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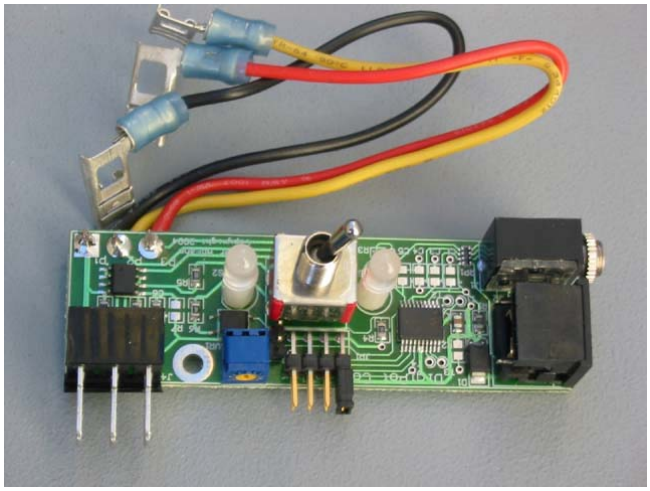

DigiSpeed™

Instruction manual

Version 1.0

http://www.homanndesigns.com

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Introduction

*** WARNING ***

The KB Electronics DC speed controller circuit, and other similar speed controllers as found in Asian imported mini lathes and mini mills are at mains voltage potential. This voltage is lethal. Do not attempt to do this conversion if you are not qualified to do so. Confidence is no replacement for qualification!

If you feel that this project is beyond your abilities to SAFELY complete, we can install the unit for you. Please contact us for details

Please ensure you read the complete manual before attempting to install or use this device.

The DigiSpeed™ DC motor controller is designed to allow computer CNC programs such as Mach2, TurboCNC and other such programs to control the spindle speed of CNC machines such as Mills and Lathes.

DigiSpeed™ is designed primarily for use with KB Electronics style DC motor controllers, such as the KBIC-120. This is the type of controller found in the Sherline Mills and Lathes. DigiSpeed™ will work with other types of DC motor controllers such as those found in the Asian imported mini lathes and Mills.

DigiSpeed™ is designed to replace the manual speed setting potentiometer found in these controllers. The original potentiometer is plugged into the DigiSpeed™ controller board to still allow for manual control when desired

The form factor of the DigiSpeed™ PCB has been designed to install as an upgrade into the current Sherline DC motor speed controller housing. Due to its compact size, it can also be installed unobtrusively into many of the existing speed controller housings.

Features

The main features of the DigiSpeed™ controller are;

- Controlled by a RISC Microchip micro-controller.
- PCB
  - FR4 Material
  - Double Sided, Plated through holes
  - Silk-Screened on Component Side
  - Solder Mask on Both Sides
- Small PCB footprint 3.14”(L) x 0.96”(W) x 0.55”(H)
- 5V dc 50mA power requirements.
- Opto-isolation between the computer logic Voltages and the DC Speed controller voltages.
- Maximum DC Speed controller voltage for the control supply of 20Vdc
- Greater than 1000 steps from 0 to Max Speed.

- Four methods to control motor speed.
    - PWM - A low frequency PWM signal. (1Hz – 50Hz)
    - Step/Dir – Can be controlled like a stepper motor
    - Up/Down – Can be controlled via separate up/down inputs
    - Synchronous Serial - Can be controlled by a serial Data, Clock interface
- Enable input to control to enable or inhibit the control voltage output.
- All signals are Active Low to reduce the possibility of inadvertent spindle control
- Programmable motor characteristics allow the DigiSpeed™ to compensate for drag and inefficiencies in the motor drive system.
- Toggle switch to select Manual or Computer control
- Multi color LEDs indicating the mode and state of the DigiSpeed™ controller.
- Uses standard Mini Din connector and cables to interface to the Controller.
- Connector for attaching a Spindle speed senor. It provides a 5V supply and input for the index signal to be feed to the breakout board via the Mini Din cable. This feature tidies up another cable.

DigiSpeed™ Operation Description

Overview

The DigiSpeed™ controller provides the capability to control the spindle speed of a DC motor via computer control, or using the existing manual control potentiometer.

The DC motor controllers that the DigiSpeed™ is designed to work with, such as the KBIC-120 controller supplied by KB Electronics, use a “Hot Ground” circuitry. That is, the reference voltages for setting the speed are at MAINS POTENTIAL voltage. This voltage is dangerous and can be lethal.

This style of controller uses a control voltage, usually in the 0 –10Vdc to control the motor speed from 0 – max speed. In reality, this voltage can be anywhere in the range of 9Vdc to 15vdc. The maximum speed of the motor can be limited by a trim-pot that reduces this control voltage supply.

The DigiSpeed™ circuitry is essentially in two parts. One part contains low voltage logic level circuitry that includes a micro controller and interfaces to the PC via the parallel port. It is supplied by 5Vdc that is referenced to the PC parallel port ground. The other part of the DigiSpeed™ circuitry is connected to the DC Speed controller control circuitry. This part is at **MAINS POTENTIAL**.

The two parts of the circuitry are separated by opto-isolation. This ensures that the dangerous MAINS POTENTIAL voltages are kept away from the low level logic circuitry. The two parts of circuitry must never be connected together. If it happens, a catastrophic failure of the DigiSpeed™ circuit and your PC will occur.

*****YOU HAVE BEEN WARNED*****

DO NOT GROUND THE MAINS POTENTIAL SIDE OF THE CIRCUITRY

The DigiSpeed™ controller provides a control voltage in place of the control voltage provided by the manual speed control potentiometer. This voltage can be varied from 0V to 100% of the maximum control voltage by computer software.

There are 1023 steps from 0 to the maximum control voltage. If your maximum spindle speed is 6000 rpm, this effectively provides for a 6-rpm resolution in controlling spindle speed.

Manual/ Computer Control Selection

Selection between manual or computer control of the DigiSpeed™ is done via the toggle switch in the center of the board. When the switch is toward the Mini Din connector, the DigiSpeed™ is in Computer control. When positioned toward the three flying leads, the DigiSpeed™ is in manual mode.

LED Indicators

The DigiSpeed™ controller has two LED indicators, one to indicate when Manual mode is selected, the other to indicate the mode and status of the computer interface.

Manual Mode Indicator

The manual mode indicator is the LED positioned towards the three flying leads. When the toggle switch is in the manual position, the LED will illuminate, indicating this mode is active.

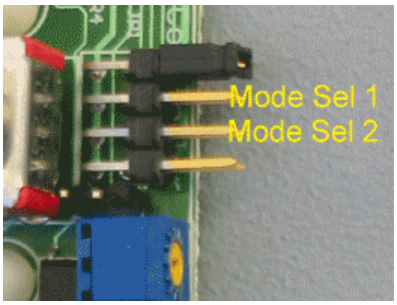
Computer Control Mode Indicator

The computer control mode indicator is the LED positioned towards the Mini Din connector. Regardless of the position of the toggle switch, the LED will illuminate in a number of ways, indicating the mode and state of the computer interface.

- **LED Off** – This indicates that there is no power supplied to the DigiSpeed™ via the mini din connector
- **Solid Colour** – A Solid colour indicates that power is supplied to the DigiSpeed™ via the Mini din connecter, and that the Enable line is NOT active. There are three solid colours indicating the input mode.
    - **RED** – Indicates that the DigiSpeed™ is in PWM input Mode.
    - **GREEN** – Indicates that the DigiSpeed™ is in either STEP/DIR or UP/DOWN input mode.
    - **YELLOW** – Indicates that the DigiSpeed™ is in SYNCHRONOUS SERIAL input Mode
- **Lazy RED Double Flash** – Indicates that the DigiSpeed™ is powered, the Enable is active and the speed is zero. At this stage, hands should be kept clear of the spindle as it is ready to start.
- **Fast RED Flash** – Indicates that the DigiSpeed™ is powered, the Enable is active and the speed is greater than zero. The spindle should be spinning as long as the set speed is large enough to over come the motor drag and inefficiencies.

Operating Mode Selection

The DigiSpeed™ can operate in a number of modes, depending on the type of control signal that is provided by your CNC software. The mode is selected via the mode selection jumpers as shown in the picture below;



The position of the mode selection jumpers for the various modes is shown in the table below.

Mode	Mode-1	Mode-2
PWM	REMOVED	REMOVED
STEP/DIR	INSTALLED	REMOVED
UP/DOWN	INSTALLED	INSTALLED
SERIAL	REMOVED	INSTALLED

Table 1 Mode Selection Jumper Table

The selection of the mode is done at power up initialization. If the mode selection jumpers are modified after the unit is powered up, the new mode will not take effect until the power is cycled. Each of the modes is discussed in detail below.

PWM Input Mode

In this mode the DigiSpeed™ controller accepts an "**Active Low**" Pulse Width Modulation signal. The duty cycle of this signal represents 0 to 100% of maximum spindle speed.

The PWM signal period can be in the range of 2Hz to 50Hz. The optimum period is 5Hz. This will provide 1023 speed increments from 0 to 100% of maximum spindle speed.

The mini-din pins used for this mode are;

- Pin 2 ENABLE
- Pin 3 Ground (0V)
- Pin 4 Supply (+5V)
- Pin 5 PWM

With +5V is supplied to the DigiSpeed™ module, the LED will be a solid Red color when the ENABLE signal is not active.

When the ENABLE line is set active (0v), and no PWM signal is present, the LED will be a Red slow double flash. This indicates that the spindle is active but the speed is set to 0 %. Then, when a PWM signal is present with an active ENABLE line, the LED will be a fast continuous flash, indicating that the spindle is active and the speed is set to a value greater than 0 %.

Note: If a PWM signal is present, but the ENABLE input is inactive. The LED will be a Red slow double flash. As soon as the Enable is made active, the Spindle will start, setting the speed to the commanded PWM value.

Step/Dir Mode

In this mode the DigiSpeed™ controller accepts an "**Active Low**" STEP signal, along with an increase (0v) or decrease (+5V) DIR signal.

With +5V is supplied to the DigiSpeed™ module, the LED will be a solid Green color when the ENABLE signal is not active.

The DigiSpeed™ controller keeps an internal speed counter that retains the current speed value for as long as power (+5V) is supplied to the module. On power up the speed counter is set to 0. The counter is limited to a range of 0 to 1023. And steps that try to count outside this range will be ignored with the speed counter being limited.

On each high to lo transition of the STEP line the speed counter will be updated. If the DIR line is low, the speed counter will be incremented. If the DIR line is high, the speed counter will be decremented.

The speed counter is operational regardless of the state of the Enable signal. Therefore, if the Step line is active while the ENABLE line is not active, the speed counter will be updated. This allows the speed of the DigiSpeed™ to be set into the speed counter before the spindle is turned on via the ENABLE line.

This feature is analogous to the S word in the G-Code language. For example, if the G-Code sets the speed by, say, S1000, the PC CNC controller software can immediately update the speed counter in the DigiSpeed™ controller. Then when the G-Code turns on the spindle with the M03 command, by making the ENABLE signal active, the spindle will start with the speed set to previously set speed counter value.

As part of the software initialization for any PC CNC controller software that uses the DigiSpeed™ in STEP/DIR mode, the software should on initialization, issue at least 1023 steps with the DIR signal set to decrease speed (+5v). This will ensure that the speed counter in the DigiSpeed™ is set to zero. This procedure should also be done whenever the PC CNC software and the DigiSpeed™ speed counter get out of synchronization.

The mini-din pins used for this mode are;

- Pin 1 DOWN
- Pin 2 ENABLE
- Pin 3 Ground (0V)
- Pin 4 Supply (+5V)
- Pin 5 STEP

Up/Down Mode

In this mode the DigiSpeed™ controller accepts "**Active Low**" UP and DOWN signals.

With +5V is supplied to the DigiSpeed™ module, the LED will be a solid Green color when the ENABLE signal is not active.

The DigiSpeed™ controller keeps an internal speed counter that retains the current speed value for as long as power (+5V) is supplied to the module. On power up the speed counter is set to 0. The counter is limited to a range of 0 to 1023. And steps that try to count outside this range will be ignored with the speed counter being limited.

.On each high to lo transition of the UP line, the speed counter will be incremented. On each high to lo transition of the DOWN line, the speed counter will be decremented.

The speed counter is operational regardless of the state of the Enable signal. Therefore, if the UP or DOWN line is active while the ENABLE line is not active, the speed counter will be updated. This allows the speed of the DigiSpeed™ to be set into the speed counter before the spindle is turned on via the ENABLE line.

This feature is analogous to the S word in the G-Code language. For example, if the G-Code sets the speed by, say, S1000, the PC CNC controller software can immediately update the speed counter in the DigiSpeed™ controller. Then when the G-Code turns on the spindle with the M03 command, by making the ENABLE signal active, the spindle will start with the speed set to previously set speed counter value.

As part of the software initialization for any PC CNC controller software that uses the DigiSpeed™ in UP/DOWN mode, the software should on initialization, issue at least 1023 DOWN steps. This will ensure that the speed counter in the DigiSpeed™ is set to zero. This procedure should also be done whenever the PC CNC software and the DigiSpeed™ speed counter get out of synchronization.

The mini-din pins used for this mode are;

- Pin 1 DOWN
- Pin 2 ENABLE
- Pin 3 Ground (0V)
- Pin 4 Supply (+5V)
- Pin 5 UP

Synchronous Serial Mode

In this mode the DigiSpeed™ controller accepts commands via a synchronous serial interface

With +5V is supplied to the DigiSpeed™ module, the LED will be a solid Yellow color when the ENABLE signal is not active.

The mini-din pins used for this mode are;

- Pin 1 CLOCK
- Pin 2 ENABLE
- Pin 3 Ground (0V)
- Pin 4 Supply (+5V)
- Pin 5 DATA

There are three commands that can be used to control the DigiSpeed™ controller;

- Set Speed with motor offsets enabled
- Set Speed with motor offsets disabled
- Write Motor offset to Flash memory

Interface Specification

The synchronous serial interface consists of three signals, an Enable signal (Pin 2), a data signal (pin 5) and a clock signal (pin 1).

The Enable signal is an active low signal. 0 volts on this line enables the analog voltage output. The serial interface is still operational, even though the Enable line is not active.

The serial data expects the LSB of a byte first.

The Data is clocked into the DigiSpeed™ on a negative transition of the clock signal. The maximum speed of the clock signal is 10KHz.

If there is no activity on the clock signal for 200ms, the serial interface is reset. This is a safety feature that also allows for the serial interface to automatically re-synchronize to a broken data stream.

Command Format

Each serial command consists of four bytes. The first byte is the command byte. The next two bytes are data bytes, defined by the particular command. The fourth and final byte is an End byte.

CMD	Data1	Data2	END

Set Speed with motor offsets enabled

This command sets the output voltage level, with the output value adjusted by the motor offsets stored in the DigiSpeed™. The voltage may be set from 0 to 100% in steps from 0 to 1023.

The CMD byte is set to the character 'S' (0x53h)

Data1 and Data2 are combined to make a 10 bit voltage value. The four high bits of Data1 are ignored.

The END byte is set to the character '<CR>' (0x0Dh).

To set the output voltage to 50%, with motor offsets, the following command is sent.

0x53	0x01	0xFF	0x0D

To set the output voltage to 100%, with motor offsets, the following command is sent.

0x53	0x03	0xFF	0x0D

Set Speed with motor offsets disabled

This command sets the output voltage level, without the output value adjusted by the motor offsets stored in the DigiSpeed™. The voltage may be set from 0 to 100% in steps from 0 to 1023.

The CMD byte is set to the character 'S' (0x73h)

Data1 and Data2 are combined to make a 10 bit voltage value. The four high bits of Data1 are ignored.

The END byte is set to the character '<CR>' (0x0Dh).

To set the output voltage to 50%, with motor offsets, the following command is sent.

0x73	0x01	0xFF	0x0D

To set the output voltage to 100%, with motor offsets, the following command is sent.

0x73	0x03	0xFF	0x0D

Write Motor offset to Flash Memory

This command writes a motor offset into the DigiSpeed™. There are 64 offsets that cover the 1024 voltage settings. The offset is added to the voltage setting before being converted to an analog voltage.

If the resultant voltage setting exceeds 1023, it will be limited to 1023.

Each offset value covers 16 voltage settings. Offset 0 is added to voltage settings 0 to 15. Offset 1 is added to voltage settings 16 to 31, etc.

