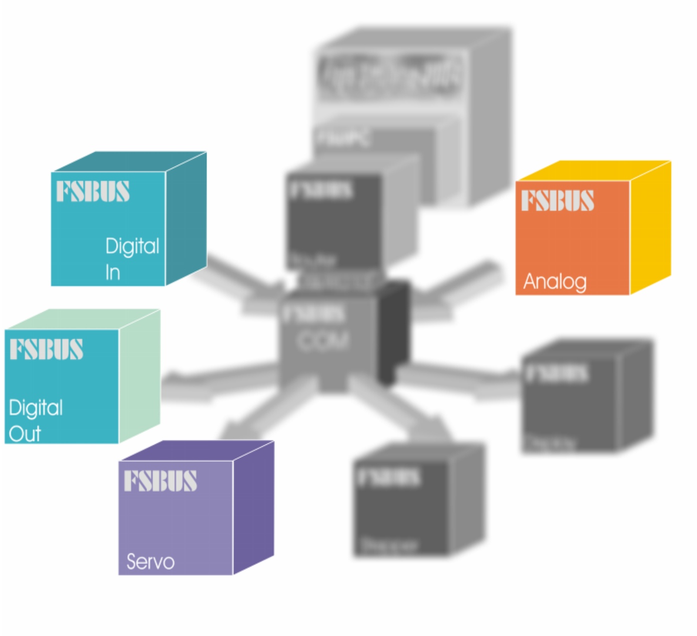
FSBUS


FSBUS
Digital
In
FSBUS
Analog
FSBUS
COM
FSBUS
Digital
Out
FSBUS
Servo

IO

Impressum

The electronic, software and this manual were designed by Dirk Anderseck. All rights reserved. Reproductions of every type require the written approval of the editor.
These instructions correspond to the technical stand at printing. Subject to alterations.

The FSBUS wirings and software are freely available for private use. A commercial use of the wirings, software or parts of it, requires a written approval by the owner Dirk Anderseck. Please contact me at dirk@anderseck.net.

History

Sep. 2005	Preliminary version	
Oct. 2005	Added Pony-Prog description for device setup	
Mar. 2007	Setup jumper J16 added FSADMIN is now part of CDK	
Apr. 2007	Grayhill optical encoder series 62B	
Nov. 2007	Reducing noise when using analogue inputs	See Chapter “PortA as Analogue Input”

Operating conditions

The operation of the assembly is provided for hobby applications in the interior.
All consumers attached directly at the FSBUS cable may not exceed a current consumption of altogether 2 amps.
The permitted environmental temperature may not exceed 0° degrees Celsius and 40° degrees Celsius.
The device is meant for the use in dry and clean rooms.
The assemblies may be taken only under supervision of an informed adult or an expert into operation!

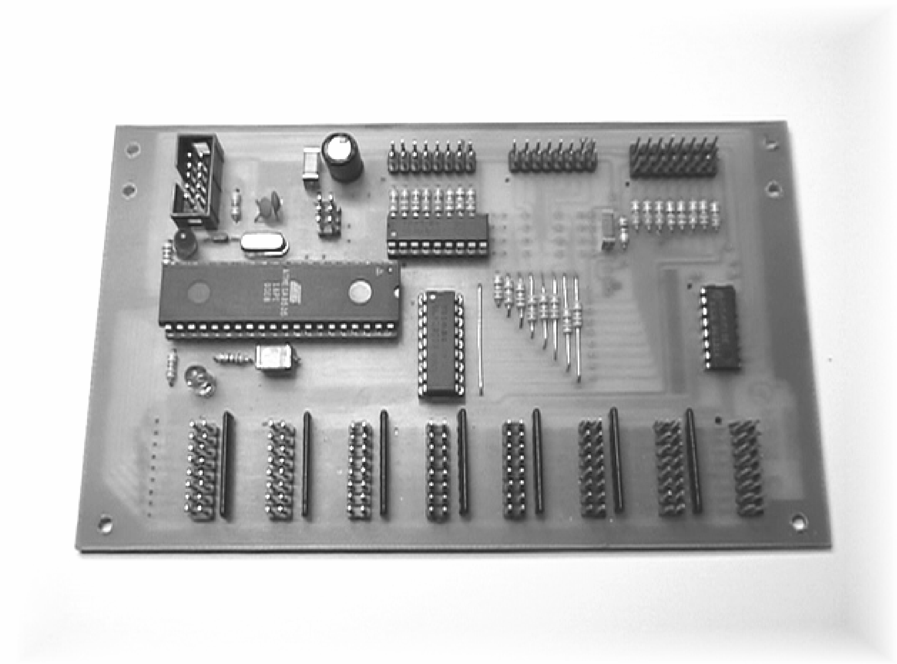
Safety

Tools only may be used if you guarantee that the equipment is separated from the supply tension and electrical charges which are stored in the components situated in the device were unloaded before.

I particularly hereby point out that FSBUS components only should be built by experienced electronics technicians. I dissociate myself from possible damages which can arise.
All operation is carried out at your own risk.

IO Controller

This IO controller is a multipurpose microcontroller driven electronic component based on ATMEL 8535 processor. You can attach switches, buttons, rotaries, lamps, analog meters, potentiometers and other equipment.
Each event on one of the inputs is sent via an attached COM board to the fsbus router software. You may send commands, configuration and data from fsbus router to a specific output port on this controller.



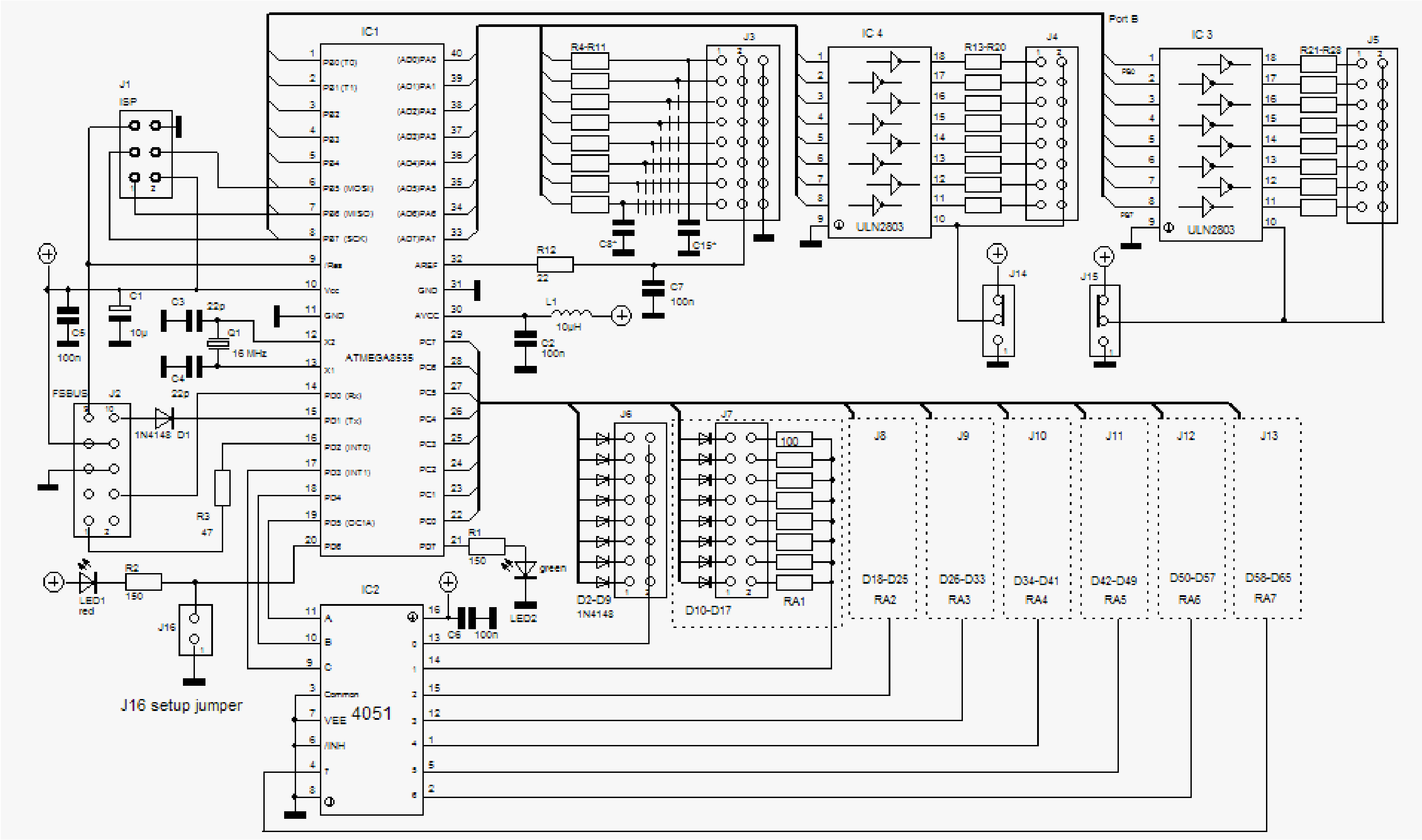
(This photo is a beta prototype. The final layout will have a few changes.)

