ElectronFlux™ USB Module

Product ID.	**: 800**
Board Rev.	**: 1.00**
Date	**: Mar 28, 2008**
Firmware Rev.	**: 1.10**
Node Firmware Rev.	**: 1.30**

Beta Innovations Inc.

Table of Contents

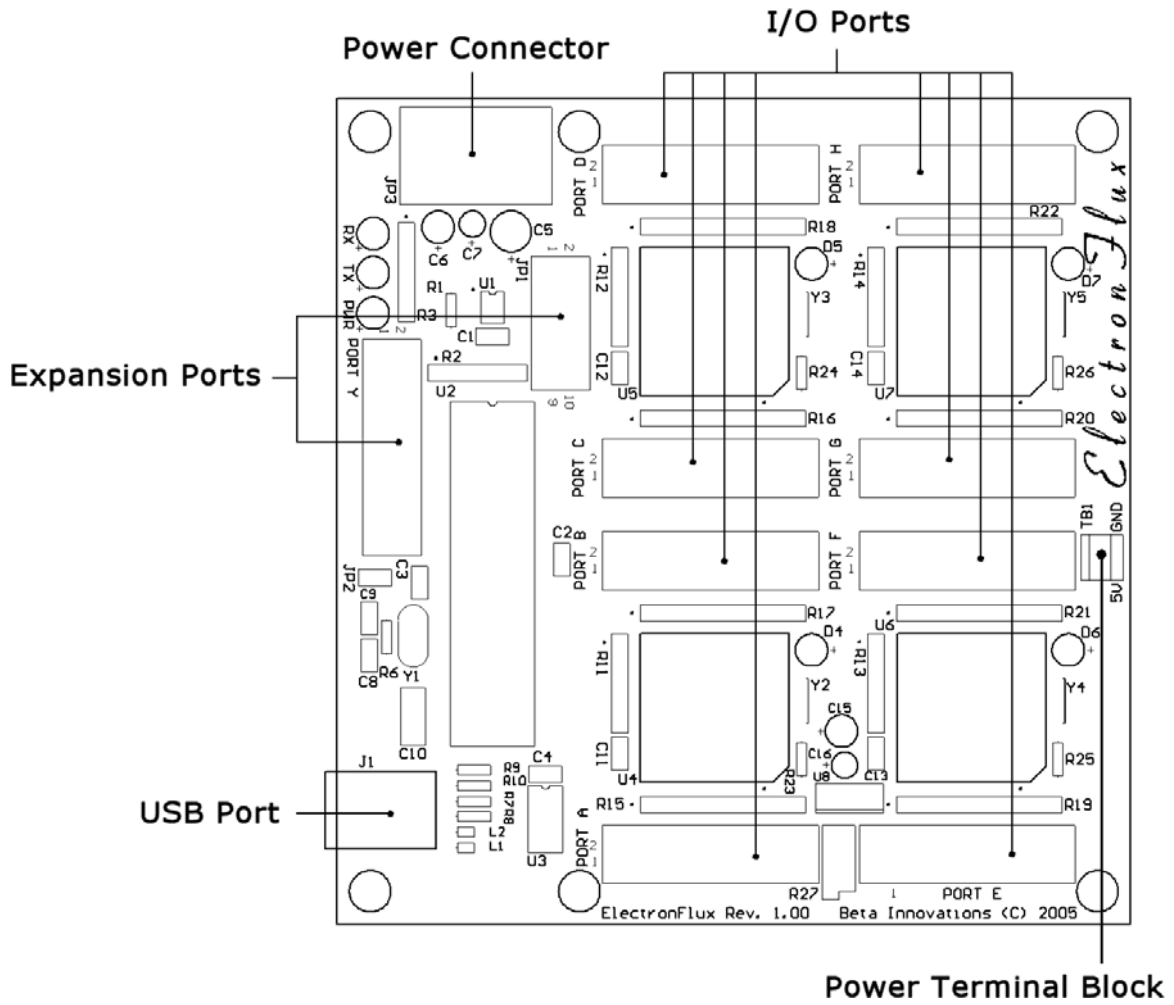## ElectronFlux USB Module

Figure 1 - ElectronFlux

Main Features

- **Easy installation**
  The ElectronFlux™ is a Full Speed USB HID compliant device, which employs default drivers supplied by most OS. Powered by any standard PC Power Supply.

- **Digital Outputs**
  120 Digital Outputs - Supports a variety of modes including direct for relays and multiplexed for 7-segment displays and LEDs.

- **Expansion Ports**
  Provides expandable functionality. Currently supports 2, EF-X120 expansion cards.

- **Short Circuit Protection**
  Up to 3 Amps available per card on all ports for external circuitry eliminating the need for additional power supplies. Monitoring circuitry prevents component damage.

- **Software Configurable Operation**
  All ElectronFlux™ functions are easily configurable through a fully visual interface.

- **Flash Loader Mode**
  Incorporates a Flash Loader for easy firmware updates via USB.

- **Software Development Kit**
  Provides easy access to communicate with the device through custom applications with skeleton samples in VB6, VC++ and MFC.

Introduction

The ElectronFlux™ USB module has been designed to provide hardware I/Os for a multitude of functions and configuration ease and flexibility through a straightforward user-friendly Windows visual tool.

Advanced configuration features allow each port to be individually controlled as needed, providing maximum flexibility without resorting to costly single function add-on cards. Each port can be set to drive LED's or 7-Segment displays without the use of resistors in Multiplexed mode or drive relays, power transistors, DAC's, LCD's, etc. in Direct mode. Minimal support circuitry may be required in certain instances.

Through a simple to use software configuration utility, device firmware can be easily updated adding new features when they become available. Additionally, various parameters and many aspects of the device can be controlled, adjusted, activated or deactivated to meet individual needs. In each case the ElectronFlux unit will reconfigure itself in real-time. As such, the configuration settings can be altered at any time during normal operation without the need to reset the device.

Driver installation is automatic and most OS will install the required drivers without any user intervention.

Flash Loader Mode : JP2

The ElectronFlux™ USB module consists of 2 devices in 1. In *Flash Loader* mode, the module enumerates as a self-programming device used solely for updating the core firmware via USB. In *Standard Device* mode the unit operates as a standard HID device.

RESET Jumper JP2
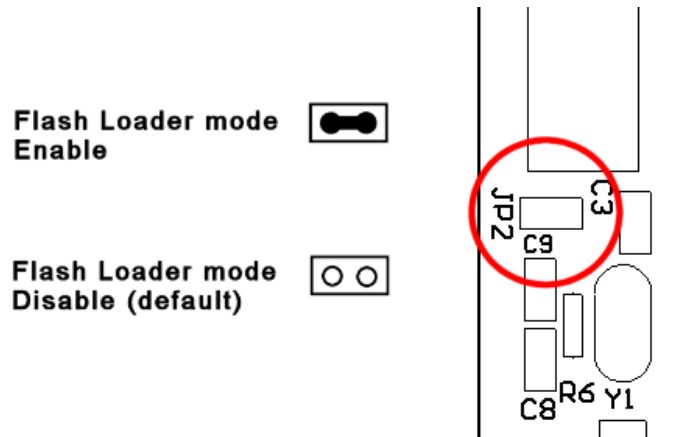
RESET jumper JP2 can be used to restart the device in Flash Loader mode should the module fail to function after an update. It should remain open (disable) for normal device operation. The device can be set in *Flash Loader* mode when needed in order to update the core ElectronFlux firmware. The jumper must be removed after successful firmware update prior to rebooting the device. See the Device Manager utility user manual for details on firmware update procedures.

ElectronFlux Dual Power

Dual Power Output

Each card in the ElectronFlux system makes use of a dual power system. The first power source is fixed at +5V and the second is an adjustable source *Vadj* varying from 0 to 5V DC. Power from these sources is available on each Port and capable of delivering up to 3 Amps per card.

