

**BSMS**

**BSMS Shim  
User Manual**

**Version 002**





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# Contents

Goto

<b>1</b>	<b>General Description .....</b>	<b>3</b>
1.1	Introduction .....	3
1.2	Basic Operation .....	3
1.3	Troubleshooting .....	3
<b>2</b>	<b>Shim Current Board SCB .....</b>	<b>5</b>
2.1	Introduction .....	5
2.2	Installation .....	8
2.3	Current Sources .....	10
2.4	HRDAC .....	14
2.5	GRASP (Homospoil) .....	14
2.6	H0 .....	14
2.7	Shim System Temperature .....	14
2.8	Shim System Version .....	14
2.9	BOSS .....	15
2.10	Technical Data .....	17
	<b>Index .....</b>	<b>21</b>
	<b>List of Figures .....</b>	<b>23</b>
	<b>List of Tables .....</b>	<b>25</b>



## Introduction

**1.1**

This manual describes the subsystem of the BSMS (Bruker Smart Magnet control System) which handles the NMR spectrometer's room temperature shims. To support the shim functions available on the BSMS, the following hardware is required:

1. A minimum of one shim current board (SCB), in particular, an SCB13R.
2. One room temperature shim system (BOSS1, BOSS2, etc.).

## Basic Operation

**1.2**

All functions of the shim subsystem of the BSMS are accessible via the BSMS keyboard or BSMS Service Tool. Please see the corresponding section in the BSMS User's Manual.

## Troubleshooting

**1.3**

An error in the shim subsystem is indicated by an error message on the BSMS keyboard and by the error LED('s) on the SCB('s). The error message has the format: **E: "Error number" SCB\_ "Error Text" press 'STD BY'.**

If such an error occurs, the basic troubleshooting procedure is as follows:

1. Check the power supply to verify that all power LED's (green) are lit. The ready LED is lit only if the local processor system is functioning properly.
2. If there appear to be several errors originating from different boards, it is possible that they stem from an error on one particular board. First remove all the boards which show an error. Next, replace one board to see if an error still appears. Remove this board and replace the next board, and so on, until the board which is the source of the errors is identified. Note that if several SCB's show an error, it is important first to remove all but the right SCB, then all but the middle SCB, and then finally, all but the left SCB (if there is one).
3. Start the BSMS Service Tool (`[bsms]` in UNIX).
4. In the submenus [7] "*board functions SCB13R...*", [8] "*board functions SCB7/SCB13M...*", and [9] "*board functions SCB13L...*" are many functions for debugging the SCB('s).

**IMPORTANT: For more information please read the Service Tools Manual.**





A shim current board (SCB) is constructed in a modular fashion and contains a maximum of 13 current sources. Each SCB is equipped with one DAC (HRDAC) and 13 sample-and-hold's. At least two current ranges are available for each current source.

One GRASP (Homospoil) DAC is required for implementing homospoil or GRadi-ent Assisted Spectroscopy (see GRASP Manual).

The SCB is driven by a local microprocessor system (80C535) that operates as a slave within the VMEBus system. The application software runs on a real time operating system and can be downloaded to the computer via the serial link (see BSMS Service Tool Manual).

Multiple SCB's can be set up within one BSMS. This is necessary only when more than 13 shims are required. When multiple SCB's are installed in one BSMS, they are always referred to in order from right to left, as reflected by the current source numbers (the right-most board contains current sources 1...13, the next board to the left contains current sources 14...26, and so on).

The High Resolution Digital to Analog Converter (HRDAC) is the resolution and stabilizing element. It is mounted as a separate board on the SCB.

The exact type and configuration of an SCB is shown by the SCB label which is visible from the front of the BSMS. The label can be interpreted as shown in Figure 1. The SCB's as seen from the front of a BSMS with a BOSS2 configuration are shown in Figure 2.

