Universal Slow Control Module

USCM V03

for AMS-II

Version 1.1

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Summary of modifications USCM V02 ó USCM V03

Digital I/O:
The user electronics will store all settings in the own data storage. Instead of the 32 digital I/O the USCM V3 has a 16 bit bi-directional LVDS port with 8 additional LVDS address lines and three LVDS control signals (R/W, STROBE to and the AC-KNOWLEDGE from the user) for the handshake to the user electronics. USCM power off state now equal to no activity state between USCM and user electronics. Two USCM modules may be connected in parallel to one user.

Power Supply:
A Silicon fuse and current monitoring for the DC DC converter (final 3 watt type still to be defined).
A remote power switch for USCM board with external on/off and suicide option.

Latch up control:
Now partly under software control to increase the sensitivity.

Watchdog:
Additional monitoring of the MCU heart beat with automatic reboot of whole the system via the board latch up control circuits.

USCM ó USCM data transfer capability:
A set of two more control signals of the LVDS port gives the possibility to exchange data between two USCM modules servicing the same user electronics.

Board identification:
To give each USCM an unique identifier one DALLAS sensor DS18S20Z is mounted near the MCU.

Software safety:
Illegal address access in case of a bit flip is monitored and may be used to reboot the system.

Can Bus:
An AIRBORN connector type is installed, sex and mechanical construction still has to be defined.

System Considerations

The Universal Slow Control Module (USCM-3[4]) for AMS II experiment is constructed on basis of the conclusions of the 3rd AMS02 Slow Control Meeting 15.-16-03.2001 at Aachen.
Based on a micro controller DS80C390[5], an upgraded version of the 8051, it should be possible to fulfil the requirements in terms of computing power, speed and power consumption. Two different memory address schemes are implemented in the USCM V03 version, the first one has a RAM window in the address range below 64k and a second one (flat memory address model) enables a 4 X 128kb memory address range for program ROM, data RAM, program & data RAM, program & data EEROM and I/O ports.
Part of this version are 16 LVDS in/outputs, 8 LVDS address outputs, 3 LVDS control signals, which may be used bit, byte or word wise to read or control external circuits.
32 ADC channels with a 0.0 to 4.096 VDC input range, 12 bit resolution and 16 DAC channels with 0.0 to 4.096 VDC output range are part of the module.
8 Ports for DALLAS DS1820 temperature sensor chains are provided.
The micro controller involves 2 CAN BUS ports with CAN 2B protocol and 2 serial ports with up to 38400 bd.
The power supply of all components is divided into 7 separated isles. This way the limits for an over current situation may be set very close to the normal operating conditions.
All I/O , including the power supply, may be done via two VME type 96 pin connectors. For special purposes the CAN BUS and serial I/O may be connected to a set of three front panel connectors. For more final applications a DC/DC converter is part of the module to convert 28VDC to 5VDC. The estimated power consumption of the module is in the range of 0.4A@5VDC.

[4] This name may be changed at any time due to good arguments!
[5] http://www.dalsemi.com

Component Selection & Layout

The component selection has been done under the aspect of thermal requirements, costs and pin pitch in terms of the possibility to fulfil the request for a MIL specs conformable board layout (wire and via dimensions). A selection of fine pitch components may reduce the space requirements of the semiconductors itself, but space needed to make all the connections to the associated circuits will consume all the space earned by the smaller components. In terms of costs it will not be possible to use MIL specified semiconductor components. Even under the aspect of board space requirements it will be necessary to omit MIL specified components, because these parts are mostly produced in the large 2.54mm pin spacing dual in line packages. The experience of AMS-I and other space missions gains that the semiconductor components of the industrial temperature range (-40°C - +85°C) will fulfil the requirements of the control electronic.