Features of ATMEGA 8535

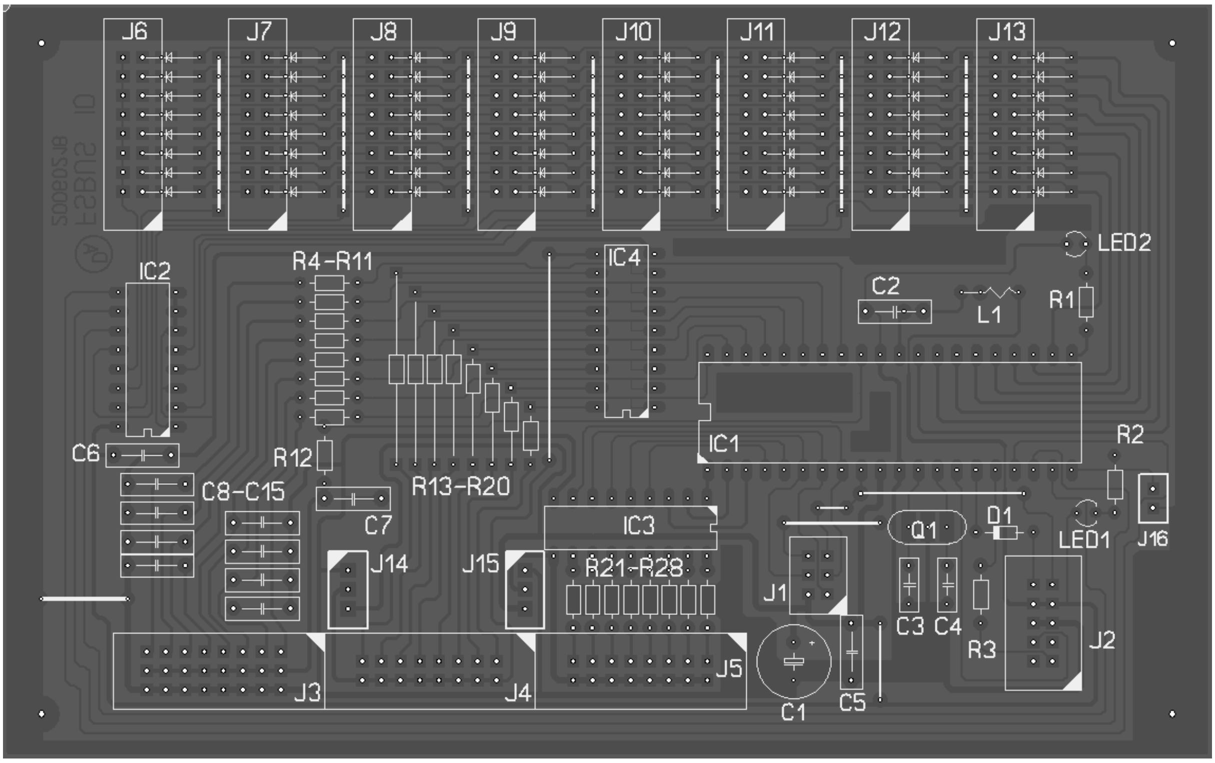
- High-performance, Low-power AVR® 8-bit Microcontroller
- 16 MIPS Throughput at 16 MHz
- Nonvolatile Program and Data Memories
- 8K Bytes of In-System Self-Programmable Flash
- In-System Programming by On-chip Boot Program
- True Read-While-Write Operation
- 512 Bytes EEPROM
- Endurance: 100,000 Write/Erase Cycles
- 512 Bytes Internal SRAM
- 8-channel, 10-bit ADC
- Programmable Serial USART
- 32 Programmable I/O Lines

Input / Output

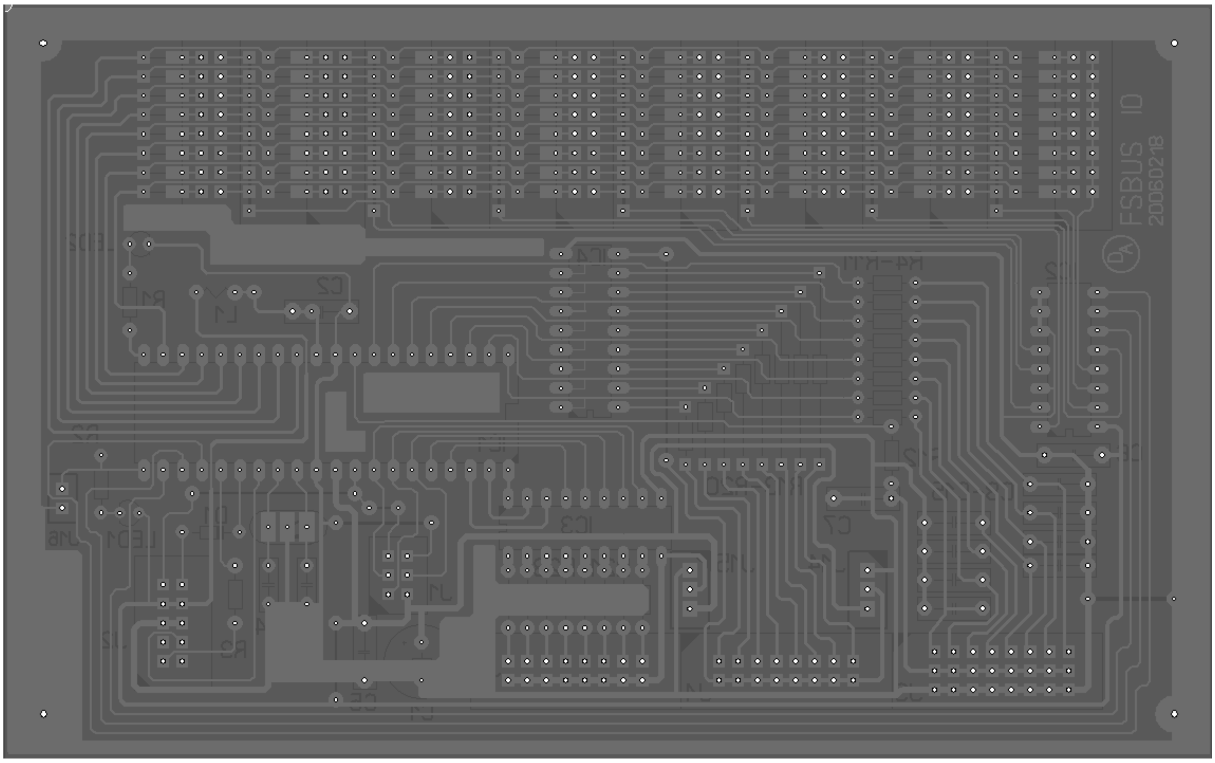
Schematic



PCB



IO controller component side



IO controller copper side

Microcontroller section

The heart of the IO board is a microcontroller ATMEGA8535 which is driven by a 16Mhz chrystal. Connection blocks for FSBUS (10pin) and a compatible ISP adapter (6pin) as well as a few capacitors builds the core of the controller.