Figure 1: Type and Configuration of an SCB

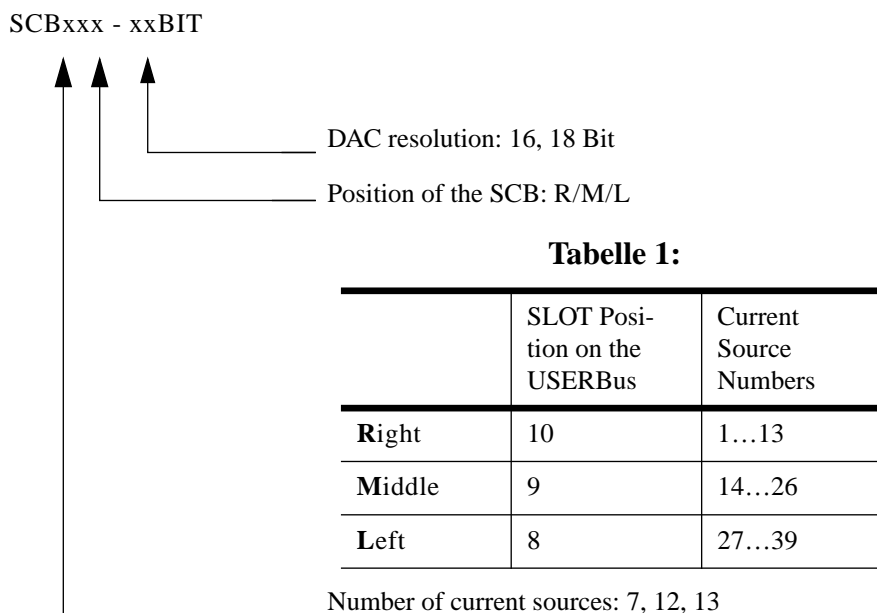


Figure 2: Three SCB's in a BSMS with BOSS2 Configuration:

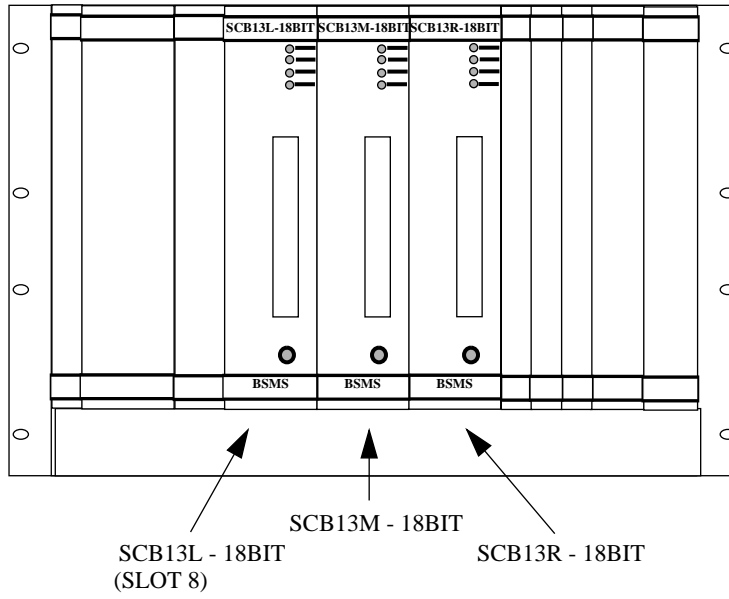
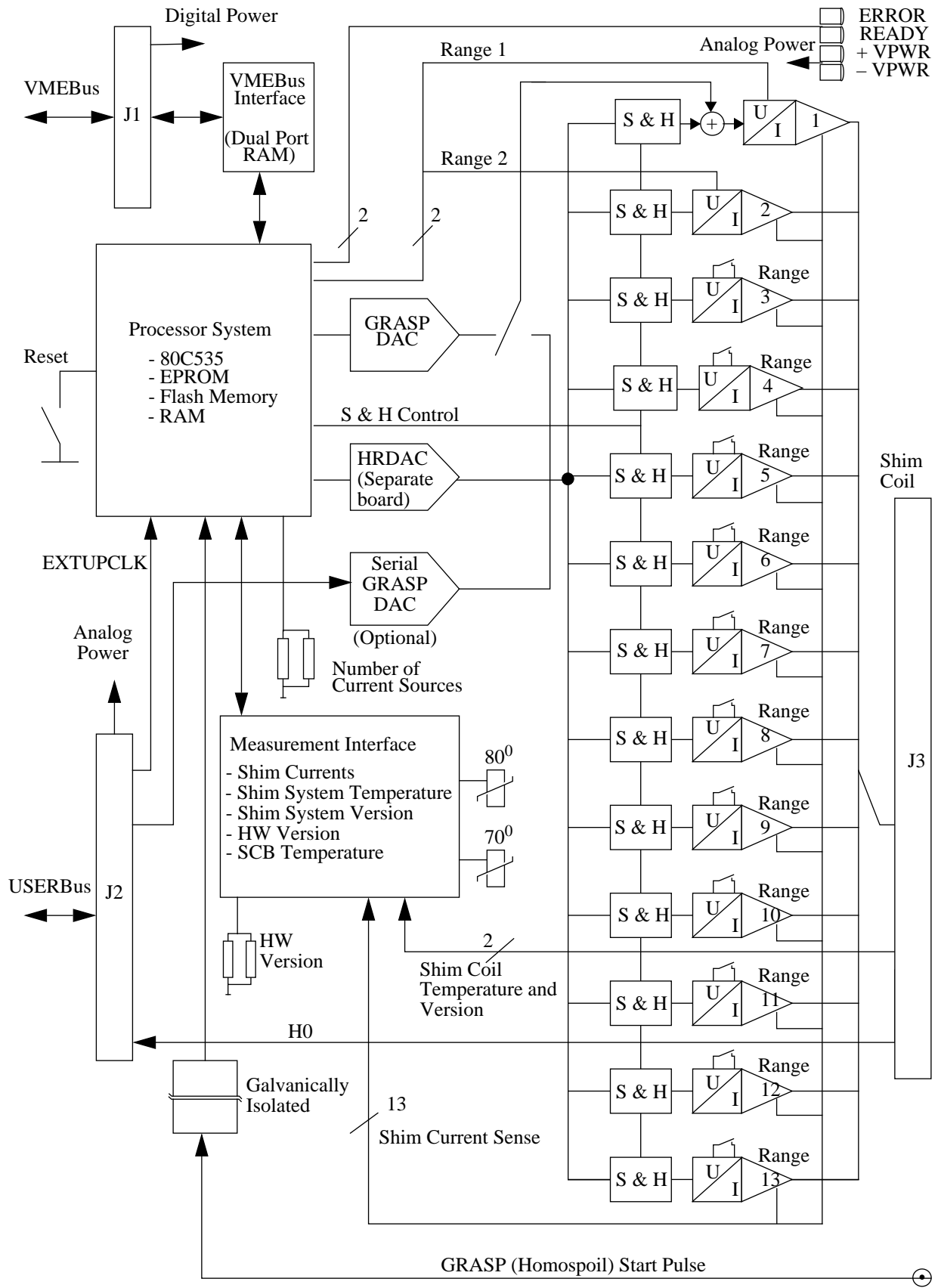


