GALIL

# GL/1200

## Pulse-Input Servo Controller

## Features

- Dedicated single-chip controller for DC motors
- Provides position and velocity control
- Accepts feedback from an incremental encoder
- Accepts input commands in pulse train format
- Computes and reports position error
- Operates with or without a tachometer
- 100,000:1 speed range
- Phase-lock speed accuracy

## Applications

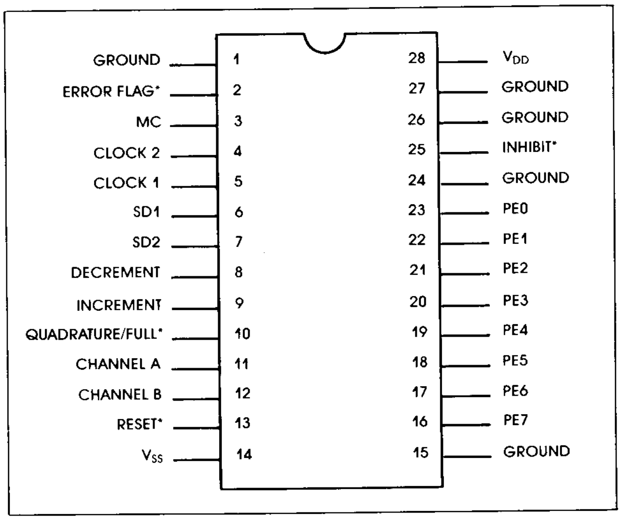
- Step motor to servo motor conversions
- Phase-locked loops

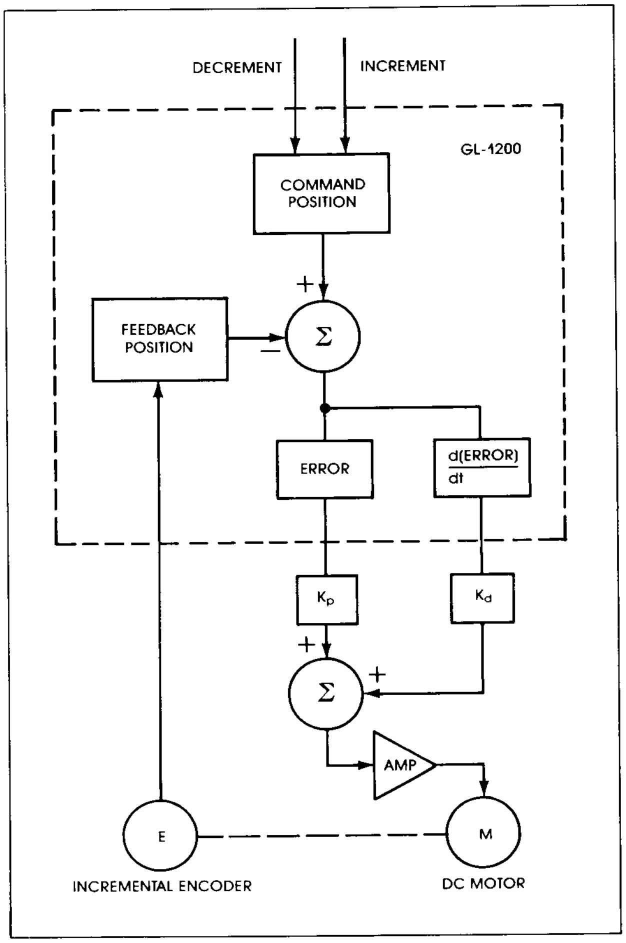
## General Description

The GL-1200 is a single-chip controller contained in a 28-pin DIP. It provides closed-loop position and velocity control of a DC motor. The control chip accepts position feedback from a two channel, incremental encoder. The position command is accepted in a pulse train format. The actual position and command position are continuously stored and updated in a 12-bit register. The GL-1200 compares the actual position with the command position to form a 12-bit position error. Eight bits of the position error are pulse-width-modulated and output for motor control. The GL-1200 also computes the derivative of the position error for damping. This eliminates the need for velocity feedback from a tachometer.

