User's Manual

For

DSB810A

Digital DC Servo Driver

Version 1.0

©2007 All Rights Reserved

Attention: Please read this manual carefully before using the driver!

The content in this manual has been carefully prepared and is believed to be accurate, but no responsibility is assumed for inaccuracies.

Motion Control Products Ltd reserves the right to make changes without further notice to any products herein to improve reliability, function or design. Motion Control Products Ltd does not assume any liability arising out of the application or use of any product or circuit described herein; neither does it convey any license under its patent rights of others.

Motion Control Products Ltd's general policy does not recommend the use of its products in life support or aircraft applications wherein a failure or malfunction of the product may directly threaten life or injury. According to Motion Control Products Ltd's terms and conditions of sales, the user of Motion Control Products Ltd's products in life support or aircraft applications assumes all risks of such use and indemnifies Motion Control Products Ltd against all damages.

Table of Contents

1. Introduction, Features and Applications

Introduction

The DSB810A is a digital DC servo driver developed with FPGA and high efficient MOSFET technologies. In position control, it's easy for the end users to change stepping drivers to the DSB810A without changing control systems, because its input command is PUL/DIR signal, which is compatible with that of stepping driver. In velocity control, the position feedback of the encoder can effectively eliminate the "zero-speed drift" when the servo is standstill. In low power motion control applications, performances of DC servo systems using the DSB810A are better than those of digital AC servo systems in velocity, precision, noise, stability, or at least as good as those of digital AC servo systems. However, the price of the DSB810A stays at the price line of stepping driver, namely far lower than that of AC servo.

Features

● 18-80VDC, 0-20A, 20-400W
● PID feedback servo drive
● Feedback resolution ×4 encoder line count
● Lock range +/- 128 count following error
● Opto-isolated pulse and direction inputs (differential)
● Small size
● Over-current and short-circuit protection

Applications

Suitable for a wide range of equipments and instruments such as mini type engraving machines, jet-ink machines, etc. It performs better in equipments desired for low noise, high velocity and high precision.

2. Specifications and Operating Environment

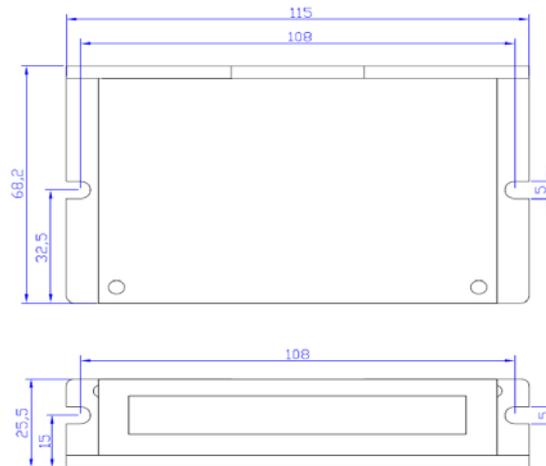**Mechanical Specifications (unit: mm, 1 inch = 25.4 mm)**

Figure 1: Mechanical specifications

Electrical Specifications ($T_j = 25℃$)

Parameters	DSB810A			
	Min.	Typical	Max.	Unit
Peak output current	0	-	20	Amps
Supply voltage	+18	-	+80	VDC
Logic signal current	7	10	15	mA
Pulse input frequency	0	-	250	KHz
Isolation resistance	500			MΩ
Current provided to encoder			50	mA

Operating Environment and Parameters

Cooling	Natural cooling or forced cooling	
Operating Environment	Environment	Avoid dust, oil fog and corrosive gases
	Ambient Temperature	0℃ - 50℃
	Humidity	40 - 95%RH
	Vibration	5.9 m/s^2 Max
Storage Temperature	-20℃ - +65℃	
Weight	Approx. 130 grams (4.6 oz)	

3. Connections

Connector Configuration

Term.	Pin	Description
1	PUL+	Connect to positive pole of the pulse control signal.
2	PUL-	Connect to negative pole of the pulse control signal.
3	DIR+	Connect to positive pole of the direction control signal.
4	DIR-	Connect to negative pole of the direction control signal.
5	EA+	Connect to positive pole of the encoder channel A feedback signal.
6	EA-	Connect to negative pole of the encoder channel A feedback signal.
7	EB+	Connect to positive pole of the encoder channel B feedback signal.
8	EB-	Connect to negative pole of the encoder channel B feedback signal.
9	E +5V	Positive pole of the auxiliary power supply (50 mA (Max)).
10	EGND	Ground of the auxiliary power supply.
11	ERR/RES	Error alarm or reset/start port.
12	Motor+	Connect to positive pole of the DC servo motor.
13	Motor-	Connect to negative pole of the DC servo motor.
14	+18 TO 80VDC	Connect to positive pole of the +18 TO 80VDC power supply.
15	Power GND	Connect to ground of the power supply.