Figure 3: Shim Current Board Block Diagram



*To install an SCB please follow the guide below, making sure to do each step in the order given:*

1. Check the range switches (see Position of Range Switches and HRDAC on the SCB on page 11) on the SCB. These should be set so that no error messages appear on the BSMS keyboard display. No more hardware adjustment is necessary!
2. Insert the SCB('s) in the corresponding slot(s) of the BSMS. If more than one SCB is being installed, insert the boards in order from right to left. Tighten the restraining screws.
3. Connect the shim system (the adapter board SCB13/7-BSN18 INTERFACE Z002734 may be required).
4. Switch on the BSMS. After one second, all the green LED's on the front of the SCB('s) should be lit. No error LED's should be lit.
5. Check the software version with the BSMS Service Tool and download the new software if necessary.
6. If the shim system is a BOSS2, follow the instruction for Installation of a BOSS2 System with the BSMS below.

*Note: If you are changing from the BSN-18/BSN-3 to the BSMS you should measure and note each current value of the BSN-18/BSN-3 and then set the corresponding current values on the BSMS to these same values. This will reduce the final shimming to a minimum.*

### Installation of a BOSS2 System with the BSMS

#### 2.2.1

To install the BOSS2 shim system (see BOSS on page 15), the following hardware configuration is required:

1. Set of three wires for power supply Z12171.
2. SCB13L-18BIT Z012709.
3. SCB13M-18BIT Z022709.
4. SCB13R-18BIT Z002709.
5. Fan Board Z002741.
6. BOSS Keyboard Z012706.

