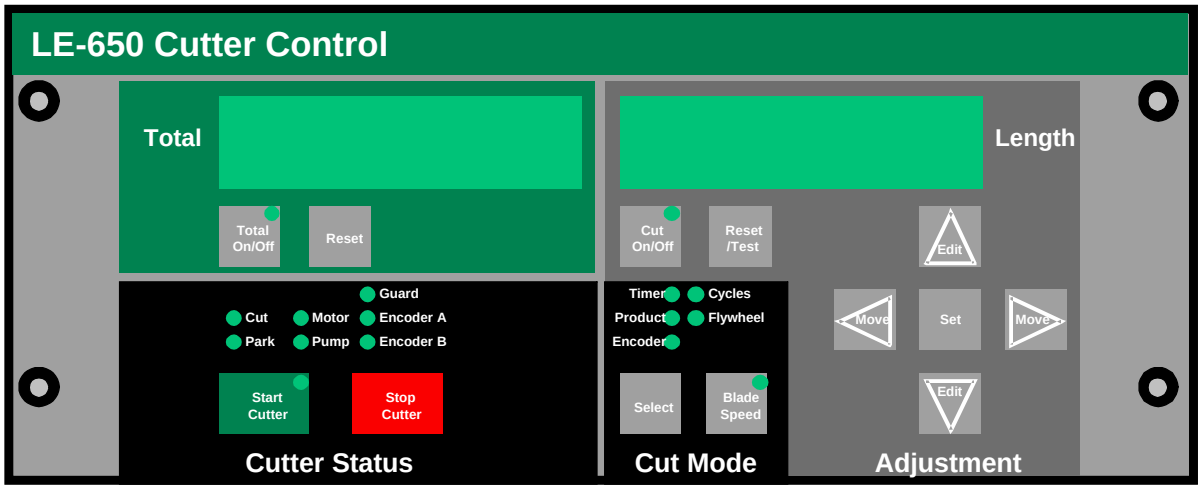
LE-650
Instruction
Manual

LE-650 Controller

The LE-650 Controller is a user-friendly panel mounted operator interface for Rotary Cutting machines, Planetary Cutters and Saws. Everything required to provide correct system operation and ease of product length setting is contained within. Various cutting methods (modes) are available. A piece counter and length counter are normally displayed, although the display also serves to assist the operator when setting presets or explaining any fault condition.



A six-digit presetable Length Counter provides the "cut to length signal". The operator may set a scale factor to calibrate the length when using an Encoder to provide for metric / imperial conversion, or shrinkage compensation.

An RS-485 communications port allows control and monitoring of variables by a master control system. An RS-423 communications port is also available but is dedicated to Servo Cutters for communicating with Servo drives that have variable Blade Speed.

Fascia Panel
The fascia is a flat membrane type consisting of two six-digit counters, LED indicators and operator tactile feel keypads. Primarily the left-hand display is used to show the Total (Cut Pieces) Count, and the right-hand display is used to show the Length Count. These displays will show legends and presets during programming, or error messages if any fault condition is detected. Displays are large, 0.56" high, Green Light Emitting Diodes (LED's) for clear and distant visibility.

Some keypads, like the displays, take on different roles when setting presets.

Key Pads
Each press of a keypad will cause a momentary beep to be heard from the built in buzzer. Some keypads have no functions in certain modes, yet a beep will still indicate a response.

Constant Functions
Seven of the keypads have fixed functions that do not alter between normal running and programming. These keypad functions are as follows:-

has an alternating action i.e. each press will select the opposite state, off to on, or on to off. The Total Counter will be active when set to on, as shown by an indicator (LED) inside the switch. This function may be set to off when producing samples.

clears the Total Counter to zero.

will switch on the Motor output and then start the selected Cut Mode after a two-second delay providing the CUT ON/OFF is on. The indicator in the switch will light to show that START has been accepted. If the guard is open then the START function will be refused and "Guard Error" will be displayed (See "Guard" section).

On a Vacuum machine the vacuum pump will be switched on one second before the motor.