Setup jumper

To prevent modification of the internal EEPROM section by power failures or other unexpected events, jumper 16 needs to be set when CID and keytype setup is made.
After setup is done, remove the jumper. If jumper is set, the red led will shine continuously.

Diagnostic LED

A green and a red led mounted on the pcb indicate several states.
After power on and reset, the green LED shows the configured CID (Controller ID). Before you set the CID with fsadmin, the default value of 31 is shown. The 3 is displayed as 3 long blips in sequence and the 1 is shown as 1 short blip.

Short red blips show a transmission process to the PC.

Long red blips shows an error situation, which may appear, if fsbus router sends an illegal command to this controller.

Short green blips indicates a receive dataframe from fsbus router. Only commands directed addressed to this controller are shown.

Reset

A reset is caused by different events.

- Power On
- Low on FSBUS pin 9
- Software command 128
- Configuration commands

In any case, the initialization function rereads the internal EEPROM and resets the internal states.
The controller then sends some information to fsbus router:

- Reset occurred, version number of firmware
- Current analogue output portbits on port A
- Current analogue input portbits on port A
- The 8 analogue tolerance values

The first information causes the fsbus router to resend output state. This gets LED's shining, which shined before the reset.
The other informations are used by fsadmin to update the controls of the windows program.

Key section

The keys section consists of a CMOS multiplexer 4051 and 8 16pin terminal blocks to connect up to 64 simple keys.
Rotaries, UpDown buttons require 2 inputs which reduces the amount of attachable keys to 32 (you can mix different types of switches). Each key different from a simple on/off button needs to be configured by fsadmin software. The keytypes as well as all other configuration are stored in the internal EEPROM of the microcontroller.
The key inputs are decoupled by 1N4148 diodes. You can either use ordinary or SMD parts. RA1-RA7 are resistor arrays. They can be substituted by simple wires, but its easier to use the arrays.

Key types

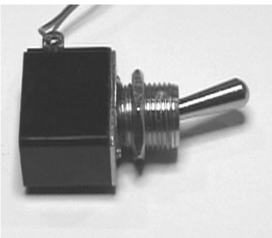
FSBUS IO controller is designed to support the keys, switches and buttons used in a homemade flightdeck.
It was a surprising experience for me, how different many of those are.
The big challenge are the rotary switches. Each kind requires its own software algorithms to decode the turn direction.
The key interface has connection blocks for up to 64 keys with 1 line input (on/off switch). The software numbers these keys from 0 to 64. If a button is pressed down, the software will send a dataframe containing the CID (controller id), key number and 1 or 0 for up or down. When the button is released, a second dataframe with the up-value (0 or 1) will be sent.

The rotaries are connected with more than 1 input line. Before using those, you must setup the controller by sending a configuration command with keytype and keynumber. The keytype also defines how many lines are occupied by this key. If you do not define a keytype, the input line will be decoded as a simple button.

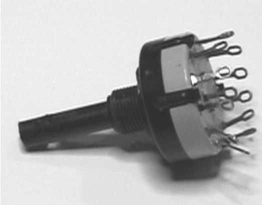
When a rotary is turned, the value sent by controller is a positive or negative value for right or left turns. The value is in most cases a 1 or -1, but if turning faster than the controller can send, it will be a value greater 1.

In version 1 the implemented keytypes are:

1 On/off button or switch

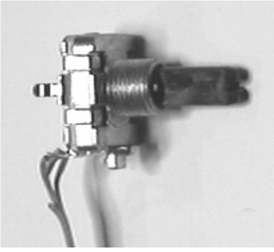


2 Ordinary modified 4 stage rotary switch with 4 input lines and 1 common line



3 Up/down rotary switch with 2 input lines and 1 common line. This key closes one switch on right turn step and the other switch on left turn step.

4 Two phase rotary with 2 input lines and 1 common line. At each step, the open or closed state of one pin at the moment of closing edge on the other pin determines the direction.



5 Two phase rotary with 2 input lines and 1 common line. At each step, the open or closed state of one pin at the moment of closing or opening edge on the other pin determines the direction.

6 Grayhill optical encoder series 62B requires extra hardware. Appendix A shows the schematic.

If there is a key on the market, which is currently not supported, I will check to see, if I can add the necessary algorithms. Please end me an email (dirk@anderseck.net).

PortA

PortA supports both, analogue and digital interfaces. The pcb layout allows different configuration. There are two connection blocks for different concerns.
Each bit of port A can be set to

- analogue input
- analogue output (pulse width signal)
- digital output

PortA as Analogue Input

PortA (J3) can be configured for up to 8 analogue input sources. A 3 * 8 pin connection block (J3) with reference voltage, ground level and input line can be used for connection of potentiometers (10k).

R4-11 are useful to protect the input pins of microcontroller for damage. The values are ~1k. C8 – C15 are optional and build a lowpath filter to remove noise. You can improve the signal quality from analogue potentiometers.

The analogue value is converted in an internal resolution of 10 bit. The transmitted value is reduced to 8 bit.

The use of PortA as analogue input must be configured by fsadmin with configuration command 124. The 8 configuration commands (72-79) defines the tolerance of each separate input.

This threshold acts as a schmitt-trigger function to prevent permanent transmissions on fsbus caused by line noise. A recommended value is 2.

Normally, you may connect one or more potentiometers to analogue inputs. Line noise is effectively reduced by a capacitor of ~10uF from potentiometer slider pin to ground. If there is a long cable between pot and controller, you should mount this capacitor near to the controller.

If you notice permanent transmission and spurious changes of the analogue value in fsbus software, you should mount such a capacitor at each analogue line.

PortA as Analogue Out

PortA can support up to 8 analogue outputs. The analog value is generated by timer driven pulse width modulation. It’s purpose is to drive analog voltmeters or something else. The interval time is 25ms.

The output is connection block J3. The low level is 0V and the high value approx. 4.2V.

The optional C8-C15 are usefull to filter high frequency from the signal.

The analogue output portbits must be configured by configuration command 125. The configuration is done by fsadmin program.

PortA as Digital Out

PortA can support up to 8 digital outputs. The outputs are amplified by a ULN2803 driver chip You can connect up to 8 lamps, LED's or other things to PortA. The current may not exceed 500mA per bit.

If all your equipment driven by this chip requires more than 300mA, I recommend an external power source connected to J14.

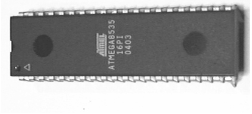
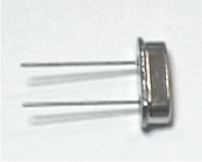
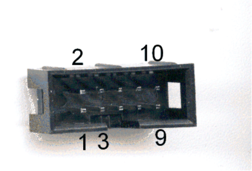
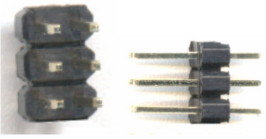
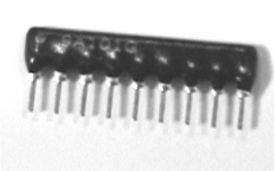
PortB

PortB can support up to 8 digital outputs. The outputs are amplified by a ULN2803 driver chip You can connect up to 8 lamps, LED's or other things to PortB. The current may not exceed 500mA per bit.

If all your equipment driven by this chip requires more than 300mA, I recommend an external power source connected to J15.

Partlist

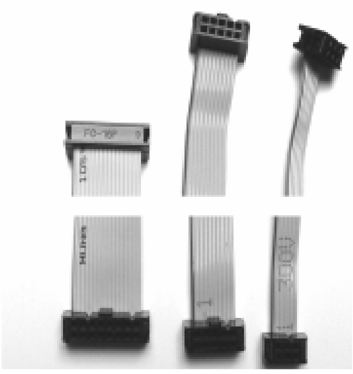
Onle a few parts in a FSBUS circuit are critical in type and value. I have marked these in red letters.

