MÜLLER-BBM
VibroAkustik Systeme

PAK MKII G2

User Manual

PAK MKII G2 User Manual, Revision 1.6

MECALC
charged to innovate

Working through the user manual

The PAK MKII is an innovative data acquisition system which is continuously being improved upon. The common characteristics of the G2 series are distinct technology, consistent modularity, high channel density and low power consumption.

This PAK MKII G2 User Manual only describes the current hardware components included in the G2 hardware series.

For the 42 series as well as PQ12/20/30 combined System Controller and Power Supply boards and SC42/SC42S Signal Conditioning boards delivered until 2012, please refer to the PAK MKII User Manual revision 10.3 or former editions.

If you are using PAK MKII components of the 41 series and PQ11/EP1A/PPC7 System Controller or SC41 Signal Conditioning boards, please refer to the PAK MKII User Manual revision 9.1 or earlier editions.

Contacts

Should you have read this manual thoroughly and are still experiencing difficulties, please contact your local support hotline. The corresponding contact details can be found on the back cover.

Note: The external third party power supply is not part of the PAK MKII system and is thus not discussed in this manual. For further specifications in this regard refer to relevant manufacturer’s details.

Table of Contents

General Warnings, Precautions and Regulatory Notices

Intended Use

This equipment measures high speed analog and digital signals in laboratory or mobile environments. The equipment may also be used in other areas for example when troubleshooting or performing filed tests. The use of the PAK MKII measurement system requires an understanding of the measurement chain and signal analysis.

Handling Precautions

Even though the PAK MKII has been designed to withstand rough handling, it is a sensitive and complex electronic instrument and must be handled with care.

Changing Hardware

The PAK MKII must be powered down for 30 seconds before any Module or Board can be inserted or removed. The PAK MKII hardware is not hot swappable.

Electrostatic Discharge (ESD) Precautions

Care has been taken to provide reasonable ESD protection. However, all PAK MKII components are sensitive to ESD and may be damaged by an ESD discharge.

To avoid damaging the PAK MKII, antistatic precautions must be followed. This is especially important when swapping Modules. However, care must also be taken when swapping combined System Controller and Power Supply boards, Signal Conditioning boards or Synchronization Engines. Antistatic precautions are advisable when connecting cables or sensors to Modules.

Precautions include:

- Earthing the Mainframe by using the Chassis Ground Socket
- Discharge any excess static your body may contain by touching the earth connection
- Power down the PAK MKII
- When swapping boards or Modules, work on an earthed antistatic mat while wearing an earthed antistatic wrist strap
- Handle boards and Modules by their front panels or aluminium covers

- Place boards and Modules in antistatic bags immediately after removal from the PAK MKII and close the antistatic bags securely
- Store and transport boards and Modules in padded antistatic packaging
- Never stack boards or Modules on top of each other
- Do not mark the front panels using any pen or writing tool which cannot easily be removed as additional charges will be incurred should the board or Module be returned for repair
- When connecting signal cables to Modules, keep in mind that electrostatic charge may have built up on the cables or sensors

Laser Precautions

The PAK MKII contains IEC 825-1 AEL Class 1 LED devices. Never look directly into the SyncLink port or cables as eye damage may occur. Unused SyncLink ports should remain covered at all times with the protective rubber plugs supplied.

Cable and Power Supply Precautions

Do not use a damaged power supply, cable or any other PAK MKII component.

Extreme Environments

The PAK MKII may not be operated or stored in flammable environments (fumes, gasses, liquids, etc.), excessively harsh environments (corrosive, ambient temperature above 50°C, radioactive, hydraulic fluid, etc.), nor excessively damp environments.

Exposure to Radio Frequency Radiation

The radiated output power of the PAK MKII is within acceptable radio frequency exposure limits and is intended to be used 300 mm away from a human operator.

Weight

Depending on the configuration, the PAK MKII may become heavy and could pose a danger if not stored or transported in a responsible manner. Please use the handle provided.

Recycling and disposal

The PAK MKII contains NiCd or NiMH batteries. Please return the batteries to Müller-BBM VibroAkustik Systeme for safe disposal.

Symbols

	CE symbol indicating that the European Union's R&TTE Directive requirements have been met.
	FCC symbol indicating electromagnetic compliance with regulations in the USA.
CAN ICES-3 (A)	Text indicating electromagnetic compliance with regulations in Canada.
	TELEC symbol indicating electromagnetic compliance with regulations in Japan.

Table 1. PAK MKII accreditation symbols

CE (Europe)

The PAK MKII measurement frontend CE declaration addresses the R&TTE Directive requirements:

- Electromagnetic compatibility
- Avoidance of harmful interference
- Health and safety
- RoHS
- WEEE and Batteries
- EcoDesign Directive
- Lasers

The PAK MKII complies with the requirements of IEC 61010-1 and ETSI EN 301 489-1 in conjunction with ETSI EN 301 489-17.

FCC (USA)

The PAK MKII measurement frontend was tested and found to be compliant to the requirements of Title 74 of the CFR, Ch. 1 (10-1-06 ed.), Part 15, Subpart B when containing a SparkLAN WPEA WLAN Module.

Note: This equipment has been tested and conforms to the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

IC (Canada)

The PAK MKII measurement frontend was tested and conforms to the requirements of ICES-003 for Class A Digital Devices, Issue 5 August 2015, when containing a SparkLAN WPEA WLAN Module.

TELEC (Japan)

TRaC Global Limited, operating as a Conformity Assessment Body (CAB ID 205) with respect to the Japan/EU MRA, declared that the PAK MKII measurement frontend conforms to the Certification by Type of the Ordinance Concerning Technical Regulations Conformity Certification, etc. of Specified Radio Equipment (MPT Ordinance No. 37 of 1981). The PAK MKII was certified for categories of the Specified Radio Equipment: Article 2, Paragraph 1, Item (19) and Item (19)-3 for the GXW emission class.

WLAN channels certified for use in Japan:

- 2.4 GHz channels 1-13 (2412 MHz - 2472 MHz)
- 5 GHz channels 36 (5180 MHz), 40 (5200 MHz) and 44 (5220 MHz)

Transient and surges in vehicular environment

The PAK MKII measurement frontend conforms to ISO 7637-2 which specifies test methods and procedures to ensure the compatibility to conducted electrical transients of equipment installed on passenger cars and commercial vehicles fitted with 12 V or 24 V electrical systems.

Determining EMC compliance of a PAK MKII measurement frontend

The EMC compliance of the PAK MKII measurement frontend is determined by the combined System Controller and Power Supply boards (PQ) generation and type of WLAN module that is installed.

PQ [1]	WLAN Module	CE	FCC/IC	TELEC
G2	None	Yes	Yes	Yes
G2	Broadcom	Yes	Yes [2]	No
G2	SparkLAN	Yes	Yes	Yes

Table 1. Compliance to EMC directives

[1] Only PQ12 G2, PQ20 G2 and PQ30 G2 can be used with WLAN Modules

[2] The PAK MKII measurement frontend is classified as “a digital device used exclusively as industrial, commercial, or medical test equipment”. Therefore, according to CFR47 section 15.103 the PAK MKII measurement frontend is exempt from the specific technical standards in CFR47 part 15. Even though the starred combinations have not been explicitly certified for FCC/IC compliance, Mecalc did endeavor to have the device meet the specific technical standards. All PAK MKII measurement frontends may therefore be used in the USA or Canada provided that according to CFR47 section 15.103 “the operator of the exempted device shall be required to stop operating the device upon a finding by the Commission or its representative that the device is causing harmful interference”.

Grounding

The power and analog ground for each Module is isolated from the rest of the PAK MKII. A resistor allows the Module’s analog ground to float away from chassis ground. Selected Modules are fitted with a software controlled chassis ground switch/relay which allows the analog ground and the chassis ground of the Module to be connected to each other.

Chassis ground is directly connected to the negative terminal of the power supply and the Ethernet cable shield. Depending on the specific power supply used, the power supply may or may not be earthed.

Grounding setups must be evaluated on a case-by-case basis. It is often best to experiment with different grounding setups to determine the best combination within the specific environment and constraints.

The Ethernet connector body is connected to the PAK MKII chassis ground, and it is therefore recommended to use UTP network cable to avoid ground loops. Do not use the Ethernet connector as the primary earth connection on the PAK MKII.

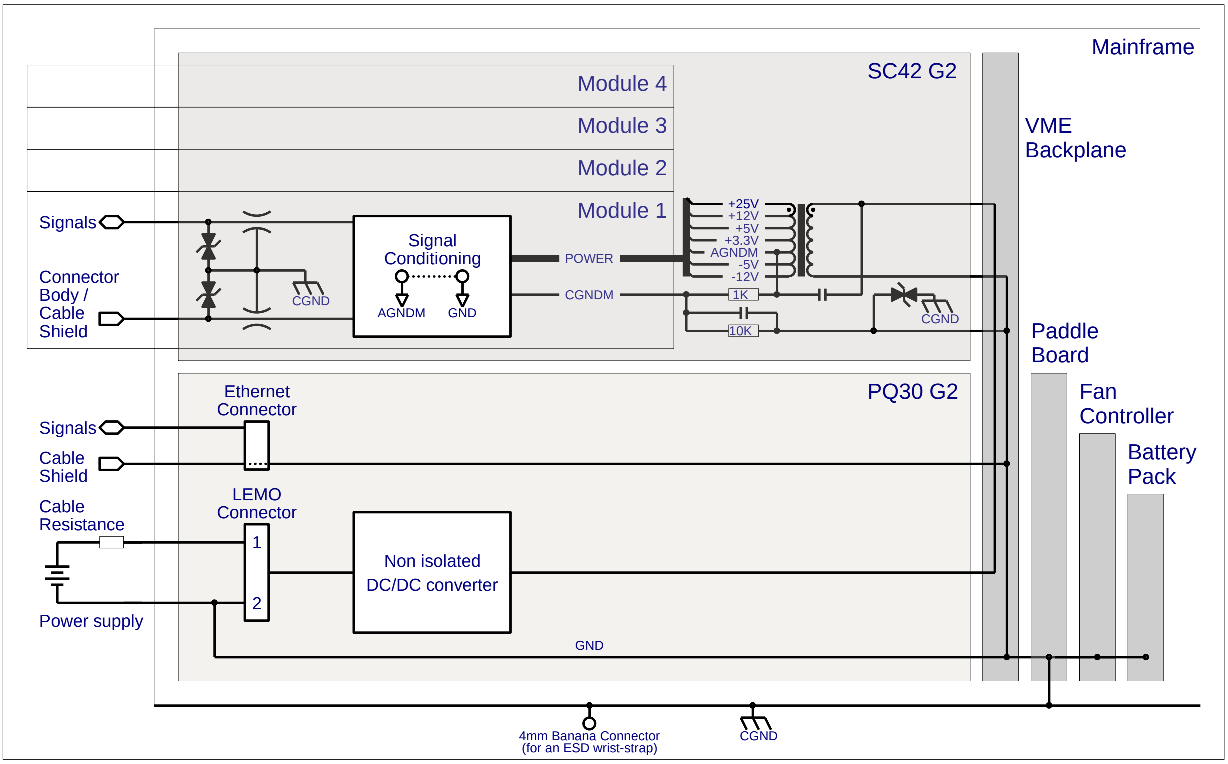


Figure 1. PAK MKII grounding

Electromagnetic Immunity

The PAK MKII complies with EMC directives.

When connecting cables, sensors or third party devices to the PAK MKII, electromagnetic noise could be introduced into the measurement.