On a Servo cutter the Drive will be enabled one second before the motor enters ready mode.

will switch off the Motor output and stop the selected Cut Mode. The indicator in the START switch will go out to show that STOP has been accepted. STOP is selected automatically after power up or when a guard is opened (See "Power up" and "Guard" sections). A signal will be sent to the brake circuit to apply the brake.

On a Vacuum machine the motor is switched off but the vacuum pump remains on for a further 20 seconds. This ensures the brake is held until the motor has come to a complete standstill.

On a Servo machine the motor is stopped but the drive remains enabled for a further 10 seconds. This ensures that the braking circuit has sufficient time to stop heavy flywheel motors.

behaves in a similar way to the TOTAL ON/OFF switch but affects the Cut output.

selects the cut source. Each press of the key is used to select the next Cut Mode. The selection process is TIMER - PRODUCT - ENCODER - CYCLES - FLYWHEEL - TIMER. Timer, product and encoder are known as “on-demand modes” where count completion or edge detection provides the cut signal. While in an on-demand mode the Cut Length display will normally be showing a count in progress from one of the various sources (See "Cut Modes" section). An indicator above the switch shows which source the controller is using. Only one light out of the five choices will be illuminated. When changing between modes the new mode does not become active until two seconds have elapsed and no cuts will be performed during that time.

Some modes will not be available due to machine type or application restrictions.

is available for Servo cutters with variable Blade Speed. This function is described in the programming section. Older panels have a keypad that reads Comp instead of Blade Speed. However, the function is exactly the same.

Dual Functions - Edit Keys
Normal Running

provides a sample cut while the motor is enabled. The cut piece is not counted on the Total Counter. The Length Counter will reset, but counting will continue on the next count pulse. The following length will therefore be correct (equal to the programmed Length Preset). Test cuts can be made with the CUT ON/OFF in either state while the motor is enabled.

This key also has a special function for releasing the clutch on an ESC machine. The requirements are that the motor must have been stopped for at least 20 seconds and the guards must be closed. If those conditions are met and the key has been kept pressed for two seconds the clutch will be popped. This allows the operator to move the blade to an accessible position for changing.

WARNING - ENSURE THE MACHINE IS ISOLATED WHEN CHANGING BLADES. EVEN WHEN ISOLATED BEWARE OF THE SHARP BLADE.

The Length Preset will appear in the Length Display window with the word "Preset" (PrESEt) shown in the Total Display window. (Seven segment displays cannot faithfully produce all letters of the alphabet, some characters can only be shown in upper case, others in lower case). The whole display will count up 1 for each press (in the least significant digit position).

Holding the keypad down will also provide the same function. After two seconds the preset will change more rapidly. The value in the Length window is instantly used as the new Length Preset. When the key is released the displays will continue to hold the preset for five more seconds before returning to display the count in progress. The preset can be trimmed up to 999999. The edit keys are not accepted in Flywheel mode.

This key complements the Trim up key providing a count down of the preset. The preset can be trimmed down to 000000. The cutter will make the most amount of cuts (CPM Maximum) that it can when the preset is set too low.

no function during normal running.

no function during normal running.

will switch from normal running to preset programming. The key is not accepted in Flywheel mode.

Programming
Length Preset

The Length Display will show the previous Length Preset with one of the digits flashing. This display is ready for editing on a digit by digit basis. The range is zero to 999,999 (zero acts like a preset of 1). The Total Display will show the word "Preset" (PrESEt). Decimal points are fixed for the type of preset (See Cut Modes and Scale).

sets the Length Preset to zero (000000).

increases the value of the flashing digit by 1. Numbers step from 0 through to 9 and then back to 0 with each key press.

decreases the value of the flashing digit by 1. Numbers step from 9 through to 0 and then back to 9 with each key press.

selects the digit to the left of the flashing digit. This becomes the next editable digit and the previous digit stops flashing. Wrap around is used so that if the left-most digit was editable then the right-most digit will become the next editable digit after a "<" key press.

selects the digit to the right of the flashing digit. This becomes the next editable digit and the previous digit stops flashing. Wrap around is used so that if the right-most digit was editable then the left-most digit will become the next editable digit after a ">" key press.

will accept the Length Preset as displayed. After five seconds the display will revert to showing actual count. When in the Encoder mode a second rapid press of Set will gain access to the Pre-scaler preset (this facility is locked out if the Start indicator is on - except for special applications).