Micro Controller

The main part of the module is a 8 bit micro controller DS80C390QNR[6] driven by a 16MHz oscillator. This type of micro controller is compatible to the 8051 instruction set, as used for the AMS I slow control modules, it may run in an extended mode with an 20bit address range to give more flexibility in terms of memory and I/O ports. Because of the reduced number of clock cycles (4 instead of 12) necessary per instruction an improvement of speed is given. Part of this controller are two CAN BUS port with the full 2.B implementation.
One watchdog function is part of the DS80C390 controller, a second is implemented in a power controller circuit, which has to be clocked from the system program every second. On a watch dog time out condition the latch up control is fired and the system is set to power off state for ca. 80ms. This way even bit flips will be detected and corrected by complete initialisation of the micro controller. An increased number of possible interrupt sources may be useful in the specific application. Two additional serial ports may be used during the software debugging phase for download and communication.

CAN BUS

The two CAN BUS port are fed to two I/O circuits of the PCAC250TE[7] type to fulfil the physical CAN BUS requirements (from 11 bit standard to 29 bit extended identifier). Two CAN BUS I/O connectors are provided, one on the front panel side and a second possibility is at the rear VME.J2 connector. To improve the CAN BUS performance one may disconnect the rear connector by special SMD jumpers.

Serial Input / Output

The actual software version supports only the port TTY0 up to a speed of 38400kb. The port signal are TTL levels and have to be converted off board to RS232 (MAX232CPE for example). Because of VCC present at the serial connector one may drive the TTL ? RS232 converter by the board power.

[6] http://www.dalsemi.com
[7] hhtp://www.philips.com

Digital Input / Output

16 LVDS I/O channels are part of the USCM V03. Additional 8 LVDS outputs are implemented to make a user address selection. The output port may be driven in bit, byte or word wise. Three control signals are foreseen to define data transfer direction, write/read, data strobe and the user acknowledge. On a power down or reboot situation at USCM side the control signals remain in their inactive state. The data and acknowledge signals are terminated at USCM level. All digital I/O is done via the VME.J1 connector at the rear.

Analogue Input / Output

32 ADC channels with 12 bit resolution and a 0.0 to 4.096 input voltage range may be used for reading of analogue information. The inputs are protected up to a certain degree by diodes.
16 DAC channels with 12 bit resolution and a 0.0 to 4.096 V output span may be used to control external circuits. ADCs and DACs are controlled via serial protocol as defined by MAXIM[8] Integrated Products.

Dallas DS1820 Ports

For temperature measurements eight DS1820 ports are provided. Every port may serve for up to 32 temperature sensors of the DS1820 type via a three wire link and the serial protocol defined by DALLAS. Every port is linked to the USCM power via a separate short circuit protection. In case of a permanent short circuit on the external cables a simple PNP transistor will brake, but the functionality of the board is still guaranteed. An additional latch up control for the temperature ports is provided. The threshold level have to be adjusted to the specific application.
One DS18S20Z is mounted on the USCM to monitor the board temperature near the MCU itself and may be used as board identifier. This Dallas sensor is linked to the MCU port pin P3.5 and has its own power fusing.

[8] http://maxim-ic.com

Latch Up Protection

Part of the module is a seven fold latch up protection. This way it was possible to lower the threshold for different supply isles to 110% level of the normal operation current. In case of a over current the power of whole the module is switched off for ca. 80ms. During data transfers to the user (external electronic boards) the current limit for the data and address drivers are set to a higher value, due to the larger supply current in case a LVDS driver is enabled.

Reset and watchdog circuit

A power controller circuit MAX813L serves for a reset signal to MCU in case of powering the board and a supply voltage below the defined threshold (4.5VDC). A second function is the watchdog of this circuit. The MCU delivers by the program implemented a heart beat signal. In case this signal fails the watchdog circuit will fire the latch up protection and switches this way the board power of. On rebooting the complete initialisation of the board is done.

Power Supply

There are five different possibilities provided to power the USCM module. Three are accessible at the front panel, two times via the serial port connectors J1 and J2, the third via the CAN BUS connector J3. The power source used depends on the installation of the bridges R8, R9 or R10. The fourth possibility is a link from VME connector J1 Pin C24 via the bridge R89. Finally the supply may be taken from the DC DC converter, which is fed via VME.J1 and will convert 28VDC to 5VDC with up to 0.4A. The DC DC converter is fused by a special “silicon fuse circuit”, which cuts the power to the converter in case of a 200% input current without blowing a real fuse. The power for the converter may be restarted by a power off/on cycle with at least some seconds remaining in the power off state. The output of the DC DC converter may be disconnected from the board power distribution by removing R146 to ensure no power feedback to the converters output stage.