Recommendations for good measurement practice include:

- Remove or isolate electromagnetic noise sources
- Use shielded cables, with the shield and signal voltage difference minimized
- Use twisted pair cables with differential measurements
- Avoid ground loops by isolating sensors and/or cable shields
- Use low impedance signal sources where possible
- Correctly ground the PAK MKII
- Use shorter cables

Connecting Power, Ethernet, WLAN and Fiber Optics

Connecting Power

The PAK MKII requires a special power cable. Do not attempt to use third party cables as this may damage your system.

The PAK MKII operates within the following voltage ranges:

- Minimum DC voltage: 10 V
- Maximum DC voltage: 30 V

When running the PAK MKII from low voltages, the increased current could cause power cables and connectors to heat up. When the supply voltage is lowered, there is a quadratic increase in heat caused by more current flowing through the resistance of the cable and connector. When powering larger PAK MKII systems, it is therefore recommended to:

- Use short cables
- Use higher voltages, e.g. 24 V instead of 12 V
- Avoid any intermediate connectors or joints in the power cable

The PAK MKII should always be switched off in a safe manner using the Web Interface or User Interface buttons on the combined System Controller and Power Supply board. Never switch off by disconnecting the power supply if a battery is not present. Permanent hardware damage could result.

WARNING
Never switch off or reset the PAK MKII while it is busy booting or while a firmware upgrade is in progress. This could permanently damage the system. Only when the PAK MKII display indicates ‘IDLE’, ‘LIVE’, ‘REC’ or ’FAIL’ can further User interaction take place.

Connecting Ethernet

A Gigabit Ethernet connection (1000 BASE-T) is available on the PQ11 G2, PQ12 G2, PQ20 G2 or PQ30 G2’s front panel that can accept compatible Ethernet cables.

When using Ethernet on the PAK MKII use only a CAT5E UTP cable. This will ensure the correct screening of signals throughout the length of the cable.

Using Ethernet

To use the Ethernet interface, Users need simply plug in an Ethernet cable. The PAK MKII will automatically detect the Ethernet cable and initialize it as the primary network interface. The PQ30 G2 has two RJ45 connectors available. The one closest to the text ‘ENET’ or ‘PTP’ should be used to connect the PAK MKII. The one furthest from the text ‘ENET’ or ‘PTP’ is reserved for future applications. Once booted, the User interface can be used to acquire the combined System Controller and Power Supply’s IP address. Thereafter the Web Server can be used (with the IP address as hyperlink) to make modifications to the network setup.

Connection Range

Gigabit Ethernet connections have a range of 100 m. If a longer distance is required, then a repeater station will be needed at intervals of every 100 m.

Connecting WLAN

An IEEE 802.11b/g/n WLAN connection is available as an option on any PAK MKII with a PQ12 G2, PQ20 G2 or PQ30 G2 combined System Controller and Power Supply board. The WLAN network interface can be used in combination with the Ethernet interface where truly mobile operation of the PAK MKII is required.

Using WLAN

The PAK MKII will automatically detect the WLAN and attempt to initialize it as the default network interface.

Connection range and throughput

The connection range and throughput are a function of the specific WLAN in use. A throughput of between 11 Mbit/s and 55 Mbit/s is supported.

Connecting Fiber Optics

A Fiber Optic input connector is available on any PAK MKII with a PQ11 G2, PQ12 G2, PQ20 G2 or PQ30 G2 combined System Controller and Power Supply board. This is used to accurately synchronize the timing between multiple PAK MKII Mainframes.

Each combined System Controller and Power Supply board has a Fiber Optic input connector. A Fiber Optic cable is used to connect from the output of a synchronization board to the input of a combined System Controller and Power Supply board.

Using Fiber Optics

To use the Fiber Optic clock from the synchronization board, simply connect a Fiber Optic cable between the output of the synchronization board and the input of the combined System Controller and Power Supply board. The PAK MKII will automatically detect the Fiber Optic clock and use it as its main clock.

Connection range and cable matching lengths

The connection range between a synchronization board and a combined System Controller and Power Supply board is 800 m. Fiber Optic cables should be kept to within 2 m lengths of one another.

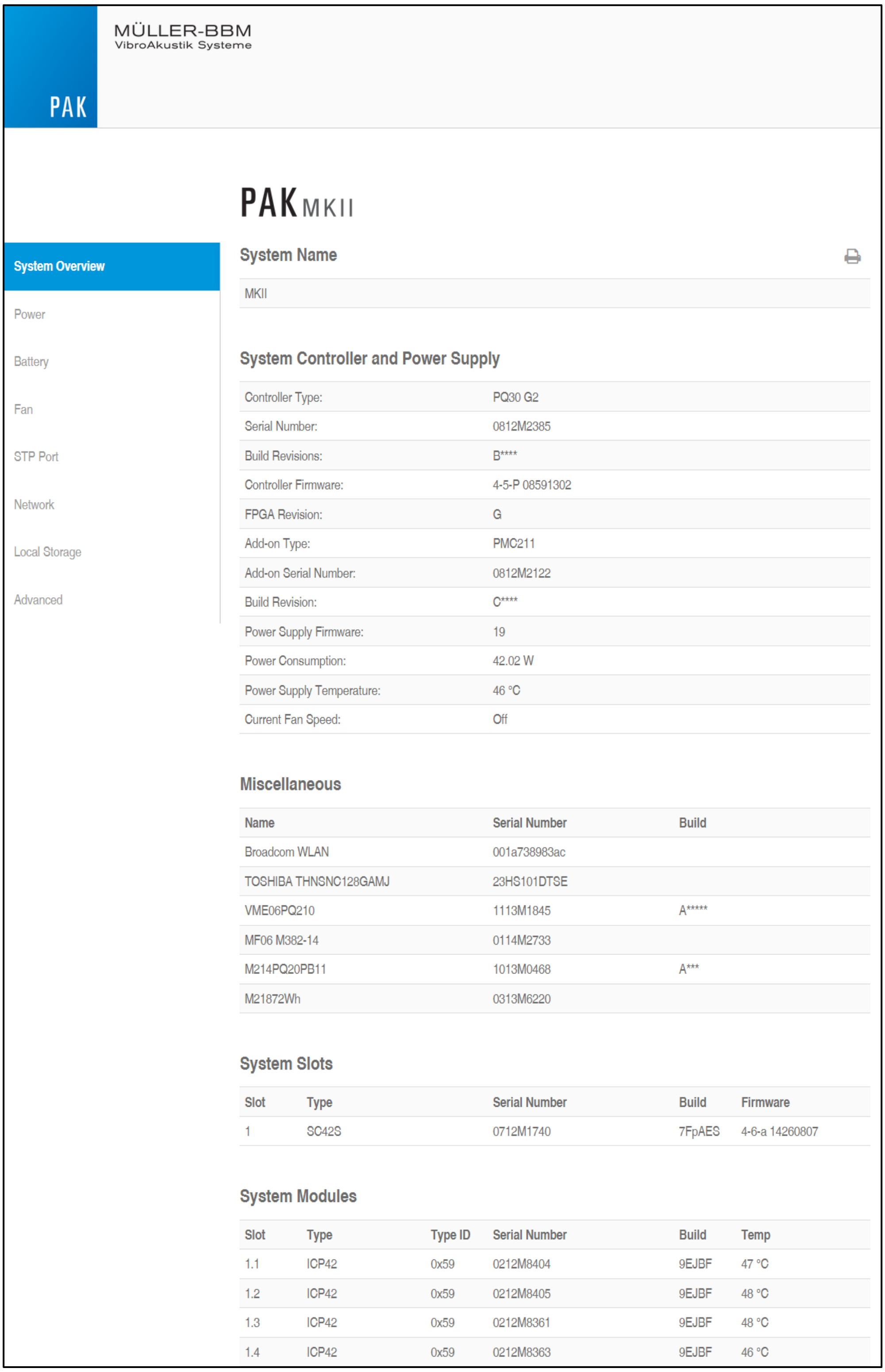
Web Server

PAK MKII system information is available on the Web Server. This includes all boards that make up the specific system, their serial numbers and firmware.

The following PAK MKII parameters are shown and can be configured via the Web Server:

- Global power settings or when running on battery
  - Setting input current limit
  - Length of time to power down
  - Length of time to standby
  - Automatic on when power detected
- Battery charging method (slow, dynamic or trickle charge)
- Fan behavior and speed settings
- STP port settings (for example to enable the use of the MiniTerminal)
- LAN settings
  - IP address
  - Subnet mask
- WLAN settings
  - Network mode
  - IP address
  - Subnet mask
  - Country code
  - SSID name
  - Enable or disable Broadcast SSID
  - Channel bandwidth
  - Channel number
  - Encryption type
- Bridged mode settings (to allow the LAN and WLAN to share the same IP address, this enables the network traffic to be streamed from WLAN to LAN and vice versa)
- DHCP server settings
- Local storage device settings (change preferred device, format and perform a S.M.A.R.T assessment of the SSD)
- Advanced PAK MKII settings
  - Change boot parameters
  - Change system name

The following images of the Web Server show its features in more detail.



System Name

MKII

System Controller and Power Supply

Controller Type:	PQ30 G2
Serial Number:	0812M2385
Build Revisions:	B****
Controller Firmware:	4-5-P 08591302
FPGA Revision:	G
Add-on Type:	PMC211
Add-on Serial Number:	0812M2122
Build Revision:	C****
Power Supply Firmware:	19
Power Consumption:	42.02 W
Power Supply Temperature:	46 °C
Current Fan Speed:	Off

Miscellaneous

Name	Serial Number	Build
Broadcom WLAN	001a738983ac	
TOSHIBA THNSNC128GAMJ	23HS101DTSE	
VME06PQ210	1113M1845	A*****
MF06 M382-14	0114M2733	
M214PQ20PB11	1013M0468	A***
M21872Wh	0313M6220	