Fixed voltage output (+5V) is located on pin 19 and 20 on all ports. Adjustable voltage output will be found on pin 18 on al Ports. Note each card's *Vadj* can be set to different output voltage values through the associated trimpot.
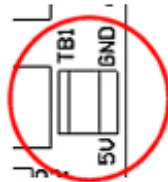
Located on edge of each card is a terminal block providing a ground and fixed 5VDC connection.

Vadj Output Voltage Calibration
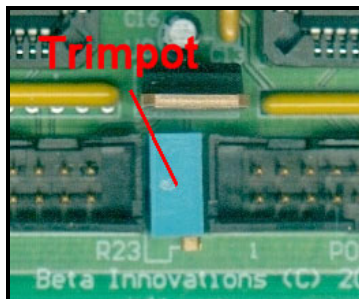
Located on each card is a trimpot, which can be used to tailor the output voltage as needed. This trimpot is labeled R27 on the main card and R3 on expansion cards EF-X120. This adjustable

output is ideally suited for use with 7-segment displays and LEDs eliminating the need for current limiting resistors.

Turning the trimpot adjustment screw CW will decrease the output voltage and CCW will increase the output voltage. Note that full range requires up to 12 turns of the adjustment screw in either direction. Use a voltmeter to measure the resulting output voltage on pin 18 on any port.

NOTE: Vadj is not shared between cards, as each is individually adjustable through its own trimpot. Make sure the voltage is adjusted and properly calibrated on each card prior to use.

ElectronFlux Port Pin-Out

Direct Output Mode

```
                  PORT
                  1  2
        GND │ 1  │ 2  │ GND
   Output 1 │ 3  │ 4  │ Output 2
   Output 3 │ 5  │ 6  │ Output 4
   Output 5 │ 7  │ 8  │ Output 6
   Output 7 │ 9  │ 10 │ Output 8
   Output 9 │ 11 │ 12 │ Output 10
  Output 11 │ 13 │ 14 │ Output 12
  Output 13 │ 15 │ 16 │ Output 14
  Output 15 │ 17 │ 18 │ Vadj.
        Vcc │ 19 │ 20 │ Vcc
```

All ports including expansion card ports follow this configuration in Direct Output mode. Vcc is fixed at +5V and Vadj can be adjusted from 0-5V on each card.

Connecting Relays
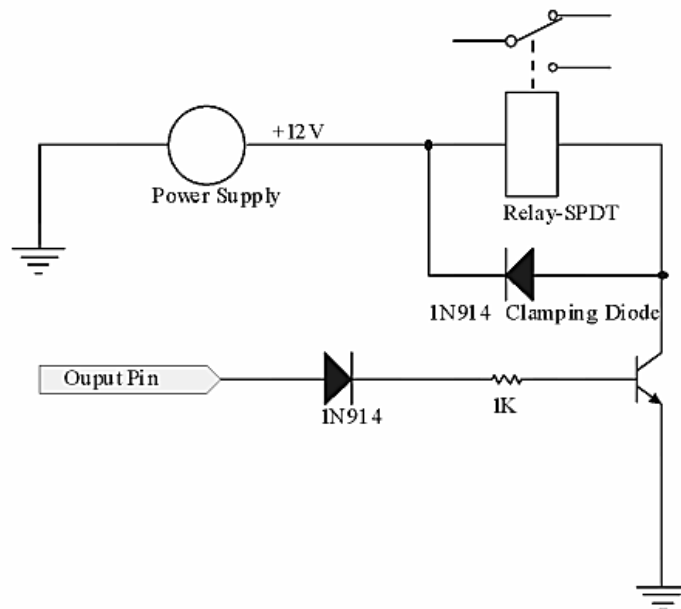
Since the output pins cannot provide sufficient supply for a relay coil (approx. 100+mA is required; output pins can provide up to 25mA), a transistor is used to provide the current necessary to drive a relay coil. A logical one delivered to the transistor base will activate the relay.

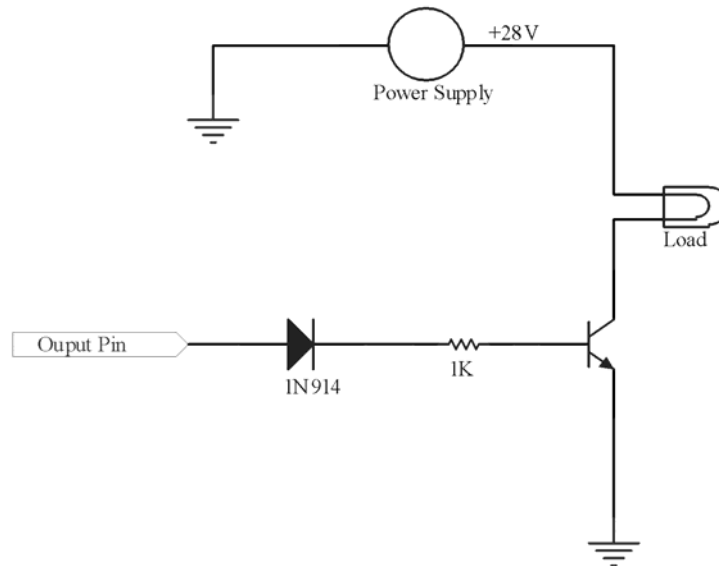Use of an external power supply is necessary if the relay requires more than +12V. 5V rated Relay coils can be driven by the +5V supplied by the module. Selection of the transistor depends largely on the current required to the drive the coil in the relay. Typically a 2N3904 can be used which is rated at 60V, 200MA.

IMPORTANT: *the clamping diode is used to eliminate "kickback" from the charged coil once power is removed. This clamping diode must be used at all times.*

Connecting Lamps

Since the output pins cannot provide sufficient supply for high voltage lamps, a transistor is used to provide the current necessary to drive the lamp. A logical 1 delivered to the transistor base will activate the lamp.

Use of an external power supply is necessary if the lamp requires more than +12V. 5V rated lamps can be driven by the power supplied by the module, eliminating the need for the protection diode. Selection of the transistor depends largely on the current required to the drive the Lamp.

Connecting LEDs
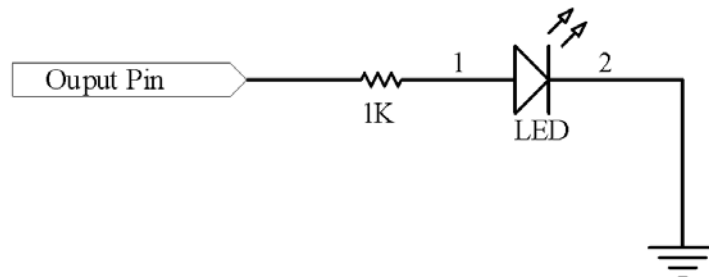
LEDs can be connected directly to the output pins. A current limiting resistor must be connected in series. This value can range from 330 Ohms to over 1K depending on the desired brightness and luminance capability of the LED. See manufacturer's specs.

This method employs positive logic. Logic 1 on the output pin will turn ON the LED; logic 0 will turn OFF the LED.
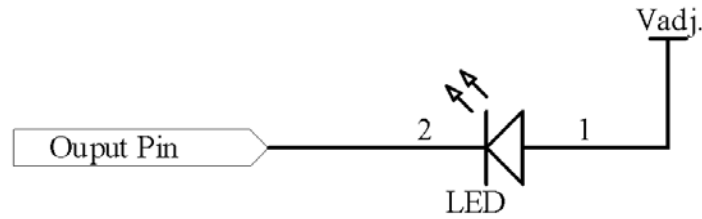
By adjusting the Vadj value to within 3V, the current limiting resistor can be eliminated. The LED will now operate using negative logic. Logic 0 on the output pin will turn ON the LED; logic 1 will turn OFF the LED.

