BRUKER

BSMS

Gradient Amplifier (GAB)

User Manual

Version 002

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Introduction *1.1*

This manual describes the Gradient Amplifier Board (GAB) for the BSMS-Rack.

In conjunction with a GCU (Gradient Control Unit, in the AQX-Rack) and a super shielded z-gradient probe head the GAB becomes an easy to use accessory for single axis (z only) gradient spectroscopy.

When designing the GAB emphasis has been given to ease of use. The user should not have to care about eddy currents, offset adjustment, power limits or load compensation. This can be headlined 'plug & play'.

Basic Operation *1.2*

For gradient spectroscopy a sequence of gradient pulses is needed to defocus and selectively refocus magnetisation.

The timing, amplitude and shape of the pulses are controled by the Gradient Control Unit (GCU) which is an intelligent real time processor located in the AQX acquisition computer. Here it's operating under direct control of the timing processor 'TCU'. This GCU is the same for all of Brukers gradient accessories for the AVANCE series, offering one consistent user- and automation-interface and opening an easy upgrade path form single axis NMR to three axis imaging hardware.

The Gradient Amplifier Board (GAB) converts the digital data from the GCU into analogue current pulses. It is located in the BSMS, the system housing the shim unit, the lock and other magnet support systems. It uses the same low noise power supply as the shims do.

The digital control data received from the GCU is converted into an analogue voltage which in turn controls a high performance power current amplifier. As the gradient strength solely depends on the current flowing through the gradient coil, the current amplifier design compensates for any inductivities and thermally changing resistances. The amplifiers high bandwidth and dynamic range result in excellent recovery time and silent stability.

The above main function is assisted by a variety of protection and selfadjustment hardware. Any overload or error condition is reported to the BSMS keyboard as it is the case for all other bsms subsystems. The error message has the format: E: "Error Number" GAB_ "Error Text" press 'STD BY'.

General Description

Hardware Installation 2

Introduction *2.1*

To equip an AVANCE series spectrometer with a GAB you need the following items:

Z002764	Gradient Amplifier Board (GAB)
H2546	Gradient Control Unit (GCU)
W1208167	Cable "Gradient" for GAB-Gradient coil, with filter
H5577	Acquisition bus extension board [1]
HZ2969	Ribbon cable ACQ bus extension [1]
3033	30 Jumpers for VME bus
H5517	Cable "40MHz" for TCU-GCU, both sides SMB
H5517	Cable "Increment" for TCU-GCU, both sides SMB
HZ0243	Cable "Data" for GCU-GAB, 50pin both sides Scotchflex, 2m
Z12171	Cable "BOSS/GAB Upgrade", bundle of three wires, 0.2m
Z31327	BSMS Gradient Amplifier User Maual (this manual)
	Cable "Lock Hold" for TCU-BSMS, burndy pin/SMB [2]
	Cable "External DW" for TCU-RCU, burndy pin/SMB [2]
	Cable "External EP" for TCU-RCU, burndy pin/SMB [2]

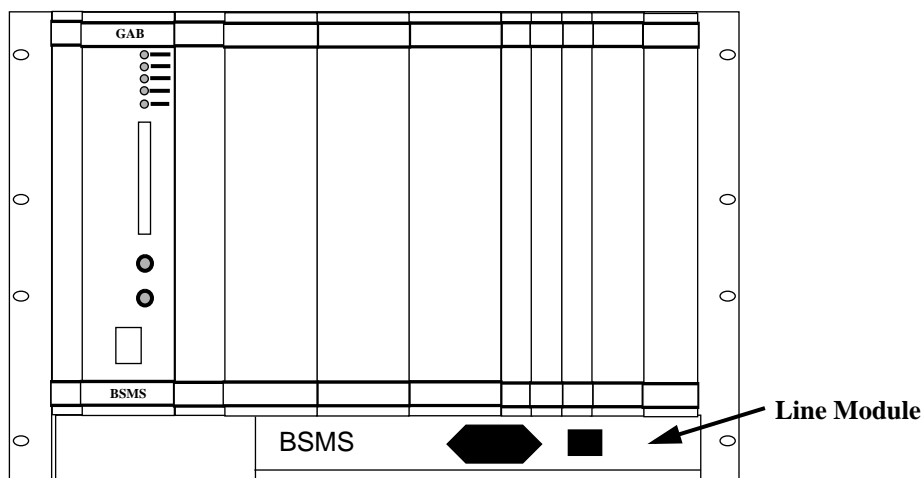1) needed only if more than 3 FCU's are present
2) included in console wiring from ECL05