To upgrade from a BOSS1 to a BOSS2 system, an additional SCB is required (the SCB13L). Furthermore, the SCB7M must be replaced by an SCB13M, and if the SCB13R is a 16 Bit type, then it must be replaced by an 18 Bit type.

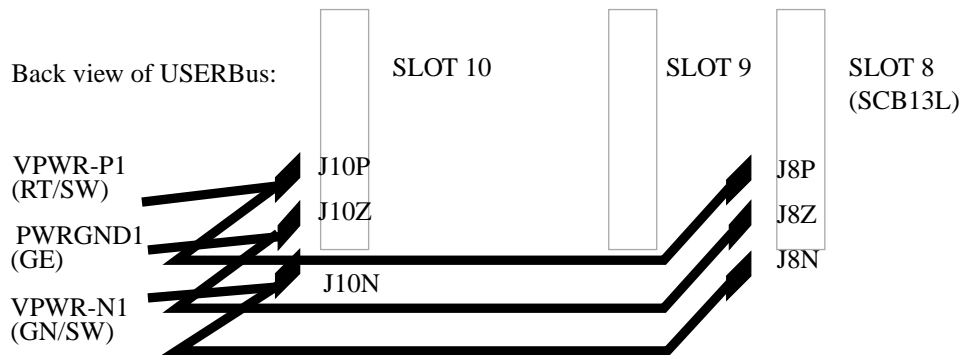
### ***Before touching anything:***

To avoid using OSAM2 to determine the new shim values, the BOSS1 shim values can be used as starting values for the BOSS2 shims. It is necessary, however, to note the BOSS1 values on a piece of paper, since the file formats of the two systems are incompatible. In addition, these values serve only as approximate starting values for the BOSS2 system, because the two shim systems function differently.

### Hardware Installation:

1. Plug in the power supply cables for the SCB13L, connecting slot 10 with slot 8 as shown in Figure 4.

*Figure 4: Power Supply Cables for the SCB13L (Z12171)*



2. Set all range switches on the three SCB's to range 1 (i.e., position the slider away from Pin1 of the DIP switch).
3. Insert the fan board in slot 6 of the BSMS rack.
4. Install the three SCB's in order from right to left.
5. Plug the BOSS2 into the three SCB's.

### Software Installation:

1. Install the BSMS service tool from tape (see Service Tools Manual).
2. Start the BSMS service tool (`[bsms]` in UNIX).
3. Download the whole BSMS (`[2]` in the main menu).
4. Change the CPU configuration to BOSS2 (`[4]` to enter the shim functions submenu, then type `[A]`).
5. Initialize the BSMS (`[I]` in the main menu).
6. Load the BOSS data (`[9]` within the shim functions submenu). Type `[Y]` when asked whether or not to save to EEPROM.
7. With the BSMS keyboard, enter the BOSS1 shim values from your paper, or use OSAM2.
8. Shim the system.

Please read the instructions for operating the shims with the BSMS keyboard in the BSMS User's Manual.

There are three active shim modes from which to choose (these are loaded automatically or with the command [*cfboss*]):

**User:** The default mode. This is the mode to be used for routine operation. Only 28 of the possible 39 gradients are active.

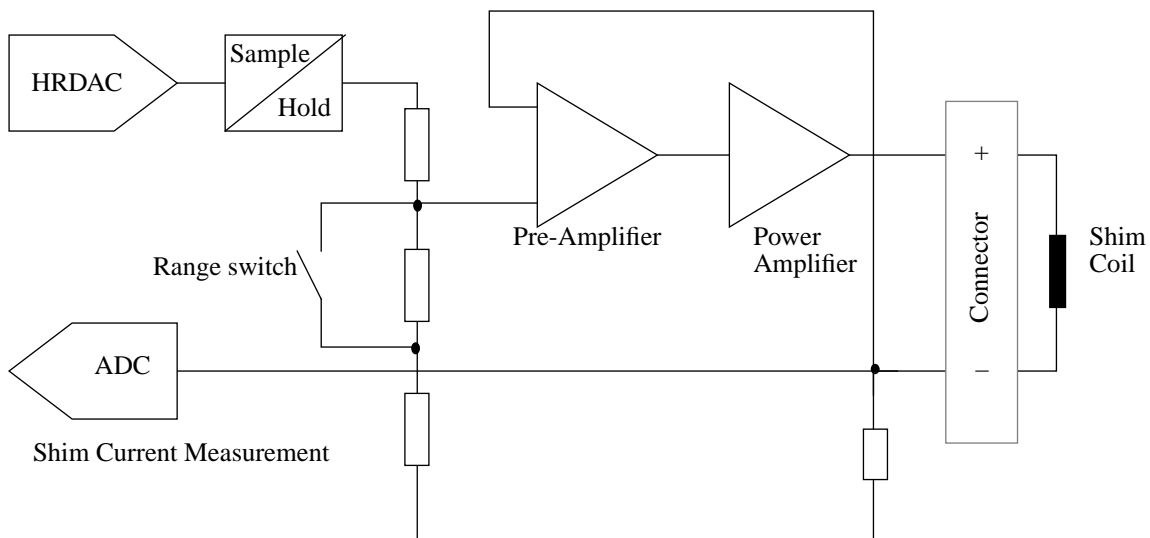
**Install:** Used by the service engineer during spectrometer installation. This mode cannot be selected on all BOSS2 systems.

**Service:** Used by the service engineer for hardware diagnosis. This mode cannot be selected on all BOSS2 systems.

## Current Sources

## 2.3

Figure 5: Block Diagram of a Current Source



All current sources are constructed in basically the same way. The HRDAC charges the corresponding sample and hold capacitor. Recharging takes place at regular intervals (~ 1 kHz refresh rate). The setting voltage is then passed through a resistor attenuator. The attenuation value is set by the range switch. The attenuated voltage is transformed via the preamplifier and power amplifier to the desired current (1V input voltage gives 1A output current). The power amplifier has a thermal shut-down that interrupts the output current if the current or the temperature is too high.

A power off or a hardware reset causes all current values to be reset. It is possible to save a set of current values on the CPU in the BSMS (see BSMS User's Manual section 4.2 Save Config on page 28). These shim currents are then reloaded every time a reset (either hardware or software) occurs.

*N.B.: If the CPU is exchanged, the shim currents are lost!*

## Shim Current Measurement

## 2.3.1

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Each shim current can be measured and displayed on the BSMS keyboard or on the computer. The accuracy and resolution of the measurement are not high, and so yield a qualitative rather than a quantitative result (see Technical Data on page 17).

*Figure 6: Position of Range Switches and HRDAC on the SCB*

1 (14, 27) no SW

2 (15, 28) no SW

3 (16, 29) SW5

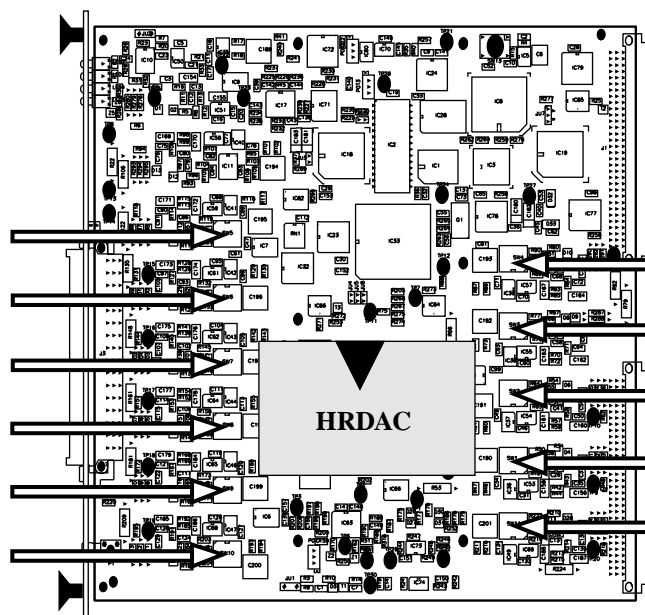
4 (17, 30) SW6

5 (18, 31) SW7

6 (19, 32) SW8

7 (20, 33) SW9

8 (21, 34) SW10



13 (26, 39) SW4

12 (25, 38) SW3

11 (24, 37) SW2

10 (23, 36) SW1

9 (22, 35) SW11

Detailed view of a range DIP switch

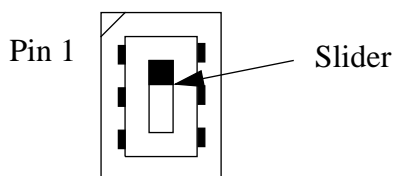


Table 2. DIP Switch Settings

Table 3:

Slider position	Current Source Range
Up (Pin 1)	0
Down	1



Figure 7: Shimcoil Connector Layout

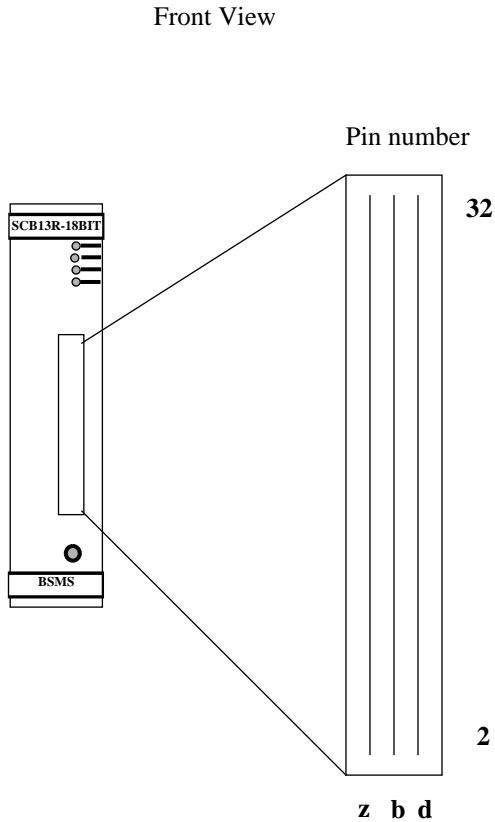


Tabelle 4:

Current Source Number	Pin Number of +	Pin Number of -
1	30 d	30 b
2	28 d	28 b
3	26 d	26 b
4	24 d	24 b
5	22 d	22 b
6	20 d	20 b
7	18 d	18 b
8	16 d	16 b
9	14 d	14 b
10	12 d	12 b
11	10 d	10 b
12	8 d	8 b
13	6 d	6 b
H0	2 z	4 z
PT100	4 b	4 d
Id	2 d	2 b

### Overheating and Power Protection

### 2.3.2

If an SCB becomes too hot ( $> 80\text{ }^{\circ}\text{C}$ ) all currents are set to zero automatically and an error message appears on the BSMS keyboard. If the temperature reaches  $70\text{ }^{\circ}\text{C}$ , an error message is displayed on the BSMS keyboard but the currents are not set to zero. To protect the shim system, an on-line power supervision calculates the power in the shim system and issues an error message if the power dissipation is too high. The calculation assumes that the average resistance of a shim coil is  $15\ \Omega$  and meas-

ures the current of each shim coil. The power dissipation limit can be changed by the BSMS Service Tool.

*N.B.: If the power dissipation is too high, the shim system will overheat and may be damaged as a result. This may occur if some room temperature shim currents are set too high. If good shimming requires some room temperature shim currents to be set too high, the cryoshims must be adjusted.*

---

## HRDAC

2.4

The HRDAC (High Resolution Digital to Analog Converter) is the resolution and stabilizing element of all current sources. It is mounted as a separate board on the SCB. The HRDAC has been balanced with respect to its offset and gain values. These balance values are, however, only of secondary importance.

---

## GRASP (Homospoil)

2.5

Please read the information in the BSMS GRASP Manual.

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## H0

2.6

The current source which produces and controls H0 is implemented on the lock controller board (LCB). It is fed to the room temperature shim system via the USERBus (see BSMS Mainframe Manual) and the SCB13R (SLOT 10). For further details refer to the Lock Manual.

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## Shim System Temperature

2.7

If the shim system has a PT100, then the temperature of the turbine can be measured.

---

## Shim System Version

2.8

The value of the version resistor on the shim system can be read electronically and is sometimes used for automatic functions.

A different configuration of the SCB's is required to support the different Bruker Orthogonal Shim Systems (BOSS's).

It is possible to use older shim systems with the BSMS; however, this requires an SCB13/7-BSN18 INTERFACE adapter board. The interface contains the old connectors and is mounted on the SCB13R and the SCB7M.

## BOSS1 Configuration

### 2.9.1

**Table 5. BOSS1 Hardware Configuration**

**Tabelle 6:**

SLOT Position	SCB	HRDAC
10	SCB13R	18 or 16 Bit
9	SCB7M	16 Bit

**Table 7. BOSS1 Current Sources Attached to the Shim Gradients**

**Table 8.**

Current Source Number SCB13R(SCB7M)	SCB13R	SCB7M
	Shim Gradient	
1 (14)	Z	—
2 (15)	Z <sup>2</sup>	—
3 (16)	Z <sup>3</sup>	Z <sup>3</sup> Y
4 (17)	Z <sup>4</sup>	Z <sup>6</sup>
5 (18)	Z <sup>5</sup>	Z(X <sup>2</sup> -Y <sup>2</sup> )
6 (19)	X	—
7 (20)	ZX	Z <sup>3</sup> X
8 (21)	Z <sup>2</sup> X	—
9 (22)	X <sup>2</sup> -Y <sup>2</sup>	ZXY
10 (23)	XY	—
11 (24)	Y	X3

**Table 8.**

Current Source Number SCB13R(SCB7M)	SCB13R	SCB7M
	Shim Gradient	
12 (25)	ZY	—
13 (26)	Z <sup>2</sup> Y	Y <sup>3</sup>

**Table 9. BOSS1 Selectable Shim Gradients (20 Gradients)**

Grade total	0	1	2 $X^2 \cong X^2 - Y^2$ $Y^2 \cong XY$	3
0				
1	Z <sup>1</sup>	X / Y		
2	Z <sup>2</sup>	XZ / YZ	X <sup>2</sup> / Y <sup>2</sup>	
3	Z <sup>3</sup>	XZ <sup>2</sup> / YZ <sup>2</sup>	X <sup>2</sup> Z / Y <sup>2</sup> Z	X <sup>3</sup> / Y <sup>3</sup>
4	Z <sup>4</sup>	XZ <sup>3</sup> / YZ <sup>3</sup>		
5	Z <sup>5</sup>			
6	Z <sup>6</sup>			

**BOSS2 Configuration****2.9.2**

Please read Installation of a BOSS2 System with the BSMS on page 8.

**Table 10. BOSS2 Hardware Configuration****Tabelle 11:**

SLOT Posi- tion	SCB	HRDAC
10	SCB13R	18 Bit
9	SCB13M	18 Bit
8	SCB13L	18 Bit

**Table 12. BOSS2 Selectable Shim Gradients (28 Gradients)**

Grade total	0	1	$X^2 \cong X^2 - Y^2$ $Y^2 \cong XY$	3
0	$Z^0$			
1	$Z^1$	X / Y		
2	$Z^2$	XZ / YZ	$X^2 / Y^2$	
3	$Z^3$	$XZ^2 / YZ^2$	$X^2Z / Y^2Z$	$X^3 / Y^3$
4	$Z^4$	$XZ^3 / YZ^3$	$X^2Z^2 / Y^2Z^2$	$X^3Z / Y^3Z$
5	$Z^5$	$XZ^4 / YZ^4$	$X^2Z^3 / Y^2Z^3$	
6	$Z^6$			

SHIM MODE: USER

**Technical Data**

**2.10**

**Table 13. Technical Data of the Current Sources**

**Table 14.**

Current Source Number	Shim-Range Switch	Current Values Limit (+/-mA)	Shim-Range Control
1 (14, 27)	0	16	Ranges are under software control
	1	59	
	2	130	
	3	480	
2 (15, 28)	0	109	
	1	242	
	2	488	
	3	980	
3...13 (16...26, 29...39)	0	520	Ranges must be selected using DIP switches on the SCB. The position of the DIP switches can be read via software
	1	980	

All values assume a supply voltage of 22 V.

**Table 15. Technical Data of a Shim Current Measurement**

**Tabelle 16:**

Shim Current Measurement				
Measurement	Range	+/- 1.27	A	8 Bit DAC (+/- 1LSB)
	Resolution	10	mA	
	Accuracy	+/- 10	mA	
	Update rate	~100	Hz	

**Table 17. Technical Data of the HRDAC**

**Tabelle 18:**

HRDAC 18Bit				
Input Values	Range	+/- 130000	Unit	
	Resolution	+/- 1	Unit	
Output Currents	Max. Range	+/- 980	mA	Current Source 2, Range 1
	Max. Resolution	123	nA	Current Source 1, Range 0

**Tabelle 19:**

HRDAC 16Bit				
Input Values	Range	+/- 130000	Unit	
	Resolution	+/- 4	Unit	
Output Currents	Max. Range	+/- 980	mA	Current Source 2, Range 1
	Max. Resolution	492	nA	Current Source 1, Range 0

**Table 20. Technical Data of the Shim System Temperature**

**Tabelle 21:**

<b>Shim System Temperature</b>				
Measurement	Range	-100...+150	°C	With PT100 on a 2-wire system. No software correction of the linearity!
	Resolution	1	°C	
	Accuracy	+/- 10	%	





# Index

Goto

<b>B</b>		
	Bruker Orthogonal Shim Sytem .....	15
	BSMS .....	3
	BSMS Service Tool .....	3
<b>D</b>		
	DIP switch.....	12
<b>H</b>		
	High Resolution Digital to Analog Converter .....	14
	HRDAC .....	14
<b>O</b>		
	Overheating .....	13
<b>P</b>		
	Power Protection .....	13
<b>S</b>		
	SCB .....	5
	SCB13/7-BSN18 INTERFACE Z002734 .....	8
	Service Tools manual .....	3
	Shim Current Board.....	5
	Shim Current Measurement .....	11
<b>T</b>		
	Troubleshooting .....	3
<b>U</b>		
	USERBus .....	14



# List of Figures

**1.General Description 3**

**2.Shim Current Board SCB 5**

Figure 1: Type and Configuration of an SCB ..... 5  
Figure 2: Three SCB's in a BSMS with BOSS2 Configuration:..... 6  
Figure 3: Shim Current Board Block Diagram..... 7  
Figure 4: Power Supply Cables for the SCB13L (Z12171)..... 9  
Figure 5: Block Diagram of a Current Source.....11  
Figure 6: Position of Range Switches and HRDAC on the SCB .....12  
Figure 7: Shimcoil Connector Layout.....13

**1.General Description 3**

**2.Shim Current Board SCB 5**

Figure 1: Type and Configuration of an SCB ..... 5  
Figure 2: Three SCB's in a BSMS with BOSS2 Configuration:..... 6  
Figure 3: Shim Current Board Block Diagram..... 7  
Figure 4: Power Supply Cables for the SCB13L (Z12171)..... 9  
Figure 5: Block Diagram of a Current Source.....10  
Figure 6: Position of Range Switches and HRDAC on the SCB .....11  
Figure 7: Shimcoil Connector Layout.....13



# List of Tables

**1.General Description ..... 3**

**2.Shim Current Board SCB ..... 5**

Table 1. DIP Switch Settings .....12  
Table 2. BOSS1 Hardware Configuration .....15  
Table 3. BOSS1 Current Sources Attached to the Shim Gradients .....15  
Table 4. BOSS1 Selectable Shim Gradients (20 Gradients) .....16  
Table 5. BOSS2 Hardware Configuration .....16  
Table 6. BOSS2 Selectable Shim Gradients (28 Gradients) .....17  
Table 7. Technical Data of the Current Sources .....18  
Table 8. Technical Data of a Shim Current Measurement .....18  
Table 9. Technical Data of the HRDAC .....19  
Table 10. Technical Data of the Shim System Temperature .....19

**1.General Description ..... 3**

**2.Shim Current Board SCB ..... 5**

Table 2. DIP Switch Settings .....12  
Table 5. BOSS1 Hardware Configuration .....15  
Table 7. BOSS1 Current Sources Attached to the Shim Gradients .....15  
Table 8. .....15  
Table 9. BOSS1 Selectable Shim Gradients (20 Gradients) .....16  
Table 10. BOSS2 Hardware Configuration .....16  
Table 12. BOSS2 Selectable Shim Gradients (28 Gradients) .....17  
Table 13. Technical Data of the Current Sources .....17  
Table 14. .....17  
Table 15. Technical Data of a Shim Current Measurement .....18  
Table 17. Technical Data of the HRDAC .....18  
Table 20. Technical Data of the Shim System Temperature .....19

