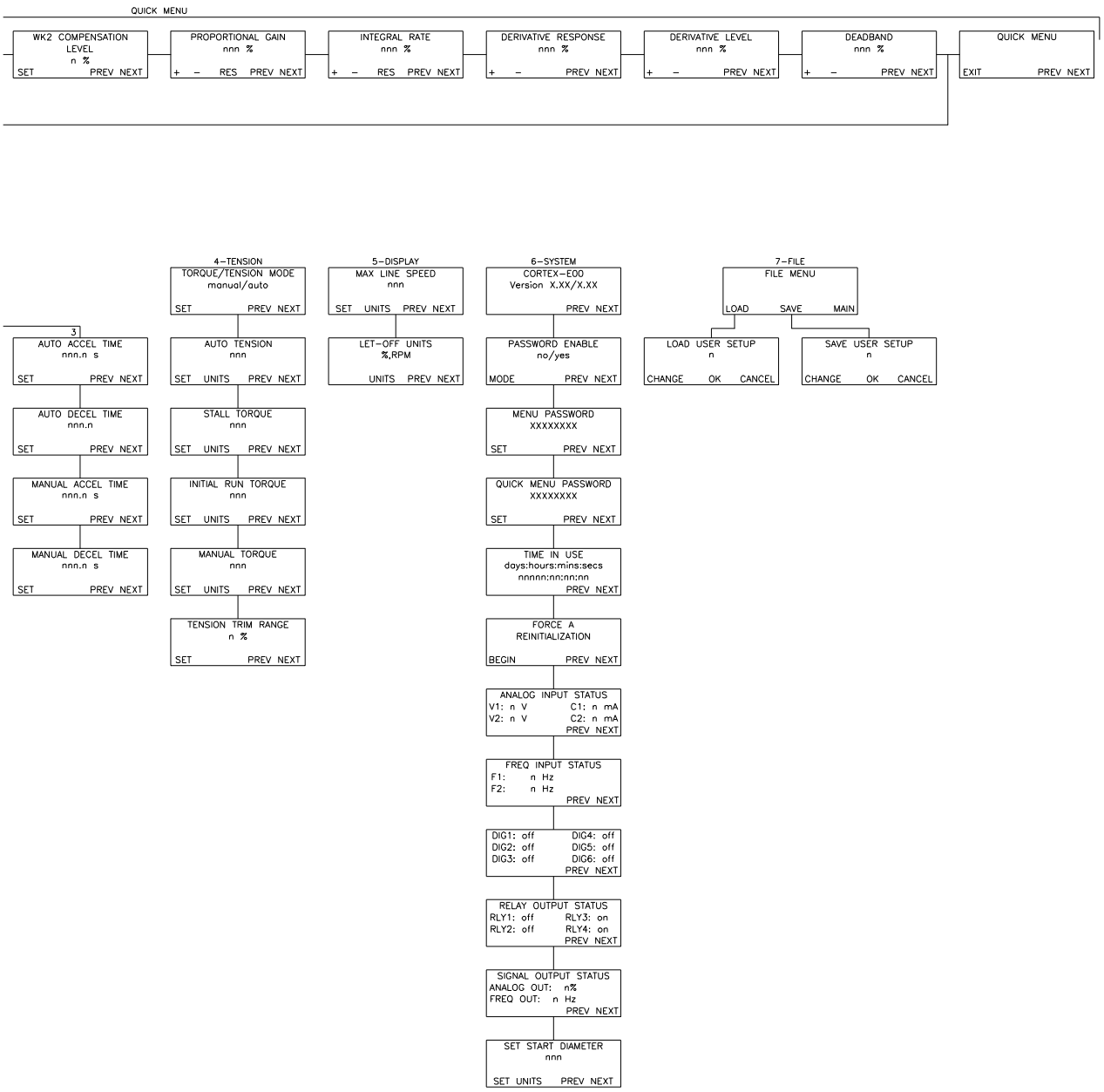


NOTE:
IF A NORMALLY CLOSED SWITCH IS USED ON THE FAULT OR ANY OTHER DIGITAL INPUT, THE INPUT WILL NEED TO BE CONFIGURED TO "OPEN=ON".

REV. A, 8-7-98, DIGITAL INPUTS TO SOURCING

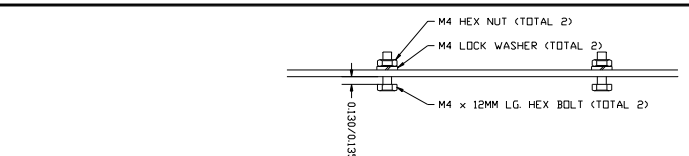
DRAWN BY: BKP DATE: 2/4/98	CAROTRON Driven by Excellence
APPROVED BY: DATE:	HEATH SPRINGS, SC TEL 803-286-9614 FAX 803-286-6063
TOLERANCES: ± 2 DEC PL = .010" 3 DEC PL = .005"	TITLE: CORTEX BRAKE LET-OFF CONNECTION DIAGRAM
SCALE:	
DRAWING NUMBER: D11989	REV. A SH. 1 OF 1


MONITORING SCREENS
LINE: X.XX
DIAMETER: XXXX
LETOFF: XXXX
OFF/MANUAL/FACTORY
TORQUE: X.XX
TENSION: X.XX
SET: X.XX P: X.XX
LC: X.XX I: X.XX
ERR: X.XX D: X.XX
OUT: X.XX
MAIN MENU
1-I/O 5-DISPLAY
2-BRAKE 6-SYSTEM
3-OPTIONS 7-FILE
4-TENSION 8-EXIT
ENTER
ENTER
AUTO MODE
AUTO TENSION nnn
SET UNITS PREV NEXT
AUTO ACCEL TIME nnn.n s
SET PREV NEXT
AUTO DECEL TIME nnn.n
SET PREV NEXT
WK2 COMPENSATION RESPONSE n %
+ - PREV NEXT
MANUAL MODE
MANUAL TORQUE nnn
SET UNITS PREV NEXT
MANUAL ACCEL TIME nnn.n s
SET PREV NEXT
MANUAL DECEL TIME nnn.n s
SET PREV NEXT
1-I/O
INPUTS/OUTPUTS
INPUTS OUTPUTS MAIN
INPUTS
ANALOG
DIGITAL FREQ MAIN
OUTPUTS
RELAY
ANALOG FREQ MAIN
DIGITAL INPUT VOLTAGE internal/external
TYPE PREV NEXT
DIGITAL INPUT LOGIC sink/source
TYPE PREV NEXT
DIGITAL INPUT 1 off/b123/s/r/m,a/mr/es closed/open=on
FUNC TYPE PREV NEXT
DIGITAL INPUT 2 off/b123/s/r/m,a/mr/es closed/open=on
FUNC TYPE PREV NEXT
DIGITAL INPUT 3 off/b123/s/r/m,a/mr/es closed/open=on
FUNC TYPE PREV NEXT
DIGITAL INPUT 4 off/b123/s/r/m,a/mr/es closed/open=on
FUNC TYPE PREV NEXT
DIGITAL INPUT 5 off/b123/s/r/m,a/mr/es closed/open=on
FUNC TYPE PREV NEXT
DIGITAL INPUT 6 off/b123/s/r/m,a/mr/es closed/open=on
FUNC TYPE PREV NEXT
VOLTAGE 1 INPUT off/auto ten/man torq/st/ init torq/LS/dia/loadcell
FUNC CAL PREV NEXT
CURRENT 1 INPUT off/auto ten/man torq/st/ init torq/LS/dia/loadcell
FUNC CAL PREV NEXT
VOLTAGE 2 INPUT off/auto ten/man torq/st/ init torq/LS/dia/loadcell
FUNC CAL PREV NEXT