The GL-1200 outputs the pulse-width-modulated position error and derivative of the position error. These signals, which are externally summed and converted into an analog signal, are the only output signals required for precise motor control. The system gain and damping are adjustable by external resistors for optimum performance.

The GL-1200 is a pulse following device. For example, a single pulse input command will cause the motor to move one encoder count. The velocity profile of the motor is determined by the pulse input frequency. If the encoder pulses fall too far behind the command pulses, the GL-1200 provides an error output which goes low when the controller is out of its 8-bit linear range. The position error may also be continuously monitored through the 8-bit error output port.




*Motion Control System*

## Inputs

**Clock 1:** Connect external clock to this input. Maximum frequency is 5 MHz for GL-1200 and 10 MHz for the GL-1200-10.

**Decrement:** Decrements position command counter by one count for each rising edge on the decrement line.

**Increment:** Increments position command counter by one count for each rising edge on the increment line.

**Quadrature/Full*:** Selects input resolution. If low, each increment or decrement pulse will move the motor four quadrature counts or one full encoder cycle. If high, each command pulse causes a motion of one quadrature count.

**Encoder:** 2 channel, quadrature encoder. TTL level. The controller performs quadrature decoding of the encoder signals (4 x encoder cycles).

**Reset*:** Resets all position counters and tri-states the pulse-width-modulated position error output (MC).

**Inhibit*:** Tri-states the pulse-width-modulated position error output (MC).

## Outputs

**MC:** Pulse-width-modulated position error. Must be summed with SD1 and SD2 as shown in Figure 1 to form the analog motor command signal.

**SD1, SD2:** TTL level system damping signals. Must be summed with MC as shown in Figure 1 to form the analog motor command signal.

**Position Error Port:** 8-bit position error port for monitoring position error.

**Error Flag*:** When this signal goes low, the position error is greater than 8 bits or ± 127 counts. If the error flag is low, the GL-1200 is out of its linear range and the motor command is saturated.

**Clock 2:** If an external clock is not used, connect an LC circuit, as shown in Example 4, between Clock 1 and Clock 2.

## Control Algorithm

The control algorithm implemented is:

$$\text{Motor command} = K_p \cdot PE + K_d \cdot \frac{d}{dt}(PE)$$

Where PE is the position error and $K_p$ and $K_d$ are the gain and damping coefficients.

Since the GL-1200 operates off a very fast clock, the algorithm may be assumed to be implemented continuously in time. The terms $K_p$ and $K_d$ are adjusted for optimum performance by the resistors, $R_{damping}$ and $R_{gain}$. The circuit of Figure 1 has the parameters Kp = 10 volts per 128 counts and for $R_{damping} = 26.2\ K\Omega$, Kd = 1 volt per 10,000 counts/sec.

The velocity profile of the input command should also be adjusted such that the motor can follow the input command without the GL-1200 going into saturation.

*Active low

## System Evaluation

To evaluate the GL-1200, it is strongly recommended that the designer use the SSV-800 control card. This card contains the GL-1200 chip and interface circuitry, in addition to several features useful for system evaluation. These features include a 60-watt linear amplifier for driving DC motors, a variable frequency oscillator for stand-alone speed control, and a step-response test for adjustment of system gain and damping.

To simplify the system stabilization process, the SSV-800 contains a built-in step response test which inputs repeated step commands to the motor. The actual analog response of the motor is observed by connecting the SSV-800 test point to an oscilloscope. The designer then adjusts the Kp and Kd values for optimum response by turning the gain and damping knobs on the SSV-800.

To drive large motors, designers can use the PIC-850 pulse-input controller card. This controller has been optimized for large motors and high-density encoders by increasing the position error range to 16 bits.

## Electrical Specifications

| | Min | Typ | Max | Units | Comments |
|---|---|---|---|---|---|
| **Inputs** | | | | | |
| $i_{Supply}$ | | 3 | 5 | mA | |
| All Inputs | | | | | TTL threshholds. High impedance |
| **Outputs** | | | | | |
| IOL at 0.4V | | | | | |
| All(except MC) | 1.6 | | | mA | |
| MC | 1.6 | | | mA | Tri-state outputs |
| **AC Timing (GL-1200)** | | | | | |
| $f_c$ CLK1 Input Frequency | | | 5.1 | MHz | |
| $f_e$ Max Encoder Frequency | | | 75 | kHz | Full cycles† |
| | | | 300 | kHz | Quadrature counts† |
| $f_i$ Input Command Frequency | | | 75 | kHz | Full cycles† |
| | | | 300 | kHz | Quadrature counts† |
| $\tau_{ipw}$ Input Pulse Width | 6.4 | | | µsec | Full cycles† |
| | 1.6 | | | µsec | Quadrature counts† |
| Encoder Duty Cycle | 25 | 50 | 75 | % | |
| **AC Timing (GL-1200-10)** | | | | | |
| $f_c$ | | | 10 | MHz | |
| $f_e$ | | | 150 | kHz | Full cycles† |
| | | | 600 | kHz | Quadrature counts† |
| $f_i$ | | | 150 | kHz | Full cycles† |
| | | | 600 | kHz | Quadrature counts† |
| $\tau_{ipw}$ | 3.2 | | | µsec | Full cycles† |
| | .8 | | | µsec | Quadrature counts† |

†Maximum value of $f_e$, $f_i$, $\tau_{ipw}$ are scaled by the clock frequency, $f_c$.

