SIS3800
VME Scaler/Counter

User Manual

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Revision Table:

Revision	Date	Modification
1.1	18.09.98	Generation
1.13	29.01.99	introduction of revision table LEMO control/flat cable counter front panel included
1.20	10.11.99	Firmware Version 3.0
1.21	20.01.04	Firmware Version 5.0 bug fix BLT readout

1 Table of contents

2 Introduction

The SIS3800 is one of the classic VME counter/scaler implementations on the base of the SIS360x/38xx printed circuit board. The unit has 32 counter channels and a maximum counting frequency of 200 MHz (ECL and NIM) 100 MHz (TTL) respective. As all boards of the family it is of single slot double Eurocard form factor and available with flat cable connectors for ECL and TLL levels and LEMO connectors for NIM and TTL levels.
The SIS360x/38xx card is a flexible concept to implement a variety of latch and counter firmware designs. The flexibility is based on two to six Xilinx FPGAs in conjunction with a FLASHPROM from which the firmware files are loaded into the FPGAs. Depending on the stuffing options of the printed circuit board, the user has the possibility to cover several purposes with the same card, hence the manual is a combination of firmware and hardware description .
All cards of the family are equipped with the 5 row VME64x VME connectors, a side cover and EMC front panel, as well as the VIPA LED set. For users with VME64xP subracks VIPA extractor handles can be installed. The base board is prepared for VIPA style addressing, the current first version of the SIS3800 firmware does not feature VIPA modes yet however.
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. A list of available firmware designs can be retrieved from http://www.struck.de/sis3638firm.htm

3 Technical Properties/Features

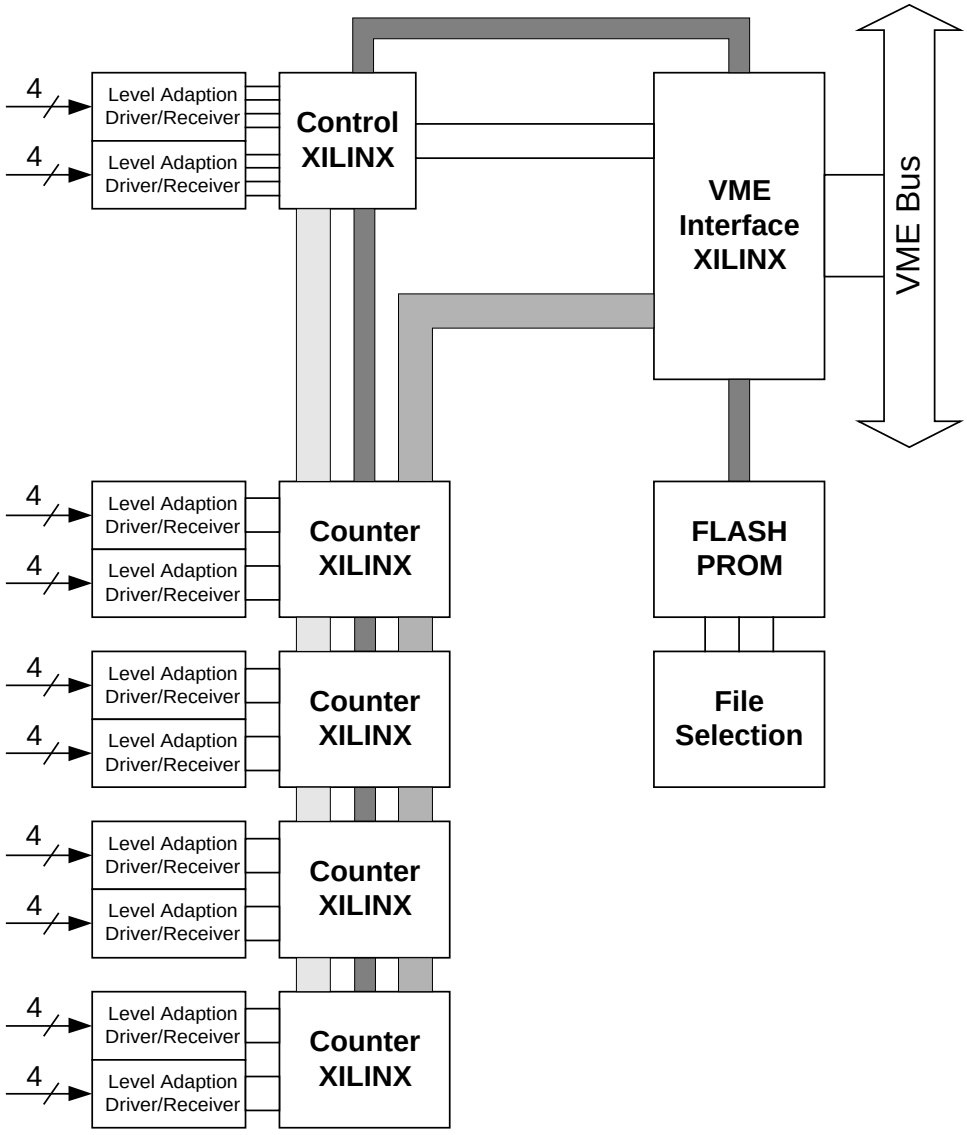
The SIS3800 is rather a firmware design in combination with given board stuffing options, than a name for the board (this is the reason, why the modules are named SIS360x/38xx on the front panel and the distinction of the units is made by the module identifier register). The firmware makes use of part of the possibilites of the SIS360x/38xx PCB, if the SIS3800 or other firmware designs of the family come close to what you need, but something is missing, a custom firmware design may be an option to consider.

Find below a list of key features of the SIS3800.

- 32 channels
- 200 MHz counting rate (ECL and NIM), 100 MHz for TTL
- 32-bit channel depth
- NIM/TTL/ECL versions
- flat cable (TTL/ECL) and LEMO (TTL/NIM) versions
- Shadow register
- Read on the fly
- A16/A24/A32 D16/D32/BLT32 (CBLT32 prepared)
- Base address settable via 5 rotary switches (A32-A12) and one jumper (A11)
- VME interrupt capability
- VIPA geographical addressing prepared
- VIPA LED set
- Reference Pulser Capability
- Up to eight firmware files
- single supply (+5 V)

3.1 Board Layout

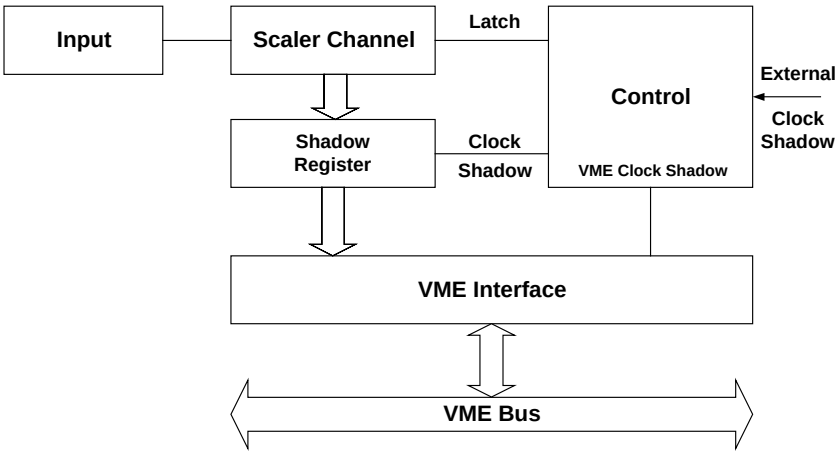
Xilinx FPGAs are the working horses of the SIS360x/38xx board series. The counter (prescaler, latch, ...) logic is implemented in one to four chips, each chip handles eight front end channels. The VME interface and the input and output control logic reside in two Xilinx chips also. The actual firmware is loaded into the FPGAs upon power up from a FLASHPROM under jumper control. The user can select among up to eight different boot files by the means of a 3-bit jumper array. The counter and control inputs can be factory configured for ECL, NIM and TTL levels, on the control outputs the same levels are the available as options. The standard SIS3800 version 1 design has no outputs implemented. The front panel is available as flat cable (ECL and TTL) or LEMO (NIM and TTL) version. The board layout is illustrated with the block diagram below:



SIS3800 Block Diagram

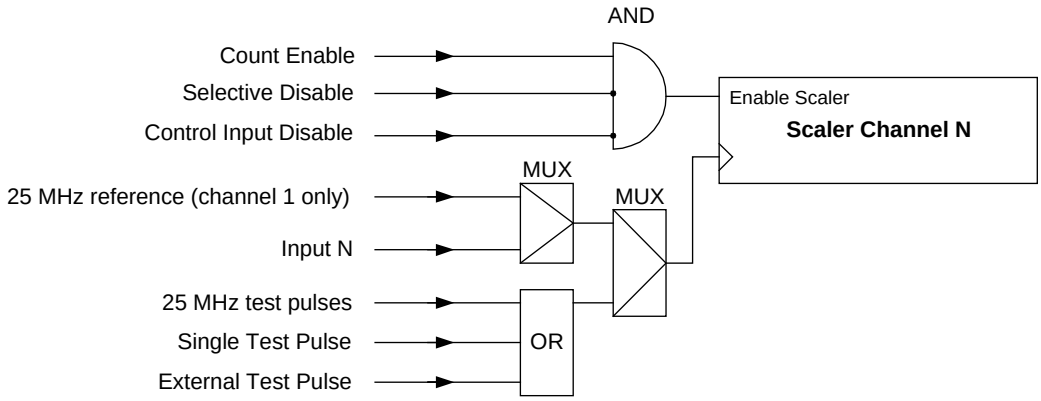
3.2 Counter Design and Modus Operandi

The counters are implemented in XILINX FPGAs. One of the counter FPGAs holds 8 32-bit deep counter channels. The actual scaler contents are passed to the VME bus via a shadow register. The scaler data have to be copied into the shadow register before readout via a software command or a front panel hardware pulse. This can take place in parallel to the acquisition of counts, what is called read on the fly. On a read on the fly the status of the lowest 6 bits may be not accurate, i.e. the counter readout value is accurate modulo 64. (read on the fly readout accuracy down to one count can be achieved with the SIS3801 multiscaler). No pulses are missed during a read on the fly, i.e. the frontend continues counting. A diagram of the setup is shown in the figure below. The different readout schemes are addressed in the key register section.



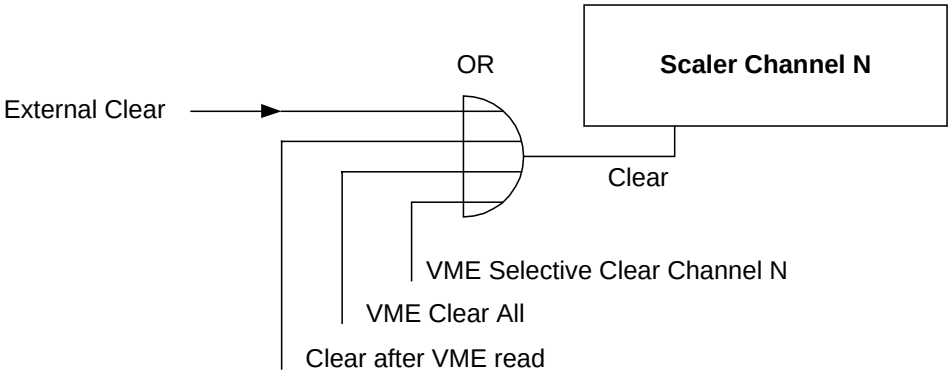
3.3 Count Enable Logic

A channel acquires input or test counts, if the selective count enable and the global count enable conditions are true. Via the test enable toggle bits in the control register the input of the counter is switched to test pulses or front panel signals.



3.4 Clear Logic

The contents of the counters can be cleared via VME access or a front panel pulse. The four possible clear sources are ored as shown in the diagram below.



4 Getting Started

The minimum setup to operate the SIS3800 requires the following steps:

- Check the proper firmware design is selected (should be design zero, i.e. all jumpers of jumper array J500 set.
- Select the VME base address for the desired addressing mode
- Select the VME SYSRESET behaviour via J520
- turn the VME crate power off
- install the scaler in the VME crate
- connect your signals to the counter
- turn crate power back on
- set global count enable via key address 0x28
- read all counters with clock shadow register via block transfer from start address 0x280 (read) or 0x300 (read and clear) or subsequent single word reads.

A good way of checking first time communication with the SIS3800 consists of switching on the user LED by a write to the control register at offset address 0x0 with data word 0x1 (the LED can be switched back off by writing 0x1000 to the control register)..

4.1 Factory Default Settings

4.1.1 Adressing

SIS3800 boards are shipped with the En_A32, the En_A24 and the En_A16 jumpers installed and the rotary switches set to:

Switch	SW_A32U	SW_A32L	SW_A24U	SW_A24L	SW_A16	J A_11	Bits 7-4	Bits 3-0
Setting	3	8	3	8	3	8	0	0

Jumper A_11 is open (bit 11 set).
Hence the unit will respond to the following base addresses:

Mode	Base address
A32	0x38383800
A24	0x383800
A16	0x3800

Firmware Design
Design 1 of the FLASHPROM is selected (lowest jumper of jumper array J500 open, the others set).

4.1.2 System Reset Behaviour

J520 is set, i.e. the SIS3800 is reset upon VME reset.

5 Firmware Selection

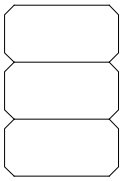
The FLASH PROM of a SIS360x/38xx board can contain several boot files. A list of available FLASHPROM versions can be found on our web site http://www.struck.de in the manuals page. If your FLASHPROM has more than one firmware design, you can select the

desired firmware via the firmware selection jumper array J500 . You have to make sure, that the input/output configuration and FIFO configuration of your board are in compliance with the requirements of the selected firmware design (a base board without FIFO can not be operated as multi channel scaler e.g.). A total of 8 boot files from the FLASHPROM can be selected via the three bits of the jumper array. The array is located towards the rear of the card between the VME P1 and P2 connectors. The lowest bit sits towards the bottom of the card, a closed jumper represents a zero, an open jumper a one.

5.1 Examples

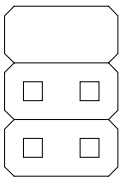
The figures below show jumper array 500 with the soldering side of the board facing the user and the VME connectors pointing to the right hand side.

Bootfile 0 selected



With all jumpers closed boot file 0 is selected

Bootfile 3 selected



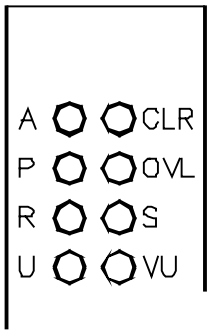
With the lowest two jumpers open bit 0 and bit 1 are set to 1 and hence boot file 3 is selected

6 Front Panel LEDs

The SIS3800 has 8 front panel LEDs to visualise part of the units status. Three LEDs according to the VME64xP standard (Power, Access and Ready) plus 5 additional LEDs (VME user LED, Clear, Overflow, Scaler enable and VIPA user LED).

Designation	LED	Color	Function
A	Access	yellow	Signals VME access to the unit
P	Power	red	Flags presence of VME power
R	Ready	green	Signals configured logic
U	VME user LED	green	To be switched on/off under user program control
CLR	Clear	yellow	Signals soft or hardware clear
OVL	Overflow	red	Signals Overlow in one or more channels
S	Scaler Enable	green	Signals one or more enabled channels
VU	VIPA user LED	green	for future use

The LED locations are shown in the portion of the front panel drawing below.



The VME Access, the Clear and the Scaler enable LED are monostable (i.e. the duration of the on phase is stretched for better visibility), the other LEDs reflect the current status.
An LED test cycle is performed upon power up (refer to the chapter 17.1).

7 VME addressing

7.1 Address Space

As bit 11 is the lowest settable bit on the 360x/38xx board, an address space of 2 Kbytes (Offset plus 0x000 to 0x7ff) is occupied by the module.

7.2 Base Address

7.2.1 VME

The VME addressing mode (A16/A24/A32) is selected via the jumpers EN_A16, EN_A24 and EN_A32.The mode is selected by closing the corresponding jumper, it is possible to enable two or all three addressing modes simultaneously.
The base address is set via the five rotary switches SW_A32U, SW_A32L, SW_A24U, SW_A24L and SW_A16 and the jumper J_A11. The table below lists the switches and jumpers and their corresponding address bits.

Switch/Jumper	Affected Bits
SW_A32U	31-28
SW_A32L	27-24
SW_A24U	23-20
SW_A24L	19-16
SW_A16	15-12
J_A11	11

In the table below you can see, which jumpers and switches are used for address decoding in the three different addressing modes (fields marked with an x are used).

	SW_A32U	SW_A32L	SW_A24U	SW_A24L	SW_A16	J_A11
A32	x	x	x	x	x	x
A24			x	x	x	x
A16					x	x

Note: J_A11 closed represents a 0, J_A11 open a one

7.2.2 VIPA/VME64x

As the VME64x and the VME64xP (VIPA) standard are not yet standards to refer to and to declare conformity with, addressing modes (like geographical addressing e.g.) according to these standards are prepared but not yet implemented in the current firmware revisions.

7.3 Address Map

The SIS360x/38xx boards are operated via VME registers, VME key addresses and the FIFO (where installed). The following table gives an overview on all SIS3800 addresses and their offset from the base address, a closer description of the registers and their function is given in the following subsections.

Offset	Key	Access	Type	Function
0x000		R/W	D16/D32	Control and Status register
0x004		R/W	D16/D32	Module Identification and IRQ control register
0x00C		W	D16/D32	Selective count disable register
0x020	KA	W	D16/D32	clear all counters and overflow bits
0x024	KA	W	D16/D32	clock shadow register
0x028	KA	W	D16/D32	global count enable
0x02C	KA	W	D16/D32	global count disable
0x030	KA	W	D16/D32	Broadcast; clear all counters and overflow bits
0x034	KA	W	D16/D32	Broadcast; clock shadow register
0x038	KA	W	D16/D32	Broadcast; global count enable
0x03C	KA	W	D16/D32	Broadcast; global count disable
0x040	KA	W	D16/D32	clear counter group and overflow channel 1-8
0x044	KA	W	D16/D32	clear counter group and overflow channel 9-16
0x048	KA	W	D16/D32	clear counter group and overflow channel 17-24
0x04C	KA	W	D16/D32	clear counter group and overflow channel 25-32
0x050	KA	W	D16/D32	enable reference pulser channel 1
0x054	KA	W	D16/D32	disable reference pulser chanel 1
0x060	KA	W	D16/D32	reset register (global reset)
0x068	KA	W	D16/D32	Test pulse (generate a single pulse)
0x100-0x17C	KA	W	D16/D32	clear counter N and its overflow bit
0x180-0x1FC	KA	W	D16/D32	clear overflow bit of counter N
0x200-0x27C		R	D16/D32/ BLT32	read shadow register (does not initiate clock shadow)
0x280-0x2FC		R	D16/D32/ BLT32	read counter (initiates clock shadow also)
0x300-0x37C		R	D16/D32/ BLT32	read and clear all counters
0x380		R	D16/D32	Overflow register channel 1-8
0x3A0		R	D16/D32	Overflow register channel 9-16
0x3C0		R	D16/D32	Overflow register channel 17-24
0x3E0		R	D16/D32	Overflow register channel 25-32

Note: D08 is not supported by the SIS38xx boards

8 Register Description

8.1 Status Register (0x0)

The status register reflects the current settings of most of the SIS3800 parameters in read access, in write access it functions as the control register.

Bit	Function
31	0
30	Status VME IRQ source 2 (test IRQ)
29	Status VME IRQ source 1 (ext. clock shadow)
28	Status VME IRQ source 0 (Overflow)
27	VME IRQ
26	internal VME IRQ
25	0
24	0
23	0
22	Status VME IRQ Enable Bit Source 2
21	Status VME IRQ Enable Bit Source 1
20	Status VME IRQ Enable Bit Source 0
19	0
18	0
17	0
16	reserved (read back as 0 at power up)
15	Global Count Enable
14	General Overflow Bit
13	Status enable reference pulser channel 1
12	0
11	0
10	0
9	0
8	0
7	Status broadcast mode handshake controller
6	Status broadcast mode
5	Status input test mode
4	Status 25 MHz test pulses
3	Status input mode bit 1
2	Status input mode bit 0
1	Status IRQ source 2 for software IRQ testing
0	Status user LED

The reading of the status register after power up or key reset is 0x0 (see default settings of control register).

8.2 Control Register (0x0)

The control register is in charge of the control of most of the basic properties of the SIS3800 board in write access. It is implemented via 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 1 into the clear/disable bit (which has a different location within the register). An undefined toggle status will result from setting both the enable and disable bits for a specific function at the same time.
On read access the same register represents the status register.

Bit	Function
31	reserved
30	disable IRQ source 2 (*)
29	disable IRQ source 1 (*)
28	disable IRQ source 0 (*)
27	reserved
26	reserved
25	reserved
24	clear reserved bit
23	reserved
22	enable IRQ source 2
21	enable IRQ source 1
20	enable IRQ source 0
19	reserved
18	reserved
17	reserved
16	set reserved bit
15	disable broadcast mode handshale controller (*)
14	disable broadcast mode (*)
13	disable input test mode (*)
12	disable 25 MHz test pulses (*)
11	clear input mode bit 1 (*)
10	clear input mode bit 0 (*)
9	clear IRQ test source 2
8	switch off user LED (*)
7	enable handshake controller for broadcast mode
6	enable broadcast mode
5	enable input test mode
4	enable 25 MHz test pulses
3	set input mode bit 1
2	set input mode bit 0
1	set IRQ test (source 2)
0	switch on user LED

(*) denotes the default power up or key reset state

8.3 Module Identification and IRQ control register (0x4)

This register has two basic functions. The first is to give information on the active firmware design. This function is implemented via the read only upper 20 bits of the register. Bits 16-31 hold the four digits of the SIS module number (like 3800 or 3600 e.g.), bits 12-15 hold the version number. The version number allows a distinction between different implementations of the same module number, the SIS3801 for example has the 24-bit mode with user bits and the straight 32-bit mode as versions.

Bit	Read/Write access	Function	
31	read only	Module Identification Bit 15	Module Id Digit 3
30	read only	Module Identification Bit 14	
29	read only	Module Identification Bit 13	
28	read only	Module Identification Bit 12	
27	Read only	Module Identification Bit 11	Module Id Digit 2
26	read only	Module Identification Bit 10	
25	read only	Module Identification Bit 9	
24	read only	Module Identification Bit 8	
23	read only	Module Identification Bit 7	Module Id Digit 1
22	read only	Module Identification Bit 6	
21	read only	Module Identification Bit 5	
20	read only	Module Identification Bit 4	
19	read only	Module Identification Bit 3	Module Id Digit 0
18	read only	Module Identification Bit 2	
17	read only	Module Identification Bit 1	
16	read only	Module Identification Bit 0	
15	read only	Version Bit 3	
14	read only	Version Bit 2	
13	read only	Version Bit 1	
12	read only	Version Bit 0	
11	read/write	VME IRQ Enable (0=IRQ disabled, 1=IRQ enabled)	
10	read/write	VME IRQ Level Bit 2	
9	read/write	VME IRQ Level Bit 1	
8	read/write	VME IRQ Level Bit 0	
7	read/write	IRQ Vector Bit 7; placed on D7 during VME IRQ ACK cycle	
6	read/write	IRQ Vector Bit 6; placed on D6 during VME IRQ ACK cycle	
5	read/write	IRQ Vector Bit 5; placed on D5 during VME IRQ ACK cycle	
4	read/write	IRQ Vector Bit 4; placed on D4 during VME IRQ ACK cycle	
3	read/write	IRQ Vector Bit 3; placed on D3 during VME IRQ ACK cycle	
2	read/write	IRQ Vector Bit 2; placed on D2 during VME IRQ ACK cycle	
1	read/write	IRQ Vector Bit 1; placed on D1 during VME IRQ ACK cycle	
0	read/write	IRQ Vector Bit 0; placed on D0 during VME IRQ ACK cycle	

The second function of the register is interrupt control. The interrupter type of the SIS3800 is D08(O) . Via bits 0-7 of the module identifier and interrupt control register you can define the interrupt vector, which is placed on the VME bus during the interrupt acknowledge cycle. Bits 8 through 10 define the VME interrupt level, bit 11 is used to enable (bit set to 1) or disable (bit set to 0) interrupting.

Module identification and version example:

The register for a SIS3801 in straight 32-bit mode (version 1) reads 0x38011nnn, for a SIS3801 in 24-bit mode (version 2) it reads 0x38012nnn. (the status of the lower 3 nibbles is denoted with n in the example).

8.4 Count disable register 0xC

The count disable register can be used to disable single channels or arbitrary groups of channels. Note, that both the external (if used) and the internal conditions have to be in status enable for the given channel.
The register is write only.
If bit N of the register is set, channel N+1 is disabled.
Example: If 0x5 is written to the count disable register, counting of channel 1 and 3 is disabled.

8.5 Overflow registers 0x380, 0x3A0, 0x3C0, 0x 3E0

Each overflow register holds the overflow bit of eight counter channels (i.e. of one counter XILINX) in its lowest eight bits.

Example: register 0x380 holds the overflow bits of channels 1-8 as shown in the table below.

Bit	31	30	29	28	27	26	25	24	Bits 23-1
	Ch 8	Ch 7	Ch 6	Ch 5	Ch 4	Ch 3	Ch 2	Ch 1	undefined

8.6 Broadcast Addressing

Broadcast addressing is an efficient way to issue the same command to a number of modules. It can be used in A24 and A32 mode on SIS360x/38xx boards. The higher address bits are used to define the broadcast class, the distinction of the modules is done via the A16 rotary switch and the A_11 jumper. If broadcast addressing is used, the A32_U, the A_32_L, the A24_U and the A24_L rotary switches must have the same setting in A32 mode, in A24 mode the A24_U and A24_L setting must be the same on all participating units. One of the participating units must be configured as broadcast handshake controller by setting bit 7 in the units control register. All of the participating units must have set bit 6 (enable broadcast) in the control register. The broadcast time jitter was measured to be less than 40 ns within a VME crate, i.e. you have the possibility issue commands under software control with a maximum uncertainty of 40 ns (like clear all counters), what sure is worse, than a hard wired front panel clear, but is much better than a VME single cycle loop over a number of units. The four broadcast commands are executed via the VME key addresses at offset 0x030 through 0x3C.

A32 Broadcast Example:
Let four SIS3800 participate by setting the A_32 jumper and setting the base address of the units to:

```
Unit 1: 0x32001000
Unit 2: 0x32001800
Unit 3: 0x32002000
Unit 4: 0x32002800
```

Switch on enable broadcast by setting bit 6 in the control register of the four units.
Enable broadcast handshake controller on unit 4 by setting bit 7 of its control register.
An A232 write to address 0x32000034 will clock the shadow register on units 1 through 4.

A24 Broadcast Example:
Let three SIS3800 participate by setting the A_24 jumper and setting the base address of the units to:

```
Unit 1: 0x541000
Unit 2: 0x542000
Unit 3: 0x543000
```

Switch on enable broadcast by setting bit 6 in the control register of the three units.
Enable broadcast handshake controller on unit 1 by setting bit 7 of its control register.
An A24 write to address 0x540030 will clear the counters on units 1 through 3.

9 VME Interrupts

Three VME interrupt sources are implemented in the SIS3800 firmware design:

- Overflow
- External Latch Shadow Input
- Test Interrupt

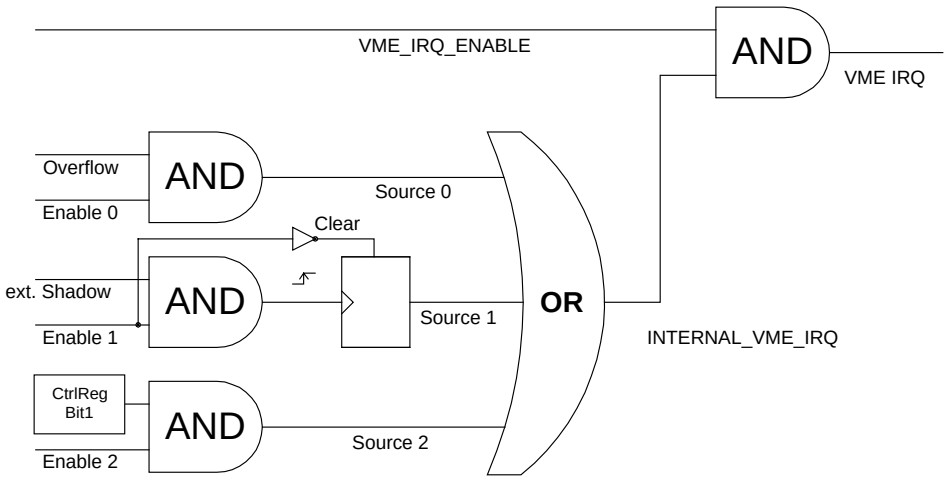
The interrupter is of type D8(O).

The interrupt logic is shown below. For VME interrupt generation the corresponding interrupt source has to be enabled by setting the respective bit in the VME control register (disabling is done with the sources J/K bit). Interrupt generation has to be enabled by setting bit 11 in the IRQ and version register. The internal VME interrupt flag can be used to check on an IRQ condition without actually making use of interrupts on the bus.

The VME interrupt level (1-7) are defined by bits 8 through 10 and the VME interrupt vector (0-255) by bits 0 through 7 of the VME IRQ and version register.

In general an interrupt condition is cleared by disabling the corresponding interrupt, clearing the interrupt condition (i.e. clear overflow) and enabling the IRQ again.

Note: In most cases your experiment may not require interrupt driven scaler readout, but the interrupt capability of the SIS3800 provides a way to overcome the problem of missing front panel inputs on most commercial VME CPUs.



10 Data Format

The data format of the actual counter values (read via the shadow register) for D16 and D32 reads is shown in the two tables below.

10.1 D16

	high Byte	low Byte
first read	Data Bits 31-24	Data Bits 23-16
second read	Data Bits 15-8	Data Bits 7-0

10.2 D32

Data Bits 31-24	Data Bits 23-16	Data Bits 15-8	Data Bits 7-0

11 Readout Schemes

Scaler data can be read from different locations. The read location has an impact on the counter behaviour.

11.1 Read Shadow Register

In a single cycle or block transfer read from the shadow register (0x200-0x27C) the data from the last transfer to the shadow register are obtained. No automatic clock shadow is initiated, i.e. if the user wants to read the actual scaler values he has to ensure a soft- or hardware clock shadow before the read.

11.2 Read and Clear all Counters

In a single cycle or block read from the read and clear all counter registers (0x300-0x37C) the data are transferred into the shadow register, all counters are cleared after the transfer and the shadow data are read.

Note: If your CPU does not support block transfer you can ensure synchronicity to 5 ns by reading the first scaler value from 0x300 and the rest from the shadow registers 0x204-0x27C.

11.3 Read Counter

The read counter behaves like the read and clear all counters except that the counter values are not cleared after the copy to the shadow register.

11.4 Special behaviour of Firmware Version 3

Firmware Version 3 differs from Versions 1 and 2 with respect to the read on the fly behaviour. To avoid the 6-bit read on the fly uncertainty the clock shadow register transaction is combined with a count inhibit of about 200 ns of all channels. This results in an accurate counter result, but at the cost of an overall deadtime. It will depend on the given application, whether this mode is an attractive option.

12 Input Configuration

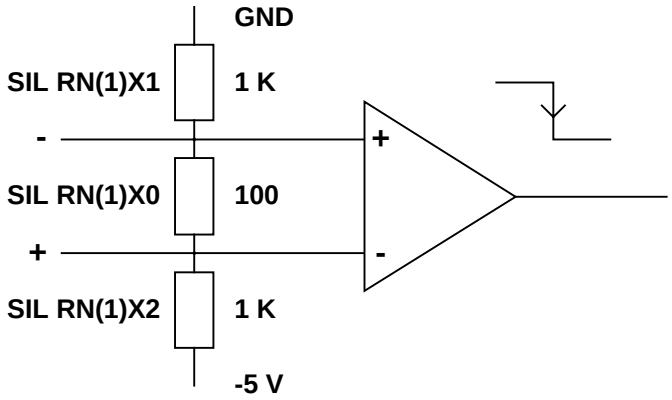
SIS36/38xx boards are available for NIM, TTL and ECL input levels and in LEMO and flat cable versions. The boards are factory configured for the specified input level and connector type, input termination is installed.

12.1 ECL

The 100 Ω input termination can be removed in groups of four channels by removing the corresponding resistor networks. The termination of single control inputs can be disabled with jumpers J101 through J108, an open jumper disables the termination of the corresponding channel.

Network	Channels	1 K Networks
RN10	1-4	RN11/12
RN20	5-8	RN21/22
RN30	9-12	RN31/32
RN40	13-16	RN41/41
RN50	17-20	RN51/52
RN60	21-24	RN61/62
RN70	25-28	RN71/72
RN80	29-32	RN81/82
RN110	Control 1-4	RN111/RN112
RN120	Control 5-8	RN121/RN122

The schematics of the ECL input circuitry is shown below.

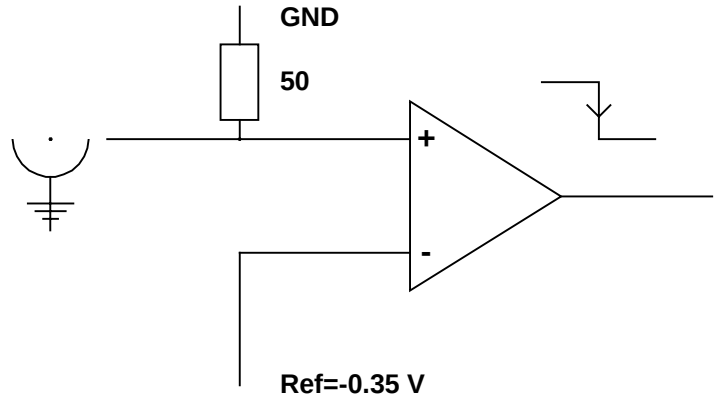


12.2 NIM

The 50 Ω input termination can be removed in groups of four channels by removing the corresponding resistor networks. The termination of single control inputs can be disabled with jumpers J101 through J108, an open jumper disables the termination of the corresponding channel.

Network	Channels
U15 (Pins 10 to 6)	1-4
U15 (Pins 1 to 5)	5-8
U35 (Pins 10 to 6)	9-12
U35(Pins 1 to 5)	13-16
U55 (Pins 10 to 6)	17-20
U55 (Pins 1 to 5)	21-24
U75 (Pins 10 to 6)	25-28
U75 (Pins 1 to 5)	29-32
U115 (Pins 10 to 6)	Control 1-4
U115 (Pins 1 to 5)	Control 5-8

The schematics of the NIM input circuitry is shown below.

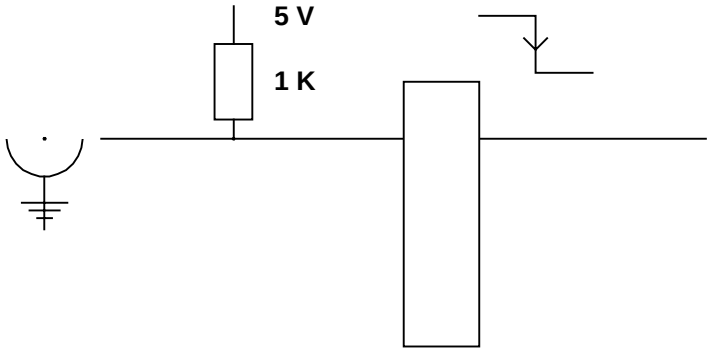


12.3 TTL

The TTL input level option is possible with LEMO and flat cable connectors.

12.3.1 TTL/LEMO

The (low active) TTL/LEMO input circuitry is sketched below. A high active version can be implemented by replacing the 74F245 with a 74F640



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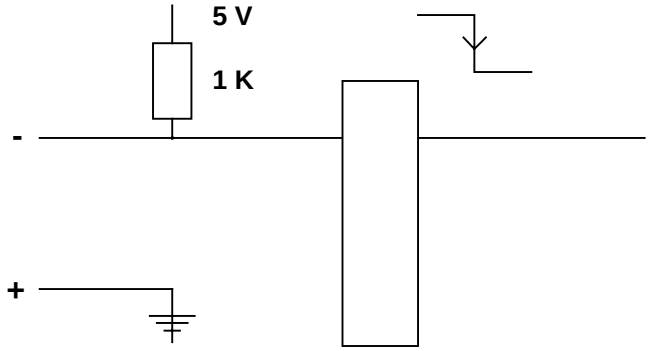
12.3.2 TTL/Flat Cable

In the flat cable TTL version the positive (right hand side) of the connector is tied to ground.



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13 Connector Specification

The four different types of front panel and VME connectors used on the SIS360x and SIS38xx boards are:

Connector	Purpose	Part Number
160 pin zabcd	VME P1/P2	Harting 02 01 160 2101
20 pin header	Control (flat cable versions)	DIN41651 20 Pin (AMP e.g.)
34 pin header	Inputs (flat cable versions)	DIN41651 34 Pin (AMP e.g.)
LEMO	Control and Input (LEMO versions)	LEMO ERN.00.250.CTL

14 Control Input Modes

The assignment of the control inputs can be controlled via the input mode bits in the control register. While the standard SIS3800 firmware design (design 3800 version 1) has inputs only, design 3800 version 2 is compatible with board, where control lines 5 to 8 are configured as outputs (what is the case for SIS3801 multiscaler boards).

14.1 Version 1

Control Input Modes

Mode 0 (bit1=0, bit0=0):	all control inputs are disabled
Mode 1 (bit1=0, bit0=1):	input 1 -> disable count all channels input 2 -> clear all channels input 5 -> external clock shadow register input 7 -> external test pulse (max 50 MHz)
Mode 2 (bit1=1, bit0=0):	input 1 -> disable count channels 1-16 input 3 -> disable count channels 17-32 input 2 -> clear channel 1-16 input 4 -> clear channel 17-32 input 5 -> external clock shadow register input 7 -> external test pulse (max. 50 MHz)
Mode 3 (bit1=1, bit0=1):	input 1 -> disable count channels 1-8 input 3 -> disable count channels 9-16 input 5 -> disable count channels 17-24 input 7 -> disable count channels 25-32 input 2 -> clear channels 1-8 input 4 -> clear channels 9-16 input 6 -> clear channels 17-24 input 8 -> clear channels 25-32

14.2 Version 2 and 3

Control Input Modes

Mode 0 (bit1=0, bit0=0):	all control inputs are disabled
Mode 1 (bit1=0, bit0=1):	input 1 -> disable count all channels input 2 -> clear all channels input 3 -> external clock shadow register input 4 -> external test pulse (max 50 MHz)
Mode 2 (bit1=1, bit0=0):	all control inputs are disabled
Mode 3 (bit1=1, bit0=1):	all control inputs are disabled

15 Signal Specification

15.1 Control Signals

The width of the clear and external latch shadow pulse has to be greater or equal 10 ns, an external inhibit has to be present for the period you desire to disable counting. An internal delay of some 15 ns has to be taken into account for all external signals.

15.2 Inputs

The SIS3800 is specified for counting rates of 200 MHz for ECL and NIM signals and 100 MHz for the TTL case. Thus the minimum high and low level duration is 2.5 ns (5 ns respective). Signal deterioration over long cables has to be taken into account.

16 Operating Conditions

16.1 Power Consumption/Voltage requirement

Although the SIS3800 is prepared for a number of VIPA features, it was decided to use an ob board DC/DC converter to generate the –5 V, which are needed for driver and receiver chips, to allow for the use of the module in all 6U VME environments. The power consumption is counting rate dependent, it varies from the idle value of +5 V 3,3 A to +5 V 4,5 A with all channels counting at 200 MHz(i.e. the power consumption is < 23 W).

16.2 Cooling

Forced air flow is required for the operation of the SIS3800 board.

16.3 Insertion/Removal

Please note, that the VME standard does not support live insertion (hot swap). Hence crate power has to be turned off for installation and removal of SIS3800 scalers.
The leading pins on the SIS3800 VME64x VME connectors and connected on board circuitry are designed for hot swap in conjunction with a VME64x backplane (a VME64x backplane can be recognised by the 5 row VME connectors, while the standard VME backplane has three row connectors only).

17 Test

The SIS380x scaler series provides the user with a number of test features, which allow for debugging of the unit as well as for overall system setups.

17.1 LED (selftest)

During power up self test and LCA configuration all LEDs except the Ready (R) LED are on. After the initialisation phase is completed, all LEDs except the Ready (R) LED and the Power (P) have to go off. Differing behaviour indicates either a problem with the download of the firmware boot file or one or more LCA and/or the download logic.

17.2 Internal pulser tests

17.2.1 Single Pulse

A single pulse into all channels can be generated with a write to the key address 0x68 if test mode is enabled via the control register. In conjunction with the count enable register more complex count patterns, like increment patterns e.g., can be generated before readout.

17.2.2 25 MHz Pulser

Simultaneous pulsing at 25 MHz into all channels can be used to test the complete readout chain and internal counter logic of the SIS3800. The feature is activated by enabling input test mode and 25 MHz test pulses via the corresponding bits in the control register.
The 25 MHz test pulser gives easy access to your VME CPUs readout timing. By making subsequent reads to the same counter and multiplying the difference in counts with 40 ns you can measure the single word access time.

17.3 Reference pulser channel 1

The reference pulser for channel 1 can be seen rather as a monitoring feature than a test feature. It sets the counting rate of channel 1 to 25 MHz (note, that a simultaneous front panel signal on channel 1 is ignored).

17.4 Signal-Input Priority

If the user happens to enable more than one input option (enable test mode, enable reference pulser, scaler enable) at the same time, the priority is as show in the table below:

Priority	Feature
1	Test mode
2	Reference Pulser (channel 1 only)
3	Front Panel Inputs

Example: If test mode and reference pulser are enabled at the same time, channel one will count test pulses (i.e. will count synchronous with the test pulser).

18 Software Support

VME multiscaler boards are tested at SIS with an OR VP6 VME CPU (Pentium II based) under Windows 95 and a National Instruments CVI user interface. The actual VME C code makes use of the OR Windows 95 DLL, which has straightforward to read and understand routines like:

```
VMEA24StdWriteWord(a32address + KEY_RESET, 0x0);   /* Key Reset */
rdata = VMEA24StdReadWord(a32address + STAT_REG);
```

In most cases the user setup will be using different hardware, a full fleshed real time operating system like VxWorks, and a different user interface. We still believe, that it is helpful to have a look at the code which is used to test the units and to take it as an example for the implementation of the actual scaler readout application. A floppy with our test software is enclosed with SIS3800 shipments.
Depending on the user feedback and co-operation we expect, that we will have drivers or at least example routines for the commonly used VME CPU operating systems at hand in the mid term.

18.1 Contents of the included Floppy

The Floppy contains a readme.txt file with the most up to date information, the CVI project file and all home made files from the project. The important part of the code for the implementation of your own program is sitting in the CVI call back routines.

19 Appendix

19.1 Address Modifier Overview

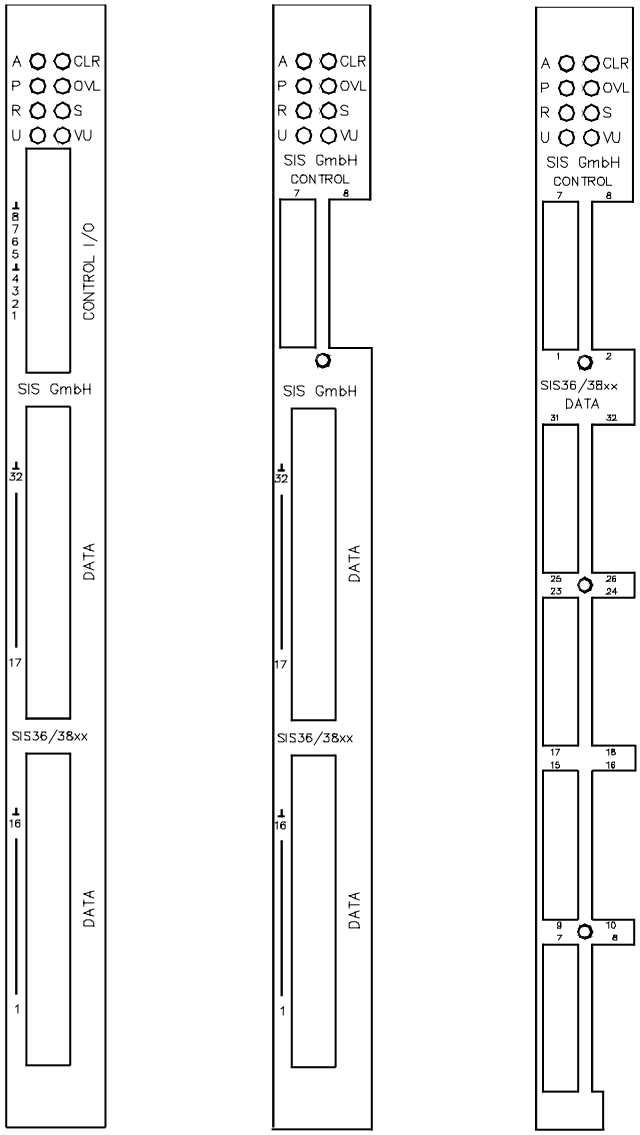
Find below the table of address modifiers, which can be used with the SIS360x/38xx (with the corresponding addressing mode enabled).

AM code	Mode
0x3F	A24 supervisory block transfer (BLT)
0x3D	A24 supervisory data access
0x3B	A24 non-privileged block transfer (BLT)
0x39	A24 non-privileged data access
0x2D	A16 supervisory access
0x29	A16 non-privileged access
0x0F	A32 supervisory block transfer (BLT)
0x0D	A32 supervisory data access
0x0B	A32 non-privileged block transfer (BLT)
0x09	A32 non privileged data access
	Future option: CBLT

19.2 Front Panel Layout

The front panel of the SIS3800 is equipped with 8 LEDs, 8 control in- and outputs and 32 counter inputs. On flat cable units (ECL and TTL) the control connector is a 20 pin header flat cable connector and the channel inputs are fed via two 34-pin headers. On LEMO (NIM and TTL) units the control in- and outputs are grouped to one 8 channel block and the counter inputs are grouped into 2 blocks of 16 channels. A mixed LEMO control/flat cable counter input version is available also. The units are 4 TE (one VME slot) wide, the front panel is of EMC shielding type. VIPA extractor handles are available on request or can be retrofitted by the user, if he wants to change to a VIPA crate at a later point in time.
In the drawing below you can find the flat cable (left hand side), the LEMO control/flat cable input (middle) and LEMO front panel layouts.

Note: Only the aluminium portion without the extractor handle mounting fixtures is shown



19.3 Flat cable Input/Output Pin Assignments

19.3.1 ECL

Data-Connector Channel 1-16

PIN	SIGNAL	SIGNAL	PIN
32	IN16 -	IN16 +	31
30	IN15 -	IN15 +	29
28	IN14 -	IN14+	27
26	IN13 -	IN13 +	25
24	IN12 -	IN12 +	23
22	IN11 -	IN11 +	21
20	IN10 -	IN10 +	19
18	IN9 -	IN9 +	17
16	IN8 -	IN8 +	15
14	IN7 -	IN7 +	13
12	IN6 -	IN6 +	11
10	IN5 -	IN5 +	9
8	IN4 -	IN4 +	7
6	IN3 -	IN3 +	5
4	IN2 -	IN2 +	3
2	IN1 -	IN1 +	1

Front view

INx + = ECL High active
INx - = ECL Low active

Data-Connector Channel 17-32

PIN	SIGNAL	SIGNAL	PIN
32	IN32 -	IN32 +	31
30	IN31 -	IN31 +	29
28	IN30 -	IN30 +	27
26	IN29 -	IN29 +	25
24	IN28 -	IN28 +	23
22	IN27 -	IN27 +	21
20	IN26 -	IN26 +	19
18	IN25 -	IN25 +	17
16	IN24 -	IN24 +	15
14	IN23 -	IN23 +	13
12	IN22 -	IN22 +	11
10	IN21 -	IN21 +	9
8	IN20 -	IN20 +	7
6	IN19 -	IN19 +	5
4	IN18 -	IN18 +	3
2	IN17 -	IN17 +	1

Front view

INx + = ECL High active
INx - = ECL Low active

Control-Connector Input 1-4 /Output 5-8

PIN	SIGNAL	SIGNAL	PIN
20	GND	GND	19
18	OUT8-	OUT8+	17
16	OUT7-	OUT7+	15
14	OUT6-	OUT6+	13
12	OUT5-	OUT5+	11
10	GND	GND	9
8	IN4 -	IN4 +	7
6	IN3 -	IN3 +	5
4	IN2 -	IN2 +	3
2	IN1 -	IN1 +	1

Front view

INx + = ECL High active
INx - = ECL Low active

OUTx + = ECL High active
OUTx - = ECL Low active

19.3.2 TTL

Data-Connector Channel 1-16

PIN	SIGNAL	SIGNAL	PIN
32	IN16 -	GND	31
30	IN15 -	GND	29
28	IN14 -	GND	27
26	IN13 -	GND	25
24	IN12 -	GND	23
22	IN11 -	GND	21
20	IN10 -	GND	19
18	IN9 -	GND	17
16	IN8 -	GND	15
14	IN7 -	GND	13
12	IN6 -	GND	11
10	IN5 -	GND	9
8	IN4 -	GND	7
6	IN3 -	GND	5
4	IN2 -	GND	3
2	IN1 -	GND	1

Front view

INx - = TTL Low active (74F245)

Data-Connector Channel 17-32

PIN	SIGNAL	SIGNAL	PIN
32	IN32 -	GND	31
30	IN31 -	GND	29
28	IN30 -	GND	27
26	IN29 -	GND	25
24	IN28 -	GND	23
22	IN27 -	GND	21
20	IN26 -	GND	19
18	IN25 -	GND	17
16	IN24 -	GND	15
14	IN23 -	GND	13
12	IN22 -	GND	11
10	IN21 -	GND	9
8	IN20 -	GND	7
6	IN19 -	GND	5
4	IN18 -	GND	3
2	IN17 -	GND	1

Front view

INx - = TTL Low active (74F245)

Control-Connector Input 1-4 /Output 5-8

PIN	SIGNAL	SIGNAL	PIN
20	GND	GND	19
18	OUT8-	GND	17
16	OUT7-	GND	15
14	OUT6-	GND	13
12	OUT5-	GND	11
10	GND	GND	9
8	IN4 -	GND	7
6	IN3 -	GND	5
4	IN2 -	GND	3
2	IN1 -	GND	1

Front view

INx - = TTL Low active (74F245)

OUTx - = TTL Low active (74F244)

19.4 List of Jumpers

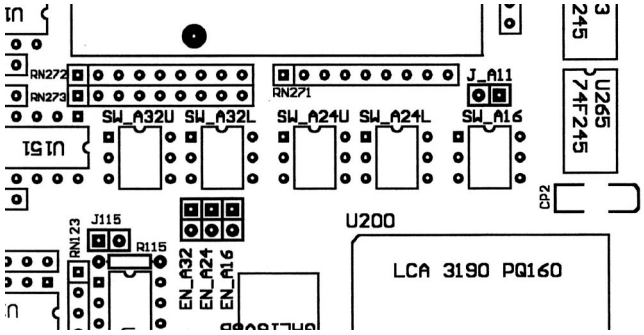
Find below a list of the jumpers and jumper arrays.

Jumper Name	Array/Single	Function
J101	Single	Input Termination Control Input 1
J102	Single	Input Termination Control Input 2
J103	Single	Input Termination Control Input 3
J104	Single	Input Termination Control Input 4
J105	Single	Input Termination Control Input 5
J106	Single	Input Termination Control Input 6
J107	Single	Input Termination Control Input 7
J108	Single	Input Termination Control Input 8
J115	Single	Level Configuration (not for end user)
J500	Array	Boot File Selection
J520	Single	VME SYSRESET Behaviour
EN_A16	Single	Enable A16 addressing
EN_A24	Single	Enable A24 addressing
EN_A32	Single	Enable A32 addressing
J_A11	Single	Address Bit 11 Selection

19.5 Jumper and rotary switch locations

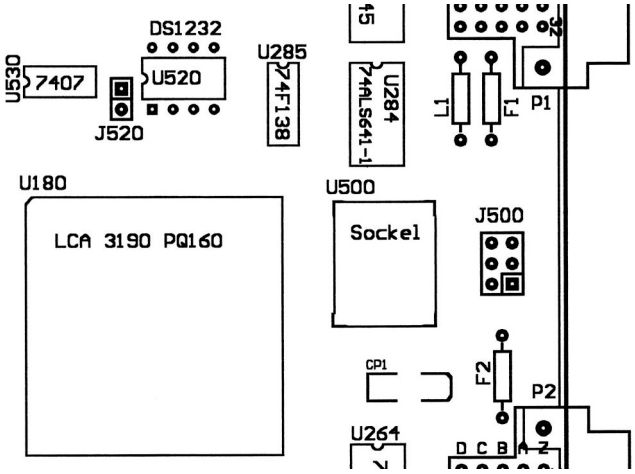
19.5.1 Addressing mode and base address selection

The EN_A32, EN_A24, EN_A16, A_11 and the 5 rotary switches are located int the middle of the upper section of the board close to the DC/DC converter, the corresponding section of the PCB is shown below.

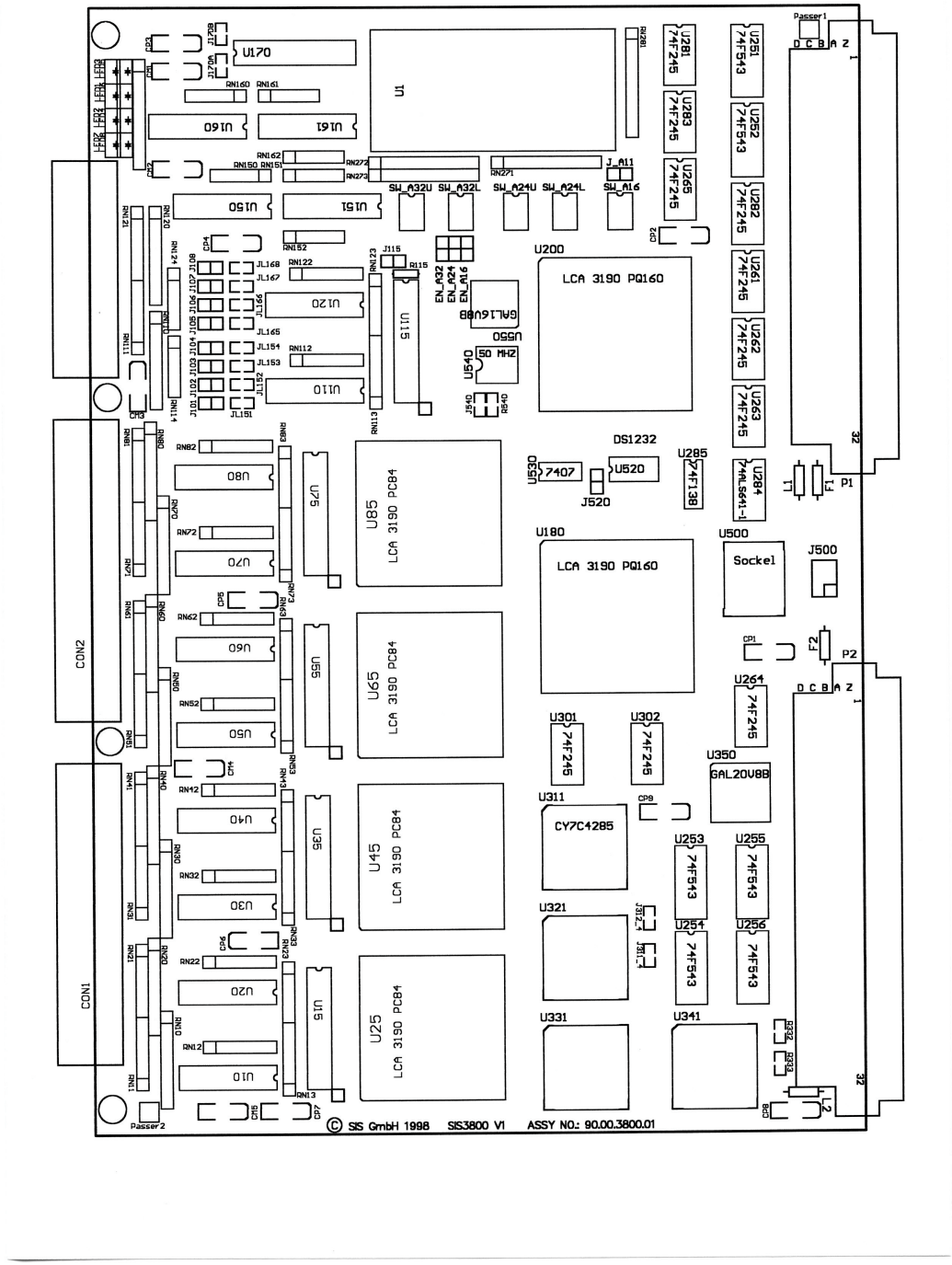


19.5.2 J500 (Bootfile Selection) and J520 (SYSRESET Behaviour)

The jumper array J500 is located between the P1 and the P2 connector. An open position in J500 defines a one (see also chapter 4), the lowest bit is next to the P2 connector.. J520 is located to the left of J500 and closer to the DC-DC converter. With jumper J520 closed the SIS3800 executes a key reset upon the VME SYSRESET signal. The section of the board with the jumper array and the SYSRESET jumper is shown below.



19.6 Board Layout



19.7 FLASHPROM Versions

A list of available FLASHPROMs can be obtained from http://www.struck.de/sis3638firm.htm. Please note, that a special hardware configuration may be necessary for the firmware design of interest (the SIS3801 design requires the installation of a FIFO e.g.).
The table on the web is of the format shown below:

SIS36/38xx FLASHPROM table

Design Name	Design	Boot File (s)
SIS3800_201098	0	SIS3800 Version 1
SIS3801_201098	0	SIS3800 Version 1
	1	SIS3800 Version 2
	2	SIS3801 Version 1 (32-bit Design)
	3	SIS3801 Version 2 (24-bit Design)
SIS3803_131198	0	SIS3803 Version 1

19.8 Row d and z Pin Assignments

The SIS3800 is prepared for the use with VME64x and VME64xP backplanes. Foreseen features include geographical addressing 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.

19.9 Geographical Address Pin Assignments

The SIS38xx board series is prepared for geographical addressing via the geographical address pins GA0*, GA1*, GA2*, GA3*, GA4* and GAP*. The address pins are left open or tied to ground by the backplane as listed in the following table:

Slot Number	GAP* Pin	GA4* Pin	GA3* Pin	GA2* Pin	GA1* Pin	GA0* Pin
1	Open	Open	Open	Open	Open	GND
2	Open	Open	Open	Open	GND	Open
3	GND	Open	Open	Open	GND	GND
4	Open	Open	Open	GND	Open	Open
5	GND	Open	Open	GND	Open	GND
6	GND	Open	Open	GND	GND	Open
7	Open	Open	Open	GND	GND	GND
8	Open	Open	GND	Open	Open	Open
9	GND	Open	GND	Open	Open	GND
10	GND	Open	GND	Open	GND	Open
11	Open	Open	GND	Open	GND	GND
12	GND	Open	GND	GND	Open	Open
13	Open	Open	GND	GND	Open	GND
14	Open	Open	GND	GND	GND	Open
15	GND	Open	GND	GND	GND	GND
16	Open	GND	Open	Open	Open	Open
17	GND	GND	Open	Open	Open	GND
18	GND	GND	Open	Open	GND	Open
19	Open	GND	Open	Open	GND	GND
20	GND	GND	Open	GND	Open	Open
21	Open	GND	Open	GND	Open	GND

19.10 Additional Information on VME

The VME bus has become a popular platform for many realtime applications over the last decade. Information on VME can be obtained in printed form, via the web or from newsgroups. Among the sources are the VMEbus handbook, http://www.vita.com (the home page of the VME international trade association (VITA)) and comp.bus.arch.vmebus. In addition you will find useful links on many high energy physics labs like CERN or FNAL

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