Power Off/On switching

After power comes up a power switch is set to on state and the USCM board is powered. This should be the normal start condition for all USCM´s. Via a CAN BUS command every USCM may switch off their own power (sucide, P1.7) or may switch off the parallel working USCM (murder, P1.6). By another CAN BUS command the still powered USCM may switch the redundant counterpart (P1.0) back to the power. The power switch circuit may be disabled by installing jumper R147.

Debug Options

For software debugging three different jumpers are provided. First the latch up control may be set to off via J4. The other jumper J5 is connected to MCU port pin P1.1. Accordingly to the jumper position one may set this port pin to fixed logical level.

Non existent memory fault interrupt

In case of a memory bit flip it may be possible that the program code is modified in a way that non existent memory address are accessed. This will give an illegal or faulty service of user boards connected. A small decoder circuit will detect a non existent memory read or write cycle an generates a interrupt to the MCU. It will possible to fire the latch up control by software and to re-initialise the board this way.

Memory Address Layout

AMS 2 Address Layout A (with LOW RAM window)

Address	Memory Type	Access Type	Memory Type	Access Type
00000 – 07FFF	ROM Range: 32 kb	Program	RAM	Data Range: 32 kb
08000 – 0FFFF			RAM Range: 32 kb	Program & Data
10000 – 1FFFF	ROM Range: 64 kb	Program	RAM Range: 64 kb	Data
20000 – 3FFFF	EEROM Range: 128 kb	Program & Data		
40000 – 5FFFF			RAM Range: 128 kb	Program & Data
7F000 – 7FFFF	I/O Range : 4 kb	Data		

AMS 2 Address Layout B

Address	Memory Type	Access Type	Memory Type	Access Type
00000 – 1FFFF	ROM Range: 128 kb	Program	RAM	Data Range: 128 kb
20000 – 3FFFF	EEROM Range: 128 kb	Program & Data		
40000 – 5FFFF			RAM Range: 128 kb	Program & Data
7F000 – 7FFFF	I/O Range : 4 kb	Data		

AMS II A/B Memory Address Jumper Settings

Resistor		AMS II-A	AMS II-B
R120		ON	OFF
R119		OFF	ON

Digital I/O Port Registers

Address 0X7F000 to 0X7F0003 LVDS Digital Output
Cleared on power on reset !

Address	Data	Signal Name
7F000	[D7::D0] / write	DOUT_0 to DOUT_7
7F001	[D7::D0] / write	DOUT_8 to DOUT_15
7F002	[D7::D0] / write	Address [A7::A0]
7F003	[D3::D0] / write	Control Write

On port 7F002 address bit 0 has the function of a master data strobe in case of a data transfer between master and slave USCM´s.

7F003	Write	Control Write
	D0	0 = Read, 1 = Write (from / to User)
	D1	1 = Data Strobe to User
	D2	1 = Set Bus request
	D3	1 = Set Bus Grant
	D4	Enable Data
	D5	Enable Address

Address 0X7F004 to 0X7F0007 LVDS Digital Input

Address	Data	Signal Name
7F004	[D7::D0] / read	DIN_0 to DIN_7
7F005	[D7::D0] / read	DIN_8 to DIN_15
7F006	[D7::D0] / read	No function
7F007	[D3::D0] / read	Control Read

7F007	Read	Control Read
	D0	1 = User acknowledge
	D1	1 = Master Bus request set
	D2	1 = Slave Bus Grant set
	D3	1 = Master Data Strobe

Definitions for data transfer to/from a user:

Data write to a user:

USCM : Enable Addresses (Addresses = Out byte 3)
USCM : Enables Data (bytes 1 & 2)
USCM : Set Read/Write to one, e.g. send data to user
USCM : Control Data Strobe high flags valid Data to User
USER : Stores data on data strobe leading edge
USCM : User Acknowledge flags User Write done
USER : On data strobe equal zero, user clears Acknowledge

Data read from a user:

USCM : Enables Addresses (Out byte 3)
USCM : User Read/Write set to zero, flags read request to user
USCM : Control Data Strobe set to high, e.g. call for user data
USER : Enables on Read flag & data strobe driver circuits
USCM : User Acknowledge flags valid User data to the USCM
USER : On data strobe = 0, user clears Acknowledge

For special applications a word data transfer between USCM´s is possible. The LVDS ports have to be connected: 16 bit data, bus request out to bus request in, DIO16 to DIO16.

Definitions for data transfer between USCM´s:

Data Transfer between USCM´s

Master		Slave
USCM-A/B		USCM-B/A
Set Bus Request	?	1.) Get Bus Request
Get Bus Grant	?	2.) Set Bus Grant
Clear address		
Enable address	Enable Out Byte 3 ?	
Enable data	Enable Out Bytes 1 & 2 ?	
Load out byte 1	?	
Load out byte 2	?	
Load out byte 3 with 0x0001 **as master data strobe**	Set master data strobe ?	3.) Get Master Strobe
		4.) Store data bytes
See slave AKN	?	5.) Clears BG as AKN
Clear out byte 3	? clear master data strobe	6.) See Master Strobe cleared, sets BG
Send Next bytes		Test BR set
Or **End of transfer**		If set, wait for Master Strobe true, go to 4.)
Clear BR		or
See BG clear		If BR clear, clear BG
End of transfer		End of transfer

Address 0X7F008 to 0X7F000A Analogue Output*

Address	Data	Function
7F008	D0 / write	Select DAC 0 (4 channels)
7F008	D1 / write	Select DAC 1 (4 channels)
7F008	D2 / write	Select DAC 2 (4 channels)
7F008	D3 / write	Select DAC 3 (4 channels)
7F009	D0 / write	DAC load clock 0/1
7F00A	D0 / write	DAC data input 0/1

* Note: For detailed information see MAX525 manual.

Address 0X7F00C to 0X7F000E Analogue Input*

Address	Data	Function
7F00C	D0 / write	Select ADC 0 (8 channels)
7F00C	D1 / write	Select ADC 1 (8 channels)
7F00C	D2 / write	Select ADC 2 (8 channels)
7F00C	D3 / write	Select ADC 3 (8 channels)
7F00D	D0 / write	ADC load clock 0/1
7F00E	D0 / write	ADC data input 0/1
7F00E	D0 / read	ADC data read 0 / 1

* Note: For detailed information see MAX186 manual

ADC Channels versus ADC-Chip channel sequence

ADC #	Channel	Analogue Input	Name
0	CH 0	7	AIN 7
0	CH 1	6	AIN 6
0	CH 2	5	AIN 5
0	CH 3	4	AIN 4
0	CH 4	3	AIN 3
0	CH 5	2	AIN 2
0	CH 6	1	AIN 1
0	CH 7	0	AIN 0
1	CH 0	7	AIN 15
1	CH 1	6	AIN 14
1	CH 2	5	AIN 13
1	CH 3	4	AIN 12
1	CH 4	3	AIN 11
1	CH 5	2	AIN 10
1	CH 6	1	AIN 9
1	CH 7	0	AIN 8
2	CH 0	7	AIN 23
2	CH 1	6	AIN 22
2	CH 2	5	AIN 21
2	CH 3	4	AIN 20
2	CH 4	3	AIN 19
2	CH 5	2	AIN 18
2	CH 6	1	AIN 17
2	CH 7	0	AIN 16
3	CH 0	7	AIN 31
3	CH 1	6	AIN 30
3	CH 2	5	AIN 29
3	CH 3	4	AIN 28
3	CH 4	3	AIN 27
3	CH 5	2	AIN 26
3	CH 6	1	AIN 25
3	CH 7	0	AIN 24

Address 0X7F010 to 0X7F0011 DS1820 Input & Output*

Address	Data	Function
7F010	[D7::D0] / write	Write DS data
7F011	D0 / write 0/1	all DS ports high Z = 0 low Z = 1
7F010	[D7::D0] / read	Read DS data

* Note: For detailed information see DS1820 manual

Address 0X7F01C Watch Dog reset input*

Address	Data	Function
7F01C	Dummy	Write or Read

* Note: For detailed information see MAX1813L manual

Debug Options

J #	Function	Settings
4	Latch Up Control	On / Off
5	Port Pin 1.1 (T2EX)	On / Off

Power Options

R #	Function	Settings
146	DC DC converter	In = On / Out = Off
147	Board power switch	In = Off / Out = On
10	VCC from 1st serial port	In = On / Out = Off
9	VCC from 2nd serial port	In = On / Out = Off
8	VCC from CAN BUS	In = On / Out = Off
89	VCC from rear connector J1	In = On / Out = Off

Connectors

Connector	Pin	Function
J1	1	GND
	2	2VCC*
TTY 1	3	TXD1
	4	RXD1
	5	Manual Reset
	6	GND

* Note: For 2nd serial power install R9, 0O SMD resistor!

Connector	Pin	Function
J2	1	GND
	2	1VCC
TTY0	3	TXD0
	4	RXD0
	5	Manual Reset
	6	GND

* Note: For 1st serail power install R10, 0O SMD resistor!

Connector	Pin	Function
J3 / J7	1 / 1	CAN A-
	2 / 2	CAN A+
	3 / 3	CAN B-
	4 / 4	CAN B+
	5 / 5	NC
	6	NC
	7 / 6	3VCC
	8 / 7	3VCC
	9 / 8	GND
	10 / 9	GND

J7 is the AIRBORN CAN BUS Connector

* Note: For CAN BUS power install R8, 0O SMD resistor!

VME.J1

Pin	Signal	Pin	Signal	Pin	Signal
A1	DIO_0+	B1	DIO_16+	C1	GND
A2	DIO_0-	B2	DIO_16-	C2	DS_IO1
A3	DIO_1+	B3	DIO_17+	C3	DS_VCC1
A4	DIO_1-	B4	DIO_17-	C4	GND
A5	DIO_2+	B5	DIO_18+	C5	DS_IO2
A6	DIO_2-	B6	DIO_18-	C6	DS_VCC2
A7	DIO_3+	B7	DIO_19+	C7	GND
A8	DIO_3-	B8	DIO_19-	C8	DS_IO3
A9	DIO_4+	B9	DIO_20+	C9	DS_VCC3
A10	DIO_4-	B10	DIO_20-	C10	GND
A11	DIO_5+	B11	DIO_21+	C11	DS_IO4
A12	DIO_5-	B12	DIO_21-	C12	DS_VCC4
A13	DIO_6+	B13	DIO_22+	C13	GND
A14	DIO_6-	B14	DIO_22-	C14	DS_IO5
A15	DIO_7+	B15	DIO_23+	C15	DS_VCC5
A16	DIO_7-	B16	DIO_23-	C16	GND
A17	DIO_8+	B17	URW+	C17	DS_IO6
A18	DIO_8-	B18	URW-	C18	DS_VCC6
A19	DIO_9+	B19	UST+	C19	GND
A20	DIO_9-	B20	UST-	C20	DS_IO7
A21	DIO_10+	B21	BRO+	C21	DS_VCC7
A22	DIO_10-	B22	BRO-	C22	GND
A23	DIO_11+	B23	BGO+	C23	DS_IO8
A24	DIO_11-	B24	BGO-	C24	DS_VCC8
A25	DIO_12+	B25	UAKN+	C25	4VCC*
A26	DIO_12-	B26	UAKN-	C26	GND
A27	DIO_13+	B27	BRI+	C27	GND
A28	DIO_13-	B28	BRI-	C28	-28V
A29	DIO_14+	B29	BGI+	C29	-28V
A30	DIO_14-	B30	BGI-	C30	+28V
A31	DIO_15+	B31	GND	C31	+28V
A32	DIO_15-	B32	GND	C32	GND

* Note: For J1 power install R89, 0O SMD resistor!

VME.J2

Pin	Signal	Pin	Signal	Pin	Signal
A1	GND	B1	DAC 0	C1	AIN 0
A2	GND	B2	DAC 1	C2	AIN 1
A3	GND	B3	DAC 2	C3	AIN 2
A4	GND	B4	DAC 3	C4	AIN 3
A5	GND	B5	DAC 4	C5	AIN 4
A6	GND	B6	DAC 5	C6	AIN 5
A7	GND	B7	DAC 6	C7	AIN 6
A8	GND	B8	DAC 7	C8	AIN 7
A9	GND	B9	DAC 8	C9	AIN 8
A10	GND	B10	DAC 9	C10	AIN 9
A11	GND	B11	DAC 10	C11	AIN 10
A12	GND	B12	DAC 11	C12	AIN 11
A13	GND	B13	DAC 12	C13	AIN 12
A14	GND	B14	DAC 13	C14	AIN 13
A15	GND	B15	DAC 14	C15	AIN 14
A16	GND	B16	DAC 15	C16	AIN 15
A17	GND	B17	GND	C17	AIN 16
A18	GND	B18	GND	C18	AIN 17
A19	GND	B19	GND	C19	AIN 18
A20	GND	B20	GND	C20	AIN 19
A21	GND	B21	GND	C21	AIN 20
A22	GND	B22	GND	C22	AIN 21
A23	GND	B23	GND	C23	AIN 22
A24	GND	B24	TXD1	C24	AIN 23
A25	GND	B25	RXD1	C25	AIN 24
A26	GND	B26	TXD0	C26	AIN 25
A27	GND	B27	RXD0	C27	AIN 26
A28	GND	B28	Man. Res.	C28	AIN 27
A29	GND	B29	CAN A-	C29	AIN 28
A30	GND	B30	CAN A+	C30	AIN 29
A31	GND	B31	CAN B-	C31	AIN 30
A32	GND	B32	CAN B+	C32	AIN 31

* Note: For CAN BUS operation install R94, R94, R111, R112, 0O SMD resistor!

Port/Pin	MCU function	USCM300	Jumper	Remarks	Date
P1.0	T2	1 = switch slave USCM on		Pull down installed	22-May 2001
P1.1	T2EX	Pull Down installed, not used	J5	0 = execute EEROM; 1 =Do Not	
P1.2	RXD1	TTY1 Input, not used		2nd Serial input	
P1.3	TXD1	TTY1 Output, not used		2nd Serial output	
P1.4	INT2 HIGH	Bus Request Inter-rupt		USCM / USCM data transfer option	
P1.5	INT3 LOW	Pull Up installed, not used		FREE	
P1.6	INT4 HIGH	1 = switch slave USCM off		Pull down installed	
P1.7	INT5 LOW	1 = suicide, e.g. switch own power off		Pull down installed	
P3.0	**RXD0**	**CTY Input**		1st Serial input	
P3.1	**TXD0**	**CTY Output**		1st Serial output	
P3.2	INT0 LOW	Pull Up installed, not used		FREE	
P3.3	INT1 LOW	Pull Up installed, not used		FREE	
P3.4	TIMER 0 In	Linked to external watch dog		Heart beat, T = 2ms	
P3.5	TIMER 1 In/ckout	Pull Up installed & local DS18S20Z		Board identifier and MCU temperature	
P4.0	PMCE 0	Free, not connected			
P4.1	PMCE 1	Free, not connected			
P4.2	PMCE 2	Free, not connected			
P4.3	PMCE 3	Free, not connected			
P5.4	PCE 0	Free, not connected			
P5.5	PCE 1	Free, not connected			
P5.6	PCE 2	Free, not connected			
P5.7	PCE 3	Free, not connected			

Circuits Diagrams & Layout, USCM Connector Board & USCM Power Supply with RS232/TTL Converter to be added.