IMPORTANT: *Prior to connecting LEDs using this method, it is imperative that the voltage output on Vadj pin is measured and adjusted through trimpot R27 on the main card and R3 on expansion cards.*

Connecting Optoisolators
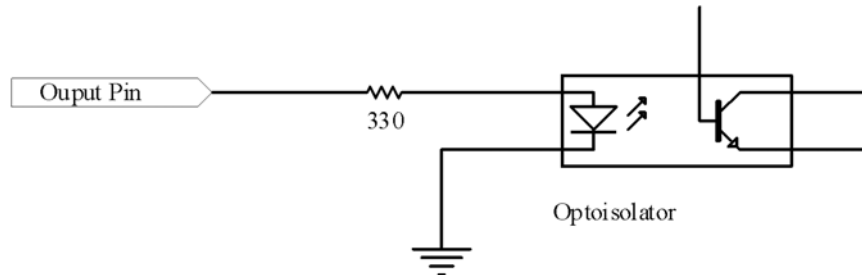
Optoisolators can be employed to completely isolate the module from any external circuitry and can be connected directly to the output pins. A current limiting resistor must be connected in series. This value is typically 330 Ohms. See manufacturer's specs.

This method employs positive logic. Logic 1 on the output pin will turn ON the optocoupler LED, in turn activating the transistor. Logic 0 will turn OFF the optocoupler LED, turning off the transistor.

Multiplexed Output Mode

```
          PORT
          1  2

   GND  | 1 | 2 |  GND
Segment a | 3 | 4 | Segment b
Segment c | 5 | 6 | Segment d
Segment e | 7 | 8 | Segment f
Segment g | 9 |10 | Segment dp
  Digit 1 |11 |12 | Digit 2
  Digit 3 |13 |14 | Digit 4
  Digit 5 |15 |16 | Digit 6
  Digit 7 |17 |18 | Vadj.
     Vcc  |19 |20 | Vcc
```

All ports including expansion card ports follow this configuration in Multiplexed Output mode. Vcc is fixed at +5V and Vadj can be adjusted as from 0-5V on each card.

Connecting Common Anode 7-Segment Displays
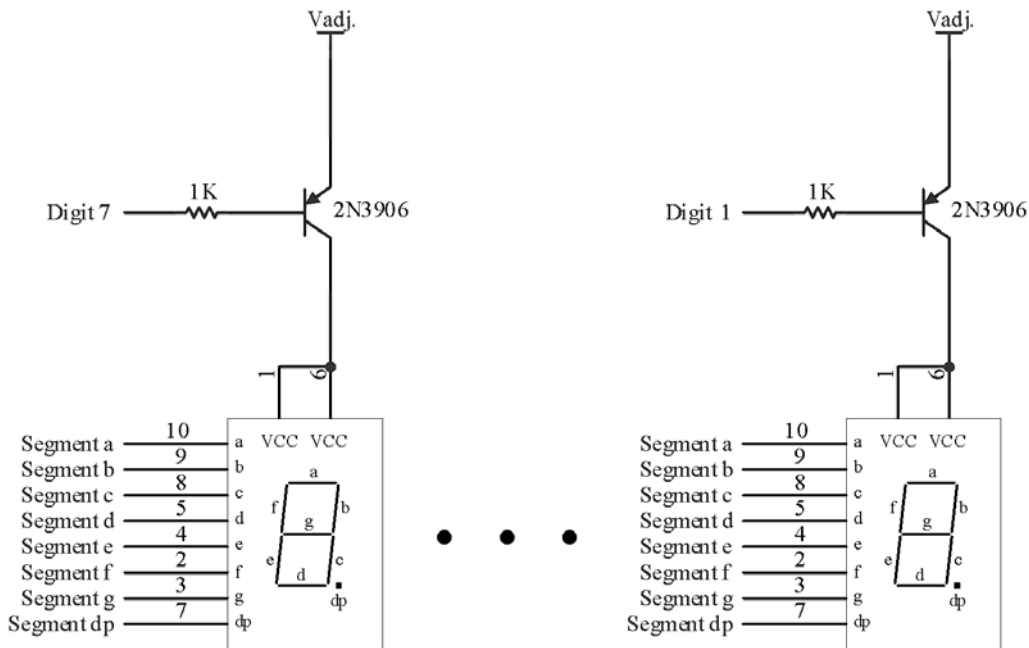
Up to 7, 7-segment CA displays can be connected per port. By using the Vadj capability of the module, individual current limiting resistors can be eliminated, simplifying wiring. Care must be taken to insure the Vadj does not exceed manufacturer recommended limits. All segment lines are shared.

IMPORTANT: *Prior to connecting CA 7-Segment displays using this method, it is imperative that the voltage output on Vadj pins is measured and adjusted through trimpot R27 on the main card and R3 on expansion cards.*

Connecting Common Cathode 7-Segment Displays
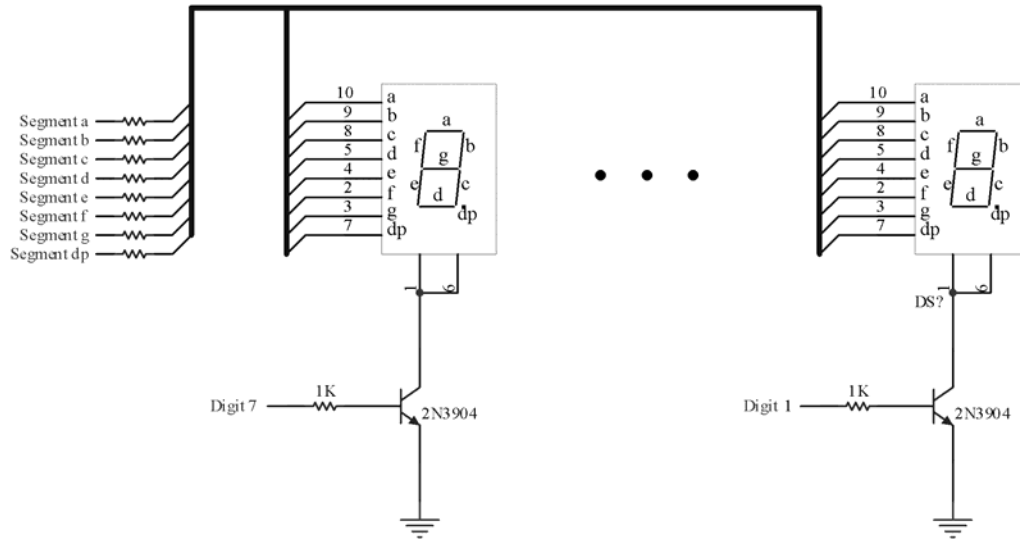
Up to 7, 7-segment CC displays can be connected per port. Unlike CA displays, CC displays do not rely on Vadj for power and must be protected from over current through a current limiting resistor to each segment. These resistors can be shared between each display. Care must be taken to insure the current through the segments does not exceed manufacturer recommended limits.

Beta Innovations Inc.