IC1	ATMEGA8535 16PI		ATMEL microcontroller, 40DIP package, 16MHz
IC2	CD4051		Multiplexer for the key interface.
IC3, IC4	ULN2803		Driver containing 8 darlingtons for a maximum of 500mA per bit.
D1	1N4148		
D2-D9 D10-D17 D18-D25 D26-D33 D34-D41 D42-D49 D50-D57 D58-D65	1N4148 SMD		The pcb layout allows to mount 1N4148 instead of the SMD parts. But you can also drill prepared holes and mount ordinary 1N4148 diodes.
LED1	5mm LED green		Indicates incoming commands from router
LED2	5mm LED red		Indicates transmitted values from controller
Q1	Chrystal 16MHz		
J1	10 pin		
J2	6 pin terminal block		
RA1-RA7	100Ohm resistor array		Instead of this resistor bridge, you can use wire and shortcut all 9 pins. Using these arrays simplifies the work. The resistance can vary between 0 Ohm and 100 Ohm.
C1	10uF		
C2,C5,C6	100n		

C3,C4	22p		
L1	100µH		This coil and C2 filters the supply voltage for AD converter. It is recommended by ATMEL. FSBUS IO controller doesn't use the full resolution of the AD converters, so it is no problem to use a 22Ohm resistor instead of this coil.
R1,R2	150		Current limiting resistors for the indicator LED's
R3	47		

Cables

FSBUS modules require some cables and connectors



16 pin ribbon cable is used to connect controller pcb to keys.

10 pin ribbon cable is used to connect controller pcb to FSBUS COM pcb for ordinary use. This is also called FSBUS cable.

6 pin ribbon cable is used to connect controller pcb to FSBUS COM pcb for ISP flash mode. This is also called ISP cable.

DIY Production of the printed circuit boards

The layout of PCB was designed with “sprint layout version 4.0” from ABACOM (Germany). The download area of www.fsbus.de provides you with the original CAD file made with sprint layout. It is viewed and printed only by sprint layout.

Fortunatly, ABACOM has a free Viewer available (www.abacom-online.de). Using this, you can produce excellent foils for making the printed circuit boards.

My equipment to produce excellent pcb’s

- Canon i865
- transparent foil
- Bungard epoxyd base material

The Canon printer is only one recommendation. Todays photo printing devices should all be capable of drawing dense black surfaces, which is very important for fine lines.

Soldering

Since soldering is an important process which must be executed cleanly and decides decisively on the functioning of the module, the basic principles are summarized here once again:

- In principle, never use soldering water or soldering grease when soldering electronic wirings. The acid contained in it, destroys the components and track conductors.
- Use electronic tin SN 60 Pb (e.g. 60% tin, 40% lead) as soldering fluxes with Kolophonium.
- Use a small soldering iron with not more than 30 watts.
- The soldering process of a soldering point should be speedily but not too briefly carried out. For soldering the well tin-coated soldering tip is held so on the soldering point that component wire and track conductor are touched at the same time. (Not too much) becomes soldering tin supplied at the same time which is on heated. As soon as the soldering tin starts to flow, you take it of the soldering point away. You then still wait for a moment have gone to the retarded plumb line well and soldering irons from the soldering point then take this one.
- Take care that, approx. 5 sec., the just soldered component isn't moved after you have removed the piston. A silver shiny, faultless soldering point then remains back.
- Prerequisite for a faultless soldering point and soldering well is a soldering tip which is clean and not oxidized. You relieve after everybody solder superfluous soldering tin and dirt with an a damp sponge or a silicone Abstreifer.
- After soldering the connection wires are cut off directly over the soldering point with side cutting pliers.

Software

The software for the microcontroller is available in a compiled, linked and prepared format to flash into the ATMEL8535.

It is conform to the FSBUS software protocol specification. It will only work with hardware compatible to the schematic in this manual. The speed of chrystal is also very important and may not differ from 16MHz.

The software starts after reset, caused by power, hardware, or by command. It reads setup values from the internal EEPROM. After the init phase is passed, the green Led will show the configured CID. It is shown by short and long blips. A CID of 27 for example will be shown as 2 long blips and 7 small blips.

During initialization phase, some information are sent to the connected pc. It contains the CID of the controller, the version of the firmware and configuration information.

The software required to drive this IO controller with Microsoft flightsimulator:

- FSBUS IO firmware dio.hex
- FSBUS CDK package

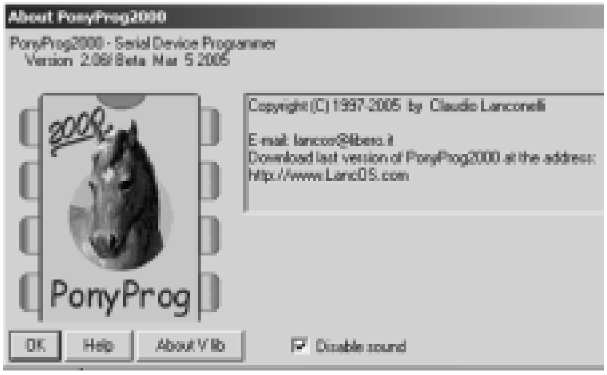
The software is available via internet “www.fsbus.de”

Flash File

You may download the file “dio.hex” from the internet site www.fsbus.de. This file contains the binary for the ATMEL 8535 program memory. It is in Intel standard hex format and can be flashed by commercial products or with the free “PonyProg2000” by Claudio Lanconeli (many thanks for this). The FSBUS COM hardware is compatible to flash with PonyProg2000 software.

Step by Step

1



About PonyProg2000

PonyProg2000 - Serial Device Programmer
Version 2.06f Beta Mar 5 2005

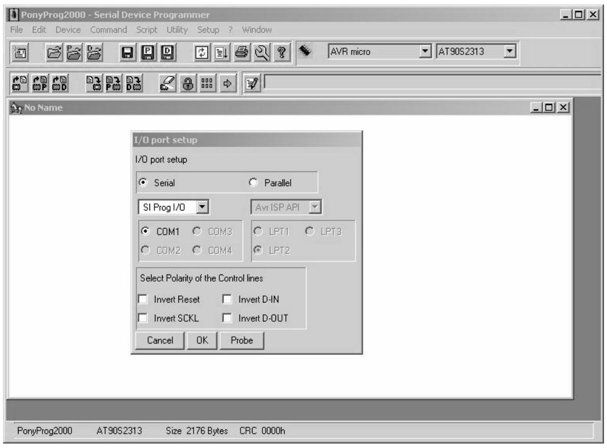
Copyright (C) 1997-2005 by Claudio Lanconelli

E-mail: lancos@libero.it
Download last version of PonyProg2000 at the address:
http://www.LancOS.com

The COM interface board contains flash hardware to support PonyProg software.

The processors used by FSBUS require PonyProg2000 version 2.06 or higher.

2



PonyProg2000 - Serial Device Programmer

I/O port setup

I/O port setup

● Serial ○ Parallel

SI Prog I/O | Avr ISP API

● COM1 ○ COM3 ○ LPT1 ○ LPT3
○ COM2 ○ COM4 ● LPT2

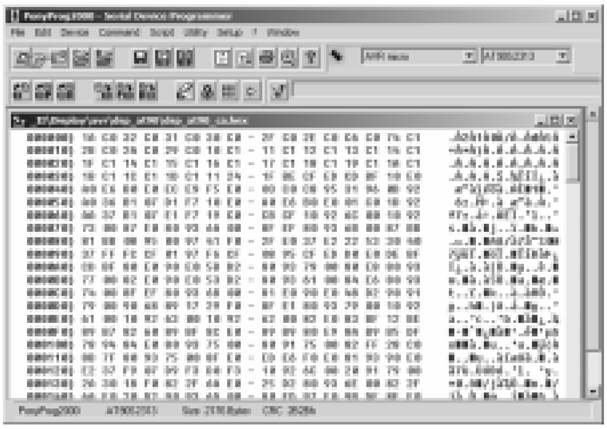
Select Polarity of the Control lines

□ Invert Reset □ Invert D-IN
□ Invert SCKL □ Invert D-OUT

PonyProg2000 AT90S2313 Size 2176 Bytes CRC 0000h

The Setup – Interface Setup dialog box must be set according to the left graphic.

