

SIS3320-250 250 MHz 12-bit VME Digitizer

User Manual

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Revision Table:

Revision	Date	Modification
0.01	08.11.07	Generation from SIS3320-M-0-001-v104
0.02	09.11.07	SPI
0.03	21.11.07	Power consumption
1.00	26.11.07	Initial official release
1.01	27.11.07	FIR trigger and memory test features limited to 200 MSamples/s
1.02	10.12.07	Broadcast
1.03	21.12.07	Version: 0x2002 Bug fix: accumulator mode register bit removed New: leading edge trigger mode added
1.04	22.12.07	Index entry fix
1.05	15.02.08	Version: 0x2004 Bug fix: odd VME IRQs Description of Clock source bit

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1 Introduction

The SIS3320-250 is an eight channel ADC/digitizer board with a sampling rate of up to 250 MHz (for the individual channel) and a resolution of 12-bit. The board is a single width 6U VME card, which has no special (i.e. non standard VME) voltage requirements.

The flexible combination of DDR2 memory technology data storage in combination with FPGA based data handling/movement allows for a generic design which covers a variety of applications.

Applications comprise but are not limited to:

- digitization of “slow” detectors like calorimeters
- accelerator/machine controls



As we are aware, that no manual is perfect, we appreciate your feedback and will try to incorporate proposed changes and corrections as quickly as possible. The most recent version of this manual can be obtained by email from info@struck.de, the revision dates are online under <http://www.struck.de/manuals.htm>.

1.1 Related documents

A list of available firmware designs can be retrieved from <http://www.struck.de/sis3320firm.htm>



2 Technical Properties/Features

2.1 Key functionality

Find below a list of key features of the SIS3320-250 digitizer.

- 8 channels
- 12-bit resolution
- 32 MSamples/channel memory
- special clock modes (clock prescaling, external “arbitrary” clock)
- 2 range settings
- offset DACs
- external/internal clock
- external random clock
- multi event mode
- read on the fly (actual sample value)
- pre/post trigger option
- readout in parallel to acquisition
- trigger generation (FIR trigger up to 200 MSamples/s)
- 4 NIM control inputs/4 NIM control outputs
- A32 D32/BLT32/MBLT64/2eVME
- Hot swap (in conjunction with VME64x backplane)
- VME64x Connectors
- VME64x Front panel
- VME64x extractor handles (on request)
- F1002 compatible P2 row A/C assignment
- +5 V, +12V and –12 V VME standard voltages

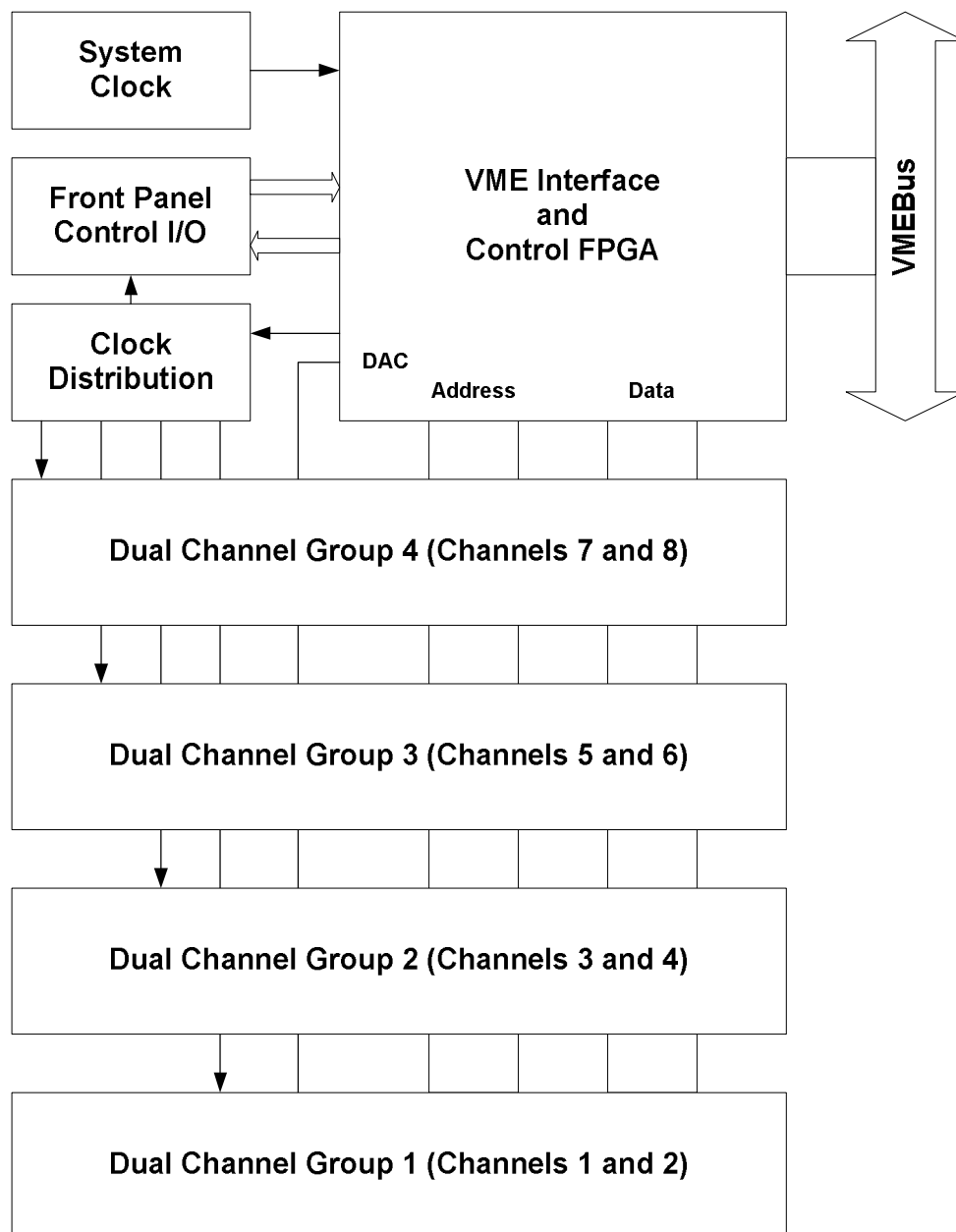
Note 1: The SIS3320-250 shall not be operated on P2 row A/C extensions, like VSB e.g. due to the compatibility to the F1001 FADC modules clock and start/stop distribution scheme.

Note 2: Changes to the original SIS3320 design

- Offset DACs no longer in a chain
- ADC SPI (Serial Peripheral Interface) (no more ADC gain register)
- CML startup configuration required
- New clock mode bit 3 in Acquisition control register (internal 250 MHz)

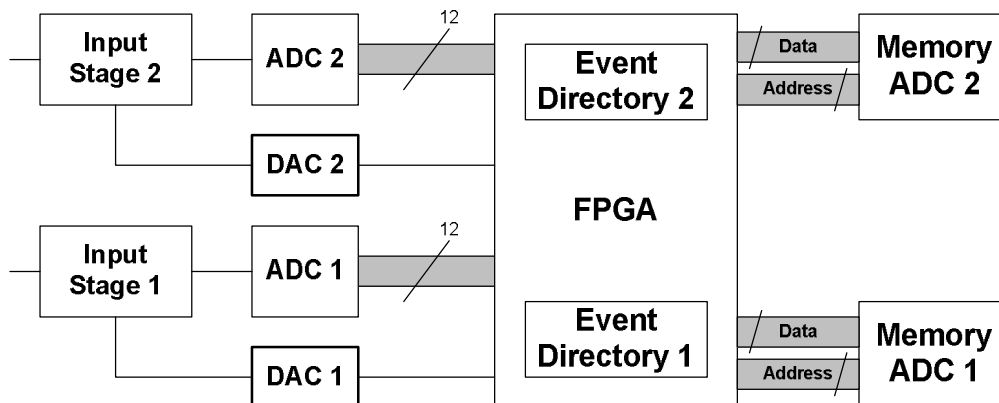
2.2 Module design

The SIS3320-250 consists of four identical groups of 2 ADC channels each and a control section as shown in the simplified block diagram below.



2.2.1 Dual channel group

Two ADC channels form a group, which memory is handled by one Field Programmable Gate Array (FPGA).



2.3 Modes of Operation

The SIS3320-250 was developed with maximum flexibility in mind. The FPGA based design of the card allows to meet the requirements of many readout applications with dedicated firmware designs in the future. The initial firmware is supposed to furnish you with an easy to use yet powerful high speed high resolution Flash Analog to Digital Converter (FADC) implementation, that covers many everyday analog to digital applications.

2.4 Memory management

The memory can be used either as one contiguous memory or as a subdivided multi event memory. In addition memory depth can be limited in single event operation to match the requirements of the given application.

2.4.1 Single Event Mode

The full memory of 32 MSamples of the SIS3320-250 is used as one big circular buffer or as single shot memory in single event mode, unless memory size is limited by the event configuration register.

2.4.2 Multi Event Mode

The memory can be divided in pages or events to make the acquisition of shorter signals more efficient. Up to 512 stop pointers for the individual page can be retrieved from the event directory. In auto start mode the ADC advances to the next page and starts sampling automatically.

2.5 Clock sources

The SIS3320-250 features the two basic clock modes

- Internal clock
- External symmetric clock

2.5.1 Internal clock

The internal clock is generated from an on board 50 MHz quartz. It doubled inside of the FPGA to generate 100 MHz. The 200 and 250 MHz are derived from that 100 MHz clock.

Internal clock speeds
250 MHz
200 MHz
100 MHz
50 MHz

2.5.2 External clock

A symmetric external clock (NIM level, ratio between 45:55 and 55:45) can be fed to the module through a LEMO00 connector. An ECL clock over rows A/C of the J2 VME backplane can be used as an alternative. For optimum performance the clock frequency should be within the specified range for the given ADC chip.

Module	Min. sym. clock	Max sym. clock
SIS3320-210	40 MHz	210 MHz
SIS3320-250	40 MHz	250 MHz

2.6 Trigger control (*pre/post, start/stop and gate mode*)

The SIS3320-250 features pre/post trigger capability as well as start/stop mode acquisition and a gate mode (in which start and stop are derived from the leading and trailing edge of a single control input signal).

The trigger behaviour is defined by the acquisition control register.

2.7 Internal Trigger generation

The trigger output of the SIS3320-250 can be either used to interact with external trigger logic or to base start/stop on a threshold (i.e. one individual threshold per ADC channel) of the digitized data. Trigger generation can be activated with two conditions:

- module armed (i.e. sample clock active, trigger can be used to start acquisition)
- module armed and started (trigger can be used to stop acquisition)

The user can select between triggering on the conditions above and below threshold

2.8 VME Interrupts

Two registers, the Interrupt configuration and the Interrupt control register, are implemented for interrupt setup and control.

Two interrupt sources are implemented:

- End of event
- End of last event in multievent mode

3 VME Addressing

As the SIS3320-250 VME FADC features memory options with up to 8 times 32 MSamples, A32 addressing was implemented as the only option. The module occupies an address space of 0x7FFFFFFF Bytes, i.e. 128 MBytes are used by the module.

The base address is defined by the selected addressing mode, which is selected by jumper array JP80 and SW1 and SW2 (in non geographical mode).

The table below summarises the possible base address settings.

J1 Setting			Bits					
A32	GEO	VIPA	31	30	29	28	27	
x			SW1				SW2=0...7 Bit 27=0	
x			SW1				SW2=8...F Bit 27=1	
x	x		Not implemented in this design					
		x	Not implemented in this design					

Shorthand	Explanation
SW1/SW2	Setting of rotary switch SW1 or SW2 respective

Notes:

- This concept allows the use of the SIS3320-250 in standard VME as well as in VME64x environments, i.e. the user does not need to use a VME64x backplane.
- The factory default setting is EN_A32 closed, SW1=3, SW2=0 (i.e. the module will react to A32 addressing under address 0x30000000). With more than one unit shipped in one batch a set of addresses (like 0x10000000, 0x20000000, 0x30000000,...) may be used also.

3.1 Address Map

The SIS3320-250 resources and their locations are listed in the table below.

Note: Write access to a key address (KA) with arbitrary data invokes the respective action

Offset	Size in Bytes	BLT	Access	Function
0x00000000	4	-	W/R	Control/Status Register (J-K register)
0x00000004	4	-	R	Module Id. and Firmware Revision register
0x00000008	4	-	R/W	Interrupt configuration register
0x0000000C	4	-	R/W	Interrupt control register
0x00000010	4	-	R/W	Acquisition control/status register (J-K register)
0x00000014	4	-	R/W	Extern Start Delay register
0x00000018	4	-	R/W	Extern Stop Delay register
0x00000020			R/W	Max. Nof Event Register
0x00000024			R	Actual Event Counter
0x00000030	4	-	R/W	Broadcast Setup register
0x00000034	4	-	R/W	ADC Memory Page register
0x00000050	4	-	R/W	DAC Control Status register
0x00000054	4	-	R/W	DAC Data register
0x00000060			R/W	XILINX JTAG_TEST/JTAG_DATA_IN
0x00000064			W	XILINX JTAG_CONTROL
0x00000400	4	-	KA W	General Reset
0x00000410	4	-	KA W	Arm Sampling Logic
0x00000414	4	-	KA W	Disarm Sampling Logic
0x00000418	4	-	KA W	VME Start sampling
0x0000041C	4	-	KA W	VME Stop sampling
0x00000428	4	-	KA W	Reset DDR2 Memory Logic

Event information all ADC groups				
0x01000000	4	-	W only	Event configuration register (all ADCs)
0x01000004	4		W only	Sample Length register (all ADCs)
0x01000008	4	-	W only	Sample Start address register (all ADCs)
0x0100000C	4	-	W only	ADC input mode register (all ADCs)

Event information ADC group 1				
0x02000000	4	-	R/W	Event configuration register (ADC1, ADC2)
0x02000004	4		R/W	Sample Length register (ADC1, ADC2)
0x02000008	4	-	R/W	Sample Start address register (ADC1, ADC2)
0x0200000C	4	-	R/W	ADC input mode register (ADC1, ADC2)
0x02000010	4	-	R	Next Sample address register ADC1
0x02000014	4	-	R	Next Sample address register ADC2
0x02000020	4	-	R	Actual Sample Value (ADC1, ADC2)
0x0200002C	4		R/W	Trigger Flag Clear Counter register (ADC1, ADC2)
0x02000030	4		R/W	ADC1 Trigger setup register
0x02000034	4		R/W	ADC1 Trigger Threshold register
0x02000038	4		R/W	ADC2 Trigger setup register
0x0200003C	4		R/W	ADC2 Trigger Threshold register
0x02000040	4	-	R/W	ADC1/2 SPI register
0x02010000	0x800	X	R	Event directory ADC1
0x02018000	0x800	X	R	Event directory ADC2

Event information ADC group 2				
0x02800000	4	-	R/W	Event configuration register (ADC3, ADC4)
And so on (as for ADC group 1)				

Event information ADC group 3				
0x03000000	4	-	R/W	Event configuration register (ADC5, ADC6)
And so on (as for ADC group 1)				

Event information ADC group 4				
0x03800000	4	-	R/W	Event configuration register (ADC7, ADC8)
And so on (as for ADC group 1)				

ADC memory pages				
0x04000000	8 MByte	X	R	ADC 1 memory page
0x04800000	8 MByte	X	R	ADC 2 memory page
0x05000000	8 MByte	X	R	ADC 3 memory page
0x05800000	8 MByte	X	R	ADC 4 memory page
0x06000000	8 MByte	X	R	ADC 5 memory page
0x06800000	8 MByte	X	R	ADC 6 memory page
0x07000000	8 MByte	X	R	ADC 7 memory page
0x07800000	8 MByte	X	R	ADC 8 memory page

Note 2: MBLT64 read access is supported from memory (i.e. not from register space) only.

4 Register Description

The function of the individual registers is described in detail in this section.

The first line after the subsection header (in Courier font) like:

```
#define SIS3320 _CONTROL_STATUS      0x0    /* read/write; D32 */
refers to the sis3320.h header file.
```

4.1 Control/Status Register(0x, write/read)

```
#define SIS3320_CONTROL_STATUS      0x0    /* read/write; D32 */
```

The control register is implemented as a selective J/K register, a specific function is enabled by writing a 1 into the set/enable bit, the function is disabled by writing a 0 into the clear/disable bit (which location is 16-bit higher in the register). An undefined toggle status will result from setting both the enable and disable bits for a specific function at the same time. The only function at this point in time is user LED on/off.

On read access the same register represents the status register.

Bit	write Function	read Function
31	Clear reserved 15 (*)	0
30	Clear reserved 14 (*)	0
29	Clear reserved 13 (*)	0
28	Clear reserved 12 (*)	0
27	Clear reserved 11 (*)	0
26	Clear reserved 10 (*)	0
25	Clear reserved 9 (*)	0
24	Clear reserved 8 (*)	0
23	Clear reserved 7 (*)	0
22	Clear reserved 6 (*)	0
21	Clear reserved 5 (*)	0
20	Clear reserved 4 (*)	0
19	Clear reserved 3 (*)	0
18	Clear reserved 2 (*)	0
17	Clear reserved 1 (*)	0
16	Switch off user LED (*)	0
15	Set reserved 15	Status reserved 15
14	Set reserved 14	Status reserved 14
13	Set reserved 13	Status reserved 13
12	Set reserved 12	Status reserved 12
11	Set reserved 11	Status reserved 11
10	Set reserved 10	Status reserved 10
9	Set reserved 9	Status reserved 9
8	Set reserved 8	Status reserved 8
7	Set reserved 7	Status reserved 7
6	Set reserved 7	Status reserved 6
5	Set reserved 7	Status reserved 4
4	Set reserved 7	Status reserved 4
3	Set reserved 3	Status reserved 3
2	Set reserved 2	Status reserved 2
1	Set reserved 1	Status reserved 1
0	Switch on user LED	Status User LED (1=LED on, 0=LED off)

(*) denotes power up default setting

4.2 Module Id. and Firmware Revision Register (0x4, read)

```
#define SIS3320_MODID          0x4          /* read only; D32 */
```

This register reflects the module identification of the SIS3320-250 and its minor and major firmware revision levels. The major revision level will be used to distinguish between substantial design differences and experiment specific designs, while the minor revision level will be used to mark user specific adaptations.

Bit	Function	Reading
31	Module Id. Bit 15	3
30	Module Id. Bit 14	
29	Module Id. Bit 13	
28	Module Id. Bit 12	
27	Module Id. Bit 11	3
26	Module Id. Bit 10	
25	Module Id. Bit 9	
24	Module Id. Bit 8	
23	Module Id. Bit 7	2
22	Module Id. Bit 6	
21	Module Id. Bit 5	
20	Module Id. Bit 4	
19	Module Id. Bit 3	0
18	Module Id. Bit 2	
17	Module Id. Bit 1	
16	Module Id. Bit 0	
15	Major Revision Bit 7	
14	Major Revision Bit 6	
13	Major Revision Bit 5	
12	Major Revision Bit 4	
11	Major Revision Bit 3	
10	Major Revision Bit 2	
9	Major Revision Bit 1	
8	Major Revision Bit 0	
7	Minor Revision Bit 7	
6	Minor Revision Bit 6	
5	Minor Revision Bit 5	
4	Minor Revision Bit 4	
3	Minor Revision Bit 3	
2	Minor Revision Bit 2	
1	Minor Revision Bit 1	
0	Minor Revision Bit 0	

4.2.1 Major revision numbers

Find below a table with major revision numbers used to date

Major revision number	Application/user
0x20	Generic designs

4.3 Interrupt configuration register (0x8)

```
#define SIS3320_IRQ_CONFIG 0x8 /* read/write; D32 */
```

This read/write register controls the VME interrupt behaviour of the SIS3320-250 ADC. Four interrupt sources are foreseen, for the time being three of them are associated with an interrupt condition, the fourth condition is reserved for future use.

The interrupter type is DO8 .

4.3.1 IRQ mode

In RORA (release on register access) mode the interrupt will be pending until the IRQ source is cleared by specific access to the corresponding disable VME IRQ source bit. After the interrupt is serviced the source has to be activated with the enable VME IRQ source bit again.

In ROAK (release on acknowledge) mode , the interrupt condition will be cleared (and the IRQ source disabled) as soon as the interrupt is acknowledged by the CPU. After the interrupt is serviced the source has to be activated with the enable VME IRQ source bit again.

Bit	Function	Default
31		0
...		0
16		0
15		0
14		0
13		0
12	RORA/ROAK Mode (0: RORA; 1: ROAK)	0
11	VME IRQ Enable (0=IRQ disabled, 1=IRQ enabled)	0
10	VME IRQ Level Bit 2	0
9	VME IRQ Level Bit 1	0
8	VME IRQ Level Bit 0	0
7	IRQ Vector Bit 7; placed on D7 during VME IRQ ACK cycle	0
6	IRQ Vector Bit 6; placed on D6 during VME IRQ ACK cycle	0
5	IRQ Vector Bit 5; placed on D5 during VME IRQ ACK cycle	0
4	IRQ Vector Bit 4; placed on D4 during VME IRQ ACK cycle	0
3	IRQ Vector Bit 3; placed on D3 during VME IRQ ACK cycle	0
2	IRQ Vector Bit 2; placed on D2 during VME IRQ ACK cycle	0
1	IRQ Vector Bit 1; placed on D1 during VME IRQ ACK cycle	0
0	IRQ Vector Bit 0; placed on D0 during VME IRQ ACK cycle	0

The power up default value reads 0x 00000000

4.4 Interrupt control register (0xC)

```
#define SIS3320_IRQ_CONTROL          0xC          /* read/write; D32 */
```

This register controls the VME interrupt behaviour of the SIS3320-250 ADC. Eight interrupt sources are foreseen, for the time being two of them are associated with an interrupt condition, the others are reserved for future use.

Bit	Function (w)	(r)	Default
31	Update IRQ Pulse	Status IRQ source 7 (reserved)	0
30	unused	Status IRQ source 6 (reserved)	0
29	unused	Status IRQ source 5 (reserved)	0
28	unused	Status IRQ source 4 (reserved)	0
27	unused	Status IRQ source 3 (reserved)	0
26	unused	Status IRQ source 2 (reserved)	0
25	unused	Status IRQ source 1 (End Address Threshold Flag; level sensitive)	0
24	unused	Status IRQ source 0 (End Address Threshold Flag; edge sensitive)	0
23	Disable/Clear IRQ source 7	Status flag source 7	0
22	Disable/Clear IRQ source 6	Status flag source 6	0
21	Disable/Clear IRQ source 5	Status flag source 5	0
20	Disable/Clear IRQ source 4	Status flag source 4	0
19	Disable/Clear IRQ source 3	Status flag source 3	0
18	Disable/Clear IRQ source 2	Status flag source 2	0
17	Disable/Clear IRQ source 1	Status flag source 1	0
16	Disable/Clear IRQ source 0	Status flag source 0	0
15	unused	Status VME IRQ	0
14	unused	Status internal IRQ	0
13	unused	0	0
12	unused	0	0
11	unused	0	0
10	unused	0	0
9	unused	0	0
8	unused	0	0
7	Enable IRQ source 7	Status enable source 7 (read as 1 if enabled, 0 if disabled)	0
6	Enable IRQ source 6	Status enable source 6 (read as 1 if enabled, 0 if disabled)	0
5	Enable IRQ source 5	Status enable source 5 (read as 1 if enabled, 0 if disabled)	0
4	Enable IRQ source 4	Status enable source 4 (read as 1 if enabled, 0 if disabled)	0
3	Enable IRQ source 3	Status enable source 3 (read as 1 if enabled, 0 if disabled)	0
2	Enable IRQ source 2	Status enable source 2 (read as 1 if enabled, 0 if disabled)	0
1	Enable IRQ source 1	Status enable source 1 (read as 1 if enabled, 0 if disabled)	0
0	Enable IRQ source 0	Status enable source 0 (read as 1 if enabled, 0 if disabled)	0

The power up default value reads 0x00000000

IRQ source 3: reserved
 IRQ source 2: reserved
 IRQ source 1: end of last event (disarm)
 IRQ source 0: end of event

4.5 Acquisition control register (0x10, read/write)

```
#define SIS3320_ACQUISTION_CONTROL    0x10    /* read/write; D32 */
```

The acquisition control register is in charge of most of the settings related to the actual configuration of the digitization process.

Like the control register it is implemented in a J/K fashion.

Bit	Write Function	Read
31	Clear reserved 15 (*)	0
30	Clear Clock Source Bit2	0
29	Clear Clock Source Bit1	0
28	Clear Clock Source Bit0	0
27	Clear reserved 11 (*)	0
26	Clear reserved 10 (*)	0
25	Clear reserved 9 (*)	0
24	Disable front panel LEMO start/stop logic	0
23	Clear reserved 7 (*)	0
22	Disable internal trigger as stop (*)	0
21	Disable Multi Event mode (*)	0
20	Disable Autostart mode (*)	0
19	Clear reserved 3 (*)	0
18	Clear reserved 2 (*)	0
17	Clear reserved 1 (*)	ADC Sampling Busy
16	Clear reserved 0 (*)	ADC Sampling Logic Armed
15	Set reserved 15	Status reserved 15
14	Set clock source Bit 2	Status clock source Bit 2
13	Set clock source Bit 1	Status clock source Bit 1
12	Set clock source Bit 0	Status clock source Bit 0
11	Set reserved 11	Status reserved 11
10	Set reserved 10	Status reserved 10
9	Set reserved 9	Status reserved 9
8	Enable front panel Lemo Start/Stop logic	Status front panel start/stop logic
7	Set reserved 7	Status reserved 7
6	Enable internal trigger as stop	Status internal trigger as stop
5	Enable Multi Event mode	Status Multi Event mode
4	Enable Autostart mode	Status Autostart mode
3	Set reserved 3	Status reserved 3
2	Set reserved 2	Status reserved 2
1	Set reserved 1	Status reserved 1
0	Set reserved 0	Status reserved 0

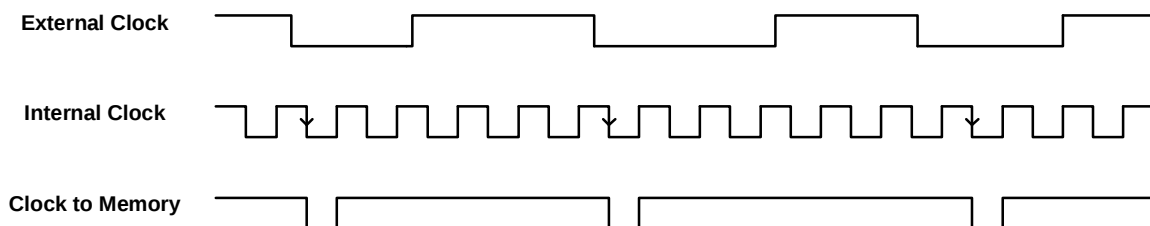
The power up default value reads 0x00000000

Clock source bit setting table:

Bit2	Bit1	Bit0	Clock Source
0	0	0	internal 200 MHz
0	0	1	internal 100 MHz
0	1	0	internal 50 MHz
0	1	1	external clock x 5
1	0	0	external clock with internal doubling (the external clock has to be in the range 24 MHz-100 MHz)
1	0	1	Random Clock
1	1	0	external clock (LEMO front panel) ; min. 40 MHz
1	1	1	internal 250 MHz

External random clock mode :

This mode allows for sampling at arbitrary low and non symmetric external clock. The digitizer is set up for an internal clock of 200 MHz and will strobe one datum to memory with the leading edge of the internal clock cycle that follows the leading edge of an external clock pulse as illustrated below. Pipelining between the actual analog input signal and the value stored to memory has to be taken into account.



Multi Event mode :

- 0 : Sampling Logic Armed state will be cleared at end of event
- 1 : Sampling Logic Armed state will be cleared at end of last event (defined with Max_NOF_Event register)

Autostart mode:

- 0 : The Sampling will start when the Sampling Logic is armed and a START issue (External LEMO or VME KEY command).
- 1 : The Sampling will start with the Sampling Logic Arm command (VME KEY command) and if Multi Event Mode is enabled with end of Event to start sampling in the next page

4.6 Start Delay register (0x14, read/write)

```
#define SIS3320_START_DELAY    0x14    /* read/write; D32 */
```

Pretrigger operation can be implemented via the start delay register in conjunction with front panel start/stop mode operation. The external Start Signal and the Autostart Signal will be delayed by the value of the register .

Bit	
31	unused, read as 0
...	
24	unused, read as 0
23	START_DELAY_BIT23
..	
..	
0	START_DELAY_BIT0

The power up default value is 0

4.7 Stop Delay register (0x18, read/write)

```
#define SIS3320_STOP_DELAY    0x18    /* read/write; D32 */
```

Posttrigger operation can be implemented via the stop delay register in conjunction with front panel start/stop mode operation. The external stop signal and the internal trigger (if enabled) will be delayed by the value of the register .

Bit	
31	unused, read as 0
...	
24	unused, read as 0
23	STOP_DELAY_BIT23
..	
..	
0	STOP _DELAY_BIT0

The power up default value is 0

4.8 Max_Nof_Events_Register (0x20, read/write)

```
#define SIS3320_MAX_NOF_EVENT          0x20          /* read/write; D32 */
```

The Sampling Logic will be disarmed In Multi Event mode as soon as the Event counter reaches the value of the Max_Nof_Events register.

Bit	
31	unused, read as 0
...	
20	unused, read as 0
19	MAX NOF Events Bit19
..	
..	
0	MAX NOF Events Bit 0

The power up default value is 0

4.9 Actual_Event_Counter (0x24, read)

```
#define SIS3320_ACTUAL_EVENT_COUNTER    0x24          /* read; D32 */
```

This register holds the actual number of events in multi event mode.

The Event Counter is cleared when the Sampling Logic is armed and it is incremented with every start sampling.

Bit	
31	unused, read as 0
...	
20	unused, read as 0
19	Actual event counter Bit 19
..	
..	
0	Actual event counter Bit 0

The power up default value is 0

4.10 Broadcast setup register

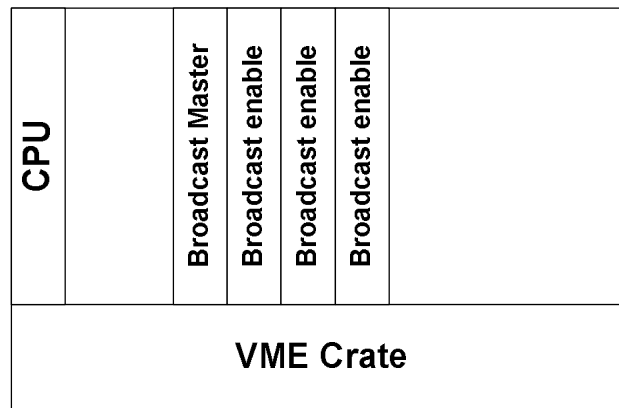
```
#define SIS3320_CBLT_BROADCAST_SETUP    0x30    /* read/write; D32 */
```

This read/write register defines, whether the SIS3320-250 will participate in a Broadcast. The configuration of this register and the registers of other participating modules is essential for proper Broadcast behaviour.

Bit	Function
31	Broadcast address bit 31
30	Broadcast address bit 30
29	Broadcast address bit 29
28	Broadcast address bit 28
27	Broadcast address bit 27
26	Broadcast address bit 26
25	Broadcast address bit 25
24	Broadcast address bit 24
23	reserved
22	reserved
21	reserved
20	reserved
19	reserved
18	reserved
17	reserved
16	reserved
15	reserved
14	reserved
13	reserved
12	reserved
11	reserved
10	0
9	0
8	0
7	0
6	0
5	Enable Broadcast Master
4	Enable Broadcast
3	0
2	reserved
1	reserved
0	reserved

Broadcast functionality is implemented for all Key address cycles.

Modules which are supposed to participate in a broadcast have to get the same broadcast address. The broadcast address is defined by the upper 8 bits of the broadcast setup register. One module has to be configured as broadcast master, the enable broadcast bit has to be set for the others as illustrated below.



Broadcast setup example (broadcast address 0x34000000):

Module	Broadcast Setup Register	Comment
1	0x34000020	Broadcast Master
2	0x34000010	Broadcast enable
3	0x34000010	Broadcast enable
4	0x34000010	Broadcast enable

All 4 modules will participate in a key reset (A32/D32 write) to address 0x34000400.

Note: Do not use a broadcast address that is an existing VME address of a VME card in the crate.

4.11 ADC Memory Page register

```
#define SIS3320_ADC_MEMORY_PAGE_REGISTER 0x34      /* read/write; D32 */
```

The SIS3320-250 default memory size per channel is 64 MByte (i.e. 32 MSample).

The VME address space window per ADC is limited to 8 MByte (4 MSample) however. The read/write ADC memory page register is used to select one of the 8 memory subdivisions (pages).

Bit	Function
31	reserved
..	
..	
4	reserved
3	Page register bit 3 (reserved)
2	Page register bit 2
1	Page register bit 1
0	Page register bit 0

Example: readout routine for 32MSample readout
(see sis3320_single_event_sample_wrap_test1.c)

```
int sis3320_Read_ADC_Channel(    unsigned int module_address,  
                                unsigned int vme_read_mode,  
                                unsigned int adc_channel /* 0 to 7 */,  
                                unsigned int event_sample_start_addr,  
                                unsigned int event_sample_length,  
                                unsigned int* uint_adc_buffer)
```

4.12 DAC Control Registers

This set of registers is used to program the 16-bit offset DACs for the 8 ADC channels. Refer to the documentation of the AD5570 DAC chip for details also and have a look to the configuration example in `sis3320_adc_test1.c` (CVI directory)

Example routine:

```
int sis3320_250_write_dac_offset( unsigned int module_addr,
                                unsigned int *offset_value_array)
```

4.12.1 DAC Control/Status register (read/write)

```
#define SIS3320_DAC_CONTROL_STATUS 0x50 /* read/write; D32 */
```

Bit	Write Function	Read Function
31	None	0
..	..	..
..	..	..
16	None	0
15	None	DAC Read/Write/Clear Cycle BUSY
14	None	0
...		...
8	None	0
7	None	0
6	DAC selection Bit 2	status of DAC selection Bit 2
5	DAC selection Bit 1	status of DAC selection Bit 1
4	DAC selection Bit 0	status of DAC selection Bit 0
3	..	..
2	none	0
1	DAC Command Bit 1	DAC Command Bit 1 Status
0	DAC Command Bit 0	DAC Command Bit 0 Status

DAC Command Bit

Bit 1	Bit 0	Function
0	0	No function
0	1	Load shift register of selected DAC
1	0	Load selected DAC
1	1	Clear all DACs

A “Clear DAC” command sets the value of all DACs to analog ground

4.12.2 DAC Data register (read/write)

```
#define SIS3320_DAC_DATA          0x54          /* read/write; D32 */
```

Bit	Write Function	Read Function
31	none	DAC Input Register Bit 15 (from DAC)
..	..	..
..	..	..
16	none	DAC Input Register Bit 0
15	DAC Output Register Bit 15	DAC Output Register Bit 15
..	..	0
..	..	0
0	DAC Output Register Bit 0	DAC Output Register Bit 0

4.12.3 DAC load sequence (read/write)

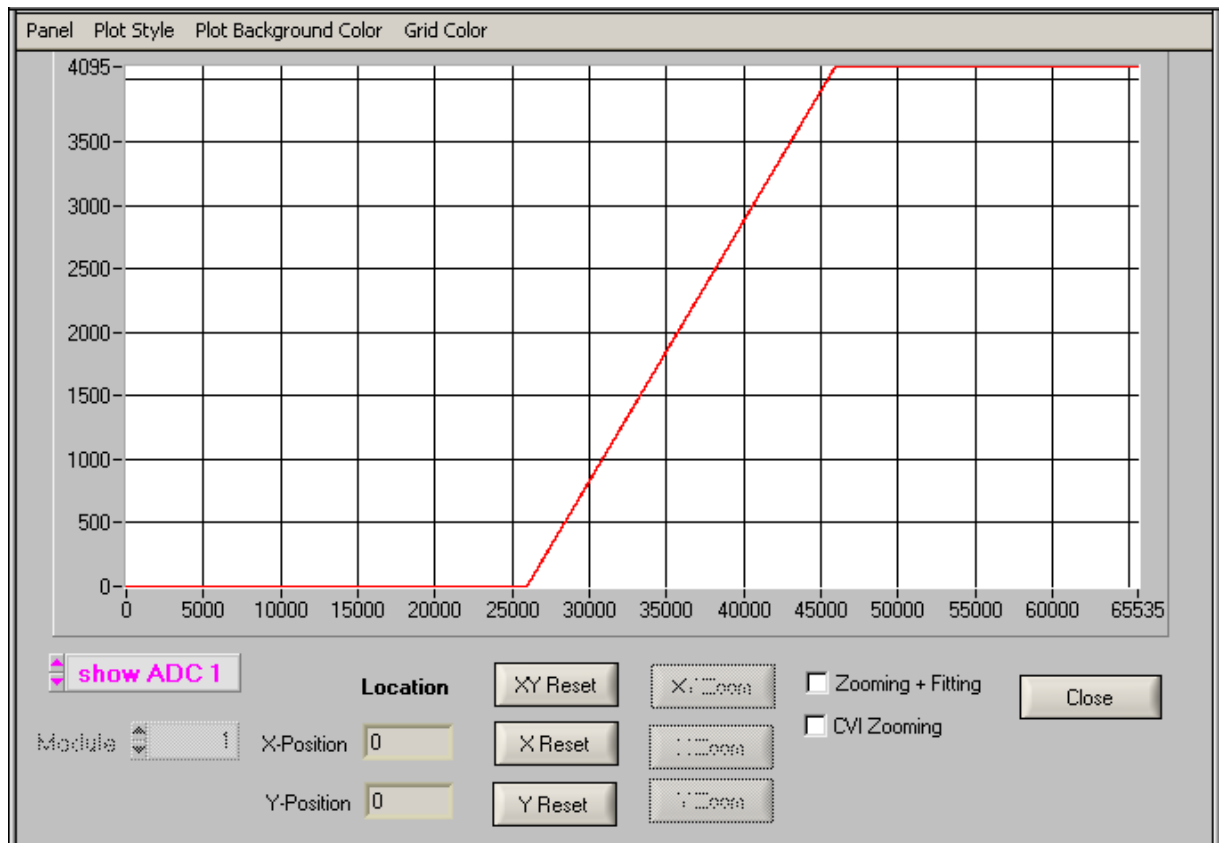
The sequence to load the DAC of a single channel is shown below.

The example routine `sis3320_250_write_dac_offset` loads the 8 DACs of a SIS3320 module at base address `module_offset` in a loop.

Sequence to load offset of channel N, N=[0,...,7]

dacdata=dacdatum[N]	
daccontrol=1 (shift) + N << 4	
	read dacstatus
until busy==0	
daccontrol=2 (load) + N << 4	
	read dacstatus
until busy==0	

Find below a DAC scan that was acquired with the DAC test function of the SIS3320-250 ADC Labwindows application. The SIS3320 under test was configured for an input span of some 4 V_{pkpk}. It can be seen, that a DAC offset of some 36000 counts is required to accomplish an input range of -2...+2V on this particular channel.



Note: The actual sample value registers can be used to monitor the influence of the DAC settings on the ADC values.

4.13 Key address general reset

```
#define SIS3320_KEY_RESET 0x400 /* write only; D32 */
```

A write with arbitrary data to this register (key address) resets the SIS3320-250 to it's power up state.

4.14 Key address VME arm sampling logic

```
#define SIS3320_KEY_ARM 0x410 /* write only; D32 */
```

A write with arbitrary data to this register (key address) will arm the sampling logic. If Autostart mode is enabled then the sampling will also start.

4.15 Key address VME disarm sampling logic

```
#define SIS3320_KEY_DISARM 0x414 /* write only; D32 */
```

A write with arbitrary data to this register (key address) will disarm the sampling logic.

4.16 Key address VME start sampling

```
#define SIS3320_KEY_START 0x418 /* write only; D32 */
```

A write with arbitrary data to this register (key address) will initiate if the sampling logic is armed for sampling.

4.17 Key address VME stop sampling

```
#define SIS3320_KEY_STOP 0x41C /* write only; D32 */
```

A write with arbitrary data to this register (key address) will halt sampling on the active page. The Sample Logic will be disarmed also in Single Event Mode or if the Actual_Event_Counter reaches the value of the Max_Nof_Events register.

4.18 Key address Reset DDR2 Memory Logic

```
#define SIS3320_KEY_RESET_DDR2_LOGIC 0x428 /* write only; D32 */
```

A write with arbitrary data to this register (key address) will reset the DDR2 Memory Logic.. A possible memory synchronization problem can be detected with the 4 DDR2 test registers.

4.19 Event configuration registers

```

#define SIS3320_EVENT_CONFIG_ALL_ADC    0x01000000 /* write only;D32 */

#define SIS3320_EVENT_CONFIG_ADC12      0x02000000 /* read/write;D32 */
#define SIS3320_EVENT_CONFIG_ADC34      0x02800000 /* read/write;D32 */
#define SIS3320_EVENT_CONFIG_ADC56      0x03000000 /* read/write;D32 */
#define SIS3320_EVENT_CONFIG_ADC78      0x03800000 /* read/write;D32 */

```

This register is implemented for each channel group and it has to be written with the same value, the best way is to make use of the address `SIS3320_EVENT_CONFIG_ALL_ADC` to write to the registers of all channel groups simultaneously.

Bit	Function
31	unused; read 0
...	...
16	unused; read 0
15	unused; read 0
14	unused; read 0
13	unused; read 0
12	Enable User In (Control Input 1) to data stream
11	unused; read 0
10	Enable User In (Control Input 1) as accumulator gate
9	unused; read 0
8	unused; read 0
7	unused; read 0
6	unused; read 0
5	Enable Sample Length stop
4	Enable Page Wrap around mode 0 : Wrap around full memory 1 : Wrap around page until STOP (External or KEY or Length Stop)
3	Wrap Page size Bit 3
2	Wrap Page size Bit 2
1	Wrap Page size Bit 1
0	Wrap Page size Bit 0

Enable Sample Length stop:

- 0: no stop from sample Length (count) logic
- 1: sampling will stop after counts defined in register “Event Length register”.

Enable Page Wrap around mode:

- 0 : Wrap around full memory (32 MSample)
- 1 : Wrap around in pages defined by pages size bits

The pages size is defined by this register in wrap event mode. The lowest four bits define the number of memory divisions as listed in the table below.

4.19.1 Wrap Page size

The page/event size is defined by the 4 page size bits as follows:

Page size Bit 3	Page size Bit 2	Page size Bit 1	Page size Bit 0	Page size
0	0	0	0	16 M Samples
0	0	0	1	4 M Samples
0	0	1	0	1 M Samples
0	0	1	1	256 K Samples
0	1	0	0	64K Samples
0	1	0	1	16 K Samples
0	1	1	0	4 K Samples
0	1	1	1	1 K Samples
1	0	0	0	512 Samples
1	0	0	1	256 Samples
1	0	1	0	128 Samples
1	0	1	1	64 Samples
1	1	0	0	reserved
1	1	0	1	reserved
1	1	1	0	reserved
1	1	1	1	reserved

4.20 Sample Length register

```
#define SIS3320_SAMPLE_LENGTH_ALL_ADC      0x01000004

#define SIS3320_SAMPLE_LENGTH_ADC12       0x02000004
#define SIS3320_SAMPLE_LENGTH_ADC34       0x02800004
#define SIS3320_SAMPLE_LENGTH_ADC56       0x03000004
#define SIS3320_SAMPLE_LENGTH_ADC78       0x03800004
```

This register defines the number of samples if the “Enable Max. Sample count stop” is enabled.

The register can be used to signal, that a page was completely filled in Stop Mode (sampling wraps in memory) with “Enable Max. Sample count stop” disabled.

Example:

Wrap in 1 K page, the wrap bit will be set in the event directory as soon as the value of the Length register is reached.

Value of Sample Length register = (Sample Length - 4) & 0xffffC

Bit	
31	unused, read as 0
...	
25	unused, read as 0
24	Sample Length Register BIT24
..	
2	Sample Length Register BIT2
1	Unused
0	Unused

The power up default value is 0

Example: Desired sample length 0x100 -> set the register to 0xFC

4.21 Sample Start address register

```
#define SIS3320_SAMPLE_START_ADDRESS_ALL_ADC      0x01000008

#define SIS3320_SAMPLE_START_ADDRESS_ADC12        0x02000008
#define SIS3320_SAMPLE_START_ADDRESS_ADC34        0x02800008
#define SIS3320_SAMPLE_START_ADDRESS_ADC56        0x03000008
#define SIS3320_SAMPLE_START_ADDRESS_ADC78        0x03800008
```

These registers define the memory start address.

The value is given in samples (i.e. number of 16-bit words)

Only Sample Start addresses on a 4 16-bit (sample) boundary (i.e. 8 bytes) are valid.

Bit	
31	unused, read as 0
...	
25	unused, read as 0
24	Sample Start Address Register Bit 24
..	
2	Sample Start Address Register Bit 2
1	unused
0	unused

The power up default value is 0

4.21.1 Explanation (sample start address)

The contents of the start sample register is assigned as memory data storage address with the arm command (key address arm sampling). The user has to distinguish between two the two wrap modes of the SIS3320-250.

No Page wrap around mode (event configuration register bit 4 =1):

Bits 24:2 of the sample start register are used as memory start address upon the arm condition. The lowest 2 bits are 0 (i.e. the start address is on a 4 sample or 8 byte boundary). The internal address is incremented by 1 with every sample clock.

The stop will be on a 4 sample boundary.

The next (adjacent) address will be used as the starting point for the next event in multi event mode.

Page wrap around mode (event configuration register bit 4 =0):

The upper part of the sample start register (page address) is used as memory start address upon the arm command. The lower bits (number of bits defined by the page size, bits 9:0 for a page size of 1K e.g.). The lower portion is incremented by 1 with every sample clock. The stop will be on a 4 sample boundary also. The exact stop location can be obtained from the lowest 2 bits of the next sample register or the event directory.

The upper portion of the address (page address) is incremented by 1 with the start of the next event and the lower portion is cleared again.

4.22 ADC Input mode register

```

#define SIS3320_ADC_INPUT_MODE_ALL_ADC      0x0100000C

#define SIS3320_ADC_INPUT_MODE_ALL_ADC12    0x0200000C
#define SIS3320_ADC_INPUT_MODE_ALL_ADC34    0x0280000C
#define SIS3320_ADC_INPUT_MODE_ALL_ADC56    0x0300000C
#define SIS3320_ADC_INPUT_MODE_ALL_ADC78    0x0380000C

```

This register set is used to generate memory test data.

Bit	Function
31	Unused; read 0
...	...
20	Unused; read 0
19	
18	
17	Test Data 32-bit Mode : 0 = 16-bit mode ; 1 = 32-bit mode
16	Enable Simulate ADC Test Data Mode
15	ADC Test Start Data Bit 15
..	
0	ADC Test Start Data Bit 0

Test Start Data has to be different from 0xYYFE and 0xYYFF.

An increment pattern is recorded in test mode (Bit 16 = 1) instead of real ADC data. Data are incremented by 2 in 32-bit mode.

Note: memory test data can be generated with clock speeds up to 200 MHz

4.23 ADC1-8 Next Sample address register

```

#define SIS3320_ACTUAL_SAMPLE_ADDRESS_ADC1    0x02000010
#define SIS3320_ACTUAL_SAMPLE_ADDRESS_ADC2    0x02000014
#define SIS3320_ACTUAL_SAMPLE_ADDRESS_ADC3    0x02800010
#define SIS3320_ACTUAL_SAMPLE_ADDRESS_ADC4    0x02800014
#define SIS3320_ACTUAL_SAMPLE_ADDRESS_ADC5    0x03000010
#define SIS3320_ACTUAL_SAMPLE_ADDRESS_ADC6    0x03000014
#define SIS3320_ACTUAL_SAMPLE_ADDRESS_ADC7    0x03800010
#define SIS3320_ACTUAL_SAMPLE_ADDRESS_ADC8    0x03800014

```

These 8 read only registers hold the next sampling address for the given channel.

Bit	Function
31	unused, read as 0
...	
25	unused, read as 0
24	Sample Address Bit 24
..	
2	Sample Address Bit 2
1	Sample Address Bit 1*
0	Sample Address Bit 0*

The power up default value is 0

* Sample address bits 1 and 0 have a dedicated meaning.

Explanation:

Data are stored to memory in packets of 4 consecutive samples by the sample logic. This implies, that either one additional sample is stored in stop mode (wrap mode respective) or that the last 1-2 samples before the stop are not stored.

Sample address bits 1:0 can be used to obtain the position of the stop signal within the 4 sample packet.

The stop delay can be used to make sure, that all samples up to the external stop condition are written to memory.

Sample Address Bits 1:0	Correction
3	- 1
0	0
1	+ 1
2	+ 2

4.24 Actual Sample Value registers

```
#define SIS3320_ACTUAL_SAMPLE_VALUE_ADC12    0x02000020
#define SIS3320_ACTUAL_SAMPLE_VALUE_ADC34    0x02800020
#define SIS3320_ACTUAL_SAMPLE_VALUE_ADC56    0x03000020
#define SIS3320_ACTUAL_SAMPLE_VALUE_ADC78    0x03800020
```

Read “on the fly” of the actual converted ADC values.

The read only registers are updated with every ADC clock, unless a concurrent VME read access is pending.

The register contents is refreshed and can be read any time (i.e. they are updated independent of the unarmed, armed, sampling state) as long as a sampling clock is distributed on the ADC board (internal clock or active/clocking external clock)

ADC 1 / 3 / 5 / 7		ADC 2 / 4 / 6 / 8	
D31:28	D27:16	D15:12	D11:0
0	12-bit data	0	12-bit data

4.25 DDR2 Memory Logic Verification registers

```
#define SIS3320_DDR2_TEST_REGISTER_ADC12    0x02000028
#define SIS3320_DDR2_TEST_REGISTER_ADC34    0x02800028
#define SIS3320_DDR2_TEST_REGISTER_ADC56    0x03000028
#define SIS3320_DDR2_TEST_REGISTER_ADC78    0x03800028
```

ADC 2 / 4 / 6 / 8			
D31:28	D27:24	D23:20	D19:16
Fifo_11_wr_addr	Fifo_10_wr_addr	Fifo_01_wr_addr	Fifo_00_wr_addr

ADC 1 / 3 / 5 / 7			
D15:12	D11:8	D7:4	D3:0
Fifo_11_wr_addr	Fifo_10_wr_addr	Fifo_01_wr_addr	Fifo_00_wr_addr

This register set can be used to verify proper operation of the DDR2 memory read logic. The contents of all registers has to be identical. So far no deviation/error condition with up to date firmware has been detected. Please report problems to Struck Innovative Systeme. The error can be salvaged by issuing a key reset DDR2 memory logic command.



4.26 Trigger setup register registers

```

#define SIS3320_TRIGGER_SETUP_ADC1      0x02000030
#define SIS3320_TRIGGER_SETUP_ADC2      0x02000038
#define SIS3320_TRIGGER_SETUP_ADC3      0x02800030
#define SIS3320_TRIGGER_SETUP_ADC4      0x02800038
#define SIS3320_TRIGGER_SETUP_ADC5      0x03000030
#define SIS3320_TRIGGER_SETUP_ADC6      0x03000038
#define SIS3320_TRIGGER_SETUP_ADC7      0x03800030
#define SIS3320_TRIGGER_SETUP_ADC8      0x03800038

```

These read/write registers hold the Peaking and Gap Time of the trapezoidal FIR filter.
(Gap Time = SumG Time – Peaking Time)

Note: The FIR trigger can be used up to 200 MHz sampling clock

Bit	Function
31	reserved; read 0
..	..
24	reserved; read 0
23	Puls Length bit 7
22	Puls Length bit 6
21	Puls Length bit 5
20	Puls Length bit 4
19	Puls Length bit 3
18	Puls Length bit 2
17	Puls Length bit 1
16	Puls Length bit 0
15	reserved
14	reserved
13	reserved
12	SumG bit 4
11	SumG bit 3
10	SumG bit 2
9	SumG bit 1
8	SumG bit 0
7	reserved
6	reserved
5	reserved
4	P bit 4
3	P bit 3
2	P bit 2
1	P bit 1
0	P bit 0

Trigger Pulse Length

SumG time
(time between both sums)

Peaking time P

$$x+P$$

$$\sum_{i=x} S_i$$

The power up default value reads 0x 00000000

Si: Sum of ADC input sample stream from x to x+P

P: Peaking time (number of values to sum)

SumG: SumGap time (distance in clock ticks of the two running sums)

The maximum SumG time: 16 (clocks)

The minimum SumG time: 1 (clocks)

Values > 16 will be set to 16

Value = 0 will be set to 1

The maximum Peaking time: 16 (clocks)

The minimum Peaking time: 1 (clocks)

Values > 16 will be set to 16

Value = 0 will be set to 1

4.27 Threshold registers

```

#define SIS3320_TRIGGER_THRESHOLD_ADC1      0x02000034
#define SIS3320_TRIGGER_THRESHOLD_ADC2      0x0200003C
#define SIS3320_TRIGGER_THRESHOLD_ADC3      0x02800034
#define SIS3320_TRIGGER_THRESHOLD_ADC4      0x0280003C
#define SIS3320_TRIGGER_THRESHOLD_ADC5      0x03000034
#define SIS3320_TRIGGER_THRESHOLD_ADC6      0x0300003C
#define SIS3320_TRIGGER_THRESHOLD_ADC7      0x03800034
#define SIS3320_TRIGGER_THRESHOLD_ADC8      0x0380003C

```

These read/write registers hold the threshold values for the ADC channels.

Bit	31-27	26	25	24	16-0
Function	none	Trigger Mode	GT/ GE	LT	Trapezoidal threshold value / threshold value

Trigger Mode = 0 : FIR Filter trigger

Trigger Mode = 1 : Leading edge trigger

4.27.1 Leading edge Trigger

A Trigger Output pulse is generated on two conditions:

1. if LT is set: the Trigger Out Pulse will be issued if the actual ADC value **goes** below the programmable threshold value.
2. if GE is set: the Trigger Out Pulse will be issued if the actual ADC value **goes** above the programmable threshold value - 1

4.27.2 FIR Filter Trigger

The value of the Sum (trapezoidal value) depends on the peaking time P. Therefore the selection of the value of the Trapezoidal threshold depends on P also.

See Trigger Example.

Trapezoidal value calculation:

Trapezoidal value = (SUM2 – SUM1) + 0x10000

Where

$$\text{SUM1} = \sum_{i=x}^{x+P} S_i$$

$$\text{SUM2} = \sum_{j=x+\text{sumG}}^{x+P+\text{sumG}} S_j$$

The FIR Filter logic adds 0x10000 to the result of the subtraction of the two running sums. This implies, that the internal value of the trapezoid is on average 0x10000.

A Trigger Output pulse is generated on two conditions:

1. LT is set: the Trigger Out Pulse will be issued if the actual trapezoidal value **goes** below the programmable trapezoidal threshold value.
2. GT is set: the Trigger Out Pulse will be issued if the actual trapezoidal value **goes** above the programmable trapezoidal threshold value

4.28 Trigger Flag Clear Counter register

```
#define SIS3320_TRIGGER_FLAG_CLR_CNT_ADC12    0x0200002C
#define SIS3320_TRIGGER_FLAG_CLR_CNT_ADC34    0x0280002C
#define SIS3320_TRIGGER_FLAG_CLR_CNT_ADC56    0x0300002C
#define SIS3320_TRIGGER_FLAG_CLR_CNT_ADC78    0x0380002C
```

The Trigger Flag bit is set as soon as an ADC channel meets the trigger criterion. This flag remains latched until the next event start, i.e. it will not be cleared as new ADC data which do not meet the trigger criterion come in with Wrap mode active.

The Trigger Flag Clear Counter register allows you to define a number of 100MHz clocks (NOT sample clock !!) after which the Trigger Flag bit will be cleared unless a new trigger occurred. A counter (for the given ADC channel) is preloaded with the value of the Trigger Flag Clear counter register when the trigger criterion for this channel is met.

The 100 MHz clock will decrement the counter and the Trigger Flag bit will be cleared as soon as the counter reaches 1. If a new trigger occurs before the counter has reached 1, it will be reloaded with the value from the register (retrigger).

Note: typically the user may want to set the value of the Trigger Flag Clear counter register to the memory page size , but this is not mandatory.

The Trigger Flag Clear Logic is disabled if the counter is loaded with 0 (power up default).

Bit	31-0
Function	Trigger Flag Clear counter register

The power up default value is 0



4.29 ADC SPI register

```
#define SIS3320_ADC_SPI_ADC12    0x02000040
#define SIS3320_ADC_SPI_ADC34    0x02800040
#define SIS3320_ADC_SPI_ADC56    0x03000040
#define SIS3320_ADC_SPI_ADC78    0x03800040
```

Several parameters of the AD9230 chip (like gain e.g.) can be configured with the SPI (serial Peripheral Interface). The 4ADC SPI registers are the interface between the SIS3320-250 front end FPGAs and the ADC SPIs.

The SPI registers and their function are described in Appendix xxx

Please refer to the documentation of the AD9230 ADC chip for details also.

Bit	Write Function	Read Function
31	none	Read datum bit 7
..	..	..
24	none	Read datum bit 0
23	none	Busy
22	Select ADC 0=1,3,5,7 1=2,4,6,8	Previous. write data, ignore
21	Write=0, Read=1	Previous. write data, ignore
20	Address bit 12	Previous. write data, ignore
..	..	..
8	Address bit A0	Previous. write data, ignore
7	Data bit D7	Previous. write data, ignore
..	..	
0	Data bit D0	Previous. write data, ignore

Note: 1**A write cycle consists of the sequence:**

write SPI data/address to ADC SPI register
wait 1 μ s (or check busy bit)
write update command to SPI register
wait 1 μ s (or check busy bit)

A read consists of the sequence:

write SPI data/address to ADC SPI register
wait 1 μ s (or check busy bit)
read data from to SPI register
wait 1 μ s (or check busy bit)

Refer to to the routines:

```
int sis3320_250_read_adc_spi(unsigned int module_addr, unsigned int
adc_channel, unsigned int spi_addr, unsigned int* spi_rd_data)
```

```
int sis3320_250_write_adc_spi(unsigned int module_addr, unsigned int
adc_channel, unsigned int spi_addr, unsigned int spi_wr_data )
```

Note: 2

The AD9230 chips on the SIS3320-250 are in their default state after power up of the board. The common mode output pin (CML) is off by default. The CML output has to be enabled prior digitization as it is used for the AD8138 preamplifier. I.e. you will have to write a setting of 0x2 (CML enable=1) to SPI address 0xF (ain_config register).

4.30 Event directories

```

#define SIS3320_EVENT_DIRECTORY_ADC1      0x02010000
#define SIS3320_EVENT_DIRECTORY_ADC2      0x02018000
#define SIS3320_EVENT_DIRECTORY_ADC3      0x02810000
#define SIS3320_EVENT_DIRECTORY_ADC4      0x02818000
#define SIS3320_EVENT_DIRECTORY_ADC5      0x03010000
#define SIS3320_EVENT_DIRECTORY_ADC6      0x03018000
#define SIS3320_EVENT_DIRECTORY_ADC7      0x03810000
#define SIS3320_EVENT_DIRECTORY_ADC8      0x03818000

```

The event directories hold the stop pointer(s) (i.e. sample end address+1) of each channel. The directories are 512 words deep and 32 bits wide. A wrap around bit (i.e. bit 28) will be set if the page was filled at least once (i.e. if the memory pointer has reached the end)

Vme offset address	(D31:30)	(D29)	(D28)	(D27:D25)	Event Next Sample Address (D24:D0)
0x0	00	T	W	000	(Next Sample Address) of Event 1
..	...	...	...		...
0x7fc	00	T	W	000	(Next Sample Address) of Event 512

W: wrap around bit

T: trigger bit

Sample End Address = Next Sample Address - 1

Wrap around bit:

This bit is cleared at start of sampling and it is set when the number of samples reached the value of the Sample Length register.

See also "Sample Length register".

Trigger bit:

The trigger bit is set with the internal trigger condition is valid.

See also "Trigger Flag Clear Counter register".

See "Next Sample Address Register" for more Information on the Next Sample Address

4.31 ADC memory

```

#define SIS3320_ADC1_OFFSET      0x04000000
#define SIS3320_ADC2_OFFSET      0x04800000
#define SIS3320_ADC3_OFFSET      0x05000000
#define SIS3320_ADC4_OFFSET      0x05800000
#define SIS3320_ADC5_OFFSET      0x06000000
#define SIS3320_ADC6_OFFSET      0x06800000
#define SIS3320_ADC7_OFFSET      0x07000000
#define SIS3320_ADC8_OFFSET      0x07800000

```

The 64 MByte ADC memory per channel can be address in pages of 8 MByte. The page is selected with the ADC Memory page register. One 32-bit word holds 2 ADC samples as shown in the table below.

Data format:

VME offset address	D31	D30:28	D27:16	D15	D14:12	D11:0
X + 0x0	U	0	12-bit data sample N+1	U	0	12-bit data sample N
X + 0x4	U	0	12-bit data sample N+3	U	0	12-bit data sample N+2
X + 0x8	U	0	12-bit data sample N+5	U	0	12-bit data sample N+4

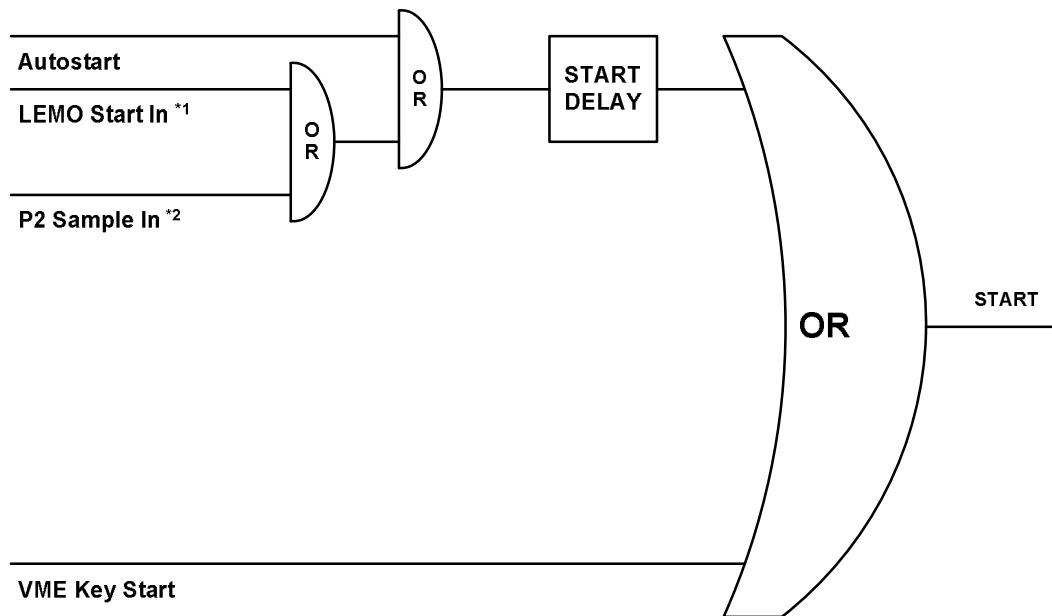
The content U of bits D15 and D31 depends on the status of bit 12 of the event configuration register and possibly the logic level of the user input.

Bit 12 of Evt. Config Reg.	User input logic level	D31/D15
0	0	U=0
0	1	U=0
1	0	U=0
1	1	U=1

5 Description of Start/Stop modes of operation

5.1 Start logic summary

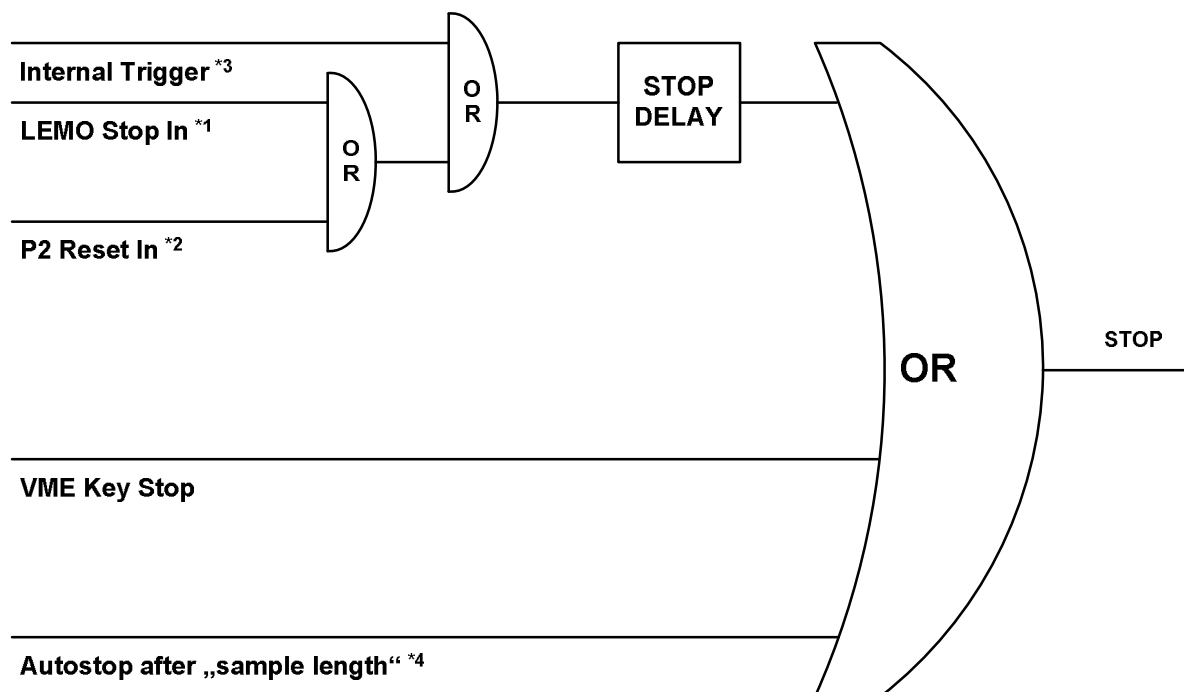
The diagram below illustrates the implemented start conditions of the SIS3320-250,



Note	Condition	Register	Comment
*1	Bit 8 = 1	Acquisition Control	Enable front panel start/stop logic
*2	Bit 9 = 1	Acquisition Control	not implemented yet (Enable P2 start/stop logic)

5.2 Stop logic summary

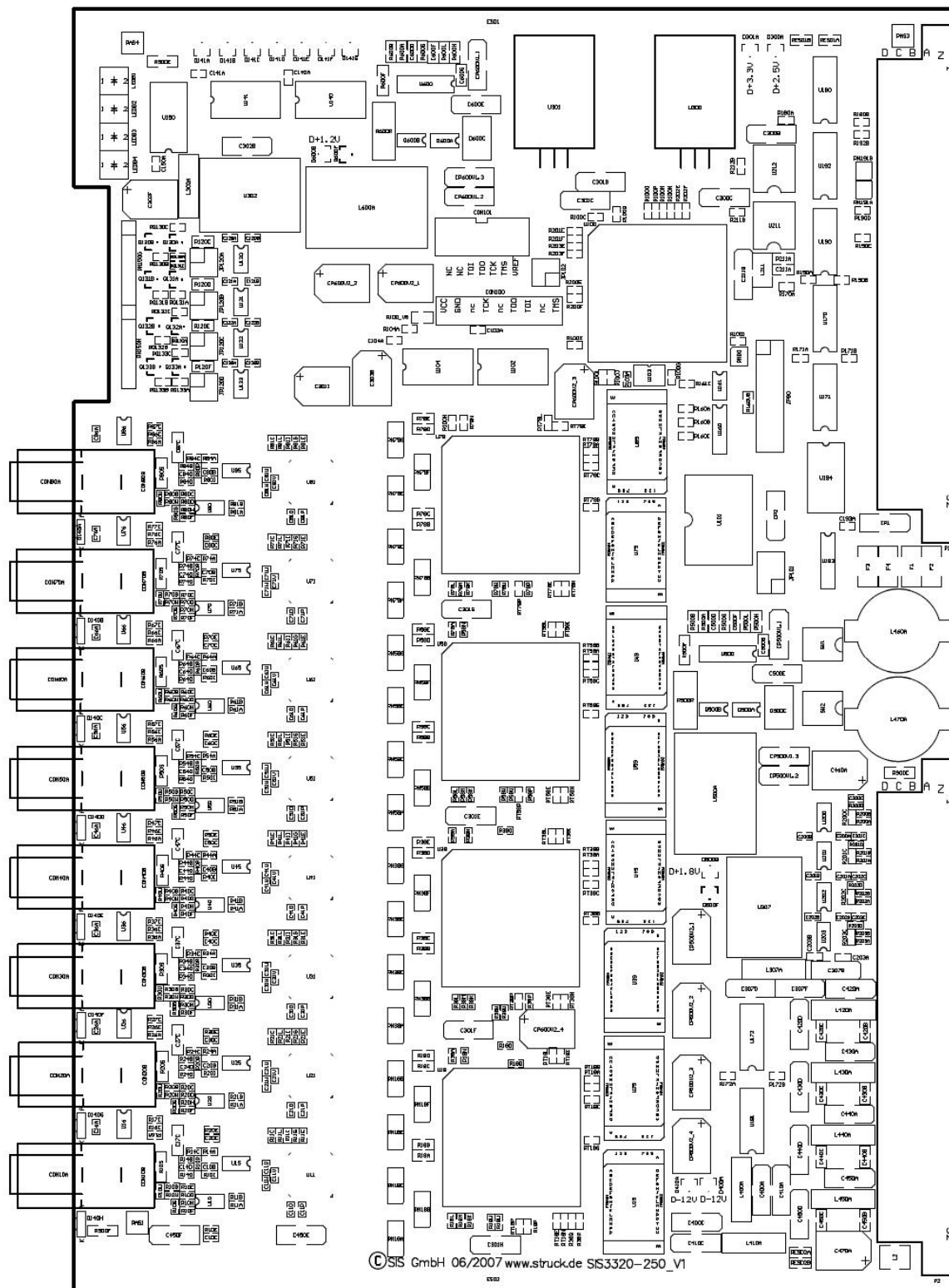
The diagram below illustrates the implemented stop conditions of the SIS3320-250.



Note	Condition	Register	Comment
*1	Bit 8 = 1	Acquisition Control	Enable front panel start/stop logic
*2	Bit 9 = 1	Acquisition Control	not implemented yet (Enable P2 start/stop logic)
*3	Bit 6 = 1	Acquisition Control	internal trigger as stop
*3	Bit 5 = 1	Event Configuration	Enable Max_Sample_count_stop

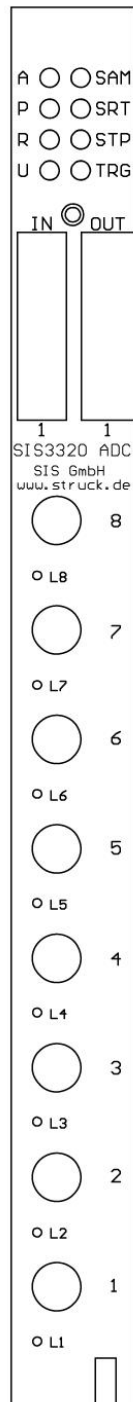
6 Board layout

A printout of the silk screen of the component side of the PCB is shown below.



7 Front panel

The SIS3320-250 is a single width (4TE) 6U VME module. A sketch of the SIS3320-250 front panel (without handles) is shown below. The IN/OUT breakouts hold 4 LEMO connectors each.



7.1 Control In/Outputs

The control I/O section features 8 LEMO00 connectors with NIM levels.

Designation	Inputs	Outputs	Designation
4	Clock In	Clock Out	4
3	Start	Ready for start (ADC sample logic armed)	3
2	Stop	Ready for stop (ADC sampling busy)	2
1	User in	Trigger output	1

The ready for start and ready for stop outputs can be used to interfere with external deadtime logic. Ready for start will become active as soon as the sample clock for one of the banks is active. Ready for stop will go active as soon as the start signal was seen by the module.

The external clock must be a symmetric signal unless the module is operated in external random clock mode

The width of an external start/stop pulse must be greater or equal two sampling clock periods.

7.1.1 User input

User input functionality was implemented to allow for synchronous recording of one external status bit (like chopper on/off e.g.) with the ADC data stream. The user bin information is recorded with the ADC data (see section 4.31). The current status of the logic level is represented by Bit 16 of the status register.

not implemented in 0102

7.2 LED's

The SIS3320-250 has 8 front panel LEDs to visualise part of the modules status. The user (and access) LED are a good way to check first time communication/addressing with the module.

Color	Designator	Function
Yellow	A	Access to SIS3320-250 VME slave port
Red	P	Power
Green	R	Ready, on board logic configured
Green	U	User, to be set/cleared under program control
Yellow	SAM	Sampling busy
Red	SRT	Start, lit with start input (or leading edge in gate mode)
Green	STP	Stop, lit with stop input (or trailing edge in gate mode)
Green	TRG	Trigger, lit if one or more channels are above threshold

The on duration of the access, sampling, start, stop and trigger LEDs is stretched to guarantee visibility even under low rate conditions.

7.3 Channel LED's

The 8 card edge surface mounted LEDs L1, ..., L8 can be seen through the corresponding holes in the front panel. They visualize the trigger status of the corresponding channel. The on duration is stretched for better visibility of short pulses.

7.4 PCB LEDs

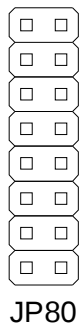
The 8 surface mounted red LEDs D141A to D141G on the top left corner of the component side of the SIS3320-250 are routed to the control FPGA, their use may depend on the firmware design.

8 Jumpers/Configuration

8.1 JP80 VME addressing mode/reset behaviour

This 8 position jumper array is used to select the addressing mode and the reset behaviour of the SIS3320-250.

Pos	Function	Factory default
1	A32	closed
2	A16 (not supported)	open
3	GEO (not supported)	open
4	VIPA (not supported)	open
5	connect VME SYSRESET IN to FPGA reset	closed
6	connect watchdog to VME SYSRESET OUT	open
7	connect FPGA reset VME SYSRESET OUT	open
8	connect VME SYSRESET to board reset	closed



The enable watchdog jumper has to be removed during (initial) JTAG firmware load.

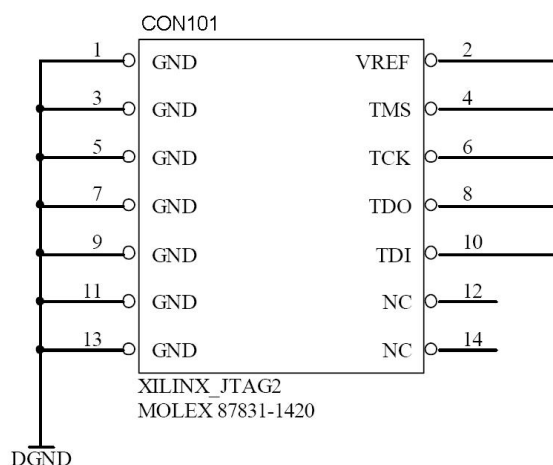
NOTE: avoid a power up deadlock situation by not setting Pos. 5 and 7 at the same time

8.2 CON101 JTAG

The SIS3320-250 on board logic can load its firmware from a serial PROMs , via the JTAG port on connector CON101 or over VME. A list of firmware designs can be found under <http://www.struck.de/sis3320firm.htm>.

Hardware like the XILINX HW-USB-JTAG in connection with the appropriate software will be required for in field JTAG firmware upgrades. The JTAG chain configuration is selected with jumper JP101, jumper JP102 is used to choose VME or CON101 as JTAG source.

CON101 is a 2mm (i.e. metric) 14 pin header that allows you to reprogram the firmware of the SIS3320-250 with a JTAG programmer. The pinout is shown in the schematic below. It is compatible with the cable that comes with the XILINX HW-USB platform cable.

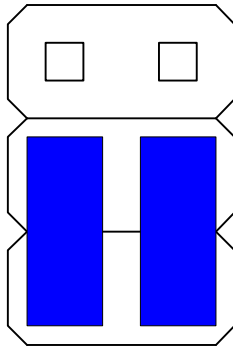


8.3 JP101 JTAG chain

The JTAG chain on the SIS3320-250 can be configured to comprise the serial PROM only (short JTAG chain) or to comprise the serial PROM and the 5 Spartan III FPGAs (long chain). The configuration is selected with the 6-pin array JP101 as sketched below:

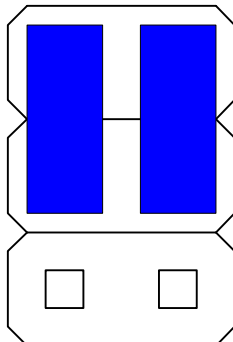
Long Chain (1-3 and 2-4 closed):

JP101



Short Chain (3-5 and 4-6 closed, factory default):

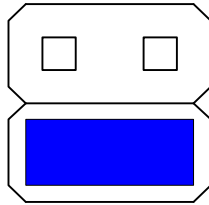
JP101



8.4 JP102 JTAG source

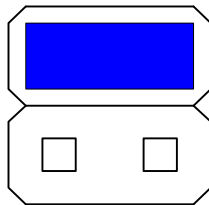
The JTAG chain can be connected to VME or to the JTAG connector CON...via the 4 pin jumper array JP102 as sketched below:

JTAG connected to VME (1-2 closed)



JP102

JTAG connected to connector CON100 (3-4 closed, factory default)

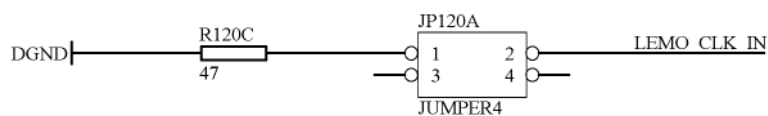


JP102

8.5 JP120A-JP120D control input termination

The contact pair 1-2 of these 4 jumper arrays is used to connect the termination resistor to the 4 control inputs as illustrated with the schematic for JP120A below.

Jumper	Control Input	Factory Default
JP120A	Clock In	Closed
JP120B	Start In	Closed
JP120C	Stop In	Closed
JP120D	User In	Closed



8.6 SW1 and SW2, VME base address

These 2 rotary switches are used to define 2 nibbles of the VME base address in non geographical addressing (refer to section base address also).

Switch	Function
SW1	ADR_LO
SW2	ADR_UP

9 Getting started

The directory `sis3320\software\win` of the Struck Innovative Systeme CDROM holds example code for VisualC++ and National Instruments Labwindows CVI. The source code can be used as a base for ports to other environments.

The `sis3320.h` header file can be found in the directory `sis3320\software`.

The routine `ConfigurationSetupAdc(void)` in the file `sis3320_adc_test1.c` (CVI directory) can be used as starting point for a setup routine for the SIS3320.

10 Appendix

10.1 Power consumption

The SIS3320-250 uses standard VME voltages only.

Voltage	Current
+ 5V	4.5A
+12 V	100 mA
- 12 V	430 mA

10.2 Operating conditions

10.2.1 Cooling

Although the SIS3320-250 is mainly a 2.5 and 3.3 V low power design, substantial power is consumed by the Analog to Digital converter chips and linear regulators however. Hence forced air flow is required for the operation of the board. The board may be operated in a non condensing environment at an ambient temperature between 10° and 25° Celsius. A power up warm up time of some 10 minutes is recommended to ensure equilibrium on board temperature conditions.

10.2.2 Hot swap/live insertion

Please note, that the VME standard does not support hot swap by default. The SIS3320-250 is configured for hot swap in conjunction with a VME64x backplane. In non VME64x backplane environments the crate has to be powered down for module insertion and removal.

10.3 Connector types

The VME connectors and the different types of front panel connectors used on the SIS3320-250 are:

Connector	Purpose	Part Number
160 pin zabcd	VME P1/P2	Harting 02 01 160 2101
LEMO PCB	Coax. control connector	LEMO EPB.00.250.NTN
90° PCB LEMO	Analog input connector	LEMO EPL.00.250.NTN
90° PCB LEMO	Analog input connector (3320 differential input version)	LEMO EPL.0S.302.HLN

10.4 P2 row A/C pin assignments

The P2 connector of the SIS3320-250 has several connections on rows A and C for the F1002 compatible use at the DESY H1 FNC subdetector. This implies, that the module can not be operated in a VME slot with a special A/C backplane, like VSB e.g.. The pin assignments of P2 rows A/C of the SIS3320-250 is shown below:

P2A	Function	P2C	Function
1	-5.2 V	1	-5.2 V
2	-5.2 V	2	-5.2 V
3	-5.2 V	3	-5.2 V
4	not connected	4	not connected
5	not connected	5	not connected
6	DGND	6	DGND
7	P2_CLOCK_H	7	P2_CLOCK_L
8	DGND	8	DGND
9	P2_START_H	9	P2_START_L
10	P2_STOP_H	10	P2_STOP_L
11	P2_TEST_H	11	P2_TEST_L
12	DGND	12	DGND
13	DGND	13	DGND
14	DGND	14	DGND
15	DGND	15	DGND
16	not connected	16	not connected
...	...	17	...
31	not connected	18	not connected

Note: The P2 ECL signals are bussed and terminated on the backplane of F1002 crates. The user has to insure proper termination if a cable backplane or add on backplane is used.

10.5 Row d and z Pin Assignments

The SIS3320-250 is prepared for the use with VME64x and VME64xP backplanes. Foreseen features include geographical addressing (PCB revisions V2 and higher) and live insertion (hot swap). The prepared pins on the d and z rows of the P1 and P2 connectors are listed below.

Position	P1/J1		P2/J2	
	Row z	Row d	Row z	Row d
1		VPC (1)		
2	GND	GND (1)	GND	
3				
4	GND		GND	
5				
6	GND		GND	
7				
8	GND		GND	
9		GAP*		
10	GND	GA0*	GND	
11	RESP*	GA1*		
12	GND		GND	
13		GA2*		
14	GND		GND	
15		GA3*		
16	GND		GND	
17		GA4*		
18	GND		GND	
19				
20	GND		GND	
21				
22	GND		GND	
23				
24	GND		GND	
25				
26	GND		GND	
27				
28	GND		GND	
29				
30	GND		GND	
31		GND (1)		GND (1)
32	GND	VPC (1)	GND	VPC (1)

Note: Pins designated with (1) are so called MFBL (mate first-break last) pins on the installed 160 pin connectors, VPC(1) pins are connected via inductors.

10.6 Firmware upgrade

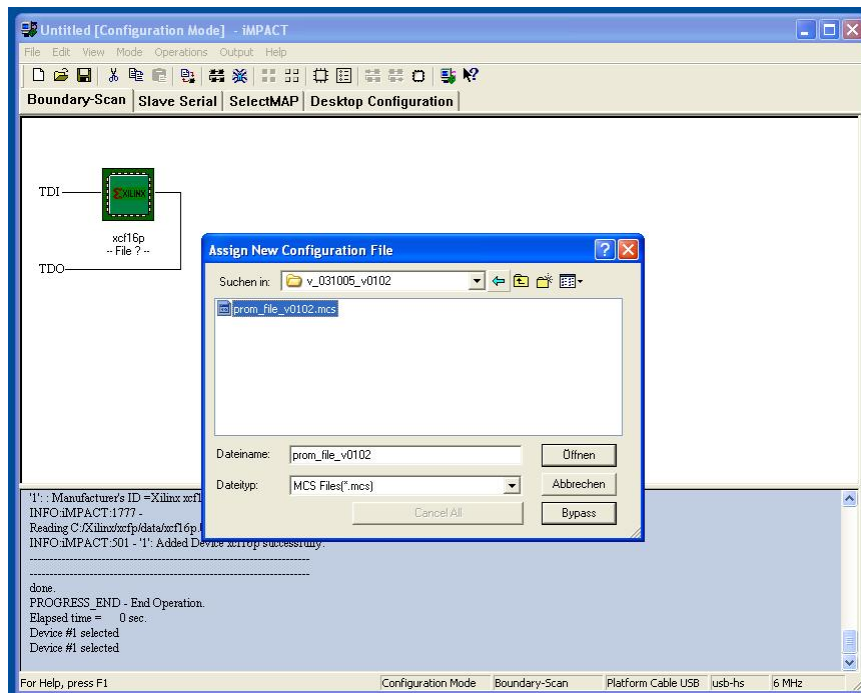
The firmware of the SIS3320-250 can be upgraded over JTAG. The upgrade options are VME (on units that have intact firmware) and the JTAG connector CON101.

10.6.1 Upgrade over CON101

The firmware can be upgraded with the Xilinx Impact software, which is part of the Webpack that can be downloaded from the Xilinx web page for free. A version of the Webpack software (which may not be up to date and not compatible with your JTAG hardware) can be found in the `xilinx_webpack` directory of the Struck Innovative Systeme CDROM also. A Xilinx JTAG parallel cable or USB (Xilinx part number HW-USB) cable can be used to roll in the firmware.

Configure the SIS3320-250 for short JTAG chain (refer to section 8.3 JP101) and set the unit to JTAG over CON101 (refer to section 8.4 JP102 JTAG source).

With your hard- and software properly set up you should see a screen as illustrated below after executing the initialize chain command.



Load the mcs file to the serial PROM (shown as xcf16p).

10.6.2 Upgrade over VME

The directories

`sis3150usb\Driver_Software\Windows\sis3150usb_vme_applications\VisualC_applications\Xilinx_Jtag_Programing\sis3320_xilinx_jtag`
and

`sis1100_3100_win2k\VisualC_applications\Xilinx_Jtag_Programing\sis3320_xilinx_jtag`

holds example code for VisualC++.

10.7 AD9230 ADC SPI registers

10.7.1 ADC chip_port_config Register (0x00, write/read)

Bit	write Function	read Function
7	none	0
6	none	LSB first
5	none	Soft reset
4	none	1
3	none	1
2	Soft reset	Soft reset
1	none	LSB first
0	none	0

power up default setting is 0x18

10.7.2 ADC chip_id Register(0x01, read only)

Bit	read Function
7	Chip id bit 7
6	Chip id bit 6
5	Chip id bit 5
4	Chip id bit 4
3	Chip id bit 3
2	Chip id bit 2
1	Chip id bit 1
0	Chip id bit 0

power up default setting is 0x0C =AD9230

10.7.3 ADC chip_grade Register(0x02, read only)

Bit	read Function
7	0
6	0
5	0
4	Speed grade bit
3	Speed grade bit
2	0
1	0
0	0

power up default setting is 0x00

Chip speed grade reading table:

Speed grade Bit4	Speed grade Bit3	Speed grade
0	0	250 MSPS (default)
0	1	210MSPS
1	0	170MSPS

10.7.4 ADC modes Register(0x08, write/read)

Bit	write Function	read Function
7	0	0
6	0	0
5	Power down	Power down
4	0	0
3	0	0
2	Internal power-down bit 2	Internal power-down bit 2
1	Internal power-down bit 1	Internal power-down bit 1
0	Internal power-down bit 0	Internal power-down bit 0

power up default setting is 0x00

ADC power mode settings table:

Power down Bit2	Power down Bit1	Power down Bit0	Internal power down mode
0	0	0	Normal (power-up, default)
0	0	1	Full-power-down
0	1	0	Standby
0	1	1	Normal (power-up)

Note: The External Power down pin overrides this setting.

10.7.5 ADC CLOCK Register(0x09, write/read)

Bit	write Function	read Function
7	0	0
6	0	0
5	0	0
4	0	0
3	0	0
2	0	0
1	0	0
0	Activate Duty cycle stabilizer	Duty cycle stabilizer active

power up default setting is 0x01

10.7.6 ADC test_io Register(0x0D, write/read)

Bit	write Function	read Function
7	x	x
6	x	x
5	PN23 test sequence active	PN23 test sequence active
4	PN9 test sequence active	PN9 test sequence active
3	Output test mode bit3	Output test mode bit3
2	Output test mode bit2	Output test mode bit2
1	Output test mode bit1	Output test mode bit1
0	Output test mode bit0	Output test mode bit0

power up default setting is 0x00

ADC Test I/O settings table:

Output test mode bit3	Output test mode bit2	Output test mode bit1	Output test mode bit0	Output test mode
0	0	0	0	Off (default)
0	0	0	1	Midscale short
0	0	1	0	+full scale short
0	0	1	1	-full scale short
0	1	0	0	Checker board output
0	1	0	1	PN23 sequence
0	1	1	1	PN 9 sequence
1	0	0	0	One/zero word toggle
1	0	0	1	unused
1	0	1	0	unused
1	0	1	1	unused
1	1	0	0	unused

Note: Format determined by output_mode

10.7.7 ADC ain_config Register(0x0F, write/read)

Bit	write Function	read Function
7	0	0
6	0	0
5	0	0
4	0	0
3	0	0
2	Analog input disable	Analog input disable
1	CML enable	CML enable
0	0	0

power up default setting is 0x00

10.7.8 ADC output_mode Register(0x14, write/read)

Bit	write Function	read Function
7	0	0
6	x	x
5	0	0
4	Output disable	Output disable
3	Double data rate output	Double data rate output
2	Output invert	Output inverted
1	Data format select Bit 1	Data format select Bit 1
0	Data format select Bit 0	Data format select Bit 0

power up default setting is 0x00

Data output mode settings table:

Data format Bit1	Data format Bit0	Data format
0	0	Binary (default)
0	1	Twos complement
1	0	Gray code

10.7.9 ADC output_adjust Register(0x15, write/read)

Bit	write Function	read Function
7	0	0
6	0	0
5	0	0
4	0	0
3	LVDS course adjust to 2.0mA (default 3.5mA)	LVDS course adjust to 2.0mA (default 3.5mA)
2	LVDS fine adjust Bit2	LVDS fine adjust Bit2
1	LVDS fine adjust Bit1	LVDS fine adjust Bit1
0	LVDS fine adjust Bit0	LVDS fine adjust Bit0

power up default setting is 0x00

LVDS output current settings table:

LVDS fine adjust Bit2	LVDS fine adjust Bit1	LVDS fine adjust Bit0	LVDS fine adjust
0	0	1	3.50mA
0	1	0	3.25mA
0	1	1	3.00mA
1	0	0	2.75mA
1	0	1	2.50mA
1	1	0	2.25mA
1	1	1	2.00mA

10.7.10 ADC output_phase Register(0x16, write/read)

Bit	write Function	read Function
7	Output clock polarity inverted	Output clock polarity inverted
6	0	0
5	0	0
4	0	0
3		
2		
1		
0		

power up default setting is 0x03

10.7.11 ADC flex_output_delay Register(0x17, write/read)

Bit	write Function	read Function
7	Output delay disable	Output delay disable
6	x	x
5	x	x
4	Output clock delay Bit4	Output clock delay Bit4
3	Output clock delay Bit3	Output clock delay Bit3
2	Output clock delay Bit2	Output clock delay Bit2
1	Output clock delay Bit1	Output clock delay Bit1
0	Output clock delay Bit0	Output clock delay Bit0

power up default setting is 0x00

Output clock delay settings table:

Clock delay Bit4	Clock delay Bit3	Clock delay Bit2	Clock delay Bit1	Clock delay Bit0	Output clock delay
0	0	0	0	0	0.1ns (default)
0	0	0	0	1	0.2ns
0	0	0	1	0	0.3ns

1	1	1	0	1	3.0ns
1	1	1	1	0	3.1ns
1	1	1	1	1	3.2ns

10.7.12 ADC INPUT RANGE (flex_vref) Register(0x18, write/read)

Bit	write Function	read Function
7	x	x
6	x	x
5	x	x
4	Input voltage range Bit4	Input voltage range Bit4
3	Input voltage range Bit3	Input voltage range Bit3
2	Input voltage range Bit2	Input voltage range Bit2
1	Input voltage range Bit1	Input voltage range Bit1
0	Input voltage range Bit0	Input voltage range Bit0

power up default setting is 0x00

Input range settings table:

Input voltage Bit4	Input voltage Bit3	Input voltage Bit2	Input voltage Bit1	Input voltage Bit0	Input voltage range
1	0	0	0	0	0.98V
1	0	0	0	1	1.00V
1	0	0	1	0	1.02V
1	0	0	1	1	1.04V

1	1	1	1	1	1.23V
0	0	0	0	0	1.25V (default)
0	0	0	0	1	1.27V

0	1	1	1	0	1.48V
0	1	1	1	1	1.50V

10.7.13 ADC OVER RANGE (ovr_config) Register(0x2A, write/read)

Bit	write Function	read Function
7	x	x
6	x	x
5	x	x
4	x	x
3	x	x
2	x	x
1	Over range position (DDR mode only)	Over range position (DDR mode only)
0	Over range enable	Over range enable (default)

The power up default setting is 0x01

10.7.14 ADC device_update Register(0xff, write/read)

Bit	write Function	read Function
7	0	0
6	0	0
5	0	0
4	0	0
3	0	0
2	0	0
1	0	0
0	SW transfer	SW transfer

power up default setting is 0x00

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