Connecting 56 LEDs - Common Anode Method

Up to 56 individual LEDs can be connected to each port in multiplexed output mode. Each group of 8 LEDs can be connected to the "Segment" lines and share a common "Digit" line as illustrated above. This method will employ negative logic. Logic 0 on the output pin will turn ON the LED and logic 1 will turn it OFF. Selecting "invert" on supporting software with result in positive logic.
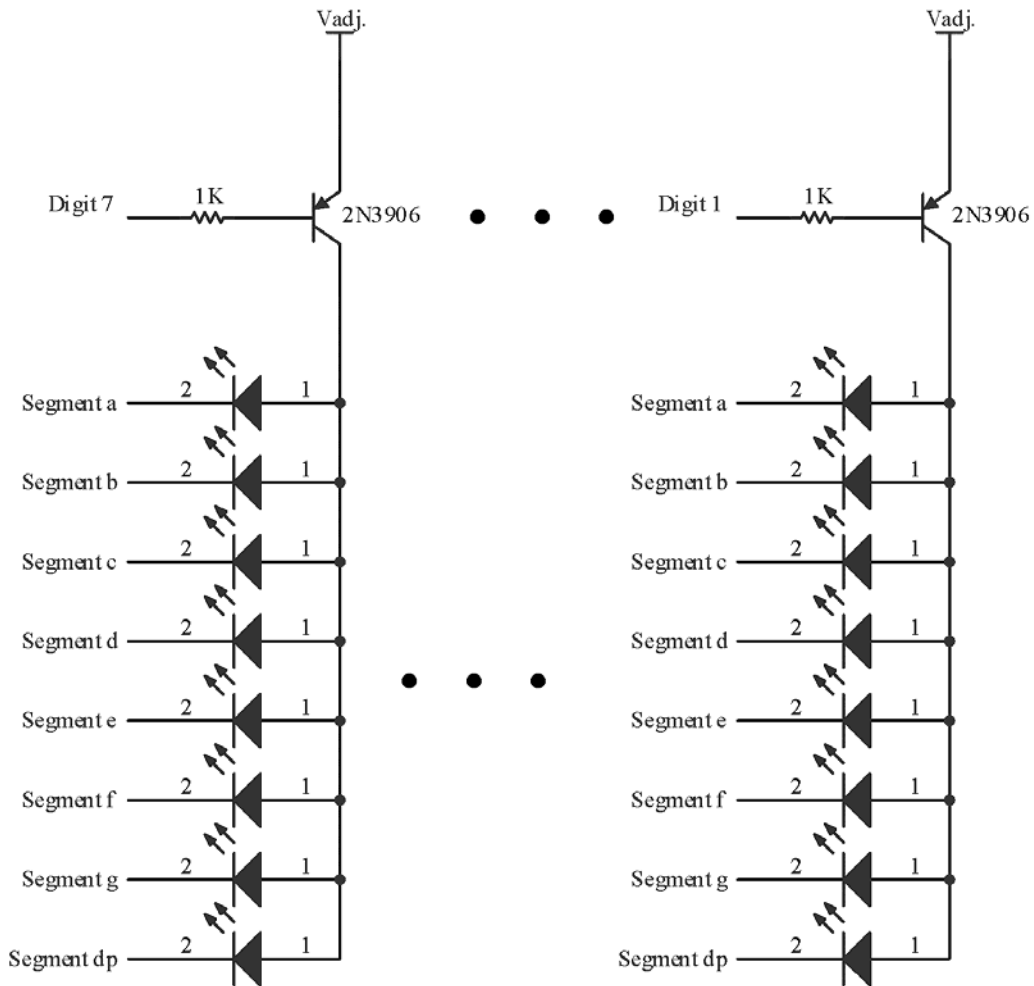
IMPORTANT: *Prior to connecting LEDs using this method, it is imperative that the voltage output on Vadj pin is measured and adjusted through trimpot R27 on the main card and R3 on expansion cards.*
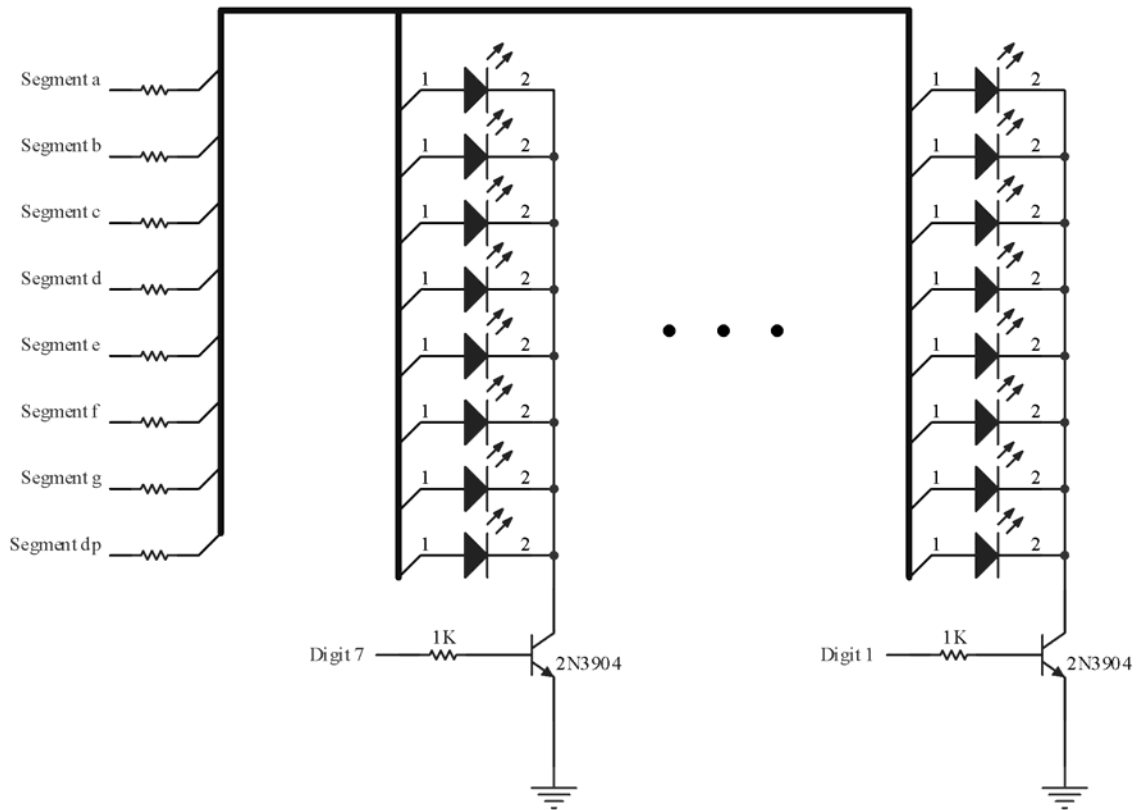
Connecting 56 LEDs - Common Cathode Method

Up to 56 individual LEDs can be connected to each port in multiplexed output mode. Each group of 8 LEDs can be connected to the "Segment" lines through a current limiting resistor and share a common "Digit" line as illustrated above. This method will employ positive logic. Logic 1 on the output pin will turn ON the LED and logic 0 will turn it OFF.

IMPORTANT: *Care must be taken when determining the current limiting resistor value in order to insure the current through the LEDs does not exceed manufacturer recommended limits.*
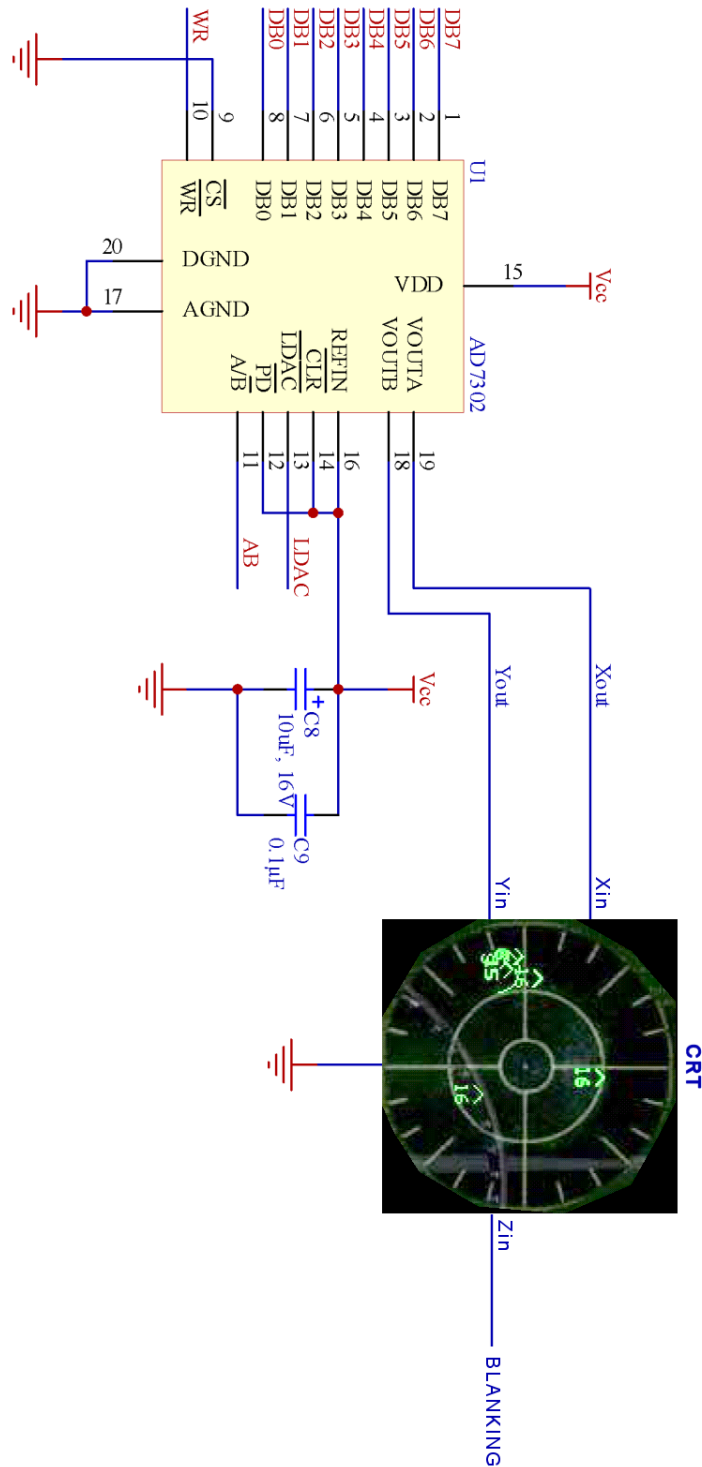
CRT RWR Output Mode

```
                    PORT
                    1  2

         GND  │ 1 │ 2 │  GND
         DB0  │ 3 │ 4 │  DB1
         DB2  │ 5 │ 6 │  DB3
         DB4  │ 7 │ 8 │  DB5
         DB6  │ 9 │10 │  DB7
    BLANKING  │11 │12 │  WR
          AB  │13 │14 │  LDAC
          NC  │15 │16 │  NC
          NC  │17 │18 │  NC
         VCC  │19 │20 │  VCC
```

When the port is configured for CRT RWR mode, the following pinout can be used to control a DUAL DAC in turn connected to any suitable CRT display that accepts X & Y axis inputs.

Connecting CRT Display

The schematic below uses an Analog Devices AD7302 DUAL DAC, but any suitable 8-bit dual DAC can be used. If the CRT is equipped with a Z-axis, you should connect this to the BLANKING signal pin on the port. Note, this signal may need to be inverted depending on the CRT type used. Refer to manufacture's specifications before connecting the blanking signal to the Z-axis. When this signal is 0, the display is turned off, and 5V turns on the display.

The DAC outputs produce a 0 to 5V output. In order to calibrate the CRT, set the port to test mode and adjust the X and Y gain and position controls so that the test pattern fills the screen.

IMPORTANT: *If using a standard dual trace oscilloscope, it is imperative that you calibrate the probes by adjusting the compensating capacitor. Failure to do so may result is warped icons on the display. If not using probes, it may be necessary to add an adjustable capacitor to the CRT inputs in order to compensate for cable capacitance and the CRT's input capacitance.*

Be sure to connect the probe's ground leads to the DAC or Port's ground pins.

GLCD Output Mode

```
              PORT
               1  2
        GND │ 1 │ 2 │ GND
        DB0 │ 3 │ 4 │ DB1
        DB2 │ 5 │ 6 │ DB3
        DB4 │ 7 │ 8 │ DB5
        DB6 │ 9 │10 │ DB7
        D/I │11 │12 │ R/W
          E │13 │14 │ NC
        RST │15 │16 │ CSA
        CSB │17 │18 │ NC
        VCC │19 │20 │ VCC
```

Graphical LCD (GLCD) mode can be used to control any KS0107 & KS0108 compatible LCD comprised of 192 by 64 pixels. The node is preloaded with special custom 11x7 fonts including special glyphs matching those used on F-16 based DED and PFD displays.

Connecting the GLCD Display

With the exception of a contrast trimpot, all LCD IO pins can be connected directly to the port pins using a ribbon cable of suitable length. Power can be supplied directly from the port VCC pins with the exception of the negative bias voltage on LCDs not equipped with a voltage inverter (VEE). An external negative voltage source will have to be used in such cases.
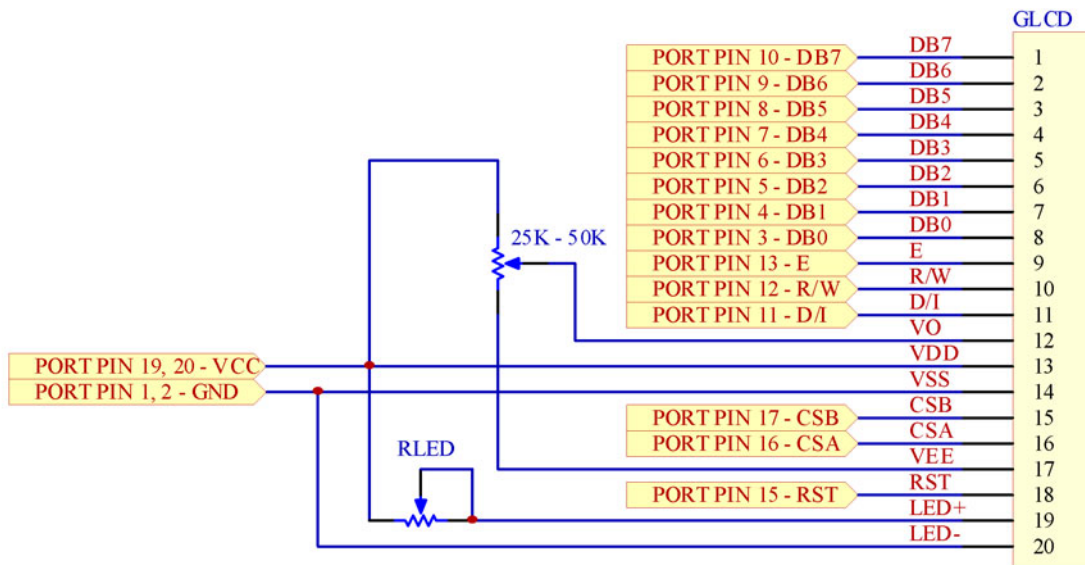
The example above illustrates the connection diagram for a typical Samsung KS0170 & KS0108 interface compatible graphical LCD with onboard negative bias voltage supplied on the VEE pin.

Pin Name	Description
DB0-DB7	Data Bus
E	Enable
R/W	Data Read / Write
D/I	Data / Instruction
VO	LCD Contrast Reference
VDD	Positive Power Supply
VSS	Ground
CSA-CSB	LCD Region Chip Select
VEE	Negative Bias Voltage
RST	LCD Reset
LED+	Positive Power for LED backlight
LED-	Negative Power for LED backlight

If the *LCD Region Chip Select* lines consist of 3 pins (i.e. CS1, CS2 & CS3) a 3 line to 8 line decoder IC such as the 74LS42 will need to be used in the following manner.
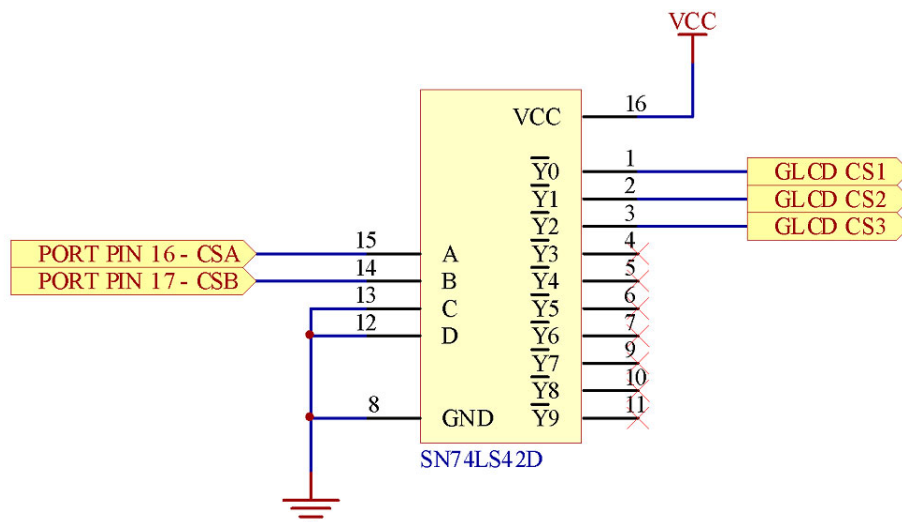
IMPORTANT: *Some LCDs require a current limiting resistor RLED on the backlight LED pins (LED+ & LED-).* **Refer to manufacturer's specifications for details on all pin parameters** *to insure compatibility with above examples.* **Failure to use resistor may result in permanent damage to the LCD circuitry.**