3



Open the file “dio.hex”.

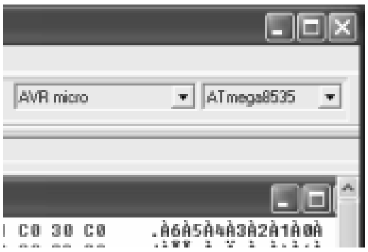
4

Remove 10-pin FSBUS cable and connect the 6-pin ISP cable from COM board to the IO controller.

Take care of correct setting. Pin 1 is marked with the red wire.

PonyProg uses the serial COM interface. No other software (FSBUS) should have the serial interface opened!

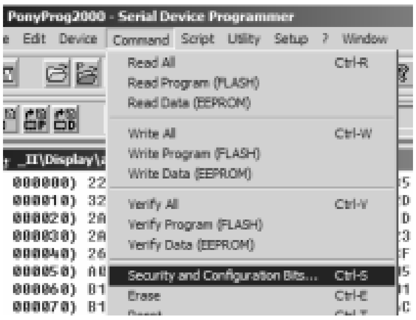
5



AVR micro ▾ ATmega8535 ▾

Select the correct processor in PonyProg.

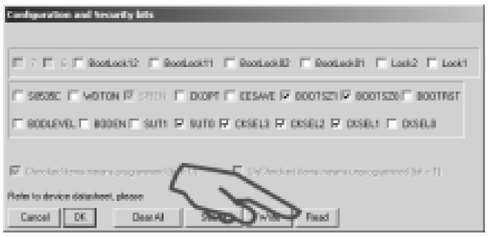
6



Before first flash of the ATMEGA8535, you must setup the security and configuration bits.

This is to be done very carefully. Wrong settings may result in a unusable device.

7



Configuration and Security bits

□ 7 □ 6 □ BootLock12 □ BootLock11 □ BootLock02 □ BootLock01 □ Lock2 □ Lock1

□ S8535C □ WDTON ☑ SPIEN □ CKOPT □ EESAVE ☑ BOOTSZ1 ☑ BOOTSZ0 □ BOOTRST

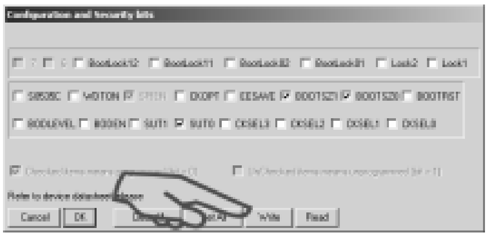
□ BODLEVEL □ BODEN □ SUT1 ☑ SUT0 ☑ CKSEL3 ☑ CKSEL2 ☑ CKSEL1 □ CKSEL0

☑ Checked items means programmed (bit = 0) □ UnChecked items means unprogrammed (bit = 1)

Refer to device datasheet, please

You can read the current settings and check it’s correctness.

8



Configuration and Security bits

□ 7 □ 6 □ BootLock12 □ BootLock11 □ BootLock02 □ BootLock01 □ Lock2 □ Lock1

□ S8535C □ WDTON ☑ SPIEN □ CKOPT □ EESAVE ☑ BOOTSZ1 ☑ BOOTSZ0 □ BOOTRST

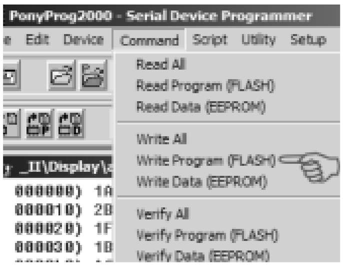
□ BODLEVEL □ BODEN □ SUT1 ☑ SUT0 □ CKSEL3 □ CKSEL2 □ CKSEL1 □ CKSEL0

☑ Checked items means programmed (bit = 0) □ UnChecked items means unprogrammed (bit = 1)

Refer to device datasheet, please

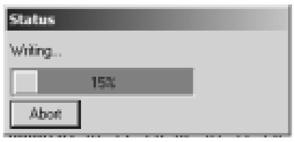
Set the checkboxes according to the left picture and press the “Write” button.

9



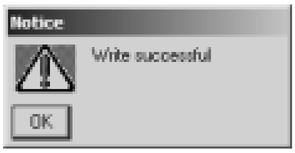
Now it’s time to flash the program into the microcontroller.
The Write Program menu point will start it.

10



Writing...

15%



Write successful

You will be proud and happy, if the progress window followed by success message appears.

Now you can close PonyProg.

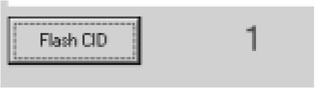
11

Remove the 6-pin ISP cable and connect the 10-pin fsbus cable from COM to the new controller.

12

Select Setup – FSBUS setup in Fsbus CDK.
Set J16 jumper on the IO board.
Change to Set CID tab and set the desired controller ID.

13

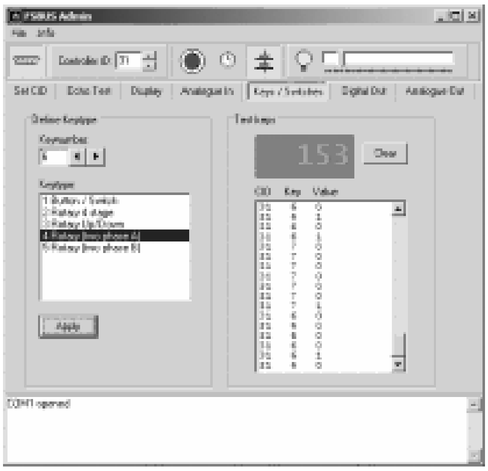


Follow the guidelines in textbox. Press the flash button 3 times.

With each press, the green LED on IO board should lit for a short period.

After this procedure, the new CID is stored in EEPROM.

14

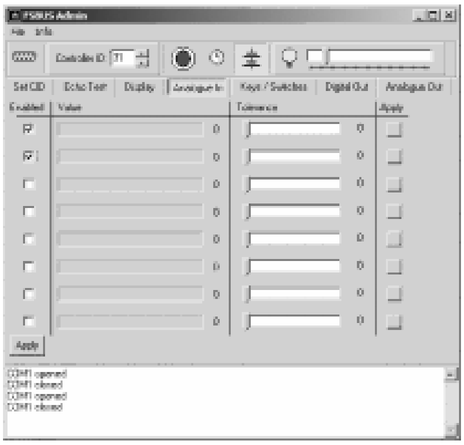


COM1 opened

Define all key types different from a simple button. FSADMIN has a configuration button.

- Setup correct CID
- Set Keynumber from 0-63
- Select Keytype
- Press “Apply” button

14

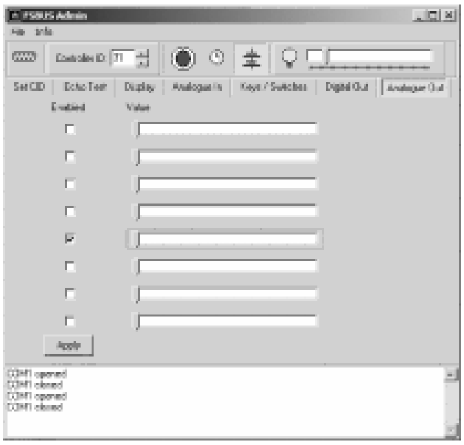


COM1 opened
COM1 closed
COM1 opened
COM1 closed

If you have analogue input on port A, setup the propriate mask for PortA by setting the “Enabled” checkboxes and the press the “Apply” button.