Control Signal Connections

The DSB810A can accept differential and single-ended inputs (including open-collector and PNP output). The DSB810A have 2 optically isolated logic inputs to accept line driver control signals. These inputs are isolated to minimize or eliminate electrical noises coupled onto the drive control signals. Recommend use line driver control signals to increase noise immunity of the driver in interference environments. In the following figures, connections to open-collector and differential control signals are illustrated.
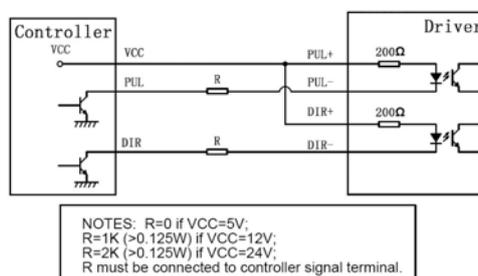

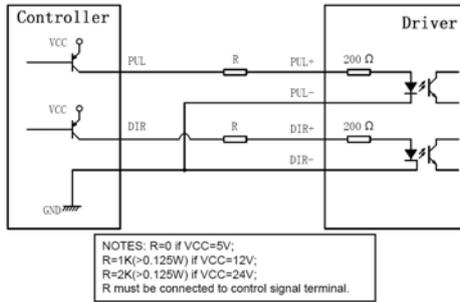Figure 2: Connections to open-collector control signal (common-anode)

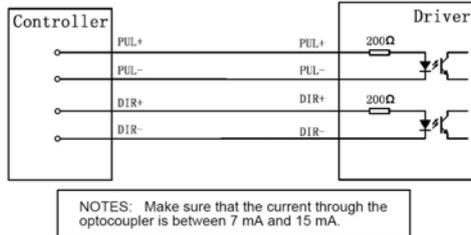Figure 3: Connections to PNP signal (common-cathode)

Figure 4: Connections to differential control signal

Encoder Connections

If the encoder drains less than 50mA, the DSB810A can supply the encoder directly, and connect it as Figure 5 or Figure 6. If the encoder drains more than 50mA, use an external DC supply and connect it as Figure 7 or Figure 8.
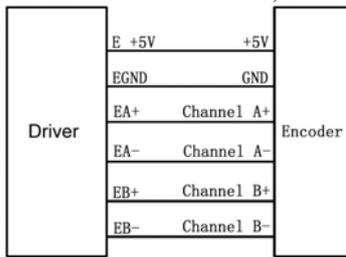

Figure 5: The DSB810A supplies the differential encoder directly
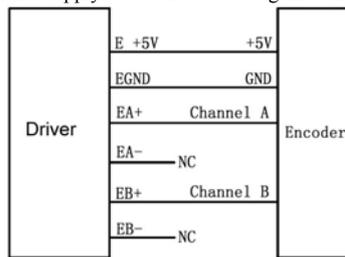
Figure 6: The DSB810A supplies the single-ended encoder directly
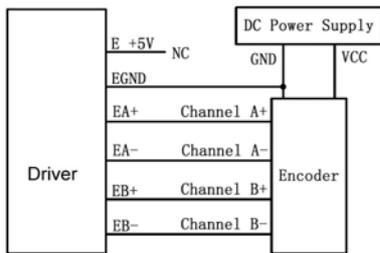

Figure 7: Using external DC power supply to supply the differential encoder
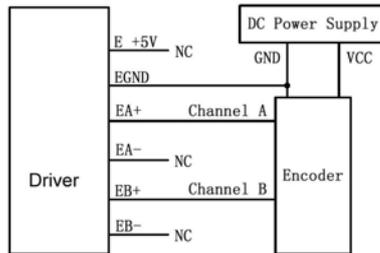