GCU Installation *2.2*

For GCU installation please refer to "Avance GRASP Installation/User Manual" by Joost A. B. Lohmann, Bruker Spectrospin Ltd, 1995, P/N: Z31299

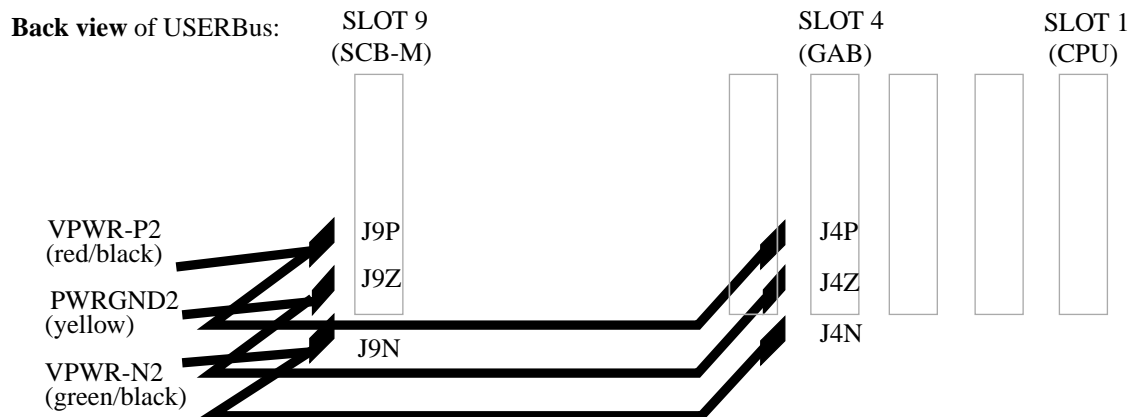Figure 2.1.   *The location of the GAB in the BSMS rack*

Remove all wiring of the BSMS and slide it out of the cabinet. Put it upside down and remove the Line Module (containing line filter and fans). Remove the wires at J9 of the user bus backplane, insert the GAB upgrade wires and reconnect the old wires to J9. Connect the other end of the upgrade wires to J4. Make sure you don't mix up the colors or the order of the wires. See drawing below.

Before remounting the BSMS into the cabinet it is recomended to check the correct power supply of the GAB.

Insert the GAB into its slot and check the +/-15V LED's. They have to be lit now. Connect GCU and GAB with the "Data" cable (HZ0243). Connect GAB and Probe Head with the "Gradient Cable" (W1208167). Connect the lock hold input. Leave open the GAB GATE input. This input is not needed.

Figure 2.2.   Power Supply Cables for the GAB

Back view of USERBus:
SLOT 9
(SCB-M)

SLOT 4
(GAB)

SLOT 1
(CPU)

VPWR-P2
(red/black)

J9P

J9Z

PWRGND2
(yellow)

J9N

VPWR-N2
(green/black)