Adjust the individual tolerance sliders for each channel and press the associated button on right side.

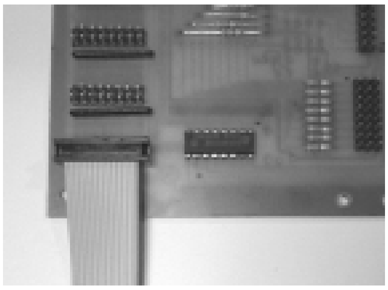
15



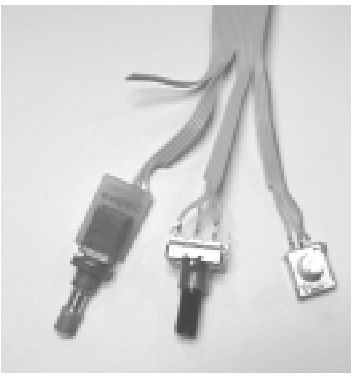
COM1 opened
COM1 closed
COM1 opened
COM1 closed

If using analog output on port A, setup the propriate mask for PortA.

Tutorial - Switches

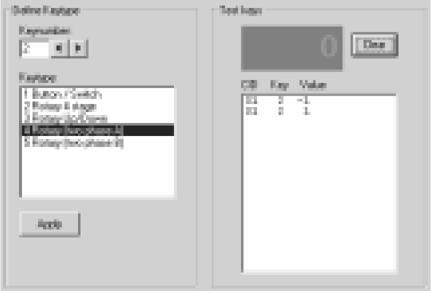


This chapter shows, how to add different switches. The next photo shows a 16 wire flat ribbon cable connected to J6 terminal block. Pin1 is marked by the red wire.
Pin 2,4,6,8,10,12,14,16 are connected to the common line (the common line is NOT at ground level).
Pin 1,3,5,7,9,11,13,15 are the input lines. Pin1 is the right most and pin 16 the left most in this picture.



This picture shows 3 different rotary switches. All of these have 1 common pin and two signal lines. You must not assume, the common pin is the middle pin. This is only valid for the left ALPS switch and the right "Conrad" switch. The center "dutch" switch (my favourite) has the common line at left pin.
You need to look at the manufacturers specification or try it out. There is no risk of damage.
Important: any rotary must begin at an even port pin. This is port pin 0,2,4,6 or if you look at the cable, it is cable pin 0,4,8,12.

Remark:
- The unused common cables 3,7 and 11 are cut away.



Define Keytype
Keynumber: 2
Keytype:
1 Button / Switch
2 Rotary 4 stage
3 Rotary Up/Down
4 Rotary (two-phase A)
5 Rotary (two-phase B)

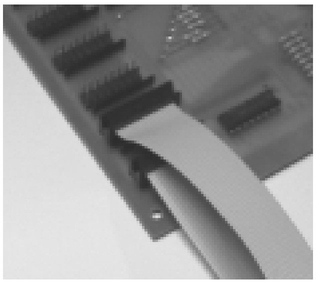
Test keys

CID	Key	Value
01	2	-1
01	2	1

Now its time to configure the switch types with fsadmin. The left hardcopy shows the setup for the middle rotary, connected to port pin 2. You set the keynumber to 2 and select keytype 4.

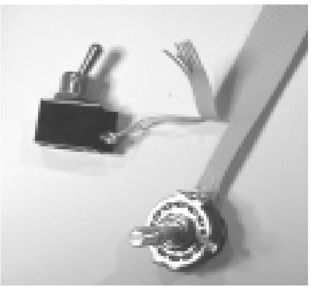
After pressing the Apply button, the controller will store this permantly in the internal EEPROM.

Test the new configuration by turning one step right and one step left. The right "Test keys" window shows the result.
–1 followed by +1 is exactly what we expect to see.

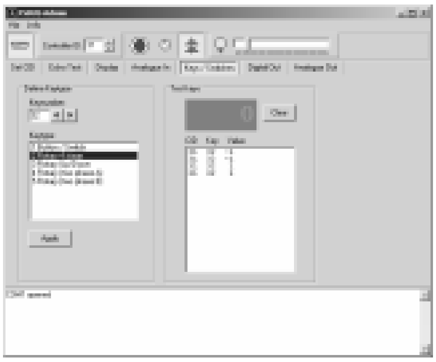


Lets connect a second ribbon cable to the next block on the IO card.

This cable will have an ordinary 12 stage switch modified as a rotary. This type requires 4 input lines and covers half of this port. In the fsadmin program, this type appears as 4stage rotary. In fact you may use 12 stage or 4 stage. The 12 stage needs to be wired as if it is a 4 stage.



There is room for another 4 ordinary on/off switches or 2 rotaries of the first example or another 12 stage rotary.

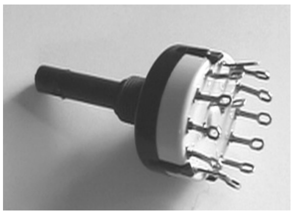


Now test the beheavior of the 4(12)stage rotary. The picture shows 2 right turns followed by 2 left turns.

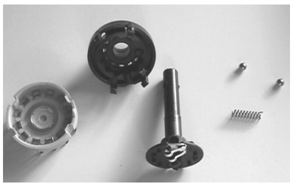
This fsadmin window is the best diagnostic tool to see test switches. The IO controller board has a red diagnostik LED which shines a short time, when a dataframe is sent to the attached PC.

Prepare the 12 stage switches

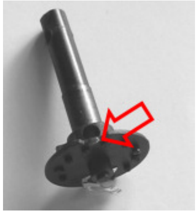
This chapter explains, how you can make a rotary from an ordinary 12 stage switch. These kind of switches are bigger and feel a bit more robust than the smaller original rotaries.
In my flightdeck, I use the smaller rotaries in the 737 MCP panel to control autopilot heading, speed, altitude .. and the 12 stage switches in the radio panels. In my opinion, this is closer to the original feeling.
Another issue, using this kind might be the availability.



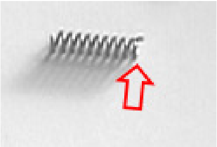
The subject to change, an ordinary cheap 12 stage switch.



After you carefully opened it, you get 6 parts out of it. If you are missing one of the balls, it flew awy powered by the spring (I said: carefully).

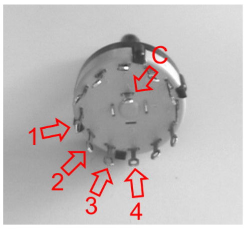


Remove the plastic nose to turn the switch around without stopping.

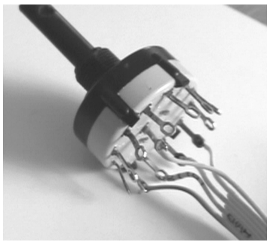


Cut away a small amount of the spring. This will make lower friction when turning.

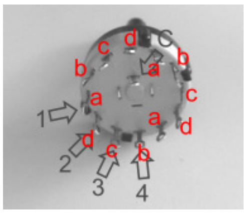
You can now assemble all parts together again. Put the spring in its whole and put the balls, each at one end. This is a bit tricky, but after 50 tries you are an experienced rotary manufacturer.



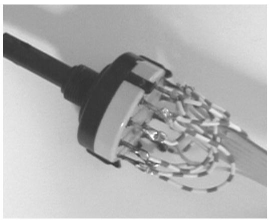
Now you choose 4 pins in sequence to connect to the 4 input bits and the middle common connection. These are wired to the FSBUS IO controller.



Pin 1 of the 16 pole keycable (the lower one) is mounted to Pin 1 of the switch. On the backside of this kind of switch you will find pin 1 marked, but the real position is not importatn. Choose what you want.
Pin 2,4,6 of the 16 pole keycable is cut away, since this is the common line. Pin 8, also common line) is connected to the middle pin C.