CURRENT 2 INPUT off/auto ten/man torq/st/ init torq/LS/dia/loadcell
FUNC CAL PREV NEXT
FREQUENCY 1 INPUT off/auto ten/man torq/st/ init torq/LS/dia/lc/los
FUNC CAL PREV NEXT
FREQUENCY 2 INPUT off/auto ten/man torq/st/ it/LS/dia/lc/los/rev
FUNC CAL PREV NEXT
ANALOG REFERENCE internal/external
TYPE PREV NEXT
ANALOG OUTPUT voltage/current
TYPE PREV NEXT
ANALOG OUTPUT BIAS nnn.nn COARSE/FINE
+ - RES PREV NEXT
ANALOG OUTPUT GAIN nnn.nn COARSE/FINE
+ - RES PREV NEXT
FACTORY OFFSET nnn.nn
+ - PREV NEXT
FACTORY GAIN nnn.nn
+ - PREV NEXT
FACTORY BIAS nnn.nn
+ - PREV NEXT
RELAY #1 FUNCTION off/on/ZS/line@speed/ run/stall/estop/tr
FUNC PREV NEXT
RELAY #2 FUNCTION off/on/ZS/line@speed/ run/stall/estop/tr
FUNC PREV NEXT
RELAY #3 FUNCTION off/on/ZS/line@speed/ run/stall/estop/tr
FUNC PREV NEXT
RELAY #4 FUNCTION off/on/ZS/line@speed/ run/stall/estop/tr
FUNC PREV NEXT
FREQUENCY OUTPUT off/tens/dia/LS/LOS/torq nnnn Hz
FUNC SET PREV NEXT
2-BRAKE
BRAKE TORQUE nnn
SET UNITS PREV NEXT
LET-OFF ENCODER PPR nnn
SET PREV NEXT
LET-OFF GEAR RATIO nnn:1
SET PREV NEXT
3-OPTIONS
1-OPERATING PARAMS
2-PID
3-ACCEL/DECEL TIMES
4-MAIN
1
CORE DIAMETER nnn
SET UNITS PREV NEXT
MAX DIAMETER nnn
SET UNITS PREV NEXT
MATERIAL THICKNESS nnn
SET UNITS PREV NEXT
RUN DELAY MODE timer/line@speed/either
MODE PREV NEXT
STOP DELAY MODE timer/line@zs/either
MODE PREV NEXT
LINE AT SET SPEED SENSITIVITY n %
+ - PREV NEXT
ZERO SPEED SETPOINT n %
+ - PREV NEXT
RUN DELAY TIMER nnn.n s
SET PREV NEXT
STOP DELAY TIMER nnn.n s
SET PREV NEXT
WK2 COMPENSATION RESPONSE n %
+ - PREV NEXT
WK2 COMPENSATION LEVEL n %
SET PREV NEXT
PARAMETER LOADING Off mode/instantly
MODE PREV NEXT
2
PROPORTIONAL GAIN nnn %
+ - RES PREV NEXT
INTEGRAL RATE nnn %
+ - RES PREV NEXT
DERIVATIVE RESPONSE nnn %
+ - PREV NEXT
DERIVATIVE LEVEL nnn %
+ - PREV NEXT
DEADBAND nnn %
+ - PREV NEXT
PID TRIM RANGE nnn %
SET PREV NEXT

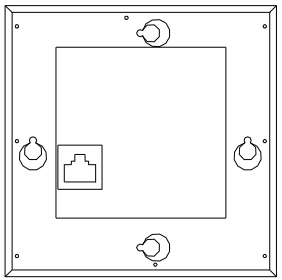


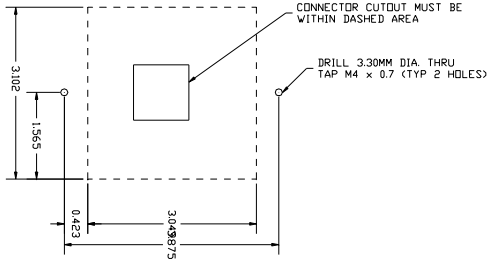
REV. B, ERROR REVISIONS, 9–3–99
REV. A, VERSION 2.02 UPDATES, 5–18–98

DRAWN BY: BKP	DATE: 12/12/97
APPROVED BY:	DATE:
TOLERANCES: ± 2 DEC. PL. = .010" 3 DEC. PL. = .005"	CAROTRON Driven by Excellence HEATH SPRINGS, SC TEL 803-286-8614 FAX 803-286-6063
SCALE:	TITLE: CORTEX–E00 BRAKE LET–OFF MENU STRUCTURE
DRAWING NUMBER: D11928	REV. B SH. 1 OF 1



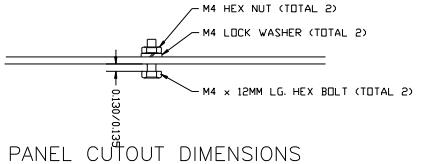
PANEL CUTOUT DIMENSIONS



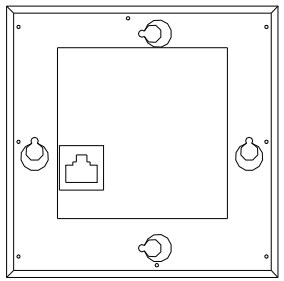


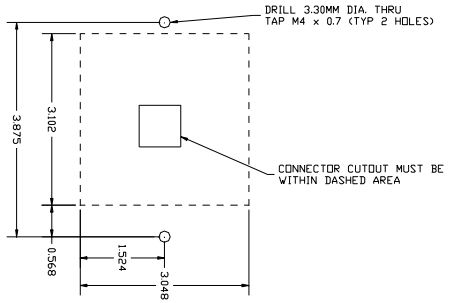
SLIDE UNIT UP WHEN DETACHING

NOTES:
1. VERTICAL DETACHABLE MOUNTING CONFIGURATION
2. RECOMMENDED PANEL THICKNESS: 0.0625"–0.125"



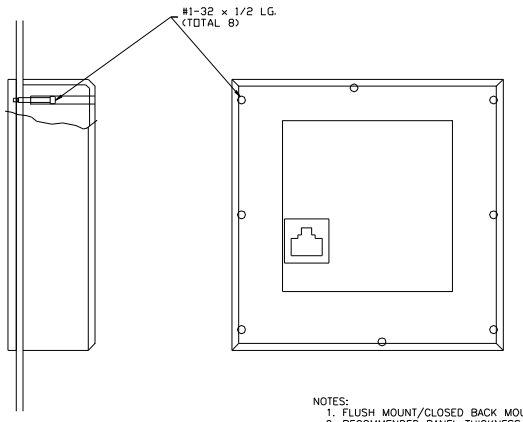
PANEL CUTOUT DIMENSIONS



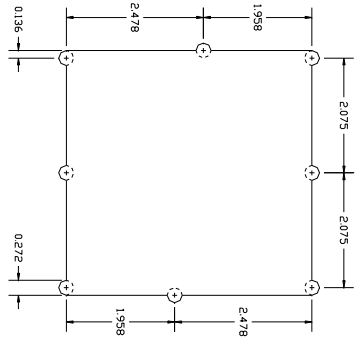


SLIDE UNIT TO THE RIGHT WHEN DETACHING

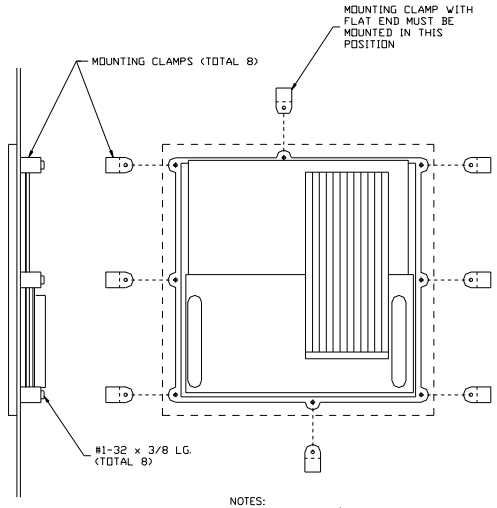
NOTES:
1. HORIZONTAL DETACHABLE MOUNTING CONFIGURATION
2. RECOMMENDED PANEL THICKNESS: 0.0625"–0.125"



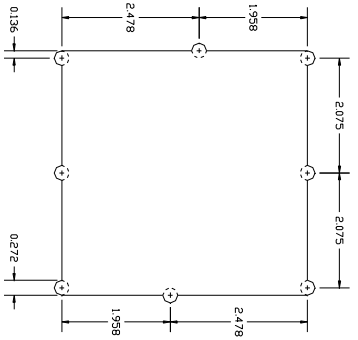
PANEL CUTOUT DIMENSIONS



NOTES:
1. FLUSH MOUNT/CLOSED BACK MOUNTING CONFIGURATION
2. RECOMMENDED PANEL THICKNESS: 0.0625"–0.125"



PANEL CUTOUT DIMENSIONS



NOTES:
1. FLUSH MOUNT/OPEN BACK MOUNTING CONFIGURATION
2. RECOMMENDED PANEL THICKNESS: 0.0625" ONLY.

DRAWN BY:	DATE: 1-28-99	CAROTRON Driven by Excellence
APPROVED BY:	DATE:	HEATH SPRINGS, SC TEL 803-286-8614 FAX 803-286-6063
TOLERANCES: X ± DEC PL. ± .010" X DEC PL. ± .005"		TITLE: CORTEX PANEL MOUNT KEYPAD/DISPLAY VERSION 2 INSTALLATION INFO
SCALE:		
DRAWING NUMBER: D12064	REV. -	SH. 1 OF 1

Parameter Quick Reference Table		
Parameter	Factory Preset	Customer Setting
Analog Output	voltage	
Analog Output Bias	0 %	
Analog Output Gain	100 %	
Analog Reference	internal	
Auto Accel Time	5.0 s	
Auto Decel Time	5.0 s	
Auto Tension	50%	
Brake Torque	100 In-Lbs	
Core Diameter	1"	
Current 1 Input Avg.	16	
Current 1 Input Func	off	
Current 1 Input Max	4095	
Current 1 Input Min	0	
Current 1 Input Avg.	16	
Current 2 Input Func	off	
Current 2 Input Max	4095	
Current 2 Input Min	0	
Deadband	50 %	
Derivative Level	0 %	
Derivative Response	0 %	
Digital Input 1 Func	Stall	
Digital Input 1 Type	closed=on	
Digital Input 2 Func	Run	
Digital Input 2 Type	closed=on	
Digital Input 3 Func	Auto/Manual	
Digital Input 3 Type	Closed=on	

Parameter	Factory Preset	Customer Setting
Digital Input 4 Func	Bit 1	
Digital Input 4 Type	closed=on	
Digital Input 5 Func	Bit 2	
Digital Input 5 Type	closed=on	
Digital Input 6 Func	Bit 3	
Digital Input 6 Type	closed=on	
Digital Input Logic	source	
Digital input Voltage	internal	
Factory Bias	49.80 % *	
Factory Gain	94.90 % *	
Factory Offset	49.80 % *	
Freq 1 Input Avg.	40	
Freq 1 Input Func	Let-Off Speed	
Freq 1 Input Max	32,000 Hz	
Freq 1 Input Min	0 Hz	
Freq 2 Input Avg.	40	
Freq 2 Input Func	off	
Freq 2 Input Max	32,000 Hz	
Freq 2 Input Min	0 Hz	
Freq Out Func	off	
Freq Out Max	1000 Hz	
Initial Run Torque	10 %	
Integral Rate	33 %	
Let-Off Encoder PPR	300	
Let-Off Gear Ratio	1:1	
Let-Off Speed Units	%	