8-bit DACs Output Mode

When the port is configured for 8-Bit DAC mode, the following pinout can be used to control up to 5 DUAL DACs (10 single DACs) per port in turn connected to any circuitry that requires a 0-5V input. This includes Air-Core meters, Voltage to PWM generators for use with servomotors, etc.
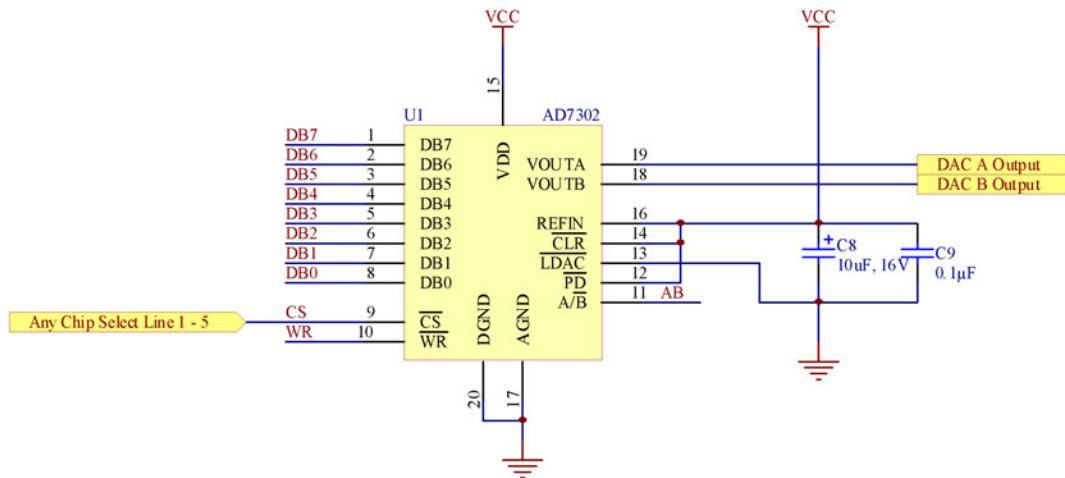
Connecting 305 Degree Air-Core Meter

The schematic below uses an Analog Devices AD7302 DUAL DAC, but any suitable 8-bit dual DAC can be used. Drivers such as the CS8190 or LM1819 can be used to control the meter movement through 305 degrees from a 0V–5V analog input source. Refer to manufacture's specifications for details.
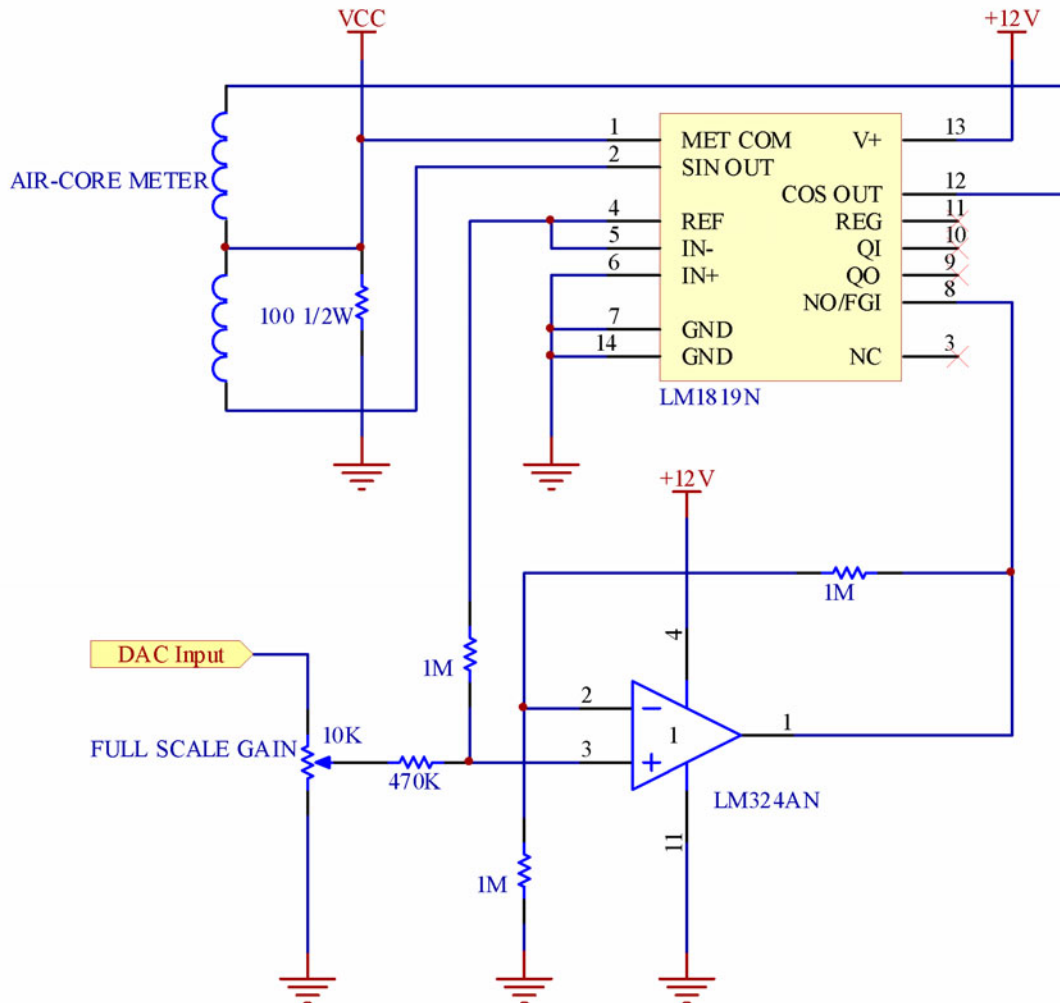
Calibration Procedure

The DACs produce a 0 to 5V output. In order to calibrate the driver circuit, use the USBSPIDAC.exe test utility provided with the toolkit for the following procedure:

1. Set the output to 0V. Press the needle onto the Air-Core shaft at the minimum position on the gauge.

2. Set the output to 5V. Adjust the FULL SCALE GAIN trim pot so that the needle moves to the maximum position on the gauge.

The Air Core driver circuit is now calibrated and will not need to be adjusted unless the physical meter range is changed. Additional in software calibration may be required depending on the intended application. Refer to accompanying software help file for details.