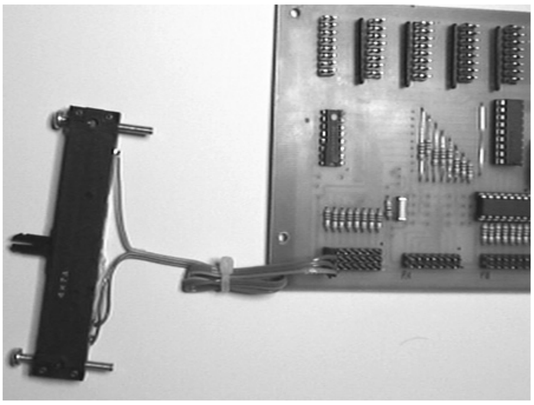
Make small wires bridges and connect the 3 pins (a), the 3 pins (b), (c) and (d).



Now, all bridges are mounted and the switch is ready to use.

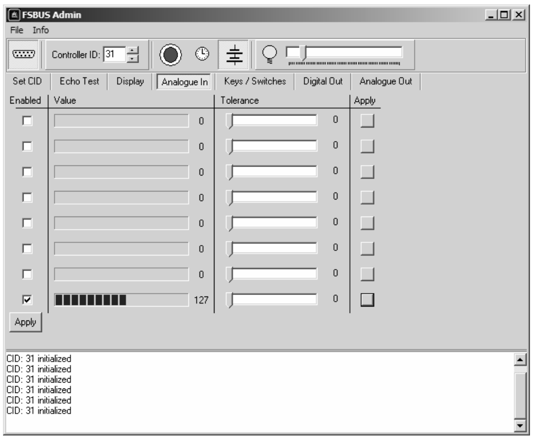
Tutorial – AD converter

J3 gives the opportunity to connect up to 8 potentiometer. Each value is converted into a binary 8bit value and sent to an attached PC.



A 4k7 linear potentiometer is connected to bit7 of J3. The values of resistors R4-R11 are 1k. IC4 is also mounted to use other ports as output.
This affects the linearity a bit but in most cases, this doesn't matter.
C8-C15 are not used in this first example.
The 3 pins for each potentiometer are (top to down):

- input
- +2.56V
- GND



Enabled	Value	Tolerance	Apply
□	0	0	□
□	0	0	□
□	0	0	□
□	0	0	□
□	0	0	□
□	0	0	□
□	0	0	□
☑	127	0	□

```
CID: 31 initialized
CID: 31 initialized
CID: 31 initialized
CID: 31 initialized
CID: 31 initialized
CID: 31 initialized
```

Start fsadmin and set the 7th checkbox to "enabled". Press "Apply", the controller will make a reset and after that, you must see the progressbar showing the potentiometer value.

That's all.

Remark:
If an analogue input is enabled, any attempt to send a digital out signal to that port will fail.

What is the tolerance slider for ?

When moving the slider of your potentiometer, you see the red LED burning. That indicates a dataframe sent to PC. Even when slider remains in a position, the LED may continue burning or flickering. This happens, because the resistance of a potentiometer is not as stable as expected.

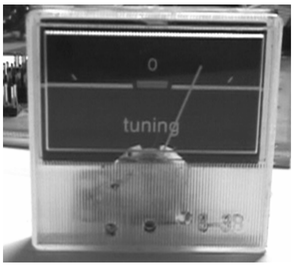
The huge amount of datatraffic is the big disadvantage of this. In most cases there are more than one potentiometers in use and that can drop the FSBUS line performance down.

To avoid this, set the tolerance from 0 to 1 or more. Press the right "Apply" button and test again. Soon you will find a position, where the flicker of the red LED stops.

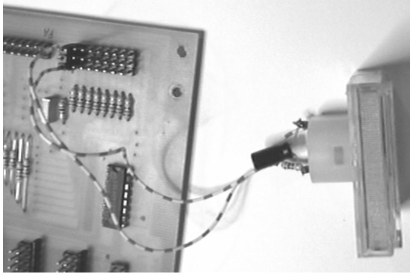
You can improve the stability of the AD process also by mounting capacitors(C8-C15) to the ports in use. I suggest a value of 220nF.

Tutorial – Analogue out

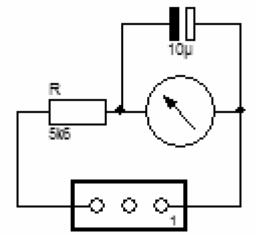
One interesting feature of the FSBUS IO controller is the analogue output feature. It’s not a real dc level, but a pwm signal which is enough for controlling analogue meters as shown below.



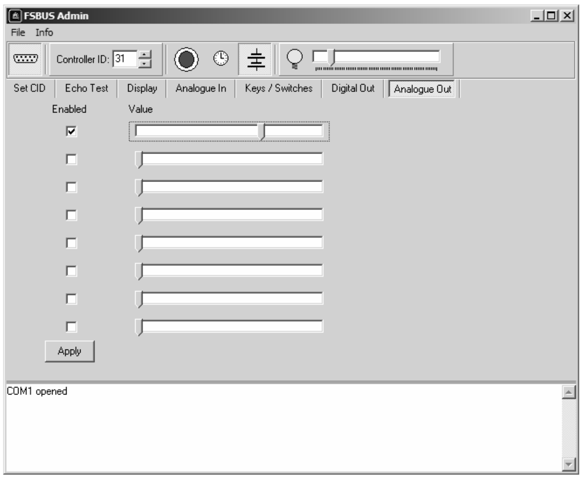
You can attach max. 8 voltmeters to the J3.



Bit 0 of J3 is connected to the voltmeter. A lowpass with a resistor 5k6 and a capacitor of 10uF are used to filter the pwm signal.



Eventually you must change the value of R.



☑
□
□
□
□
□
□
□

COM1 opened

Start fsadmin and set the first checkbox of the “Analogue Out” window to “Enabled”. Press “Apply” and the controller will reset.

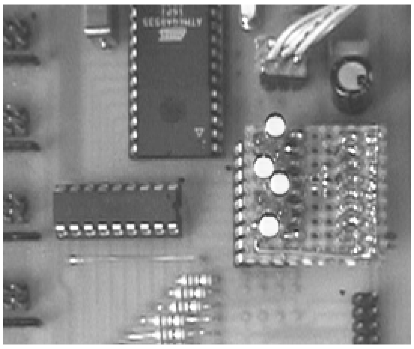
Now you can move the slider and see the needle of the voltmeter following the move.

Remark:
If an analogue input on this pin is enabled, any attempt to send an analogue out signal will fail.

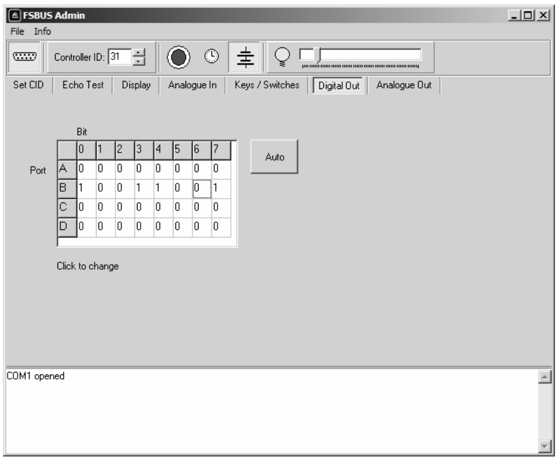
Tutorial – digital out

You can simply mount LED's and or lamps to J4 and J5. If you don't use any analogue interface, a total of 16 outputs is possible. IC3 and IC4 are driver chips to decouple the processor from the external environment and to increase the possible current from 20mA to 500mA.

Resistors R13-R28 limit the current of each output. This is very important for LED's. Other devices may not need a resistor. You can insert a wire or a very small resistor (10 Ohm) instead.



This is a small testboard with 8 LED's mounted on J5. The resistor values R21-R28 are 180 Ohm each.