Pre-scaler (Calibration Factor, Scale Factor, Multiplier) (Encoder Mode only)
The Length Display will show the previous Pre-scale value with one of the digits flashing. This display is ready for editing on a digit by digit basis. The range is 0 to 0.999999, the decimal point is not shown as the preset represents six decimal places. The Total Display will show the word "Scale" (SCALE).

In Quadrature Encoder mode (encoders with A and B channels connected) the pre-scale is the unit of measure that equates to the distance between two signal edges on the Encoder A channel (consecutive off to on and on to off edges). This value is expected to be very small i.e. lower than 1 so six decimal places are provided for scale. The encoder counter is increased (or decreased) by the value of the pre-scale at each edge detection of the Encoder A input. To find the Scale Factor it is required to know how many Encoder A edges occur in a particular distance. The formula for scale factor is :-

$$\text{Scale Factor} = \frac{\text{Any Distance}}{\text{Counts (Signal Edges) per Distance}}$$

For example - an encoder with a 12” circumference wheel provides 600 pulses per revolution. 600 pulses equate to 1,200 signal edges.

$$\text{Scale Factor} = \frac{12}{1{,}200} = .01$$ (Set Scale to 010000).

Using the same encoder for metric (centimeters) multiply by 2.54.

$$\text{Scale Factor} = \frac{12 \times 2.54}{1{,}200} = .0254$$ (Set Scale to 025400).

If the Encoder is a uni-directional type only the rising edges are counted. In this case a 600-pulse encoder will provide 600 counts.

Encoder parameters

The Encoder counter consists of 10 decades fixed to 6 decimal places (xxxx.xxxxxx). The scale factor is 6 decades (all decades are after the decimal point - 0.xxxxxx). The Encoder preset is 10 decades. Only the upper 6 decades may be set and seen - the lower four decades are permanently zero (xxxx.xx0000).

Example: Scale is 0.005000 (5 thou.) and Length Preset is 0012.00 (12-inches)

Scale.....0000.**005000**

Count.....**0009.750000** (current count example at 9.75")

Preset.....**0012.00**0000

clears the Pre-scale preset to zero (000000).

increases the value of the flashing digit by 1. Numbers step from 0 through to 9 and then back to 0 with each key press.

decreases the value of the flashing digit by 1. Numbers step from 9 through to 0 and then back to 9 with each key press.

selects the digit to the left of the flashing digit. This becomes the next editable digit and the previous digit stops flashing. Wrap around is used so that if the left-most digit was editable then the right-most digit will become the next editable digit after a "<" key press.

selects the digit to the right of the flashing digit. This becomes the next editable digit and the previous digit stops flashing. Wrap around is used so that if the right-most digit was editable then the left-most digit will become the next editable digit after a ">" key press.

will accept the Pre-scaler as displayed and end the programming facility. Normal running will resume. The display will return to showing the actual count after five seconds.

Blade Speed - Servo Machines with Variable Blade Speed only

accesses the Blade Speed RPM. The displayed preset can be adjusted using the edit keys. The Length Display will show the previous Blade Speed value with one of the digits flashing. This display is ready for editing on a digit by digit basis. The adjustable range is 0 to 9999.99 with the decimal point fixed to two decimal places. Each servo type has a minimum and maximum speed - please see Machine Selects chart for minimum and maximum values). A value set outside the allowable range will be corrected. The Total Display will show the word "Blade" (bLAdE). On older panels the keypad reads Comp although the function is the same.

clears the Blade Speed preset to zero (0000.00).

increases the value of the flashing digit by 1. Numbers step from 0 through to 9 and then back to 0 with each key press.

decreases the value of the flashing digit by 1. Numbers step from 9 through to 0 and then back to 9 with each key press.

selects the digit to the left of the flashing digit. This becomes the next editable digit and the previous digit stops flashing. Wrap around is used so that if the left-most digit was editable then the right-most digit will become the next editable digit after a "<" key press.

selects the digit to the right of the flashing digit. This becomes the next editable digit and the previous digit stops flashing. Wrap around is used so that if the right-most digit was editable then the left-most digit will become the next editable digit after a ">" key press.

will accept the Blade Speed preset as displayed and end the programming facility. If the value is greater than the maximum speed allowed the preset will be replaced by the maximum. The same applies to setting a value less than minimum in which case the minimum value will be used. The display will return to showing the actual count after five seconds.

will function exactly the same as the SET key. On older panels the keypad reads Comp although the function is exactly the same.