Parameter	Factory Preset	Customer Setting
Line at Speed Sensitivity		
Manual Accel Time	5.0 s	
Manual Decel Time	5.0 s	
Manual Torque	50 %	
Material Thickness	0.005"	
Max Diameter	10"	
Max Line Speed	100 Ft/Min	
Parameter Loading	Off Mode	
Password Enable	no	
PID Trim Range	10 %	
Proportional Gain	15 %	
Relay #1 Function	Stall	
Relay #2 Function	Run	
Relay #3 Function	Zero Speed	
Relay #4 Function	off	
Run Delay Mode	either	
Run Delay Timer	5.0 s	
Stall Torque	50 %	
Stop Delay Mode	either	
Stop Delay Timer	5.0 s	
Tension Trim Range	100 %	
Torque/Tension Mode	manual	
Voltage 1 Input Avg.	16	
Voltage 1 Input Func	Line Speed	
Voltage 1 Input Max	4095	
Voltage 1 Input Min	0	

Parameter	Factory Preset	Customer Setting
Voltage 2 Input Avg.	16	
Voltage 2 Input Func	off	
Voltage 2 Input Max	4095	
Voltage 2 Input Min	0	
WK2 Comp. Level	0 %	
WK2 Comp. Response	20 %	
Zero Speed Setpoint	5 %	

*The factory settings for the offset, bias, and gain parameters are unique for each individual Cortex unit. The actual values may differ slightly from the nominal values listed in the table.

Standard terms & conditions of sale

1. General

The Standard Terms and Conditions of Sale of Carotron, Inc. (hereinafter called "Company") are set forth as follows in order to give the Company and the Purchaser a clear understanding thereof. No additional or different terms and conditions of sale by the Company shall be binding upon the Company unless they are expressly consented to by the Company in writing. The acceptance by the Company of any order of the Purchaser is expressly conditioned upon the Purchaser's agreement to said Standard Terms and Conditions. The acceptance or acknowledgement, written, oral, by conduct or otherwise, by the Company of the Purchaser's order shall not constitute written consent by the Company to addition to or change in said Standard Terms and Conditions.

2. Prices

Prices, discounts, allowances, services and commissions are subject to change without notice. Prices shown on any Company published price list and other published literature issued by the Company are not offers to sell and are subject to express confirmation by written quotation and acknowledgement. All orders of the Purchaser are subject to acceptance, which shall not be effective unless made in writing by an authorized Company representative at its office in Heath Springs, S.C. The Company may refuse to accept any order for any reason whatsoever without incurring any liability to the Purchaser. The Company reserves the right to correct clerical and stenographic errors at any time.

3. Shipping dates

Quotation of a shipping date by the Company is based on conditions at the date upon which the quotation is made. Any such shipping date is subject to change occasioned by agreements entered into previous to the Company's acceptance of the Purchaser's order, governmental priorities, strikes, riots, fires, the elements, explosion, war, embargoes, epidemics, quarantines, acts of God, labor troubles, delays of vendors or of transportation, inability to obtain raw materials, containers or transportation or manufacturing facilities or any other cause beyond the reasonable control of the Company. In no event shall the Company be liable for consequential damages for failure to meet any shipping date resulting from any of the above causes or any other cause.

In the event of any delay in the Purchaser's accepting shipment of products or parts in accordance with scheduled shipping dates, which delay has been requested by the Purchaser, or any such delay which has been caused by lack of shipping instructions, the Company shall store all products and parts involved at the Purchaser's risk and expense and shall invoice the Purchaser for the full contract price of such products and parts on the date scheduled for shipment or on the date on which the same is ready for delivery, whichever occurs later.

4. Warranty

The Company warrants to the Purchaser that products manufactured or parts repaired by the Company, will be free, under normal use and maintenance, from defects in material and workmanship for a period of one (1) year after the shipment date from the Company's factory to the Purchaser. The Company makes no warranty concerning products manufactured by other parties.

As the Purchaser's sole and exclusive remedy under said warranty in regard to such products and parts, including but not limited to remedy for consequential damages, the Company will at its option, repair or replace without charge any product manufactured or part repaired by it, which is found to the Company's satisfaction to be so defective; provided, however, that (a) the product or part involved is returned to the Company at the location designated by the Company, transportation charges prepaid by the Purchaser; or (b) at the Company's option the product or part will be repaired or replaced in the Purchaser's plant; and also provided that Cc) the Company is notified of the defect within one (1) year after the shipment date from the Company's factory of the product or part so involved.

The Company warrants to the Purchaser that any system engineered by it and started up under the supervision of an authorized Company representative will, if properly installed, operated and maintained, perform in compliance with such system's written specifications for a period of one (1) year from the date of shipment of such system.

As the Purchaser's sole and exclusive remedy under said warrant in regard to such systems, including but not limited to remedy for consequential damages, the Company will, at its option, cause, without charges any such system to so perform, which system is found to the
Company's satisfaction to have failed to so perform, or refund to the Purchaser the purchase price paid by the Purchaser to the Company in regard thereto; provided, however, that (a) Company and its representatives are permitted to inspect and work upon the system involved during reasonable hours, and (b) the Company is notified of the failure within one (1) year after date of shipment of the system so involved.

The warranties hereunder of the Company specifically exclude and do not apply to the following:

a. Products and parts damaged or abused in shipment without fault of the Company.

b. Defects and failures due to operation, either intentional or otherwise, (l) above or beyond rated capacities, (2) in connection with equipment not recommended by the Company, or (3) in an otherwise improper manner.

c. Defects and failures due to misapplication, abuse, improper installation or abnormal conditions of temperature, humidity, abrasives, dirt or corrosive matter.

d. Products, parts and systems which have been in any way tampered with or altered by any party other than an authorized Company representative.

e. Products, parts and systems designed by the Purchaser.

f. Any party other than the Purchaser.

The Company makes no other warranties or representation, expressed or implied, of merchantability and of fitness for a particular purpose, in regard to products manufactured, parts repaired and systems engineered by it.

3. Terms of payment

Standard terms of payment are net thirty (30) days from date of the Company invoice. For invoice purposed, delivery shall be deemed to be complete at the time the products, parts and systems are shipped from the Company and shall not be conditioned upon the start up thereof. Amounts past due are subject to a service charge of 1.5% per month or fraction thereof.

6. Order cancellation

Any cancellation by the Purchaser of any order or contract between the Company and the Purchaser must be made in writing and receive written approval of an authorized Company representative at its office in Heath Springs, S.C. In the event of any cancellation of an order by either party, the Purchaser shall pay to the Company the reasonable costs, expenses, damages and loss of profit of the Company incurred there by, including but not limited to engineering expenses and expenses caused by commitments to the suppliers of the Company's subcontractors, as determined by the Company.

7. Changes

The Purchaser may, from time to time, but only with the written consent of an authorized Company representative, make a change in specifications to products, parts or systems covered by a purchase order accepted by the company. In the event of any such changes, the Company shall be entitled to revise its price and delivery schedule under such order.

8. Returned material

If the Purchaser desires to return any product or part, written authorization thereof must first be obtained from the Company which will advise the Purchaser of the credit to be allowed and restocking charges to be paid in regard to such return. No product or part shall be returned to the Company without a "RETURNTAG" attached thereon which has been issued by the Company.

9. Packing

Published prices and quotations include the Company's standard packing for domestic shipment. Additional expenses for special packing or overseas shipments shall be paid by the Purchaser. If the Purchaser does not specify packing or accepts parts unpacked, no allowance will be made to the Purchaser in lieu of packing.

10. Standard transportation policy

Unless expressly provided in writing to the contrary, products, parts and systems are sold f.o.b. first point of shipment. Partial shipments shall be permitted, and the Company may invoice each shipment separately. Claims for non-delivery of products, parts and systems, and for damages thereto must be filed with the carrier by the Purchaser. The Company's responsibility therefor shall cease when the carrier signs for and accepts the shipment.

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