Figure 8: Using external DC power supply to supply the single-ended encoder

Typical Connections

Two typical connections of the DSB810A are shown as Figure 9 and Figure 10. Please consult "Control Signal Connections" and "Encoder Connections" for more information about controller and encoder connections.
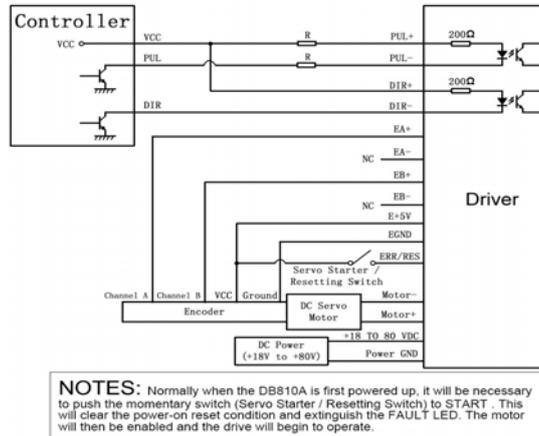
Figure 9: Typical connection (Open-collector control signal and single-ended encoder.)
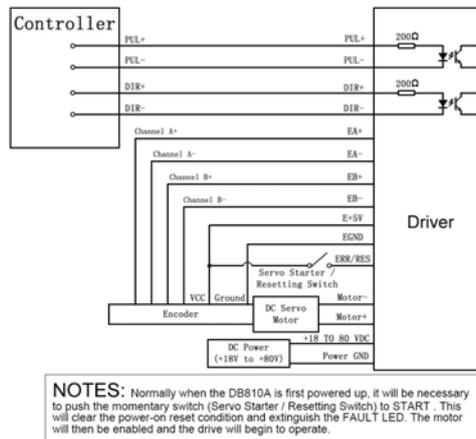

Figure 10: Typical connection (Differential control signal and differential encoder.)

4. Servo Setup

Before you start the servo, you can follow the below steps:

Install Encoder

You must have a suitable encoder properly mounted on the motor. Please assemble the encoder according to its factory manual.

Prepare Power Supply

You must have a DC power supply suitable for the motor. Do not use a power supply voltage more than 5 volts in excess of the rated voltage of the motor. The power supply current rating should not less than the maximum current you expect to run the motor at. When the power supply leads are longer than 50 cm, a 1000uF/100V electrolytic capacitor should be connected between the "pin POWER GND" and the "pin +18 TO 80VDC". Please note that the polarity can not be reversed. The green LED will light when the DSB810A is powered on.

Prepare Controller

Prepare a controller with pulse and direction signals.

Initialize DSB810A

The DSB810A use three potentiometers to tune the current LIMIT, the GAIN and the DAMP. These potentiometers are 10-turn potentiometers. CW increases value and CCW reduces value. Before going on, set the current LIMIT according to your motor's Maximum Subtransient Current and usually current LIMIT is set to 1.2 times of motor's Maximum Subtransient Current. The current LIMIT potentiometer can set the current LIMIT from 0A to 20A. Turn the GAIN potentiometer fully off . Starting form off position, turn the DAMP potentiometer CW to 2 turns.

Motor Connection

Make sure that the power is off and the pulse source is set to zero pulse per second. Check to see if the potentiometer settings are set according to the "Initialize the DSB810A" section. You may wish to secure the motor so it can't jump off the bench. Motor may return to command position rapidly with little or no overshoot in the minimal amount of time. Please refer to *"Adjusting PID Coefficients"* in page 10.

5. Tuning the Servo

Testing the Servo

Turn on the power supply, the FAULT light should be turned off after pushing the servo starter (a momentary switch).

If everything is correct you should hear the motor "singing". This is normal. The motor is dithering or bouncing between adjacent encoder counts. The integral term in a PID loop has infinite DC gain over time and will amplify even the smallest position error. Because encoder feedback can only occur on count edges, the loop is "blind" until it encounters an encoder count edge. It then reverses the motor direction until another edge is found, then the process repeats.

If the motor jumps slightly and the FAULT LED immediately turns on, then either the motor or the encoder is wired in reversal or the potentiometers are misadjusted. Check the potentiometer settings. If they are right then switch the motor leads and try again. If it still doesn't work after you followed all of the previous steps, please contact us.

Now turn on your step pulse source and ramp the speed up to see if the motor runs. It should run clockwise with a logical "1" on the direction input.