Controller ID: 31

Port	0	1	2	3	4	5	6	7
A	0	0	0	0	0	0	0	0
B	1	0	0	1	1	0	0	1
C	0	0	0	0	0	0	0	0
D	0	0	0	0	0	0	0	0

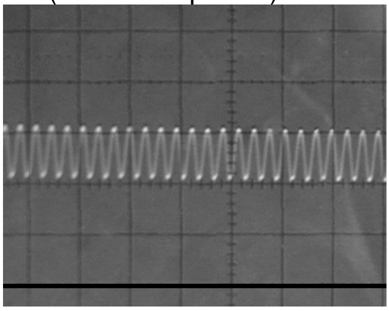
```
COM1 opened
```

Again, you can test the LED's with fsadmin. The LED's are connected to J5, which is microcontroler port B.
If you click on one of the bit cells, it will toggle between 0 and 1. The LED will follow the on/off state.

Troubleshooting

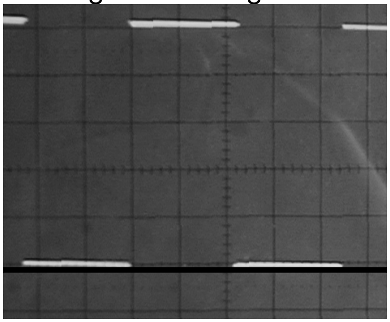
If anything is well done, you can connect the fsbus cable to J2 and the green LED will display the CID.
Now some tests to figure out a problem, if this is not the case. The photos are taken with a 30MHz oscilloscope. The black line marks 0V level.

1. Vcc (ATMEGA pin 10) should have 5V stable power supplied from FSBUS COM interface
2. Reset (ATMEGA pin 9) should also have high level near 5V
3. X1 (ATMEGA pin 12) is ~2.5V dc level and a 16MHz sine wave as shown below.

.

Hor:0.2us ver:1Vss

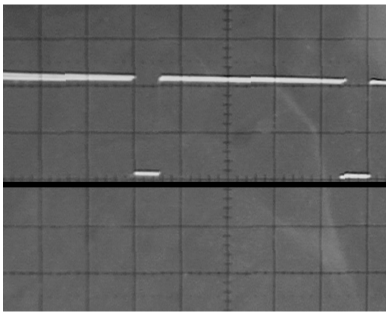
4. X2 (ATMEGA pin 13) is ~2V dc level without sine wave.
5. The regular working of firmware can be seen at PD5 (ATMEGA pin 19)



hor:0.5ms ver:1Vss

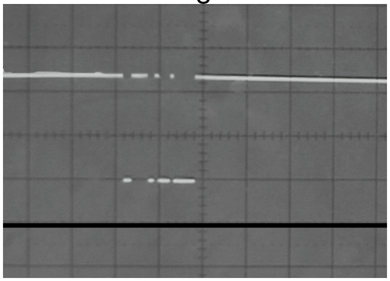
This is the clock for scanning the keyrows (~1.5ms) . Each key is scanned 800 times per second. This is fast enough for the time critical rotaries.

6. If you connect a simple on/off switch to any of the 64 key input lines and close the switch, you may see a 200us negative pulse. The low level must be far below 1V. The high level depends much on the state of other switches in the same row and is not that important. The signal is taken at pin 0 of the key terminal block.



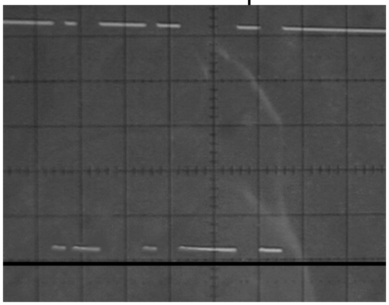
hor:0.5ms ver:1Vss

7. The transmit signal from IO controller at FSBUS connector pin 10.



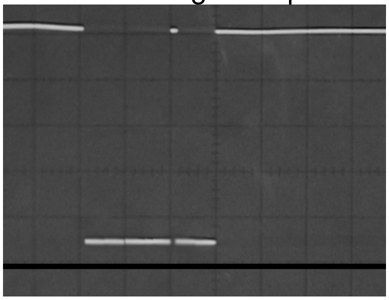
hor:1ms ver:1Vss

8. FSBUS connector pin 4 receives data from PC.



hor:0.2ms ver:1Vss

9. The SENSE signal at pin 1 of FSBUS cable synchronizes multiple host accesses.



hor:2ms ver:1Vss

You can see the arbitration phase of the sending process. Before the controller sends data, it waits for logical high. It pulls down the sense line and holds this level some microseconds. This time depends on the configured CID. In this case a CID of 31 causes ~4ms low sequence. The lower the CID, the shorter this time is. Different times prevent 2 controllers from sending at the same time.

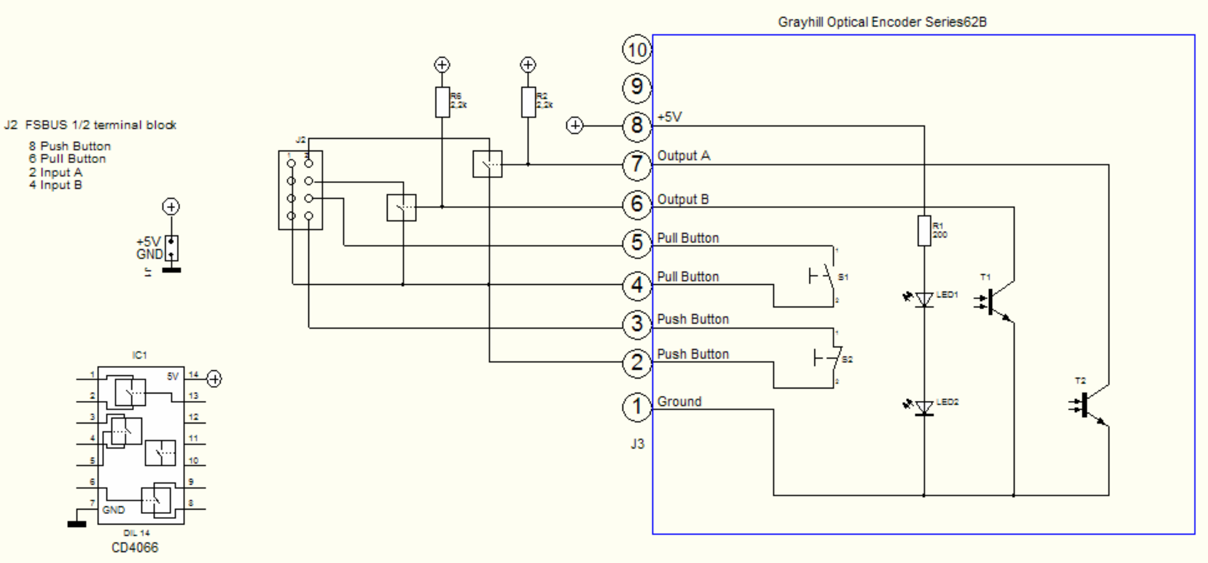
After the low time, the sending controller releases the SENSE line and tests, if no other controller helds it down. Only if SENSE line is high, the transmitting starts. The transmit time is ~1.5ms for 1 FSBUS dataframe.

You should keep in mind, that a zero at this line will prevent a FSBUS IO controller from sending anything. If it has a constant low level, something is wrong with cabling or one of the attached controllers.

Information furnished is believed to be accurate and reliable. However, I (Dirk Anderseck) assume no responsibility for the consequences of use of such information nor for any infringement of patents or other rights of third parties which may result from its use.
Specification mentioned in this publication are subject to change without notice. This publication supersedes and replaces all information previously supplied. FSBUS Microelectronics are not authorized for use as critical components in life support devices or systems.

Appendix A

Grayhill optical encoder series 62B requires extra hardware. The schematic shows an interface for 1 rotary encoder.



Grayhill Optical Encoder to FSBUS Input Interface

18.11.2006

Notes: