Versatile Single Board Controller and Driver

Carlsbad, California USA

www.signaltronix.com

The need for a versatile, compact, and inexpensive motor driver and speed controller led to the development of a successful circuit capable of delivering up to 100 Watts of power to a three phase brushless motor scanner. All of the functions necessary to achieve precise scanner speed control have been integrated into one unit. The reference frequency generator, phase-lock loop controller, and motor driver are combined on a single low cost circuit card which measures 4 X 8 inches. A great deal of flexibility has been incorporated into this low cost controller design so that many scanning applications can be readily accommodated without the need for circuit modifications. Various encoder resolutions and reference frequencies may be accommodated by setting jumpers which reconfigure the digital logic in order to present compatible frequencies to the phase comparator circuit.

This single board controller has been utilized to drive single faceted as well as polygon scanners operating between 1,000 RPM and 81,000 RPM for a variety of laser scanning applications, and has demonstrated excellent speed regulation capabilities. The rotational speed jitter in many of the air bearing scanners driven by this controller was measured to be only a few parts per million within one rotation. This successful design has been incorporated into thousands of scanning systems sold to the printing and publishing industry worldwide.

The controller is pictured in Figure 1 below.

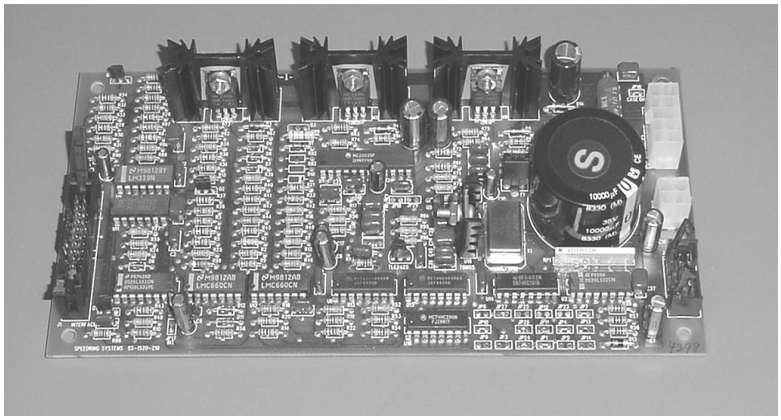

Figure 1. Single board scanner controller and motor driver.

As shown in Figure 2, the circuit functions can be divided into the following main categories:

a) Reference frequency generator and external sync processing circuit.
b) Phase detector and PWM synchronization circuit.
c) Control loop PID circuit.
d) Brushless motor controller and FET power section.

The controller reference frequency generator and external sync processing circuits function to provide a precise and stable frequency reference to the phase comparator. An on-board quartz reference oscillator and programmable divider provide for the selection of up to 16 preset operating speeds for the scanner. The speed may also be continuously varied within a wide band with the application of an external reference frequency from the imaging system controller. In this way, fine adjustments to the scanning speed may be made to trim the system optical parameters.

The phase detector and frequency comparator circuits produce the speed error voltage, which is then amplified and sent to the servo compensation network. The phase detector exhibits high gain since the output is in saturation until the two frequencies fR and fT are exactly equal. This feature is responsible for the precise nature of phase-lock loop speed control systems.

Another useful innovation developed in the quest to provide the best possible speed regulation is the synchronization of the PWM oscillator with the phase detector reference frequency. The synchronization of these two frequencies insures that the noise generated by the beat frequencies do not interfere with the scanner speed control circuits. When synchronized, the two frequencies produce a sum or difference (beat frequency) which will be constant. Stationary beat frequencies may be filtered or appear only as DC offsets which may be subtracted from the speed control signal. The PID servo controller block diagram is shown below in Figure 2 and is responsible for maintaining a high gain and stable speed control loop. Since most of the scanning systems targeted for this controller are for stable and controlled environment applications, the servo control loop is optimized for speed control regulation rather than response time. In these applications, high rotating inertia in the scanner rotor and polygon is a benefit to speed regulation.

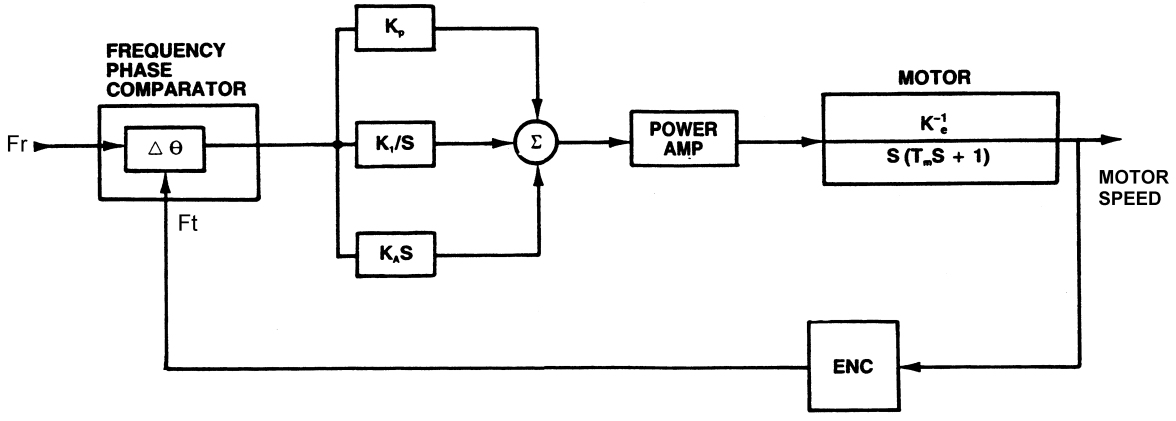

Figure 2. PID servo controller block diagram.

The motor driver and power output section consists of a monolithic (single chip) controller and discrete FET power switches. With a modest amount of forced air cooling, the FET power section is capable of delivering up to 4 Amps continuously and 6 Amps for for several seconds to deliver higher motor starting current. The motor current is regulated by the driver IC using PWM control, which is effective in delivering power to the motor with minimum heat generation in the controller. For some high-speed polygonal scanning applications it may not be possible to include an optical encoder within the scanner housing. In this instance, the polygon facet frequency may be used as the speed feedback sensor as depicted in Figure 3. The optical pulse frequency should be at or above 1KHz in order to provide precise speed regulation in this configuration.

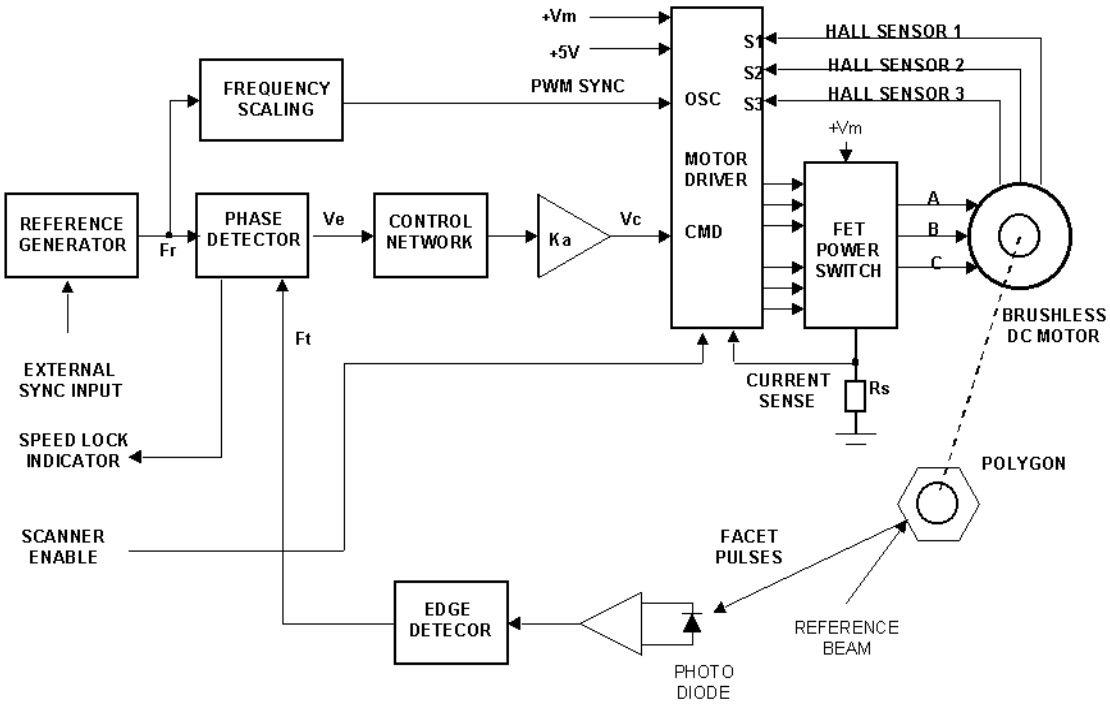

Figure 3. Scanner controller configured for high-speed polygon application.