System Slots

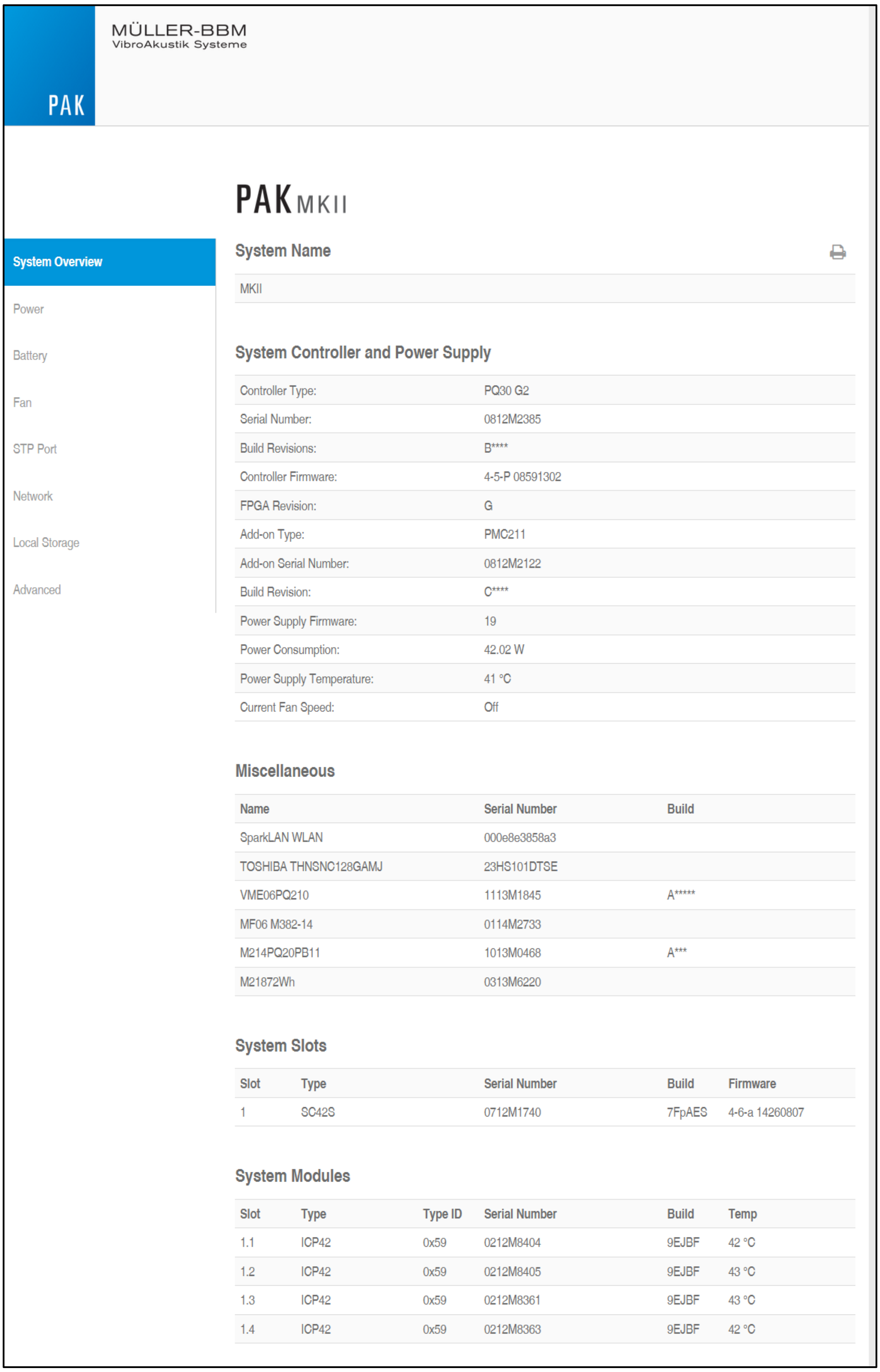
Slot	Type	Serial Number	Build	Firmware
1	SC42S	0712M1740	7FpAES	4-6-a 14260807

System Modules

Slot	Type	Type ID	Serial Number	Build	Temp
1.1	ICP42	0x59	0212M8404	9EJBF	47 °C
1.2	ICP42	0x59	0212M8405	9EJBF	48 °C
1.3	ICP42	0x59	0212M8361	9EJBF	48 °C
1.4	ICP42	0x59	0212M8363	9EJBF	46 °C

Figure 2. Web Server: System Overview (Broadcom)

Here the Web Server shows a summary of hardware configured in the PAK MKII when it contains a Broadcom WLAN card. This includes all boards that make up the specific system, their serial numbers and firmware.



System Name

MKII

System Controller and Power Supply

Controller Type:	PQ30 G2
Serial Number:	0812M2385
Build Revisions:	B****
Controller Firmware:	4-5-P 08591302
FPGA Revision:	G
Add-on Type:	PMC211
Add-on Serial Number:	0812M2122
Build Revision:	C****
Power Supply Firmware:	19
Power Consumption:	42.02 W
Power Supply Temperature:	41 °C
Current Fan Speed:	Off

Miscellaneous

Name	Serial Number	Build
SparkLAN WLAN	000e8e3858a3	
TOSHIBA THNSNC128GAMJ	23HS101DTSE	
VME06PQ210	1113M1845	A*****
MF06 M382-14	0114M2733	
M214PQ20PB11	1013M0468	A***
M21872Wh	0313M6220	

System Slots

Slot	Type	Serial Number	Build	Firmware
1	SC42S	0712M1740	7FpAES	4-6-a 14260807

System Modules

Slot	Type	Type ID	Serial Number	Build	Temp
1.1	ICP42	0x59	0212M8404	9EJBF	42 °C
1.2	ICP42	0x59	0212M8405	9EJBF	43 °C
1.3	ICP42	0x59	0212M8361	9EJBF	43 °C
1.4	ICP42	0x59	0212M8363	9EJBF	42 °C

Figure 3. Web Server: System Overview (SparkLAN)

Here the Web Server shows a summary of hardware configured in the PAK MKII when it contains a SparkLAN WLAN card. This includes all boards that make up the specific system, their serial numbers and firmware.

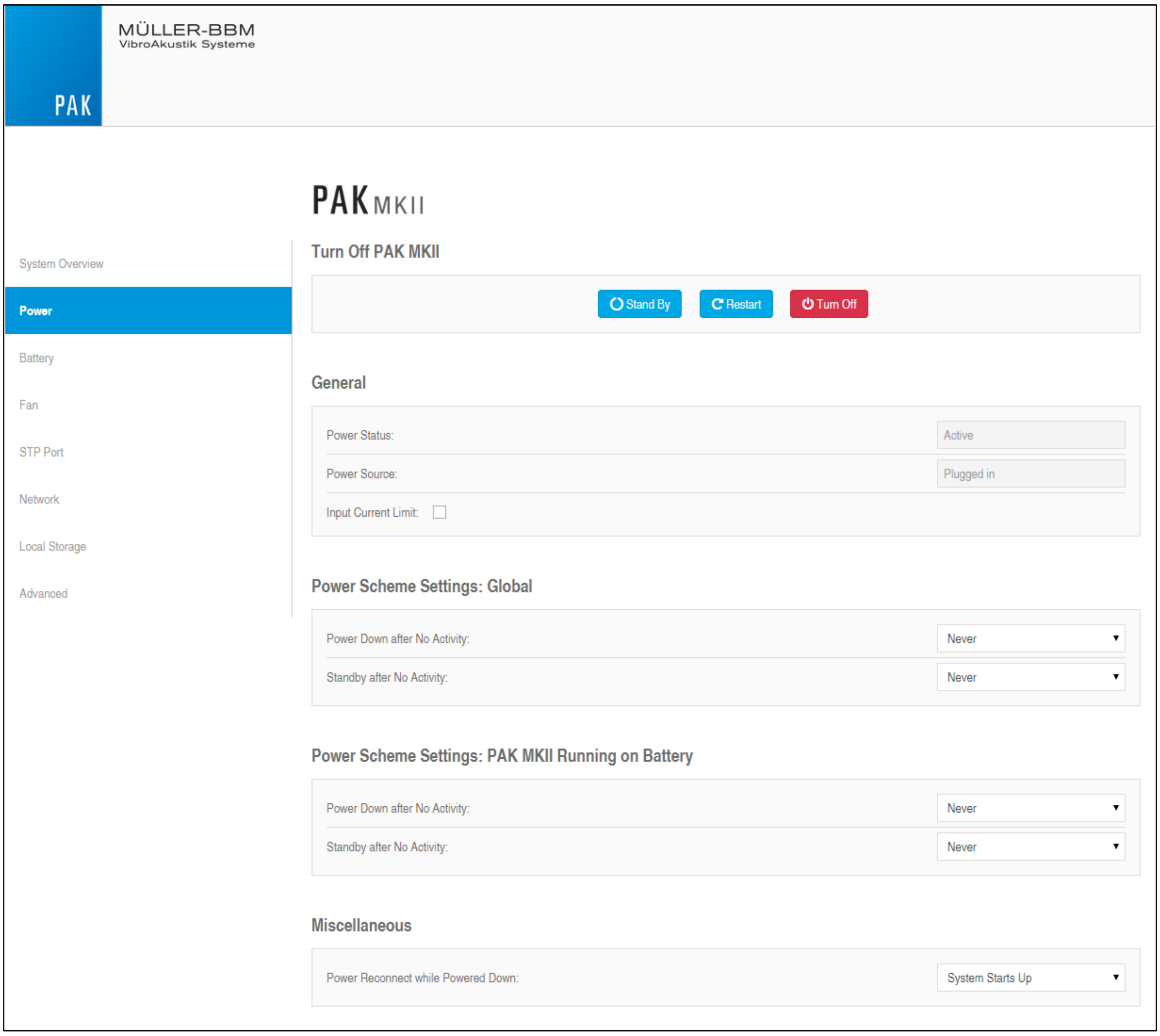


Figure 4. Web Server: Power

Here the Web Server shows the various power configurations of the PAK MKII. In this section Users can configure the PAK MKII to power down after certain periods of time as well as to automatically turn on when power is reconnected when powered down.

The following information is displayed under each heading in this section:

- **General**
    - Power Status – Active and Ready or Powered from Battery
    - Power Source – Plugged or from the battery
    - Input Current Limit – When selected, this will alert the User when the PAK MKII draws more current than the allowed maximum current level. If no action is taken by the User, the PAK MKII will shut down automatically in 40 seconds
- **Power Scheme Settings: Global**
    - Power down after No Activity – The length of time to wait before powering down the PAK MKII due to no activity (Never / 5 min / 10 min / 30 min / 1 hour)
    - Standby after No Activity – The length of time to wait before going into standby mode due to no activity (Never / 5 min / 10 min / 30 min / 1 hour)
- **Power Scheme Settings: MKII Running on Battery**
    - Power down after No Activity – The length of time to wait before powering down the PAK MKII due to no activity (Never / 1 min / 2 min / 5 min / 10 min / 30 min / Immediately)
    - Standby after No Activity – The length of time to wait before going into standby mode due to no activity (Never / 1 min / 2 min / 5 min / 10 min / 15 min)
- **Miscellaneous**
    - Power Reconnect while Powered Down – an option to automatically turn the PAK MKII on when in the powered down state. If power is provided to the input Lemo connector when in the powered down state, then enabling this option will automatically turn the PAK MKII on