Tuning the Servo

The optimum way to turn the servo is to induce an impulse load on the motor while watching an oscilloscope to see how the motor behaves in response, then adjusting the PID coefficients for optimal performances. In all cases the motor should return to the command position, what matters is how it does it. The manner in which the motor returns to its command position is called damping. At one extreme called overdamped response, the motor returns to position after a long, drawn out delay. At the other extreme called underdamped response, the motor returns to its position too rapidly, overshoots, returns and undershoots and so on until it finally settles at its command position. This is also caused ringing; when extreme, the over/undershoot builds in amplitude until the motor enters violent oscillation. Between the two extremes is the optimal response called critical damping. Here the motor rapidly returns to its position with little or no overshoot in the minimal amount of time.

There are three potentiometers at the side of the DSB810A. They are GAIN, DAMP and LIMIT separately for current setting, as shown in Figure 11.

GAIN and DAMPING setting generally track each other. If you increase GAIN (greater stiffness), then increase DAMPING is needed as well to restore critical damping. Be careful, increasing GAIN without increasing DAMPING may cause the motor to break out into violent oscillation. The higher GAIN is set, the noisier the motor will be when stopped. This is because higher gain causes more vigorous dithering between encoder counts at rest.

Adjusting PID Coefficients

The error between servo actual position and pulse command position can be reduced by tuning servo parameters.

You can detect how the motor behaves in response to an impulse load by watching an oscilloscope, as shown in Figure 12. The easiest way to induce a disturbance is to switch the DIRECTION input while commanding a constant speed via the DIR input. The abrupt direction change puts just the momentary load needed on the motor while you watch how it responds. If you are using an oscilloscope, use channel 1 on the test point and channel 2 on the DIRECTION input. Set the trigger to "normal", trigger source to channel 2 and trigger edge to "+". You should see a single sweep for every clockwise change in direction.
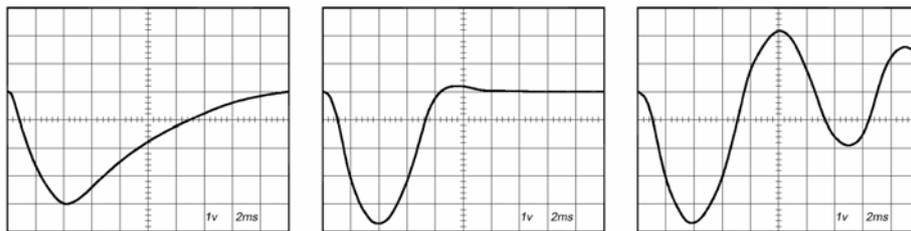
| OVERDAMPED | CRITICALLY DAMPED | UNDERDAMPED |

Figure 12: Response to an impulse load

Slowly increase PUL speed until you get a picture similar to one of the three above, and then do the following steps:

- OVERDAMPED: Decrease DAMPING or increase GAIN
- CRITICALLY DAMPED: Do nothing; you are here
- UNDERDAMPED: Decrease GAIN or increase DAMPING

In order to make it convenient for the users to tune, a test point (including TEST POINT and TEST POINT GND) is set inside of the DSB810A. Tune DAMPING and GAIN until performances of the servo are satisfying.

6. Using Tips

Current LIMIT Setting

The current LIMIT potentiometer sets maximum current the motor is permitted to have. It is adjustable from 0 amps to 20 amps. Normally the LIMIT potentiometer is set to maximum (20 amps) unless you want to limit motor torque to a lower value.

Motor speed and position are unaffected by the current LIMIT setting unless the torque demand due to load exceeds this setting, then the motor position will fall behind the command position because of insufficient torque.

Fault Indicator

Normally when the DSB810A is first powered up, it will be necessary to push the momentary switch to START for 2 seconds. This will clear the power-on reset condition and extinguish the FAULT LED. The motor will then be enabled and the drive will begin to operate.

If at any time after that a condition occurs that causes the DSB810A to "fault out", such as not being able to complete a pulse command, the ERR/RES terminal will go to "0", signaling the computer an error has occurred. This will require the operator to correct the problem that caused the fault and then push the switch to "START" for 2 seconds to re-enable the DSB810A.

At anytime the operator can push the switch to the "STOP" position to immediately halt the DSB810A drive. Anytime the DSB810A is in the "FAULT" state (FAULT LED lit), all switching action stops and the motor freewheels and is unpowered. This will light the "FAULT" light.