Connecting Continuous Rotation Air-Core Meter

The schematic below uses an Analog Devices AD7302 DUAL DAC, but any suitable 8-bit dual DAC can be used. In order to control an Air-Core meter for continuous rotation, 2 DAC outputs must be used for Sine and Cosine relation producing a meter movement across 360 degrees. The node firmware does not provide the Sine and Cosine relationship between pairs of output signals and must be calculated entirely in the interfacing software.
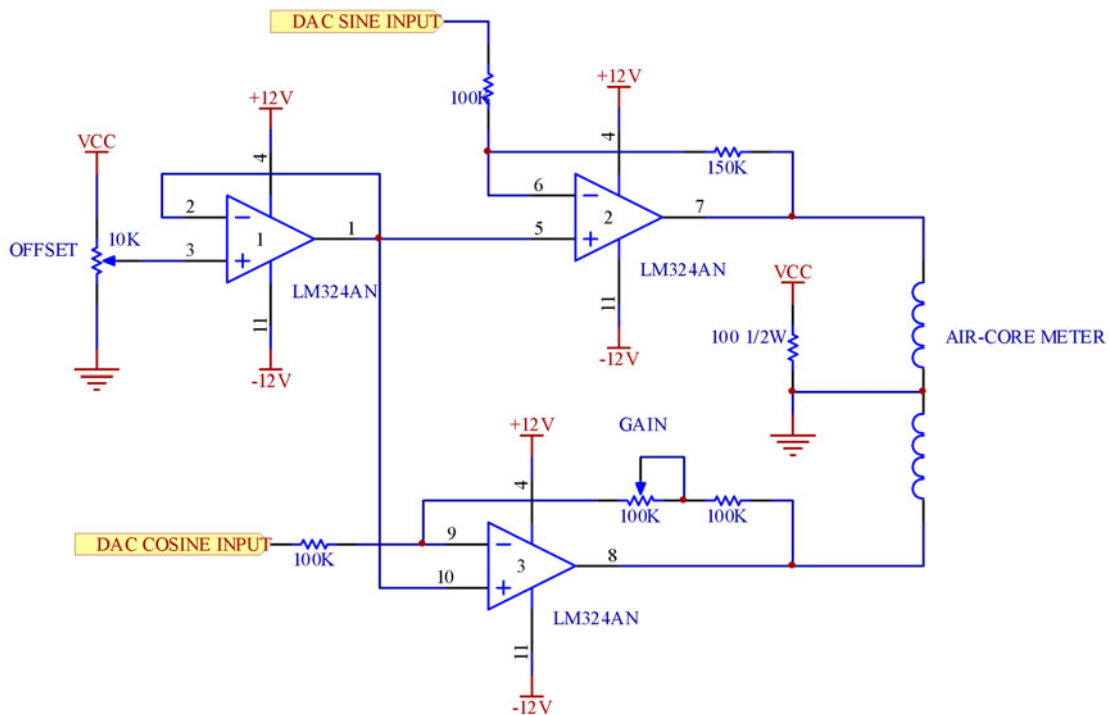
Calibration Procedure

Each DAC produces a 0 to 5V output and must be used in pairs adhering to the following mathematical relationship.

Sine Output: (Sin (A) + 1) * 2.5
Cosine Output: (Cos (A) + 1) * 2.5

Angle A	DAC A: Sine Output	DAC B: Cosine Output
0 deg	2.5V	5.0V
90 deg	5.0V	2.5V
180 deg	2.5V	0V
270 deg	0V	2.5V

Offset Calibration:
1) Set the output to 5V using the USBDAC.exe test utility for DAC A (Sine output). Measure the output of the op-amp pin 7.

2) Set the output to 0V using the USBDAC.exe test utility for DAC A (Sine output). Measure the output of the op-amp pin 7.
3) Adjust the OFFSET trim pot until the voltages measured on the outputs of the op-amp pin 7 are equal and opposite (i.e. approx. -3.4V and 3.4V).

Gain Calibration:
4) Set the output to 5V using the USBDAC.exe test utility for DAC B (Cosine output). Measure the output of the op-amp pin 8.
5) Adjust the GAIN trim pot until the voltage measured on the output of the op-amp is equal to the voltages measured in steps 1 and 2 (i.e. approx. -3.4V and 3.4V)

The Air Core driver circuit is now calibrated and will not need to be adjusted unless the physical meter range is changed. Additional in software calibration may be required depending on the intended application. Refer to accompanying software help file for details.

Connecting Servomotor

Any standard RC servo can be used in conjunction with DAC outputs through an Voltage to PWM driver circuit which converts a 0-5V voltage input to a PWM output typically 0.9ms – 2.1ms pulse width.
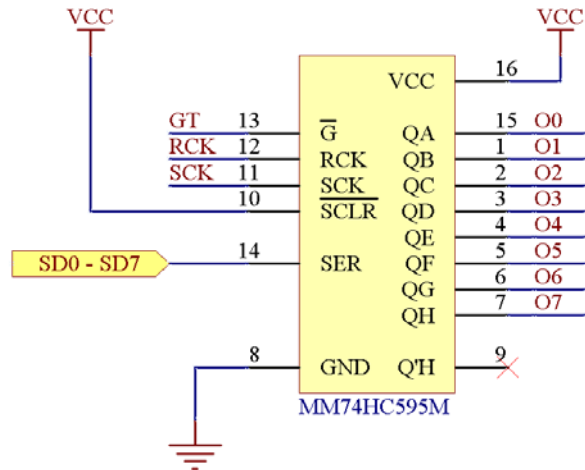
Latched Output Mode

```
              PORT
             ━ N
   GND │ 1 │ 2 │ GND
   SD0 │ 3 │ 4 │ SD1
   SD2 │ 5 │ 6 │ SD3
   SD4 │ 7 │ 8 │ SD5
   SD6 │ 9 │10 │ SD7
   RCK │11 │12 │ SCK
    NC │13 │14 │ NC
    NC │15 │16 │ GT
    NC │17 │18 │ NC
   VCC │19 │20 │ VCC
```

When the port is configured for Latched mode, the following pinout can be used to control up to 64 outputs through 8 latch ICs. These outputs can be used with any circuitry requiring TTL signals such as LEDs (through current limiting resistors) or other digital circuitry.

Connecting Latches

The schematic below uses the Fairchild's MM74HC595 Shift Register Latches, but any suitable serial interface compatible latched shift registers can be used.

Up to 8 latching ICs can be connected in this manner. Refer to the Direct Output mode section of this document for examples of connecting various peripherals to the outputs *O0* to *O7* of the latch ICs.

Dot Matrix Output Mode

```
              PORT
               1  2
    GND   | 1  | 2  |  GND
    D0    | 3  | 4  |  D1
    D2    | 5  | 6  |  D3
    D4    | 7  | 8  |  D5
    D6    | 9  | 10 |  CLR
    A0    | 11 | 12 |  A1
    BL    | 13 | 14 |  WR0
    WR1   | 15 | 16 |  WR2
    WR3   | 17 | 18 |  NC
    VCC   | 19 | 20 |  VCC
```

When the port is configured for Dot Matrix mode, the following pinout can be used to control up to 4 OSRAM compatible dot matrix displays of 4 digits each per port. Display brightness is controlled via PWM through the blanking pin *BL*.

Connecting Dot Matrix Displays

The schematic below uses the 4-Digit 5x7 OSRAM SLG2016 Alphanumeric Intelligent Dot Matrix Displays.
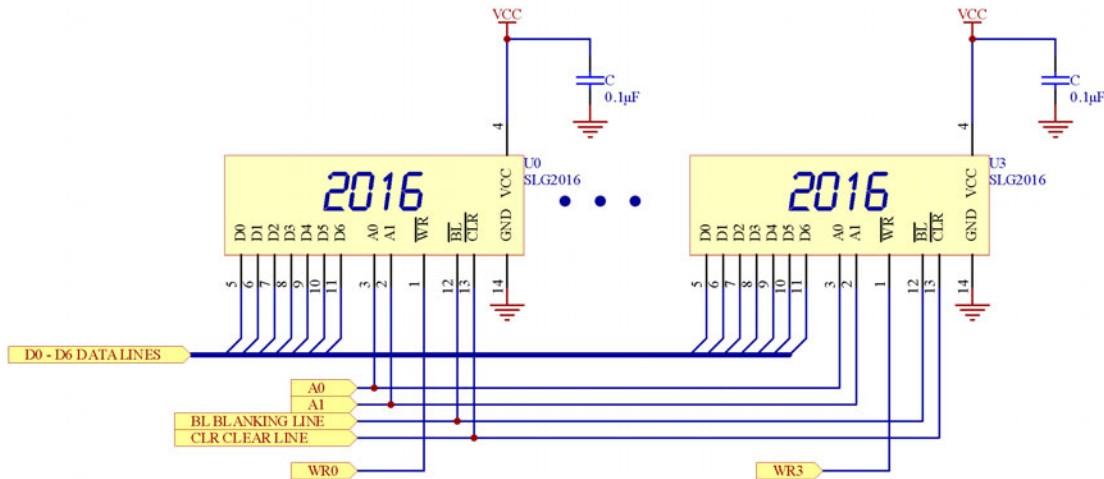
Up to 4 displays can be connected in this manner. All lines are shared with the exception of the write lines *WR0 - WR3.*

SPI Output Mode

Not currently supported.