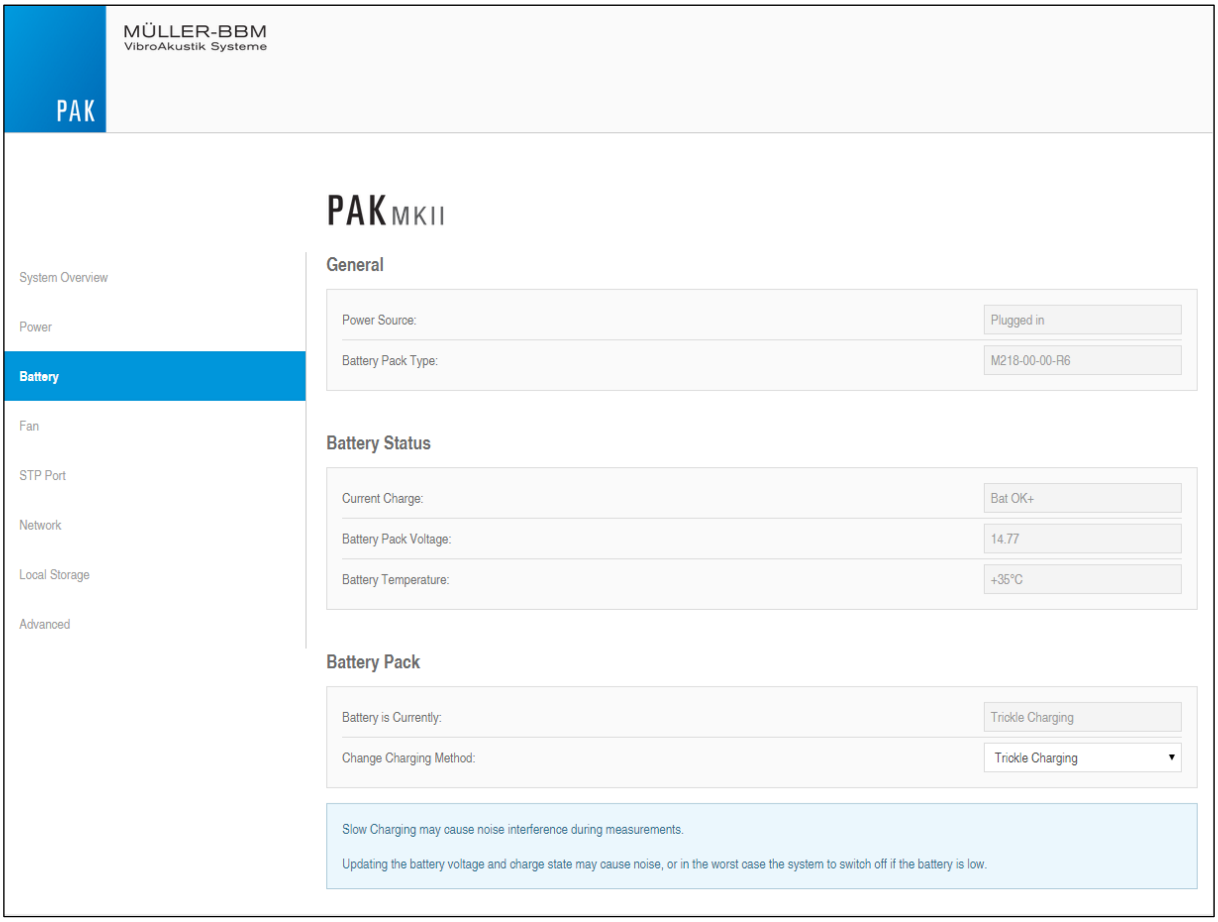


Figure 5. Web Server: Battery

Here the Web Server shows the status of the battery. This includes real time values for current, voltage and temperature as well as whether the battery is charging or discharging. If the battery is being charged, the type of charging (trickle, slow or dynamic) is displayed.

The following information is displayed under each heading in this section:

- **General**
  - Power Source - shows how the PAK MKII is being powered (either plugged into the mains or from the battery pack)
  - Battery Pack Type - the build number of the battery pack
- **Battery Status**
  - Current Charge - the amount of current being supplied to the battery
  - Battery Pack Voltage – the voltage level of the battery
  - Battery Temperature – the temperature of the battery
- **Battery Pack** - The Battery Pack section provides information on whether the battery pack is being charged (trickle, slow or dynamic) or is discharging to provide power to the PAK MKII
  - Trickle Charge – Issues the command to trickle charge the battery pack
  - Slow Charge – Issues the command to slow charge the battery pack
  - Dynamic Charge – Issues the command to charge the battery pack dynamically. A detailed description of dynamic charge is given in the Battery Maintenance section

Charging Method	Power used by battery pack	Current used by battery pack (Vin = 10 V)	Current used by battery pack (Vin = 20 V)	Current used by battery pack (Vin = 30 V)
Trickle	< 1 W	< 100 mA	< 50 mA	< 34 mA
Slow	< 10 W	< 1000 mA	< 500 mA	< 334 mA
Dynamic	< 40 W	< 4000 mA	< 2000 mA	< 1334 mA

Table 2. Power used by each battery pack for the various charging methods

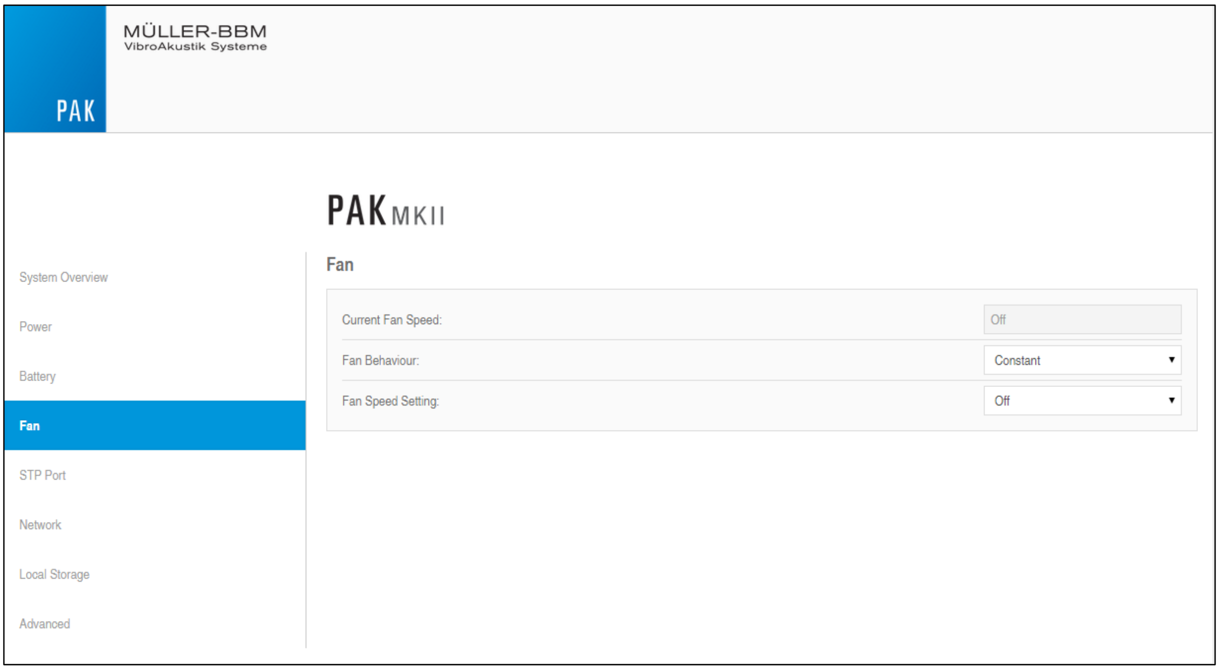


Figure 6. Web Server: Fan

Here the Web Server shows the current fan speed of the PAK MKII. It also allows the User to change the fan speed and fan behavior.

The following information is displayed in this section:

- **FAN Settings** – The current fan speed is displayed and two options are provided to change the fan settings:
    - Fan Behavior (Constant or Dynamic speed)
    - Fan Speed Setting (High, Normal, Low, Off, Lower Temperature or Lower Speed)

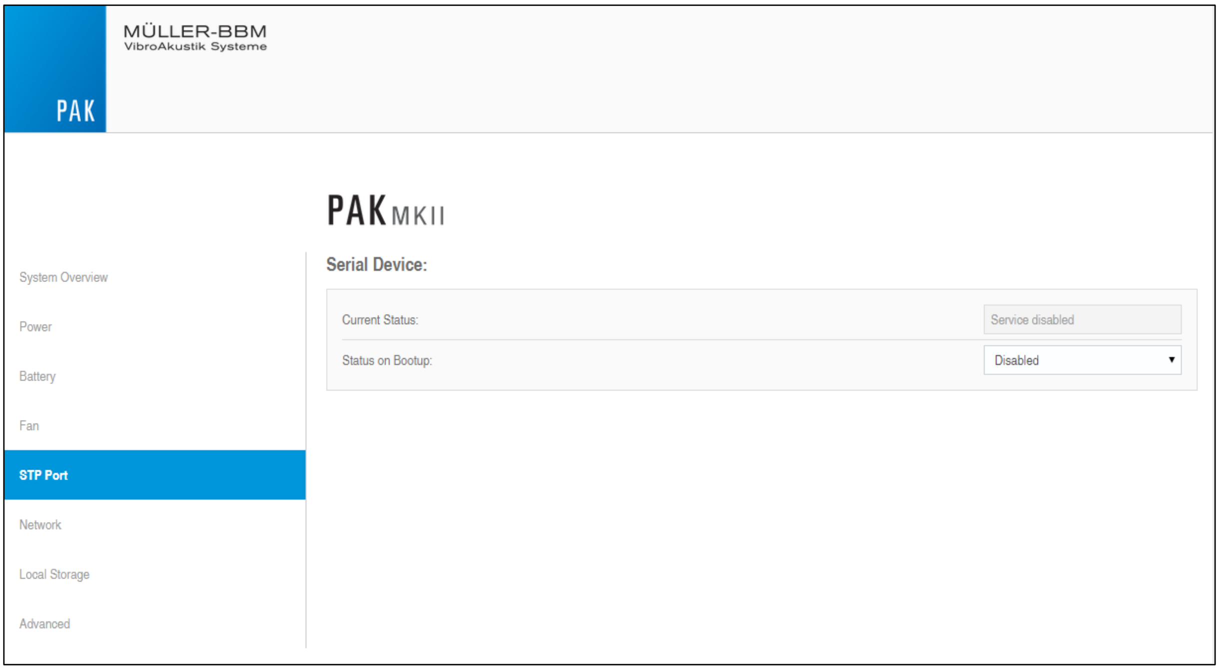


Figure 7. Web Server: STP Port

Here the Web Server shows the serial device setting of the PAK MKII. The serial device is enabled when a User wishes to use the MiniTerminal with the PAK MKII.

The following information is displayed in this section:

- **Serial Device Settings** – The current status of the serial device is displayed and the setting can be enabled for use with the MiniTerminal

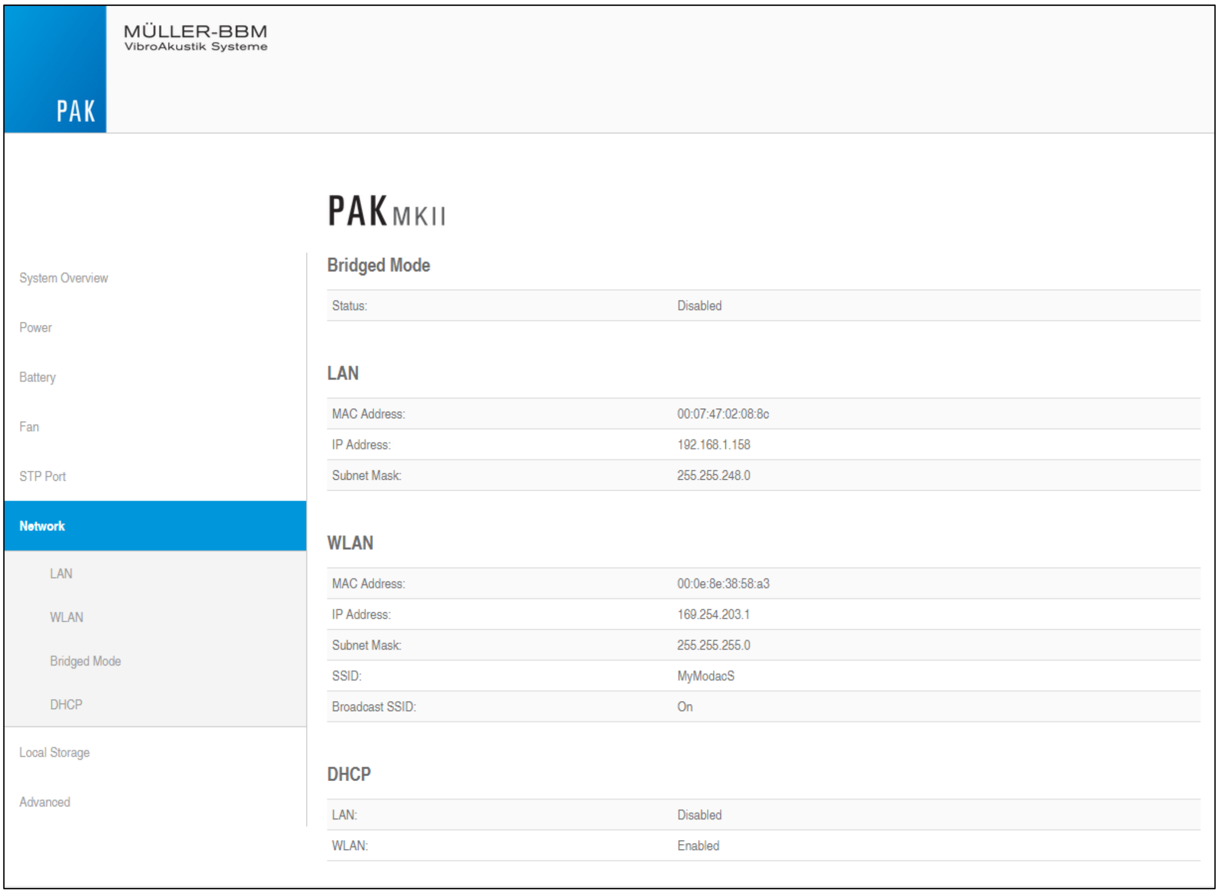


Figure 8. Web Server: Network Overview

Here the Web Server shows an overview of the Network settings of the PAK MKII:

- The LAN connection is made through a CAT5E cable to the front panel of the combined System Controller and Power Supply board
- WLAN may or may not be present depending on the combined System Controller and Power Supply board
- Bridged Mode allows the LAN and WLAN to have the same IP address. The main purpose for bridge mode is to stream network traffic from WLAN to LAN and vice versa
- A Dynamic Host Configuration Protocol (DHCP) server can be configured on the PAK MKII to automatically distribute network parameters to other devices on the LAN or WLAN

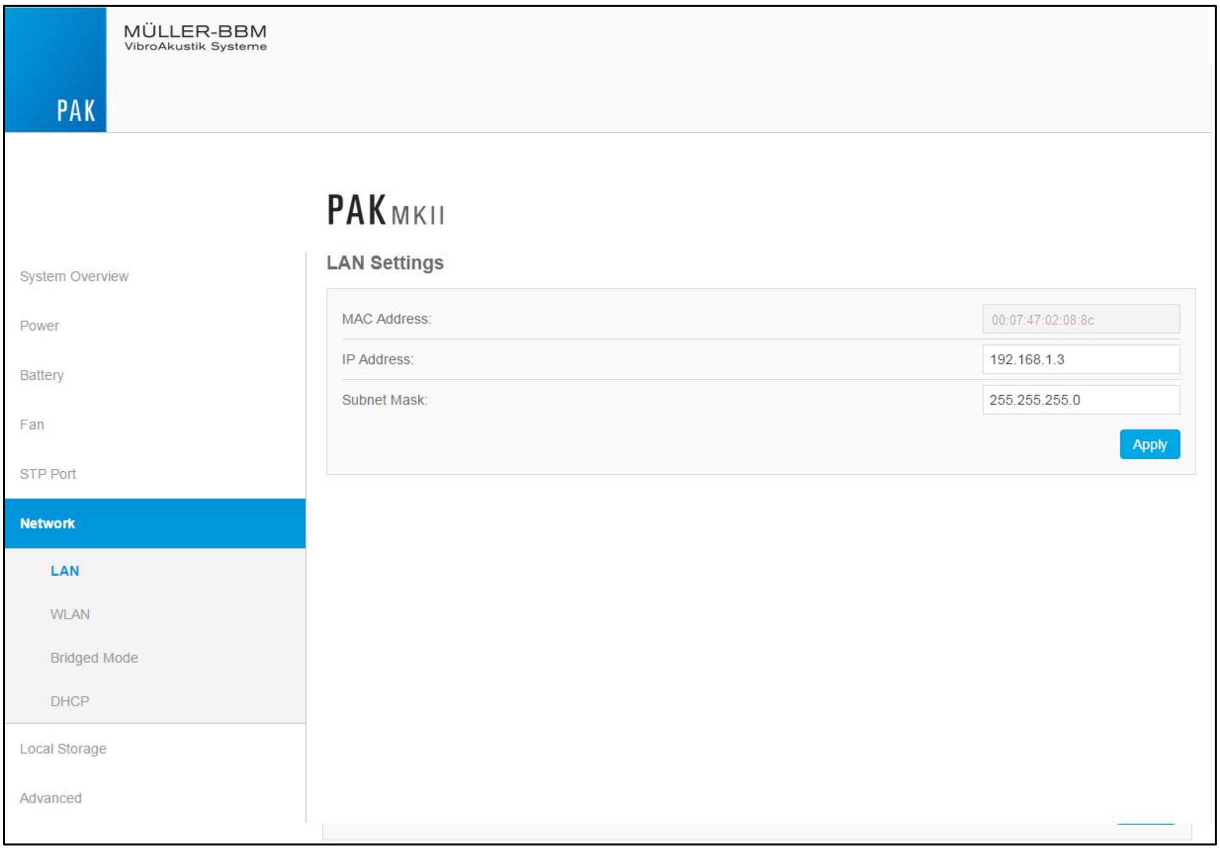


Figure 9. Web Server: Network LAN

- **LAN Settings**
  - MAC Address – the MAC Address that will be used to identify the PAK MKII on the local area network (LAN)
  - IP Address – the four octet Internet Protocol address of the LAN on the PAK MKII. This IP address can be changed by the User if the correct password is provided
  - Subnet Mask – the four octet Subnet Mask which blocks out (masks) other devices not on the same subnet

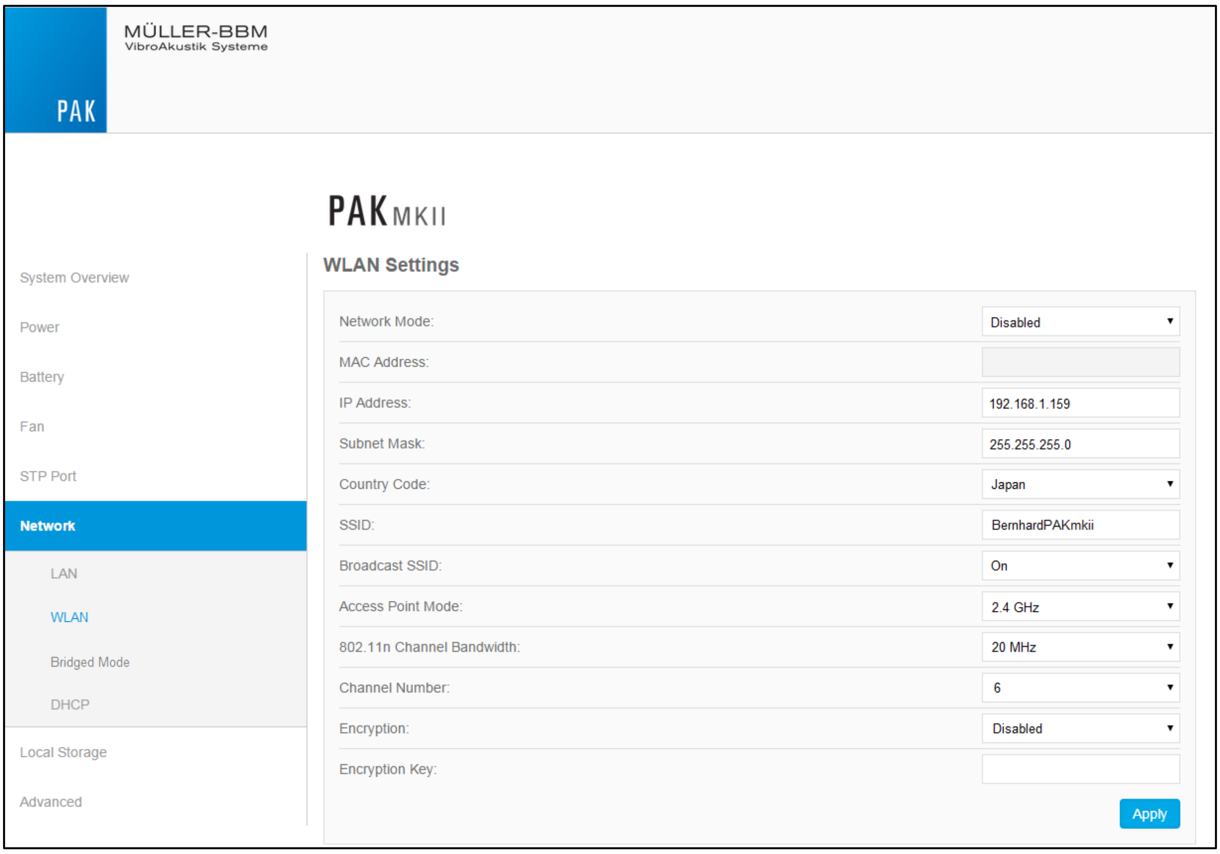


Figure 10. Web Server: Network WLAN

- **WLAN Settings**
  - Network Mode – the choice between Access Point Mode and Infrastructure Mode
  - MAC Address – the MAC Address used on the wireless local area network (WLAN)
  - IP Address – the four octet Internet Protocol address of the WLAN on the PAK MKII
  - Subnet Mask – the four octet number that masks an IP address
  - Country Code – an option to select the country that the PAK MKII will operate in
  - SSID – the name of the WLAN network (for example 'BernhardPAKmkii')
  - Broadcast SSID – an option to broadcast the network name of the PAK MKII or not
  - Access Point Mode – 2.4 or 5 GHz
  - 802.11n Channel Bandwidth – the entire 40 MHz bandwidth, or only 20 MHz
  - Channel Number – corresponds to a specific frequency within the channel bandwidth
  - Encryption – an option to select the type of encryption used on the WLAN network:
    - Wired Equivalent Privacy (WEP) with either 40/64 bit or 104/128 bit
    - Wi-Fi Protected Access (WPA) with Temporal Key Integrity Protocol (TKIP)
    - Wi-Fi Protected Access (WPA) with Advanced Encryption Standard (AES)
  - Encryption Key – the key to allow other devices access to the WLAN network created by the PAK MKII