J4P

J4Z

J4N

Software Installation   *2.3.2*

To recognize the just installed GAB, the BSMS CPU needs new software. This software is distributed together with the XWINNMR releases. The first release containing GAB software is Version 2.0.
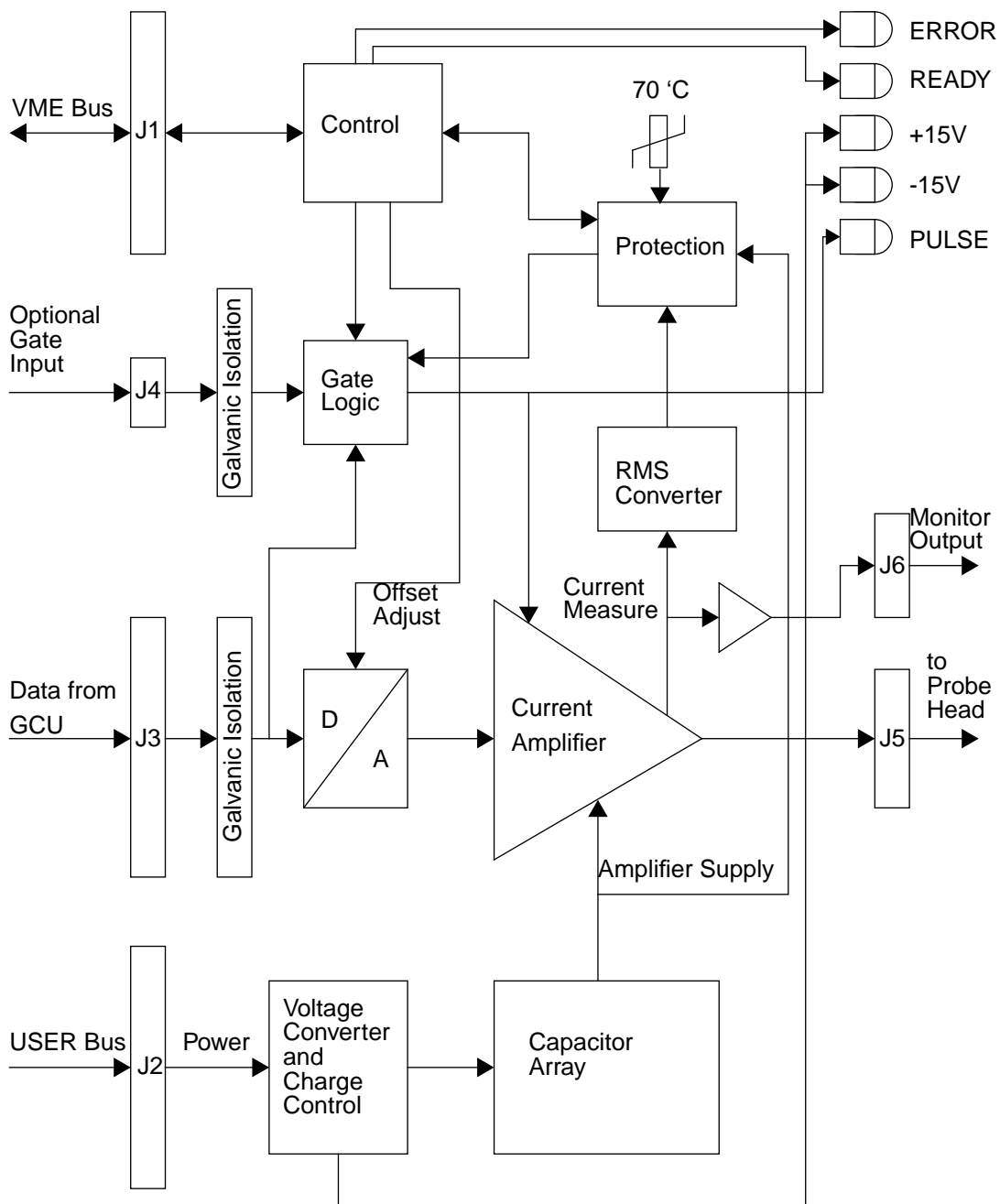
1. Install the latest XWINNMR release, at least release 2.0.

2. Start the BSMS automatic download (type [bsms download] in UNIX).

3. Wait until download has finished.

When the download has finished, the BSMS is rebooted. Afterwards the READY-LED of the GAB has to be lit. ERROR and PULSE LED's have to be off.

Hardware Description

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Figure 3.3.   GAB Block Diagram

GCU Input

The GCU controls the GAB via this connector. To prevent noise from the AQX to enter the GAB all lines of this connector are galvanically isolated.
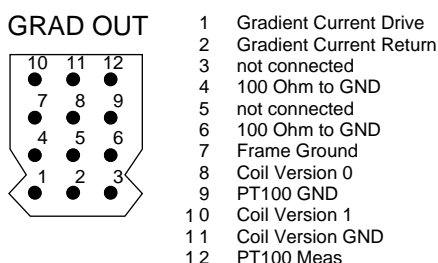
Gate Input

This input is currently not used. If enabled by software it gates the DAC output to ground. You could use it to feed a RCP from the TCU to the GAB. This would allow shorter (rectangular) pulses than possible with GCU only (<10us, which really makes no sense). The gate input is used for production tests, however.

Gradient Output

This connector houses the two gradient output pins, a shield pin connected to BSMS chassis, two version detect inputs and one PT100 measurement input. The latter three are not used at the moment. See figure below.