Expansion Ports

The ElectronFlux module supports 2 separate expansion ports. Currently only port JP1 is available for use with EF-X120 expansion cards. Each expansion card requires its own power source, which is supplied through a common FDD (Floppy Disk Drive) power connector if using a standard PC power supply.

The cards are self-enumerating requiring no user intervention with the exception of addressing the cards when connecting two to the same port. Cards with the same address will fail enumeration and will not function properly. See Device Manager help file for details on addressing cards.

The blue PWR indicator LED will turn on once the card has been properly enumerated.
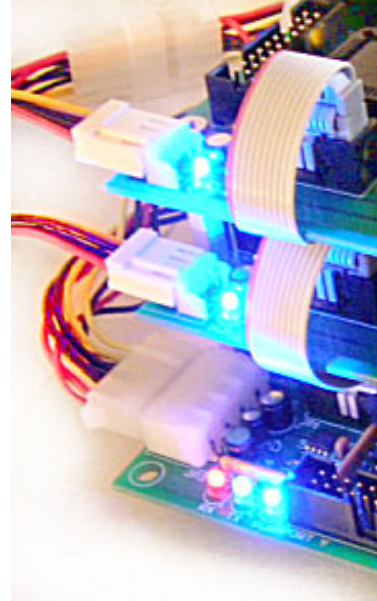
IMPORTANT: *DO NOT CONNECT any add-on cards to the expansion ports of ElectronFlux module while power is ON. Make sure the power is turned off on all cards and that you use the keyed ribbon cable supplied with your add-on card to connect them to the expansion port. If using a custom cable, observe the location of PIN 1 on each expansion port.*

Hardware Specifications

All I/Os on the ElectronFlux are TTL compliant with high current drive, capable of sourcing or sinking up to 25 mA each. Through software control, these I/Os can be configured for positive or negative logic as needed.

Most operating systems will detect and load the appropriate HID driver for your device and do not require that a custom device driver be installed. The module can be connected to a self-powered or bus-powered USB HUB or port.

IMPORTANT: *DO NOT EXCEED 3A per card when connecting peripheral devices to the ElectronFlux ports.*

Maximum power consumption is 15W (@3A per card) for each individual card or 45W total and is a self-powered device. Modules can be powered from any suitable standard PC power supply capable of delivering 15W of power per card or 45W total when used with full system comprised of 1 main card and 2 expansion cards. Exceeding the 3A limit on any individual card will trip the short circuit protection, which will shut down all power to external devices and circuitry for that specific card. When this happens, the blue PWR LED will turn off indicating a fault. The PWR LED will remain off until the fault is cleared.

NOTE: *DO NOT CONNECT any of the ElectronFlux Vcc pins to external power supplies or voltage sources.*

Although common grounds can be safely connected to external grounds, it is not recommended and should be avoided whenever possible. Doing so may adversely affect performance, possibly causing strange or erratic behavior under certain conditions.

Main Card Device Status LEDs

RX	TX	Description
● Off	● Off	Device not powered, not enumerated.
● On	● Off	Device configured in Flash Loader mode.
● On	● On	Device configured in Device mode.
●● Flashing	●● Flashing	Device in Suspend state.
● On	●● Flashing	Transmitting data to USB host.
●● Flashing	● On	Receiving data from USB host.
	D4-7	**Description**
	● Off	Node failed enumeration.
	● On	Node operational.
	●● Flashing	Node sending or receiving data.
	PWR	**Description**
	● Off	Device in Flash Loader mode or short circuit fault detected.
	● On	Power optimal.

EF-X120 Expansion Card Device Status LEDs

D1-4	Description
● Off	Node failed enumeration.
● On	Node operational.
● ● Flashing	Node sending or receiving data.
PWR	**Description**
● Off	Device in Flash Loader mode or short circuit fault detected.
● On	Power optimal.

Mechanical Specifications
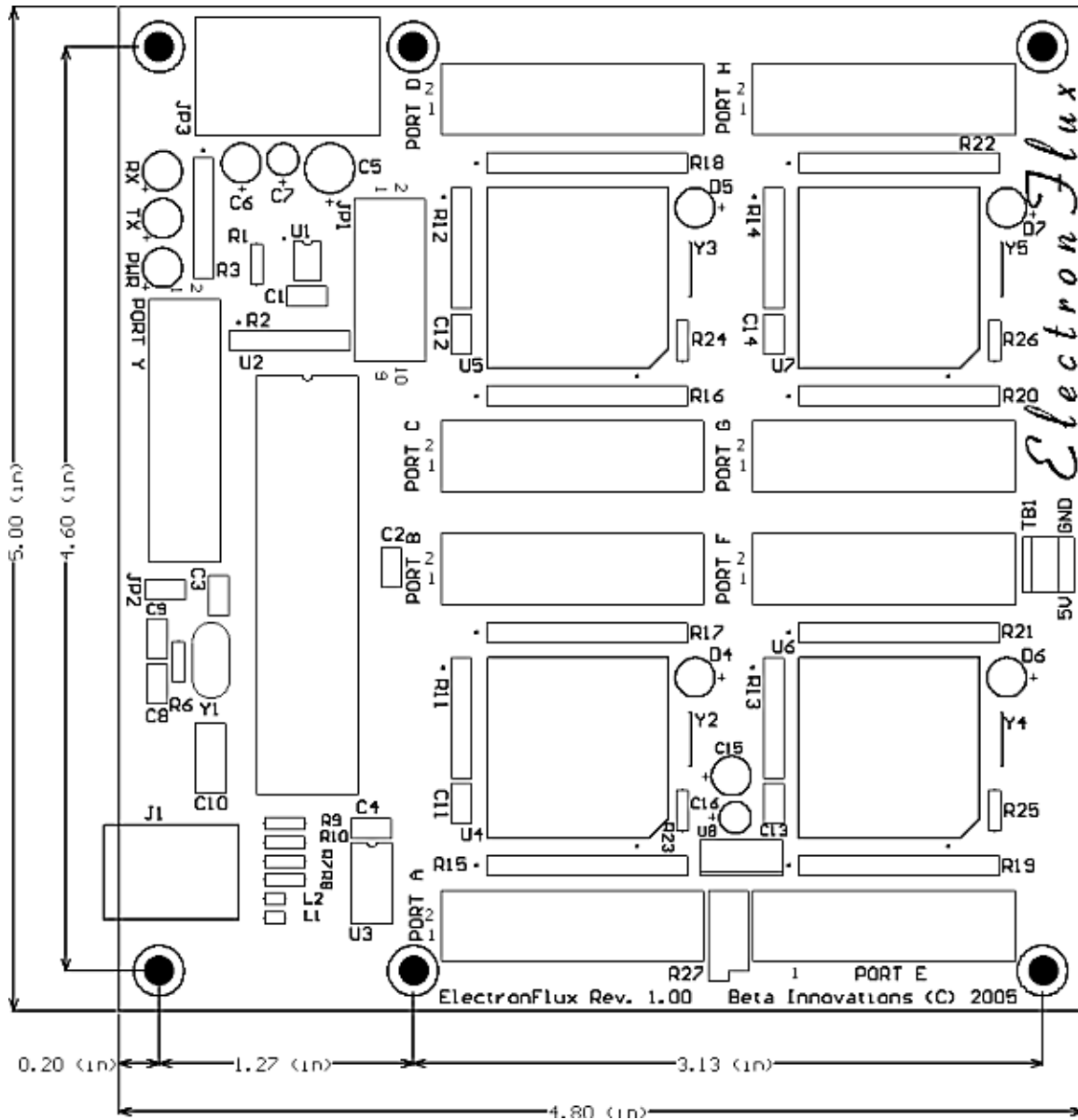
Visit www.betainnovations.com and discover our new expansion modules and accessories.