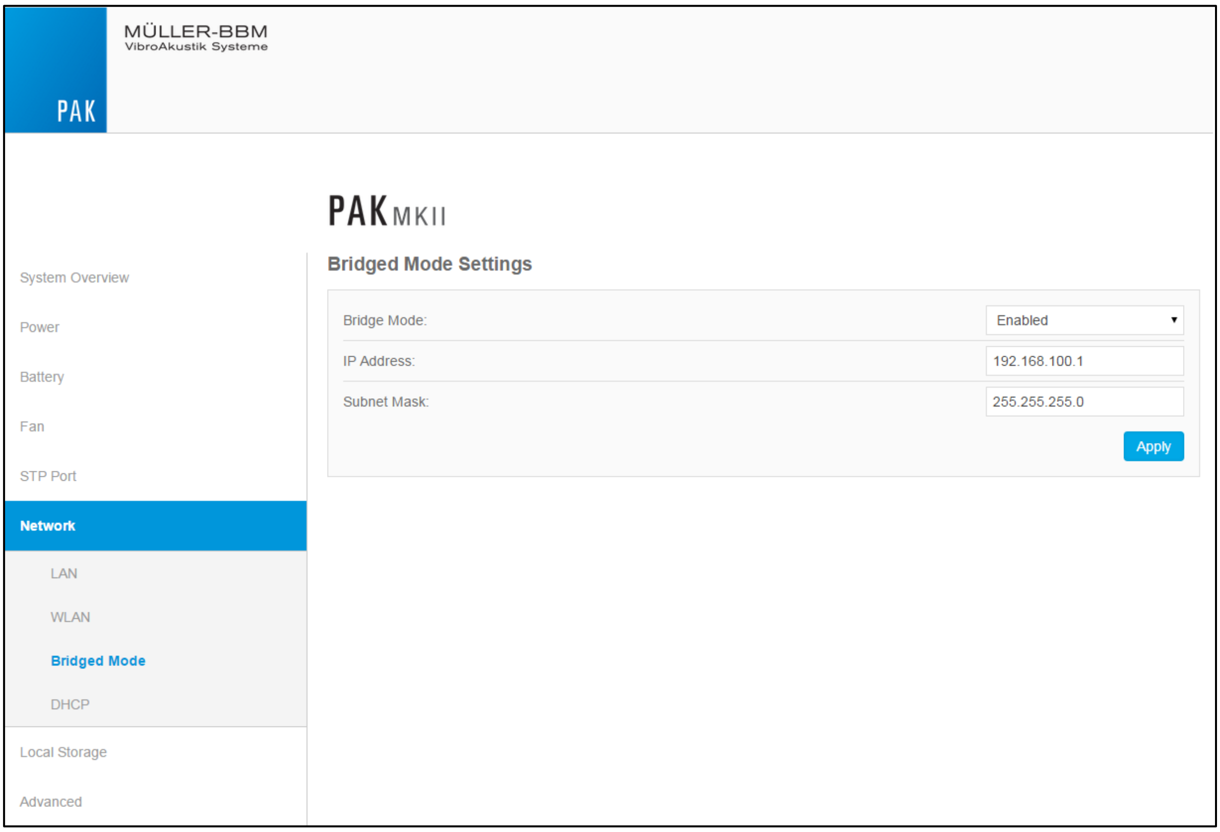


Figure 11. Web Server: Network Bridged Mode

Bridged Mode

- Status – If enabled, the LAN and WLAN have the same IP address
- IP Address – the four octet Internet Protocol address of the WLAN on the PAK MKII
- Subnet Mask – the four octet number that masks an IP address

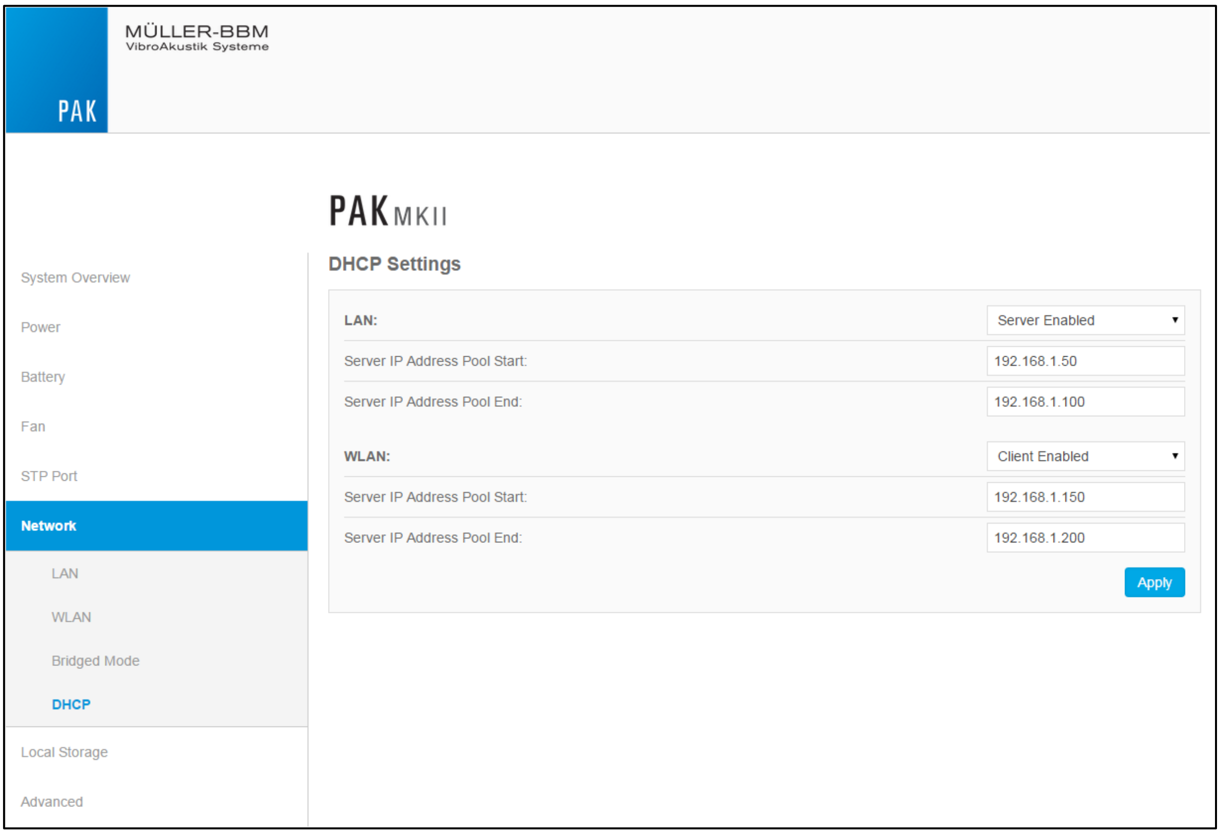


Figure 12. Web Server: Network DHCP (with Bridged Mode disabled)

DHCP Settings

- LAN – an option to enable the DHCP server on the LAN
- Server IP Address Pool Start – the first IP Address in the sequence (e.g. 192.168.1.3)
- Server IP Address Pool Stop – the last IP Address in the sequence (e.g. 192.168.1.9)
- WLAN – an option to enable the DHCP server on the WLAN
- Server IP Address Pool Start – the first IP Address in the sequence (e.g. 192.168.2.3)
- Server IP Address Pool Stop – the last IP Address in the sequence (e.g. 192.168.2.9)

Note: If Bridge mode is selected, LAN and WLAN will have the same IP address and only the DHCP server for LAN will be shown as in Figure 13.

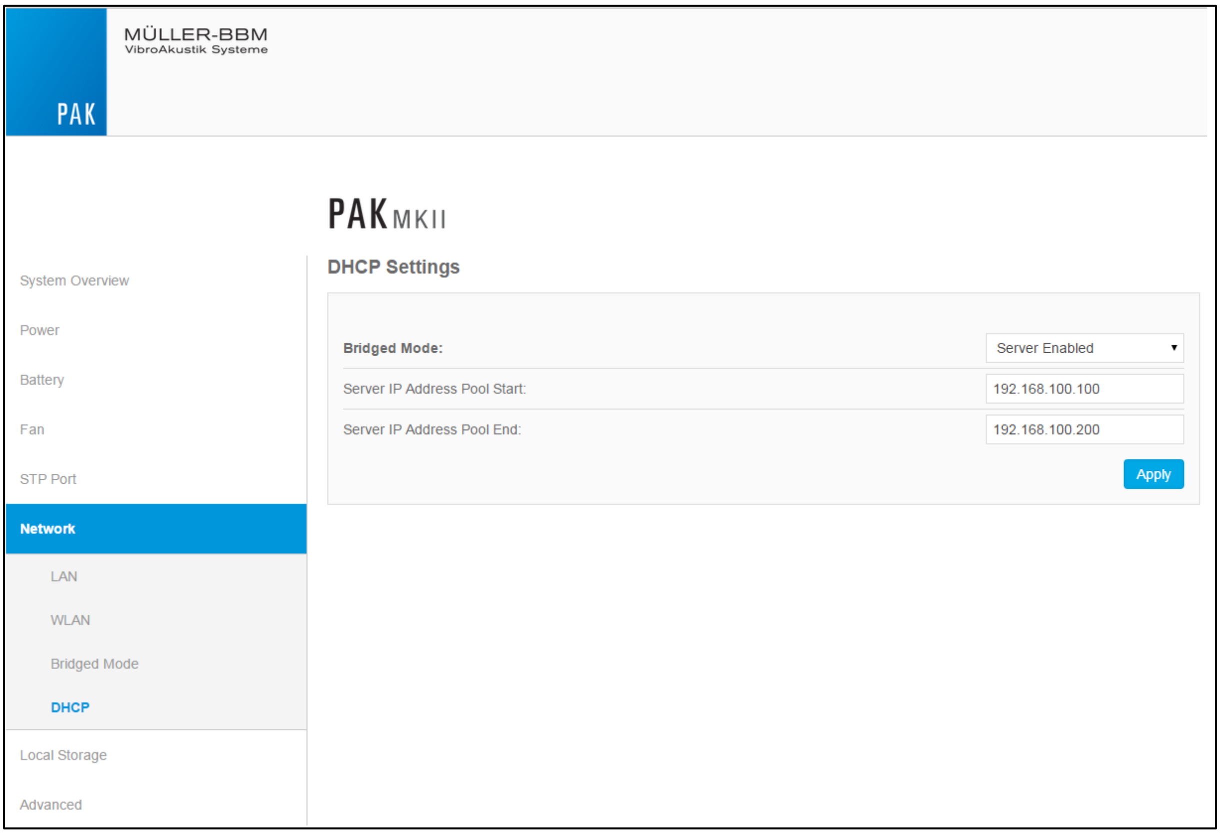


Figure 13. Web Server: Network DHCP (with Bridged Mode enabled)

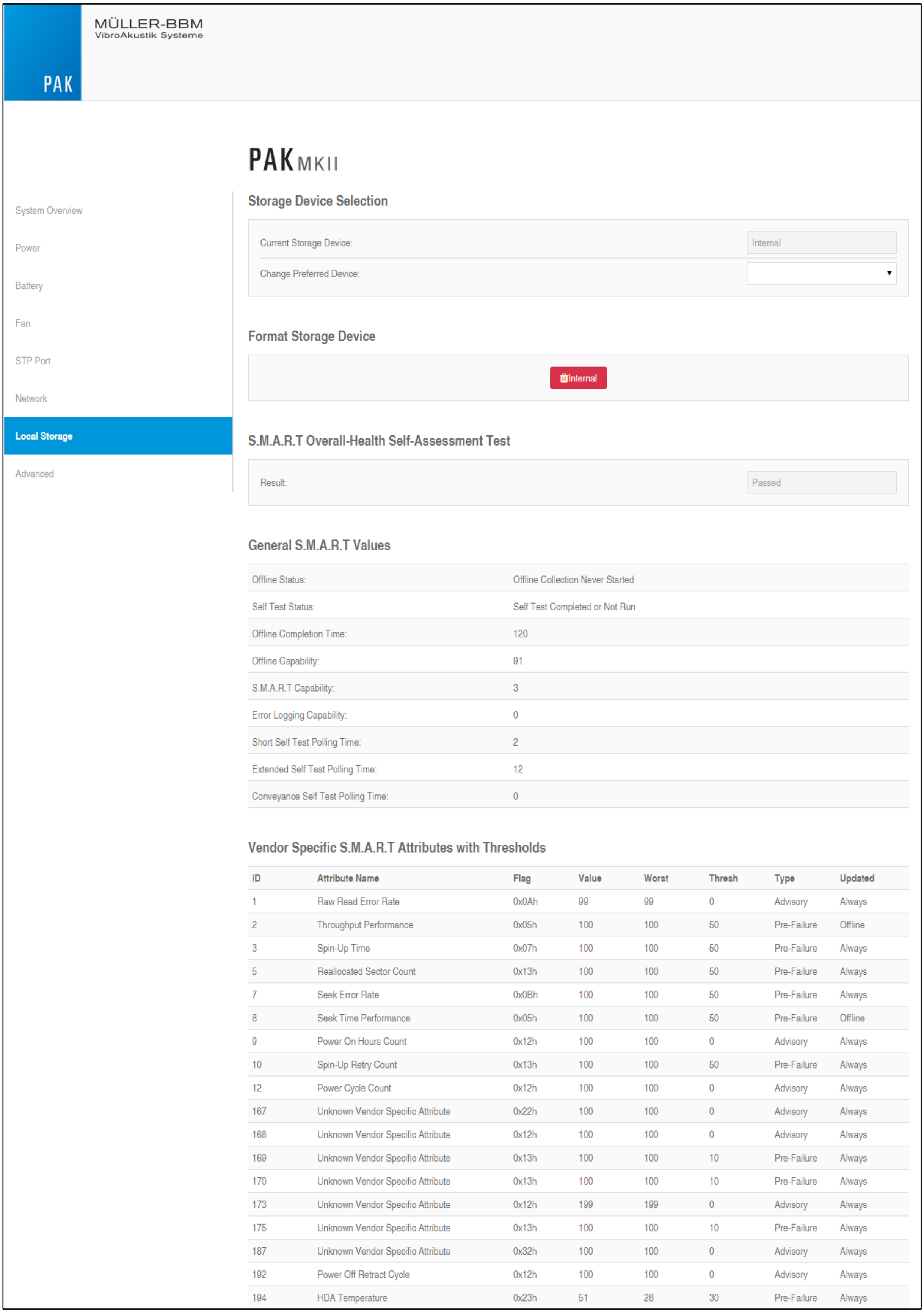


Figure 14. Web Server: Local Storage

The ‘Local Storage’ section of the Web Server allows the User to monitor both the internal and external storage devices connected to the PAK MKII.