Cut Modes

TIMER — counts milliseconds from a built in quartz crystal source. When the count equals or exceeds the Length Preset the blade will be operated to provide a single cut. The decimal point is shown to three decimal places for count and preset (seconds.milliseconds).

PRODUCT — provides a single cut in response to activation of the Product +/- terminals. The sensor providing the signal can use the LE-650 12-volt power supply. Usually the sensor is positioned to detect the product edge although the signal can also be provided by an external counting system or synchronizing source. This type of signal is prone to double triggering caused by the product jumping in front of the sensor after being cut or through contact bounce of a relay contact. This effect can be overcome using the built in Hold-Off timer. The signal initiates the cut and begins the Hold-Off timing. During the Hold-Off time the sensor activity is ignored. The Length display counts during the Hold-Off period using the quartz crystal timing source. The value entered is in milliseconds and must be set to less than the time expected between cuts so that it is ready for the next edge (i.e. 70 to 80%). The decimal point is shown to three decimal places for count and preset (seconds.milliseconds).

ENCODER — counts signals appearing on the Encoder A and B terminals as supplied by an Encoder. The Encoder is usually collecting distance information from the product being extruded and can cause the count to be up or down depending on the phase relationship of the Encoder signals. When the count equals or exceeds the Length Preset the blade will be operated to provide a cut. The Encoder can be a uni-direction or bi-direction (quadrature) type. When using uni-direction encoders only the A terminals are connected. Encoder B connections should be left open, shorted together or linked to 0v.

The controller automatically detects the encoder type by observing the activity on the two channels. If it only sees activity on the A channel the left display will briefly issue an "EnC-A" message. A quadrature encoder will briefly issue an "EnC-Ab" message. A count is made at each signal edge of A which has the effect of providing two counts for each pulse. For example: an encoder with 600 ppr will cause 1,200 counts for one revolution. 250,000 counts per second can be achieved - this is equivalent to a frequency of 125 KHz.

The counter and preset are ten decades each consisting of four integer digits and six decimal places (xxxx.xxxxxx). Only the six most significant decades are shown (xxxx.xx), although the lower decades are still registered. The upper six decades of the encoder preset can be altered, the lower four decades are set internally to zero (xxxx.xx0000). The scale factor uses six decimal places (0.xxxxxx).

A quadrature encoder is a more accurate source than a uni-directional encoder as any reverse movement or shock tends to be cancelled by the ability to count in both directions.

CYCLES is only available for ERC rotary cutters. The length counter counts the revolutions of the rotating blade actuator. The “Park Sensor” provides the cycle count. When the count equals or exceeds the Length Preset the blade will be operated to provide a single cut.

FLYWHEEL this mode is not available for ESC, Saws or Planetary cutters. This mode is expected to be used for very short lengths. The clutch is permanently engaged (clutch type cutters) so that the blade continuously rotates. For Servo cutters the motor runs at the set speed (may be fixed speed). The park sensor continues to be used to count the cuts but does not trigger the brake. The Length has no function in this mode so the display shows the term "FLYCut" meaning it is cutting using the Flywheel mode.

Power Up Reset

When power is first applied to the LE-650 Controller all outputs are switched off. An initial test is made to ensure that all presets and counters have not been corrupted. This test is made using a check-sum (sum of all presets added together). Copies of presets are retained so that the system can discover and correct any error using one of the good back-ups. The display will show a sign-on message for two seconds, "Good dAy" followed by "LE-650" and EPROM version number. If an error was encountered it will be mentioned i.e. "Point Error" otherwise the display will show "tESt Good". In the case of an error the operator can check to see if it was fixed correctly before continuing. A final message "SEt to ....." will show the machine type. The fascia will eventually display the Length and Total Counters with the previous count showing (unless an error had previously been discovered).

