The DLC-100 digital loop controller is a self-contained microprocessor-based closed loop controller designed to meet the needs of hydraulic closed loop servo and proportional based systems.

**Features:**
- Self-contained controller including valve driver
- Single 24 volt DC power input
- +/- 15 volt internal power supply provides 100 mA for powering feedback or auxiliary devices
- Single axis, single or dual loop (inner/outer) or loop limiting modes of operation
- Bumpless transfer between inner and outer loop authority
- Analog inputs for command, feedback and ramp time: 5, +/-5, 10, or +/-10 volt span
- Feedback or output via parallel I/O port, if required: 8, 10, 12, 14 or 16 bit span with handshake
- Serial interface for set-up, command setpoint, "tuning" and data monitoring.Selectable between RS 232 or RS 485/422; 1200 and 19,200 baud. Communications via intelligent multi-drop network protocol or "Dumb terminal" mode for standard terminals.
- Multi-axis support of up to 32 stations over a single twisted pair cable in RS 485 multi-drop mode
- Parameter storage in EEPROM
- 8K battery backed RAM for additional operational parameter storage

**Functional description**

The DLC-100 provides a complete single card control for closed loop systems. Providing a range of input voltages, run/stop control, up/down ramping and failure and error detection, the DLC-100 can replace several cards used in standard analog systems. The lack of drift and repeatable digital "tuning" further enhance the capabilities of the DLC-100.

Plug-in driver boards provide drive capabilities for most standard Rexroth servo and proportional valves directly from the DLC-100. Driver boards offer the ability to select up to four standard valve sizes with a single board. A "pass through" board is available to drive Rexroth integrated electronic valves with +/-10 volt inputs.

Communications with the DLC-100 is selectable between RS 232 or RS 485/422 at 9600 or 19,200 baud. In either mode, the communications protocol supports an intelligent host or "dumb terminal". In the intelligent host mode, multi-station addressing is supported in the RS 485 mode to allow for multi-drop (multi-axis) operation. In the intelligent host mode, full on-line data transferral allows all parameters, I/O points and running parameters to be read and loaded.

Setpoint command values and "tuning" parameters can be loaded or changed "on-the-fly". Likewise, all A/D, parallel ports and D/A values can be read from the DLC-100.

Complex profiling or look-up table operation is possible with special applications software. Values can be downloaded into the battery backed RAM for these capabilities when using the intelligent host communications.

With the "dumb terminal" mode, any standard ASCII terminal supporting 1200 or 9600 baud can be connected to the DLC-100. The terminal mode allows any parameter value to be read or altered, one at a time. This allows checking and setup to be done with low cost and readily available equipment, including hand-held terminals or computers.
**I/O control**

Four 24 volt DC inputs and two 24 volt DC outputs are provided. The inputs are optically coupled and require approximately 10 mA each. The outputs are sourcing transistor drivers with drive capabilities of 40 mA each. The outputs are short circuit protected; a short circuit will result in a fault and the CPU will halt process operation.

The inputs provide the following typical functions:

1. **Enable** - This input is a permissive to enable all control. When this input is off, all analog and valve outputs are disabled, and all controllers are reset and the fault status, if present, is reset. When this input is on, the controllers are enabled and the valve driver output is enabled and the analog outputs are enabled for valve nulling.

2. **Run** - This input turns the controllers on, and enables the command input through the ramp generator to start controlled operation. When this input is turned off, the command input is removed from the ramp generator input; the control setpoint ramps down. After the process has stopped, the integrators (if enabled) are reset.

3. **Direction** - This input allows reversal of the command direction (polarity) via a discrete input. Reversals controlled by this input will ramp through zero to provide smooth reversals.

4. **Auxiliary Input** - This input can be set to one of the following modes under software control:
   - A. Major loop integrator hold and track**
   - B. Major loop integrator load**
   - C. Minor loop integrator hold and track**
   - D. Minor loop integrator load**
   - E. Reset fault (if latching enabled)
   - F. Auto null - auto null valve for center

   **Denotes that major and minor loop modes can be simultaneously selected

The outputs provide the following typical functions:

1. **At Setpoint** - This output is on when the command and feedback for the major loop match each other within a settable window for a minimum time. This indicates that the controller is at position, at speed, at force, etc.