The hardware monitoring system S.M.A.R.T. (Self-Monitoring, Analysis and Reporting Technology) has been implemented to provide the User with all the indicators of reliability, in the hope of anticipating failures. When a failure is anticipated by S.M.A.R.T., the User may choose to replace the drive to avoid unexpected outage and data loss.

The following information is displayed under each heading in this section:

- **Storage Device Selection** - The User is provided an option to use either the internal or external storage with the PAK MKII
    - Current Storage Device – Displays the current storage device (internal/external)
    - Preferred Storage Device – Displays the preferred storage device (internal/external)
    - Change Preferred Device – Change the preferred storage device
- **Format Storage Device** - The User is provided an option to erase all the data on the storage device
    - Setting – to format the storage device the User can set this to ‘Format current device’
    - Confirm – To format the storage device the User must confirm the above choice
- **S.M.A.R.T. overall-health self-assessment test result** - The User is provided with a clear “Passed” or “Failed” value as to the overall health of the storage device
- **General S.M.A.R.T. Values** - The User is provided with the general information necessary to do self-test polling as well as offline data retrieval on the storage device
- **Vendor Specific S.M.A.R.T. Attributes with Thresholds** - The User is provided with vendor specific attributes and thresholds. These attributes are the reliability indicators which may assist the User in avoiding an unexpected drive failure

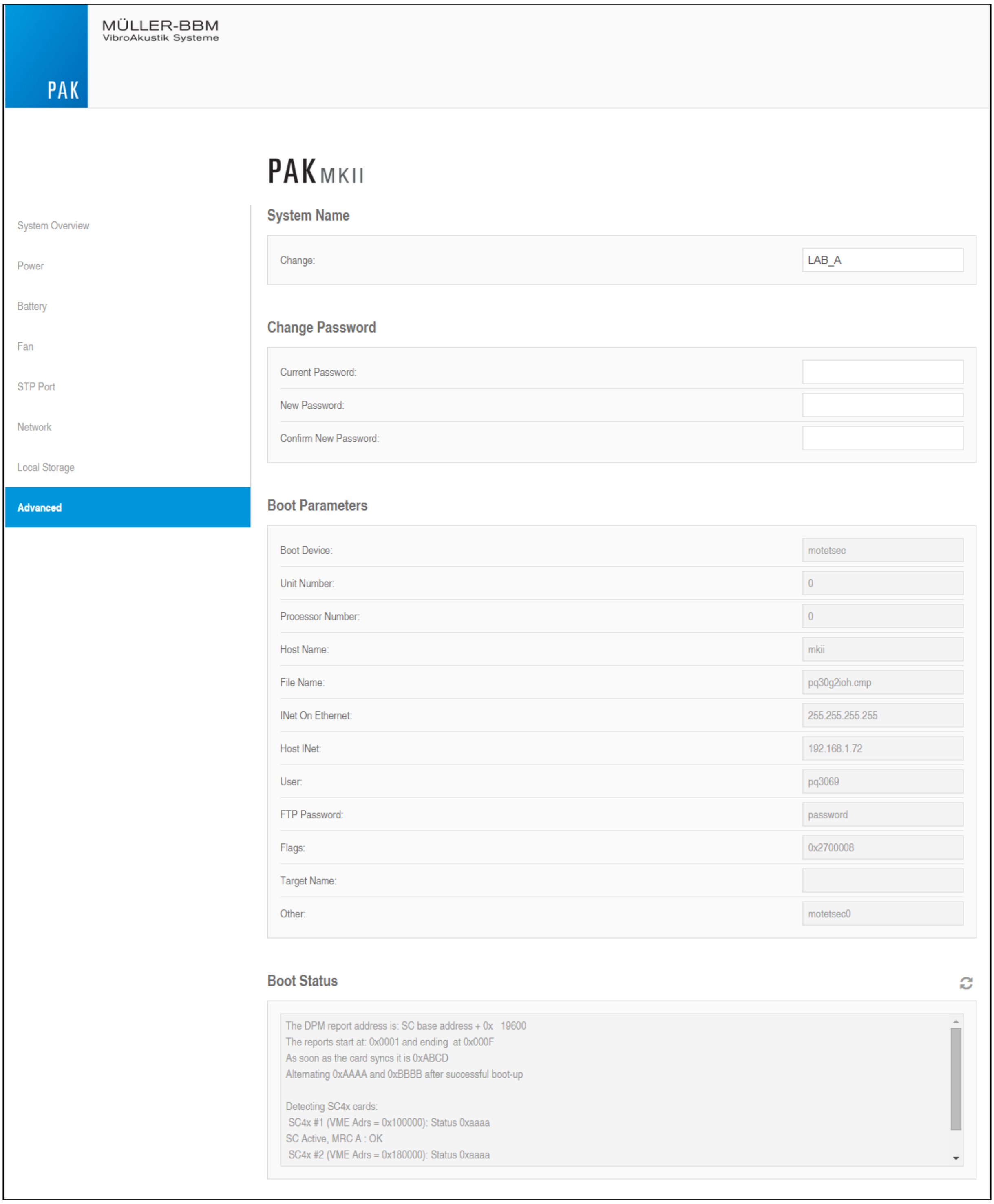


Figure 15. Web Server: Advanced

The ‘Advanced’ section of the Web Server allows the User to see the current boot parameters as well as the number of signal conditioning cards detected in the PAK MKII.

The following information is displayed under each heading in this section:

- **System Name** – Displays the name given to the PAK MKII
- **Change Password**
    - Current Password – Enter the current password
    - New Password – Enter the new password
    - Confirm New Password – Enter the new password again for confirmation
- **Boot Parameters** – Displays the PAK MKII boot parameters
    - boot device: tffs=0,0
    - unit number: 0
    - processor number: 0
    - host name: hostname
    - file name: /tffs0/pqiohtffs.cmp
    - inet on ethernet (e): 192.168.1.223:0xffffff00
    - host inet (h): 192.168.1.69
    - user (u): pq30g2
    - ftp password (pw): password
    - flags (f): 0x300008
    - target name (tn):
    - other: motetsec0
- **Boot Status** – A check to ensure all signal conditioner cards have been detected to form part of the PAK MKII
    - “The DPM report address is: SC base address + 0x 19600
      The reports start at: 0x0001 and ending at 0x000F
      As soon as the card syncs it is 0xABCD
      Alternating 0xAAAA and 0xBBBB after successful boot-up
    - Detecting SC4x cards:
      SC4x #1 (VME Adrs = 0x100000): Status 0xaaaa
      SC Active, MRC A : OK
      SC4x #2 (VME Adrs = 0x180000): Status 0xaaaa
      SC Active, MRC A : OK”

Positioning the PAK MKII for Effective Cooling

Guidelines to support cooling

Over-temperature protection has been included in the PAK MKII firmware. Guidelines for optimal cooling are:

- Place the PAK MKII where there is a free flow of cool air
- Place the PAK MKII horizontally to allow optimal airflow through the fins located on the left and right sides
- Do not cover the PAK MKII fins or cooling fans
- Elevate off carpet or other thermal-insulating material
- Avoid direct sunlight
- Charging of the PAK MKII battery does introduce additional heat

Temperature Protection and Cooling

Over temperature shutdown functionality is included in the PAK MKII firmware to protect against overheating. The over temperature protection in the PAK MKII firmware periodically measures the temperature of each Module and VMEbus board present in the system in order to determine the maximum temperature value (MaxTemp or Max) inside the PAK MKII. The MaxTemp value initiates the following actions:

MaxTemp < 83 °C	No action
83 °C < MaxTemp < 85 °C	Fan action: The speed of the fan (if present) will be automatically set to full speed, thereby overriding the User value. Once the MaxTemp has fallen below 80 °C, the speed of the fan will return to the previously selected User value
85 °C < MaxTemp < 86 °C	5 minute countdown: The PAK MKII firmware will begin a 5 minute countdown after which it will automatically switch off the PAK MKII unless MaxTemp falls below 85 °C again. Information on the countdown will be written to the PAK MKII User Interface display on a continuous basis
86 °C < MaxTemp	Shutdown: Even if the 5 minute countdown has not yet been completed, the PAK MKII will switch off immediately. At shutdown the message SYSOFF or OFF will appear on the display for a few seconds

Table 3. Actions taken on temperature

Note: TMP? In the display shows only the temperature of the system board on which the User Interface is located. This temperature is typically from 2 °C to 10 °C lower than MaxTemp or Max, depending on the PAK MKII configuration.

Note: The Dynamic Speed option of the combined System Controller and Power Supply board sets the fan to constantly evaluate the current temperature of the PAK MKII with respect to a reference value, and adjust the fan speed accordingly. If it is 3 °C higher than the reference value, it will set the fan to full speed and if it is 3 °C below, it will stop the fan. For temperatures between these two extremes, it will set the speed of the fan depending on how much above or below the reference value it is. The reference value is determined by the User selecting either “Lower Temperature” (reference value is 55 °C), or “Lower Speed” (reference value is 65 °C).

Ensuring efficient heat transfer

In ensuring the efficient transfer of heat from each Module/VMEbus board into the Mainframe, Users must ensure that:

- VMEbus boards’ expanders are fastened
- All Module screws are fastened

This is particularly applicable if any Modules or VMEbus board has been recently removed or inserted.

Cooling in measurement towers

RM04, RM06 and RM10 are 19” rackmounts for the inclusion of MF04, MF06 or MF10 PAK MKIIs in measurement towers. The sides and rear of the rackmounts have been left open to allow air entering from the bottom of the rack to properly cool each Mainframe.

Changing Modules

Interchangeability of Modules

All Modules are sensitive to electrostatic discharge and may be rendered inoperative by such a discharge. Damage may occur over time and may not cause complete system failure but may affect measurement accuracy or product reliability.

Modules should not be swapped by someone who does not have sufficient knowledge of the system as components may be damaged. If it is necessary to swap Modules between systems, it should only be performed by suitably trained employees under the correct environmental and electrostatic conditions according to certain precautions.

ESD or mechanical damage is not covered by the hardware warranty. Please follow the procedure below when changing Modules.