Messages

The displays will normally be displaying actual count. When powering up, programming or during error conditions the displays will show legends for operator assistance. For power up legends see the section on Power Up Reset. For programming legends see Programming. Errors such as a guard opening or a blade jamming will be latched into the display until the operator presses a key.

External Connections

Power (Mains Supply)

120 volts A.C. supply. Two terminals are provided labelled "Live" and "Neutral". A fuse is provided @ 250 milli-amps connected between the transformer and the Live terminal.

Ground

Two terminals marked "Ground" are connected internally to the metal case and should be taken to the machine frame ground. Regulations suggest that it is not suitable to rely on the fixings alone to provide the suitable grounding so it is recommended to also ground the LE-650 enclosure via one of its screws. A ground marking is shown beside the preferred point. Grounding also serves to provide electrical noise screening.

Sensor Inputs

All sensor inputs have similar characteristics. Inputs, except the Encoder, are connected to the control's 12-volt DC supply via internal pull-up resistor loads. The external circuit needs to sink (pull down towards 0-volts) about 10 milli-amps in order to register an active state. All sensor inputs (except encoder) should use the Controller 12-volt power supply. The Encoder connections are isolated so can use the controller supply or an isolated / non-isolated source ranging between 5 and 24-volts.

Machine Select - 8 Pin Connector

These inputs - Select 1 to Select 4 - are used for Machine selection. Each machine type has a unique code and is set during machine manufacture. The coding links are threaded into the wiring harness so that if controls are swapped between machines the correct machine selection is made. Depending on machine version some modes may not be available.

LE650											
Machine Code	Machine Select Links				Machine Type	Sign on Message	On-Demand CPM	Gear Ratio	Cut Modes Available / RPM Max		
	4	3	2	1					Timer / Product / Encoder	Cycles	Flywheel
1				X	Pneumatic	PSC	400	n/a	X	n/a	X
2			X		Vacuum	VAC	500		X		X
3			X	X	Electromagnetic	ELC	350		X		X
4		X			ERC	ERC	n/a		X	X	X
5		X		X	Wrap Spring	ESC	150		X	n/a	
6		X	X		Saw/Planetary	S_C	60		X		
7		X	X	X	E-Drive - minimum speed 200-RPM	SC1	250	4:1	750-RPM	n/a	750-RPM
8	X					SC2	350				
9	X			X		SC3	250	3:1	750-RPM		1,000-RPM
10	X		X			SC4	350				
11	X		X	X		SC5	Flywheel only		n/a		
12	X	X				SC6	350	1:1	750-RPM		2,800-RPM
13	X	X		X		SC7	Flywheel only		n/a		2,800-RPM
14	X	X	X			SC8	Flywheel only	4:1	n/a		750-RPM

Encoder A and B (Product B) - 4 pin Connector
Phase difference count inputs are possible. A quadrature encoder can supply a suitable count. Each input is monitored for a change of state, causing a count in the relative direction. LED's marked "Encoder A" and "Encoder B" display active inputs. These light when the respective input pair turns the channel on. The light will stay on for 1/20th second after the channel turns off.

A uni-direction counter should have its signal connected to Encoder A channel. The controller will automatically switch between uni-direction and bi-direction by detecting the ratio of signals occurring on the two channels. Each signal edge, high or low, will create one count therefore doubling the encoder resolution.

The Encoder B channel is also available for detecting the product edge via a suitable sensor. Turning the channel from off to on is used to initiate a trigger.

Guard - 3 pin Connector
An external circuit is available for guards. A safe condition is met by the Guard terminal being connected (via the guard circuit) to a 0 volt terminal. An open collector N.P.N. sensor or switch may provide this signal. A safe guard will light the "Guard" LED on the fascia panel. If a guard opens while the machine is running the Motor output will disable placing the blade in to a forced stop condition. The display will read "GuArd oPEn". The cause of stoppage will remain displayed until a key is pressed. The guard circuit opening places a pulsed signal on the Brake Trig. output terminal to force the brake to energize in the case of PSC, VAC, ELC and SCn machines.

For a VAC machine the vacuum pump will continue to run for a further 20 seconds after the guard has opened. This is considered a safer option as it ensures the brake remains powered (locked) until the motor has finally stopped.

For a Servo Cutter the pump output that is used for drive enable stays on so that the drive continues functioning during the deceleration period. After 20-seconds the drive is then disabled.

Cut Sense - 6 pin Connector (shared with Park)
This input is used by a Saw to signal the status of the blade. The start key sends a signal to switch on the blade (if guards are safe) and Cut Point is used to confirm that the motor starter has switched on. If the confirmation is not seen or if the motor starter drops out the Motor output will switch off and a “Latch Error” (LAtCh Error) will be displayed.

Park (Brake) - 6 pin Connector (shared with Cut)
For PSC, VAC, ELC and SCn cutters the park sensor is monitored after each cut signal to ensure that the blade has completed a rotation. If the park position target is not seen within a respectable time a blade jammed error will be displayed as "Blade Error" (bLAdE Error). The Controller sends the park sensor signal back out to the blade control switching circuit via the Brake terminal, but also has control over issuing overriding brake signals of its own i.e. after STOP has been selected. The Total Counter will increase by one when the Park sensor is sensed under correct cutting conditions.

On ERC machines the Park sensor provides details of rotary position and cycle count. When a cut is to be made the blade will be activated into its cutting position at the Park detection point. The blade will be de-activated in the same position after one revolution unless another cut is required. The Total Counter will increase by one when the park sensor is sensed with the blade set in its cutting position. If the cut cycle does not complete within a respectable time “Blade Error” will be displayed.

On ESC machines there is no need for a park sensor to be fitted or for any HSS Brake connection to be made.

On a saw (or planetary - uses same setting) this signal has to be made before a cut trigger can be accepted. It is used to signal that the table is in the home position and ready to cycle.

When the park sensor input is at 0 volts and for 1/20th of a second after the terminal returns to 12 volts the Status LED on the fascia marked "Park" will light.

Outputs - 5 pin Connector
The outputs are NPN open collector sharing a Common 0-volt reference. The Cut and Brake outputs can switch up to 50 milli-amps @ 30 volts D.C. maximum. The Motor and Pump / Jog outputs can switch up to 500 milli-amps @ 30 volts D.C. maximum. An on state is active low.

Brake / Program
This output is used to trigger the Brake sense input of the blade switching circuit as used in PSC, VAC, ELC and SCn machines. The falling edge is the triggering edge. The Controller sends the park sensor signal back out to the Switch via this terminal, but also has control over issuing overriding brake signals of its own i.e. after STOP has been selected.

On a Saw or Planetary cutter this output is not normally used, but if the table is controlled by a servo drive this output will be used as a Program Initiate. It is pulsed low momentarily after a Start has been accepted.

It is not used for ERC or ESC cutters.

Cut
This output is used to trigger a cut cycle. Connection should be made to the Cut sense input of a blade switching circuit. The falling edge is the triggering edge.

For an ERC machine the level on this terminal is used to control the blade. A low (on) switches the blade into its cutting position, a high (off) retracts the blade.

Motor
This output is used to enable a motor. When the output transistor is on (low) the motor is enabled, when off the motor is disabled. This terminal may be used to drive a solid state or 24 volt relay when observing the maximum ratings above.

Pump / Jog
This output is used to switch on a vacuum pump when used with a VAC machine. When the output transistor is on (low) the pump is on, when off the pump is off. This terminal may be used to drive a solid state or 24 volt relay when observing the maximum ratings above. An E-Drive Servo machine uses this output for drive enable.

A 500HZ square wave signal will appear at this terminal for ESC machines. Encoder A input can be linked to this Clock as a test in Encoder mode.

Communications - 7 pin Connector
RS-423 - This is dedicated for communications with a Servo drive. The signal is Modbus RTU using 19,200 Baud, 8-bits, no parity and 2-stop bits.

RS-485
Terminal A is the non inverting input / output, and terminal B is the inverting input / output.

The LE-650 Controller uses the following technique for serial communications :-

RS485 Multi Drop Ansi-X3.28-2.5-A4

Baud Rate	-	9600
Format	-	1 start, 7 data, 1 even parity, 1 stop
Address	-	00 to 99 (default is 65) (00 is normally reserved so should be avoided). (See section on Address Changing).

Officially, the standard allows for 32 drivers and 32 receivers using a maximum cable length of 4,000-feet (1,200-meters). Ideally, a shorter cable length will be used because of the typical noisy factory environment. The communications device uses a reduced slew rate driver to minimize EMI (required for CE), and reduce reflections caused by improperly terminated cables. This does not affect our data transmission rates as it is good for data rates up to 250kbps, as opposed to the possible 2.5Mbps of the standard RS485. The driver is short circuit protected.

To minimize reflections, the line should be terminated at both ends in its characteristic impedance, and stub lengths should be kept as short as possible. The total expected load for RS485 is 60R, usually made up of a 120R resistor at each end of the line. A 120R resistor is already fitted to the LE-650 controller with one end connected to the B terminal, with the other end of the resistor brought out to the A Load terminal. If this resistor is required it may simply be linked to the A terminal. Correct RS-485 style cable should be used such as Belden 9841 or equivalent.

Address - setting
The default address is 65, but can be any value from 00 to 99. To change the address to a different value requires a special key sequence. While the LE-650 is not in an edit mode (no digits are flashing) and the Start LED is off, press the right shift button and keep it pressed. After five seconds the display will change to show Addr. 0000## (where ## equals the current address). Using the edit keys it is possible to change the two-digit address to a new value. Pressing the Set key will accept the new address. Address 00 is normally reserved so should be avoided.

Parameters

A parameter is made up of two characters (mnemonics). Each parameter will fall in to a particular category such as Read Only (RO), Write Only (WO), Read and Write (RW), and a variant on Read Only known as Read Clear (RC). Read Clear is only associated with the Status Word (SW) which contains data bits (0 = off, 1 = on); the action of the read automatically clears a set bit when it is an RC type. Some of the parameters use a hexadecimal format (H) where 0 to 9, and A to F only are communicated. Hexadecimal parameters include an ">" character immediately after the mnemonic.

II Instrument Identifier RO H (returns 650x)

The first three characters "650" are the controller identifier, the last character defines the machine type as follows :-

0 Not Defined
1 PSC - Pneumatic Clutch / Brake
2 VAC /SCn - Vacuum Clutch / Brake or Servo
3 EMC - Electromagnetic Clutch / Brake
4 ERC - Electro-rotary
5 ESC - Electro-stop (Wrap Spring Clutch)
6 Saw or Planetary cutter

KY Key Code WO H

It is possible to operate four of the LE-650 keys through communications. The possible keys and their codes are :-

0 Stop
1 Start
2 Reset (Total Count)
3 Reset / Test (Length Count)

Any other codes will select Stop.

The first data character after the '>' character must be received and must be one of the values in the table above. The key buffer can contain four characters in total but data D2 to D4 are optional. If inserted the key routines will be operated one at a time until all key operations have been completed. The keyboard buffer can only accept new data when the buffer is empty. A flag in the Status Word register determines if the buffer is available (see SW codes). If key codes are transmitted while the buffer is in use a NAK will be returned.

SW Status Word *see individual bits H

Bit	Name	Digit	Bit	0	1	Type RW	RO	RC
15	Pump	1	3	Off	On		RO	
14	Motor	1	2	Off	On		RO	
13	Total Enable	1	1	Off	On	RW		
12	Cut Enable	1	0	Off	On	RW		
11	Encoder A	2	3	Off	On		RO	
10	Encoder B	2	2	Off	On		RO	
9	Park	2	1	Off	On		RO	
8	Guard	2	0	Open	Safe		RO	
The above bits are copies of LED's which have the same name.								
7	Quadrature	3	3	Uni-	Quad-		RO	
6	Cut occurred	3	2	No	Yes			RC
5	Set-point modified locally	3	1	No	Yes			RC
4	Mode changed locally	3	0	No	Yes			RC
3	Checksum	4	3	OK	Error		RO	
2	Keys - Stop key will still function	4	2	enabled	disabled	RW		
1	Key Buffer	4	1	empty	active		RO	
0	Error occurred	4	0	No	Yes			RC

CM Cut Mode RW

0 Timer
1 Product
2 Encoder
3 Cycles
4 Flywheel

This parameter consists of a single value 0 to 4. Some modes are not available by some of the machine types i.e. Flywheel is not available on an ESC cutter. Trying to select a mode that is not available will have no effect - the current Cut Mode will remain in operation.

ER Error Codes RO H
Returns the last four error codes, with the most recent error shown first.

0 No Error.
1 Guard - was open when trying to start or was opened while running.
2 Blade - did not complete a revolution within allowable time, possibly jammed.
3 Machine Select plug out - need to know machine type.
4 Machine Select set to an unrecognised machine type.
5 Encoder too fast - may need to divide the encoder signals.
6 Latch Error set by Saw machine only - indicates blade contactor dropped out or did not come on.
7 Not used
8 Repeatability Error (test must be in progress)
9 Data - data stored in RAM may have been corrupted (possibly due to static)

Counters and Presets
These parameters are each 6 decades wide. Decimal points are for display purposes only (relevant to the mode), they are not expected or transmitted in any data streams. The format is thus xxxxxx.

LC Length Count RO
TC Total Count RO
BH Blade Speed High (Maximum) RO
BL Blade Speed Low (Minimum) RO

SF Scale Factor RW
BS Blade Speed RW

SL Set-point Local RW
Read or Write value is directed from or to the parameter currently selected by the Cut Mode.

Inquiries

1. All inquiries are initially made by the host computer using :-
EOT, GID, GID, UID, UID, P1, P2, ENQ.

EOT = ASCII - Hex 04, used to clear the line. All devices on the RS485 look at the next four characters to see if they are being addressed.
GID = Group Identifier (First part of Address - expects 0 to 9, ASCII - Hex 30 to 39). This is sent twice.
UID = Unit Identifier (Second part of Address). Also sent twice.
P1 and P2 = First and second characters of required parameter.
ENQ = ASCII - Hex 05.

After a communications link has been established (as notified by a valid response to the above communication) it is possible to use a shorted inquiry using ACK and NAK (see later). The following is also valid :-
P1, P2, ENQ

2. If the address and parameter are recognized the LE-650 will respond with :-
STX, **P1, P2, D1, D2, D3, D4, D5, D6, ETX**, BCC
Characters shown in bold are used in checksum (BCC) calculation
Shorter parameters send less data (D characters).

STX = ASCII - Hex 02
P1 and P2 = Parameter mnemonic
D1 to D6 = Data (Parameter Value) - in ASCII Form
For Hex data D1 is a '>' and data which follows is treated as hexadecimal characters.
ETX = ASCII - Hex 03
BCC = Checksum of characters P1 to ETX inclusive as highlighted in bold above. BCC is calculated by using the Exclusive Or (xor) logic function :-

BCC = P1 (xor) P2 (xor) D1 (xor) D2 (xor) D3 (xor) D4 (xor) D5 (xor) D6 (xor) ETX.

The host computer will check the BCC character with its own internally calculated BCC before accepting the data.

If the parameter is not recognised the LE-650 will respond with :-
STX, P1, P2, EOT

3. If the LE-650 recognised the parameter and responded the host can now continue communicating using the following simpler inquiries:-

NAK = ASCII - Hex 15. This requests that the same parameter be repeated. This may be required because the value was not understood or can provide a quick and simple means to repeatedly monitor a value.

ACK = ASCII - Hex 06. This requests that the next parameter be returned. Only TC, LC, SL and SW parameters are cycled.

Sending Data from the Host Computer to the LE-650

1. All parameter updates are initially made by the host computer using :-
EOT, GID, GID, UID, UID, STX, P1, P2, D1, D2, D3, D4, D5, D6, ETX, BCC.

After a communications link has been established (as notified by a valid response to the previous communication) it is possible to use the shorted update :-
STX, P1, P2, D1, D2, D3, D4, D5, D6, ETX, BCC.

2. If the message was understood and parameter within range the LE-650 will respond with ACK. If the parameter is faulty the response will be NAK.

No reply will be given if the address is not recognized or if a parity, framing or overrun error occurs.

3. The host computer may now use an ACK or NAK inquiry. NAK will return the last parameter that was changed so is useful for checking that the value was modified correctly.