The FAULT indicator is on while the drive is in power-on reset, the DISABLE input is held "low" or if the protection circuit is tripped due to a fault condition. All power MOSFETs are turned off and all internal counters are reset. The FAULT condition lasts for 2 seconds, and then self-resets to try again. If the protection circuit tripped it and the cause is not cleared, then it will immediately re-enter the FAULT state again and repeat the cycle.

There are two conditions that will trip the protection circuit. One condition is if a short-circuit occurs and current exceeds current LIMIT setting.

The other condition is if the POSITION ERROR exceeds +/- 128 counts causing a break of the servo-lock. This condition can have several causes:

1). The loop settings are severely under-damped and the motor breaks out into oscillation.

2). Excessive motor load due to acceleration or workload.

3). The speed command in excess of what the motor can deliver.

4). The current LIMIT is set too low.

5). The power supply current is insufficient for the demand.

6). The motor is wired backwards, is broken or disconnected.

7). Encoder failure.

Reversing Default Motor Direction

The DSB810A will turn the motor in the CW direction when the DIRECTION input is "high" (logical "1"). If instead CCW is preferred, then:

1) Reverse the motor "+" and "-" leads

2) Reverse the encoder "Channel A" and "Channel B" leads

ERR/RES

This terminal functions as an ERROR output and as a RESET input. Because this terminal functions as both an input and an output, some detailed description is necessary.   When first testing the DSB810A, ERR/RES (term. 11) was connected to E +5V (term. 9). It can be left that way if it is not necessary to read the state of the ERROR output. Otherwise, the following details are important.

The ERROR output is latched in the "ERROR" state (term. 11 = 0) by the power-on reset circuitry in the DSB810A. It will stay in this state indefinitely until it is cleared by applying +5V to this terminal for at least 2 seconds.   The voltage on this terminal is +5VDC when the DSB810A is functioning normally. The voltage on this terminal goes to 0VDC whenever the FAULT indicator is lit. This output can be used to signal your controller that an error has occurred.
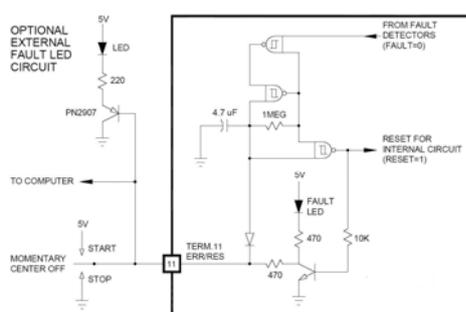
Figure 13: Error clear and Reset circuit of the DSB810A

The above circuit shows how to implement an external switch to clear an ERROR condition and RESET the DSB810A, while still being able to read the state of the drive. It also includes an optional FAULT LED circuit if a remote indication of the state of the DSB810A is desired.

APPENDIX

TWELVE MONTH LIMITED WARRANTY

Motion Control Products Ltd. warrants its products against defects in materials and workmanship for a period of 12 months from shipping date. During the warranty period, Motion Control Products Ltd will either, at its option, repair or replace products which proved to be defective.

EXCLUSIONS

The above warranty shall not apply to defects resulting from: improper or inadequate handling by customer; improper or inadequate customer wiring; unauthorized modification or misuse; or operation beyond the electrical specifications of the product and/or operation beyond environmental specifications for the product.

OBTAINING WARRANTY SERVICE

If your product should fail during the warranty period, you will need to obtain an RMA number by going to the following internet address and completing the returns form. http://www.motioncontrolproducts.com/returns.html

The customer shall prepay shipping charges for products returned to Motion Control Products Ltd for

warranty service, and Motion Control Products Ltd shall pay for return of products to customer. (If found to be a warranty repair)

WARRANTY LIMITATIONS

Motion Control Products Ltd makes no other warranty, either expressed or implied, with respect to the product. Motion Control Products Ltd specifically disclaims the implied warranties of merchantability and fitness for a particular purpose. Some jurisdictions do not allow limitations on how long and implied warranty lasts, so the above limitation or exclusion may not apply to you. However, any implied warranty of merchantability or fitness is limited to the 12-month duration of this written warranty.

SHIPPING FAILED PRODUCT

If your product should fail during the warranty period, you will need to obtain an RMA number by going to the following internet address and completing the returns form. http://www.motioncontrolproducts.com/returns.html