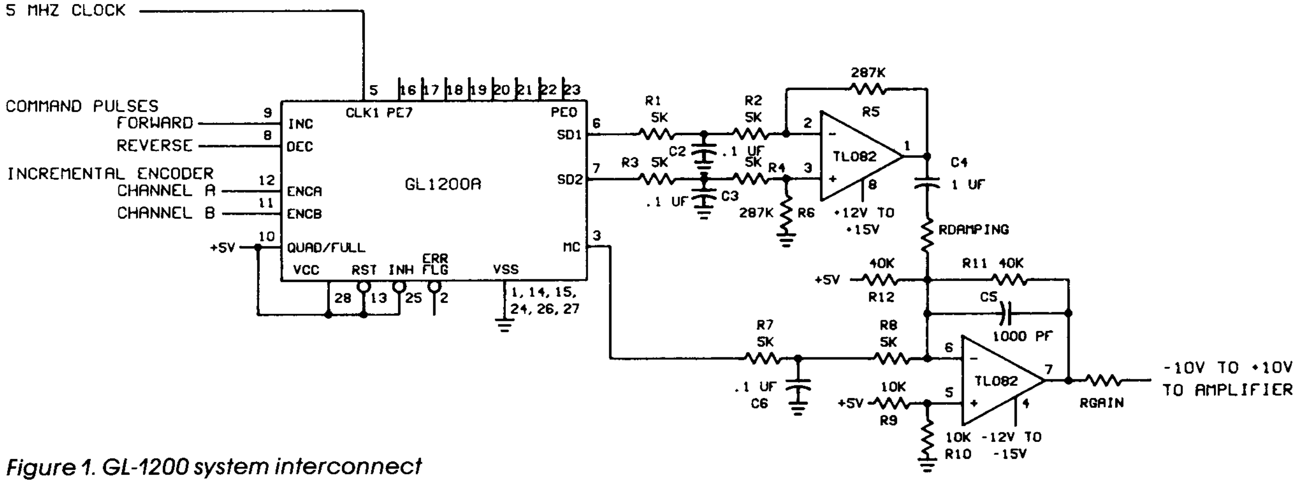



*Figure 1. GL-1200 system interconnect*

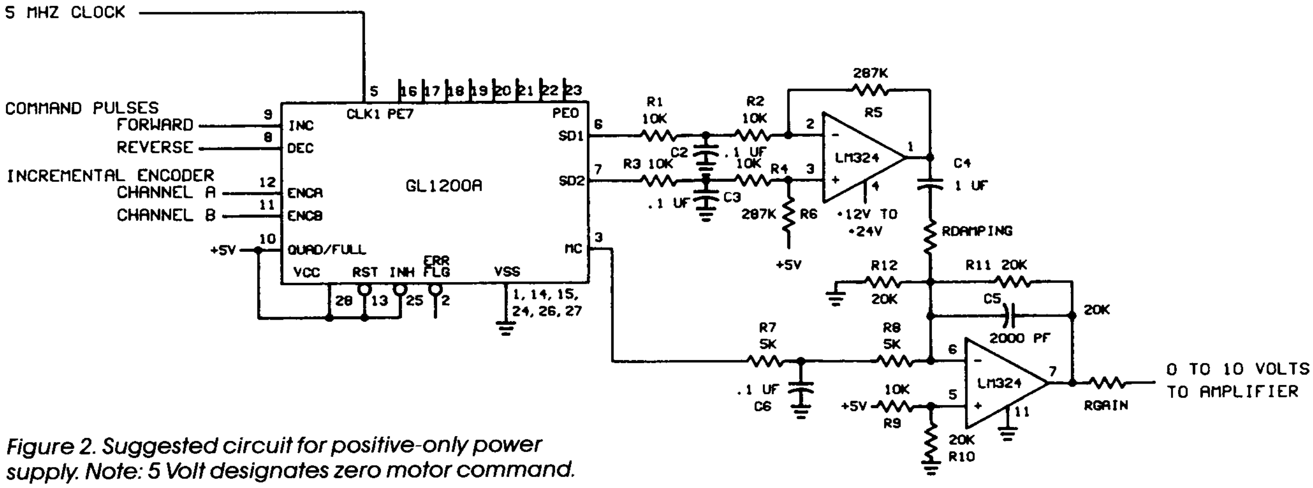



*Figure 2. Suggested circuit for positive-only power supply. Note: 5 Volt designates zero motor command.*

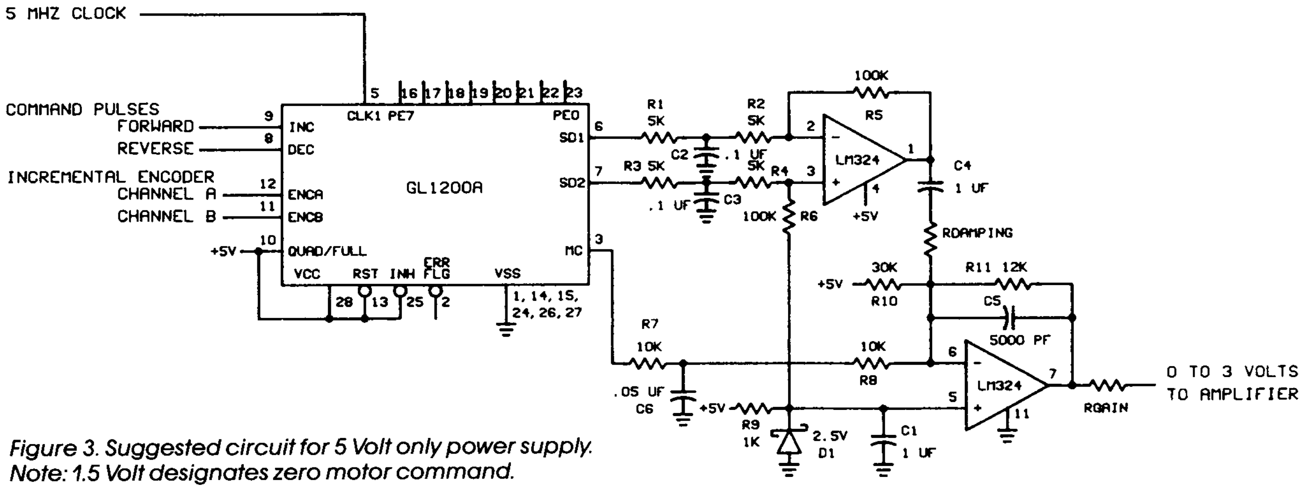
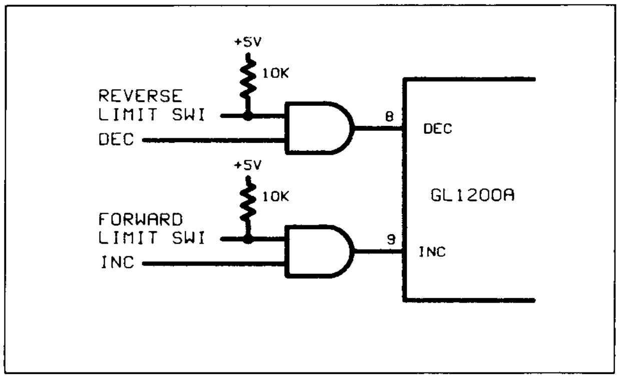


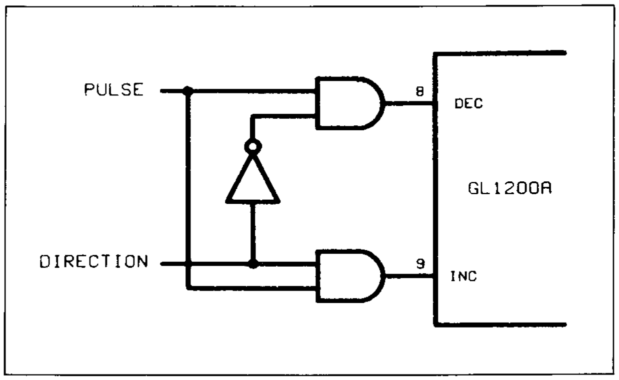

*Figure 3. Suggested circuit for 5 Volt only power supply. Note: 1.5 Volt designates zero motor command.*

# Example Applications



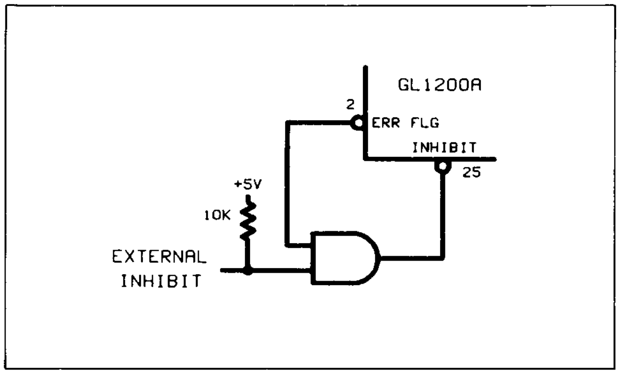

*Example 1. Use of Limit Switches*

This circuit shows how limit switches may be used to prevent motion in the forward or reverse direction.



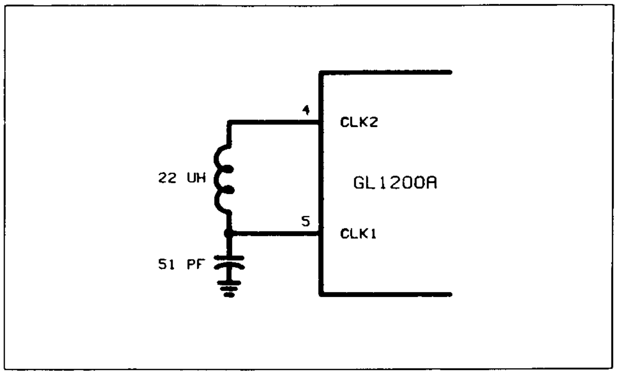

*Example 3. Using Pulse and Direction Input Commands*

This circuit shows how pulse and direction input commands may be converted into DEC and INC inputs.




*Example 2. Using the Inhibit and Error Flag*

If either an external inhibit signal or the Error Flag (position error> ± 127 counts) goes low, the Inhibit pin will go low causing the MC output to be disabled.




*Example 4. Using an LC Circuit for 5 MHz Clock*

## Ordering Information

| Part Number | Description |
|---|---|
| GL-1200 | Pulse Input chip, 5 MHz clock |
| GL-1200-10 | Pulse Input chip, 10 MHz clock |
| SSV-800 | Pulse Input trainer card |
| PIC-850 | High Resolution Pulse Input Card |

*Galil Motion Control reserves the right to make changes in this data sheet without prior written notification.*

Galil Motion Control, Inc.
1054 Elwell Court
Palo Alto, CA 94303
Telephone: (415) 964-6494
Telex: 171-409
FAX: (415) 964-0426

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