Figure 3.4.   Gradient Output Connector

GRAD OUT

10 11 12		1	Gradient Current Drive
7 8 9		2	Gradient Current Return
4 5 6		3	not connected
1 2 3		4	100 Ohm to GND

1   Gradient Current Drive
2   Gradient Current Return
3   not connected
4   100 Ohm to GND
5   not connected
6   100 Ohm to GND
7   Frame Ground
8   Coil Version 0
9   PT100 GND
1 0   Coil Version 1
1 1   Coil Version GND
1 2   PT100 Meas

Monitor Output

The monitor output monitors the gradient current in a 1V per 1A fashion. This output can be useful to debug the hardware or software (pulse programs).

Pulse LED (yellow)

This LED monitors the GAB gradient pulses. It's lit during a pulse. If it's statically on, the GCU must have forgotten to switch the gradient pulse off. Check your pulse program. If, however, the lasting gradient pulse is sufficiently strong, the GAB protection circuitry will terminate it and issue an error message.

Ready LED (green)

When the BSMS CPU has booted and the GAB is workung ok, this LED is lit.

Error LED (red)

This LED indicates an error or protection state of the GAB. The BSMS keyboard should display an error string identifying the problem. If,after booting the BSMS, only the Error LED is on (the Ready LED is off), the CPU didn't recognize the GAB. This is either because the CPU has no new software loaded or the VME interface does't work.

Figure 3.5. States of the ERROR and READY LED

○ ERROR
○ READY   CPU found GAB but did not initialize it yet

☼ ERROR
○ READY   CPU didn't find GAB (power up state)

○ ERROR
☼ READY   CPU successfully initialized GAB (ready state)

☼ ERROR
☼ READY   GAB signals an error. Read message on keyboard. (error state)

+15V and -15V LED (green)

These LED's monitor the analogue power supply. If one (or both) of them is off check the VPWR_VDD and VPWR_VSS LED of the SCB7-M or SCB13-M. If these are off too check the fuses.

Adjustment procedures   *3.5*

There is a total of three trimmers on the GAB. These are factory set and should **never be touched** under normal conditions. As nothing more than a multimeter of sufficient precision (DVM) is needed to adjust them, the procedure is described below:

POT 1: RMS power limit

Write a pulse program that makes the GAB issue one 10A (100%), 60ms pulse every second. Turn POT1 to the right end (max. RMS limit), start the pulse program, wait a few seconds and then slowly turn POT1 to the left until the ERROR LED goes on. Stop the pulse program, acknowledge the GAB error, change the pulse program to 50ms pulses and start it again. Now the protection error must not appear.

POT 2: Internal offset of the power amplifier

Make sure the GAB has reached the steady state temerature (about 40 ^{o}C) and the GCU is not pulsing (the PULSE LED has to be off). Connect a DVM between TP2 and R155 (the end close to L3). Adjust POT2 until the offset is below +/- 0.1mV.

POT 3: Quiescent current of the power amplifier

Make sure the GAB has reached the steady state temerature (about 40 ^{o}C) and the GCU is not pulsing (the PULSE LED has to be off). Connect a DVM between TP16 and TP17. Adjust POT3 until the reading is 4mV +/- 0.2mV.

Technical Data: *3.6*

Peak Current: 10A (50ms every 1s)

Hardware Description

Peak Voltage:	33V
Fall Time (90-10%):	< 10us (load: 30uH, 1Ohm)
Stability:	10uA
Fall Time to <10uA:	< 80us (load: 30uH, 1Ohm)
Amplitude Quantization:	16 Bit (+/-32767 steps)

Troubleshooting

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Q. Whenever I connect the GAB to a probehead the lock line drops several grid units or even unlocks.

A. Check the GAB power supply: Do the +15V and -15V LED shine equally bright? Is the same true for VPWR_VDD and VPWR_VSS of the SCB7-M or SCB13-M? Is the PULSE LED off? If not check GCU and pulse program.

Q. The GAB doesn't work even though its power LED's are lit.

A. If the Error-LED is lit and the Ready-LED is off the BSMS-CPU probably has old software loaded. Get yourself a BSMS tool tape of 1996 or later (included on XWINNMR releases 1996 and later) and proceed with '2. Software Installation'.

Q. Whenever I switch on the BSMS I get the Message „E:70 GAB_ Offset not adjustable."

A. Check the GAB power supply: Do the +15V and -15V LED shine equally bright? Is the same true for VPWR_VDD and VPWR_VSS of the SCB7-M or SCB13-M?

Troubleshooting