The CMD byte is set to the character 'S' (0x57h)

Data1 is the Motor Offset index. The valid range for the index is 0 x00h to 0x3Fh.

Data2 is the Motor Offset Value for the particular index. The valid range for the offset value is 0 x00h to 0xFFh.

The END byte is set to the character '<CR>' (0x0Dh).

To set the motor offset at index 4 to 15, the following command is sent.

0x57	0x04	0x0F	0x0D

The following motor offsets are pre-programmed into the DigiSpeed™. These are the offsets used for a DC motor setup on a Taig CNC Mill.

		Low Nibble															
High Nibble		**x0**	**x1**	**x2**	**x3**	**x4**	**x5**	**x6**	**x7**	**x8**	**x9**	**xA**	**xB**	**xC**	**xD**	**xE**	**xF**
	0x	88	86	84	82	80	78	76	75	73	71	69	67	65	64	62	60
	1x	59	57	55	53	51	50	49	48	46	44	43	42	41	40	38	36
	2x	34	32	30	28	26	25	24	23	22	20	18	17	16	15	13	12
	3x	11	10	8	7	6	5	4	3	2	1	0	0	0	0	0	0

Installation

Before attempting the installation please read the entire manual. If you are unsure of anything, do not do the installation. Get help from someone who is qualified for this type of work. I am not responsible for damage or injury resulting from the installation or use of this device.

The hardware installation is dependent on what you are installing the DigiSpeed™ into. The physical installation is first covered in the section below, followed by the electrical installation.

Sherline DC Motor Controller housing

TBD

Independent Controller housing

Wiring installation

Once the DigiSpeed™ controller is installed into a housing the following wiring is required.

DigiSpeed™ flying leads

The three flying leads on the DigiSpeed™ are plugged into the DC motor speed controller. The RED wire labeled P3 connects to the potentiometer positive voltage connector on the speed controller. The BLACK wire labeled P1 connects to the potentiometer connector on the speed controller. The YELLOW wire labeled P2 connects to the potentiometer control voltage on the speed controller.

These three leads plug into your speed controller in place of your existing manual speed potentiometer. Unless you are using a voltage isolation board these leads are at *****MAINS VOLTAGE POTENTIAL ***.** They can cause serious injury or death. Do not connect any earthed test equipment to the Black wire connection it is at mains potential.

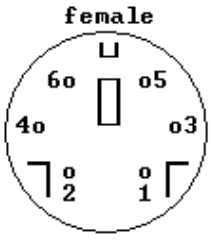
Potentiometer flying leads

The three flying leads from the manual speed potentiometer that used to plug into the DC speed controller are now plugged into the connector block J4 on the DigiSpeed™. The potentiometer lead that was connected to the potentiometer positive voltage supply is connected to P3 on J4. The potentiometer lead that was plugged into the potentiometer 0V supply is connected to P2 on J4. The control voltage lead on the potentiometer is plugged into P2 on J4.

Mini Din Control Cable

The signals carried by the 6 pin min din connector on the DigiSpeed™ are labeled as below. The picture is of the Mini din connector when looking into J2 on the DigiSpeed™ controller board. All these pins are inputs to the DigiSpeed™ except for pin 6, which is an output from the DigiSpeed™.

- Pin 1 DOWN/DIRECTION/CLOCK
- Pin 2 ENABLE
- Pin 3 Ground (0V)
- Pin 4 Supply (+5V)



- Pin 5 PWM/ UP/STEP/DATA
- Pin 6 INDEX

If you are using a 6 pin male to male mini din cable and a Mini din breakout board, these signals will be available on the screw terminals of the breakout board.

Spindle Index signal Cable

The DigiSpeed™ connector J3 is a 3.5mm Stereo jack. It can be used to route your index sensor to your motherboard via the 6 pin mini din cable.

The segments on the stereo plug that is used with this connector are labeled as below;

- TIP – Spindle index signal
- MIDDLE – Positive supply (5V)
- BASE – Ground (0V)

If your spindle index sensor is powered by 5V it can be connected via this interface. If you are using a 6 pin male to male mini din cable and a Mini din breakout board, the index signal will be available on the screw terminals of the breakout board.

DigiSpeed Board Dimensions