2. **Fault Output** - This output is high when no faults exist. A low output indicates a fault has been detected and the process has been stopped.

The parallel I/O port provides the following functions:

**Parallel I/O** - The parallel I/O port provides 22 bits of bi-directional data. This port can be used as an input from a parallel TTL feedback device. This provides the ability to use a digital feedback device to provide extremely high resolution ($2^{20}$). The port can also be used as an I/O port for additional discrete I/O. The port connector is configured to connect directly to an OPTO-22 compatible I/O rack to provide up to 22 additional discrete I/O points. The parallel port can also be used as a parallel data bus between two or more DLC-100 cards. Using the parallel port as a data bus provides a high speed bi-directional path for data transfer in multi-axis systems.
Operational features

When the DLC-100 is powered up or reset, a self-test and check of EEPROM validity is performed. The serial port not selected on the setup dip switch (i.e. RS 232 or RS 485) is tested for activity for 5 seconds. After this time, the port selected under software control is selected. This allows a terminal to be connected to the DLC-100 for testing without removing existing communication connections. The controller will then load setup and parameter information from the EEPROM into the running registers. Normal controller operation occurs at this time.

Process safety is monitored at several levels. The microcontroller has an internal watchdog timer that will reset the system on a system lock-up. Additionally, driver board faults, input over and under range limits and controller error out-of-range limits can be set to stop the process and indicate a fault on an output, if desired. Additionally, unconditional shutdown will occur if: The internal 5 volt power supply drops below 4.0 volts, the +/-15 volt power supplies go out of tolerance, or if a discrete output is short circuited. Any fault condition can be set to automatically reset after a time interval, or the fault condition can be latched. This latch can be reset by cycling the power off, or setting the enable input low or by turning on the auxiliary input, if it is selected in software as the fault reset.

Configuration of the DLC-100 software is made by using one of the many standard application software packages, or implementation of an application specific software configuration. In the application specific implementation, an applications specialist reviews the details of an application and generates a system configuration to meet the specific needs of control and interface.

Typical use

The controller can contain two PID type controllers with lead-term damping in the feedback path. Each term (P, I, D, and damping) can be used or disabled, if not required. The major loop also has the ability to pass the controller error through a square root term for damping in the feedback path. Each term (P, I, D, and damping) and controller error out-of-range limits can be set to stop the process and indicate a fault on an output, if desired. Additionally, unconditional shutdown will occur if: The internal 5 volt power supply drops below 4.0 volts, the +/-15 volt power supplies go out of tolerance, or if a discrete output is short circuited. Any fault condition can be set to automatically reset after a time interval, or the fault condition can be latched. This latch can be reset by cycling the power off, or setting the enable input low or by turning on the auxiliary input, if it is selected in software as the fault reset.

All parameters for the control loops are alterable while the controller is running, since the communications is interrupt driven.

If the intelligent host protocol is used, one or more values can be downloaded to the DLC-100, and if valid, these values will be loaded into the controllers. Data or blocks of data can be read from the DLC-100 with the intelligent host protocol. This allows real-time monitoring of parameters or of the analog and parallel inputs and outputs.

Three separate fault bits and the valve feedback signal is provided to the microcontroller for fault detection. Driver boards provide selection of up to four valve sizes (i.e. 10, 16, 25, 32) on a single board. These are selected with dip switches on the DLC-100.

Faults detected by the DLC-100 are maintained in a fault table. This data can be read via the communications port and displayed. Text messages of the faults are displayed in intelligent host protocol and in “dumb terminal” mode. Up to 16 different faults are available.

The DLC-100 is based on all CMOS digital technology. With a supply voltage input range of 20 to 35 volts DC, the DLC-100 can be used in a wide range of industrial environments.