Removing a Module

- Ensure that the PAK MKII is switched off (display must be dark) before a Module may be removed. As the PAK MKII contains an internal battery pack merely disconnecting the external power supply is not sufficient. Removing a Module while the PAK MKII is running will cause damage to the Module and the SC4x G2 VMEbus board
- Only handle Modules by their front panels or board edges and store them immediately following removal in their antistatic bags. Do not press down on Module connectors
- Obtain an antistatic bag into which the Module can be placed
- Put on an antistatic wrist strap connected to an earthed antistatic mat
- Disconnect all sensors and cables connected to the Module
- Loosen the screw (M2.5 x 6 socket head cap screw) with a 2.0 mm Allen key. While turning out (loosening) this screw, the Module will be pulled out of its slot automatically since it has a jacking nut immediately behind its front panel
- When the screw has been completely loosened, while holding the front panel, pull the Module out of its slot and place it in an antistatic bag immediately
- Not only must the PAK MKII be switched off before the Module can be removed but the Module must have cooled down to approximately 40 °C. This is important as the permanent screw retainer used between the jacking screw and its nut could fail at high temperatures

- All empty Module slots of the PAK MKII must be covered either with another Module or by using a blank Module panel (MBL). Failure to do so may allow dust or other objects to damage the PAK MKII

Inserting a Module

- Ensure that the PAK MKII is switched off (display must be dark) before a Module may be inserted. As the PAK MKII contains an internal battery pack merely disconnecting the external power supply is not sufficient. Inserting a Module while the PAK MKII is running will cause damage to the Module and the SC4x VMEbus board
- Only handle Modules by their front panels or board edges and always store them in their antistatic bags. Do not press down on Module connectors
- Put on an antistatic wrist strap connected to an earthed antistatic mat
- Extra care has to be taken when fitting a module into a PAK MKII for the first time
- Lightly flatten the EMC strip with a finger
- Loosen all the expanders on all the SC4x boards in the PAK MKII
- Tighten the expanders only on the first SC4x board when inserting the Module in this board, this creates some more space between the first and second SC4x board
- Take the Module out of its antistatic bag and push it into the empty SC4x Module slot until the left hand screw engages its thread, if necessary use a screwdriver to push the EMC strips flatter
- Fasten the screw with a 2.0 mm Allen key. The Module is pulled in by turning the screw
- Tighten the expanders on the second SC4x board and only then install the module in the second SC4x board
- On the next power-up, the PAK MKII will automatically detect the newly installed Module/s

Changing VMEbus boards

Interchangeability of VMEbus boards

All VMEbus boards are sensitive to electrostatic discharge and may be rendered inoperative by such a discharge. Damage may occur over time and may not cause complete system failure but may affect measurement accuracy or product reliability.

VMEbus boards should not be swapped by someone who does not have sufficient knowledge of the system as components are easily damaged. If it is necessary to swap VMEbus boards between systems, it should only be performed by suitably trained employees under the correct environmental and electrostatic conditions according to certain precautions.

ESD or mechanical damage is not covered by the hardware warranty. Please follow the procedure below when changing VMEbus boards.

To remove a VMEbus board

- Obtain an antistatic bag and padded packaging into which the VMEbus board can be placed
- Put on an antistatic wrist strap, which is connected to an earthed antistatic mat
- Place the PAK MKII on the earthed antistatic mat with slot 1 on the bottom
- Connect the PAK MKII Mainframe to earth using the Chassis Ground Socket
- Disconnect the power and ensure the system is switched off
- Disconnect any cables that are connected to the VMEbus board being removed
- If the system is hot, wait until it is cooled down to approximately 40 °C. This will allow the thermal expansion to subside making VMEbus boards easier to remove
- In the case of a SC4x, remove all Modules from the SC4x that is being removed
- Loosen the two VMEbus board's expanders. These are removed, by inserting a 2.5 mm Allen key through the expander holes, and turning the Allen key anticlockwise by about 4 turns
- Using a 2.5 mm Allen key, alternatively turn one screw half a turn clockwise, then turn the other screw half a turn clockwise, and so on, until the VMEbus board is freed from its backplane connector (jacking)
- No force is required to remove the VMEbus board. If the VMEbus board is difficult to remove, loosen the Expander Screws more and turn the Jacking Screws in deeper
- Pull out the VMEbus board from its slot, holding it by its front panel or board edges, and place it into an antistatic bag
- Store or transport the VMEbus board in padded antistatic packing

WARNING
When removing a VMEbus board, EMC strips could cause damage to the bottom of the VMEbus board being removed if downward force is applied.

To insert a VMEbus board

- Put on an antistatic wrist strap, which is connected to an earthed antistatic mat
- Place the PAK MKII on the earthed antistatic mat with slot 1 on the bottom
- Connect the PAK MKII Mainframe to earth using the Chassis Ground Socket
- Disconnect the power and ensure the system is switched off
- Take the VMEbus board out of its antistatic bag and place it on the earthed antistatic mat
- In the case of a SC4x, remove all Modules from the SC4x being inserted
- Loosen the two expander screws by inserting a 2.5 mm Allen key through the expander holes, and turning the Allen key anticlockwise
- Screw the two Jacking Screws out (anticlockwise) until they extend 2 mm out of the front of the VMEbus board
- Push the VMEbus board into the empty slot, ensuring that the backplane connectors are properly mated. If necessary, place the PAK MKII on its rear cover plate to apply more force. Take care not to apply force to any connector, switch or display
- Fasten the Expander Screws using a 2.5 mm Allen key. Turn it clockwise until the expanders are tightly locked. The locking torque is 0.70 Nm
- Screw the two Jacking Screws in (clockwise) securely using only a thumb and forefinger. The Jacking Screws should be tight enough as to not vibrate loose

WARNING
NEVER apply force to any connector, switch or display.

Using the handle

A convenient carrying handle is provided on MF02, MF03, MF04 and MF06. The PAK MKII's handle can be locked into five different positions namely -90°, -60°, 0°, +60° and +90° (where positive is the upward direction).

When carrying the PAK MKII by its handle, it is suggested that the handle first be moved to the 0° position - i.e. the handle must be pointing in a direction parallel to the length of the Mainframe.

To change the position of the handle

- Push in both push buttons on either side of the handle (where it meets the Mainframe)
- While holding both these buttons in, adjust the handle as required and release both depressed buttons

Removing the handle

- Place the PAK MKII on its feet
- Make sure the handle is set at -90°
- With a slotted or flat screwdriver (6 mm x 1.25 mm), push the push button in all the way, rotate 45° clockwise and release
- While holding the handle assembly in place, repeat step 3 on the other side
- Gently pull the handle assembly upwards and away from the Mainframe; making sure it is horizontal at all times

Replacing the handle

- With the Mainframe on its feet, hold the handle assembly in the -90° position above the Mainframe
- Position the handle so that the protruding pins of the push button fit into the slots on the handle assembly
- With the handle assembly in the approximate position, push down and turn the push button anti-clockwise with a slotted or flat screwdriver (6 mm x 1.25 mm)
- The push button will spring back into position if the handle is perfectly aligned
- Repeat on other side

Battery Maintenance

Charging the Battery: FCH? / SCH? / DCH?

There are three ways to charge the battery of the PAK MKII:

- Fast Charging (FCH) – A fast charge can only be performed if the PAK MKII is switched off. Charging times will vary according to the Mainframe used – the MF02 has the fastest charging time of 2 hours and the MF10 has the slowest at 3 hours
- Slow Charging (SCH) – A slow charge can charge the battery whilst the PAK MKII is either on or off. Slow charging takes 16 hours to charge the fully depleted battery of an MF10
- Dynamic Charging (DCH) – The dynamic charge setting charges the battery as fast as possible whilst the PAK MKII is switched on. All available power not used by the PAK MKII is diverted to the battery

Only one of these three charge algorithms can be active at any given time.

The most efficient way of maintaining the battery is to use the new ‘Dynamic-Charging’ feature of the PAK MKII. The system will automatically keep the battery in a fully charged state.

Alternately, the User should use the ‘Slow-Charge’ or ‘Fast-Charge’ options to fully recharge a battery that has been depleted. Charging should occur at least every six months.

In order for the uninterrupted power supply found on the combined System Controller and Power Supply board to perform its function of supplying the PAK MKII with backup power, the battery must be charged.

To recharge a discharged battery either a fast-charge, dynamic-charge or slow-charge can be used. This can be selected via the User Interface.

Note:

- If the external power is removed while charging is in progress, the PAK MKII will switch to backup mode and run from the battery
- Due to the properties of NiCd or NiMH rechargeable batteries, recharging can only be performed when the battery is in the temperature range of 10 °C to 45 °C. When 45°C is exceeded, the user interface will display **`BHOT`** and charging will stop

BHOT

`BHOT` is displayed when the Battery Pack is hot (≥65°C) or has gone above 45°C while being charged. In either instance, the system will not charge the battery:

- 45°C. When the Battery Pack is being charged, then the temperature at which the Battery Pack is defined as 'hot' is 45°C. This is for safety reasons as it is better for the Battery Pack to be charged at lower temperatures
- 65°C. If the Battery Pack is not being charged, then the temperature at which the Battery Pack is defined as being 'hot' is 65°C

For optimum battery care, the battery on the PAK MKII should be depleted and then fully recharged every six months. This will ensure that the battery maintains its maximum energy capacity.

Mainframes

The PAK MKII Mainframe series consists of 2, 3, 4, 6 and 10-slot VMEbus based Mainframes.

Their mechanical design has been optimized for thermal performance together with resistance to shock and vibration whilst retaining its compact form factor.

Figure 16. The PAK MKII Mainframes

MF02

MF02 (M515)	Slot 1:	PQ11 G2 or PQ12 G2 or PQ20 G2 or PQ30 G2	Combined System Controller and Power Supply board	
	Slot 2:	SC42 G2 and/or SC42S G2	Data acquisition	
	Number of channels (if 6 ch per Module):	24	Fan:	None
	External surface cooling system:	Natural Convection	Internal board's cooling system:	Conduction
	Dimensions (W H D):	291x 68x 267 mm	Volume:	5.3 liter
	Mass fully populated with battery:	5.08 kg	Mass fully populated without battery:	4.78 kg
	Battery type:		NiMh	
	Battery cells:		8	
	Battery capacity:		20 Wh	

Table 4. MF02 Mainframe

MF03

<table>
<tr><td rowspan="9">MF03
(M381)</td><td>Slot 1:</td><td>PQ11 G2 or
PQ12 G2 or
PQ20 G2 or
PQ30 G2</td><td colspan="2">Combined System Controller and Power Supply board</td></tr>
<tr><td>Slot 2 - 3:</td><td>SC42 G2 and/or
SC42S G2</td><td colspan="2">Data acquisition</td></tr>
<tr><td>Number of channels (if 6 ch per Module):</td><td>48</td><td>Fan:</td><td>None</td></tr>
<tr><td>External surface cooling system:</td><td>Natural Convection</td><td>Internal board’s cooling system:</td><td>Conduction</td></tr>
<tr><td>Dimensions (W H D):</td><td>307x 88x 267 mm</td><td>Volume:</td><td>7.2 liter</td></tr>
<tr><td>Mass fully populated with battery:</td><td>7.1 kg</td><td>Mass fully populated without battery:</td><td>6.3 kg</td></tr>
<tr><td colspan="2">Battery type:</td><td colspan="2">NiMh</td></tr>
<tr><td colspan="2">Battery cells:</td><td colspan="2">12</td></tr>
<tr><td colspan="2">Battery capacity:</td><td colspan="2">40 Wh</td></tr>
</table>

Table 5. MF03 Mainframe

MF04

<table>
<tr><td rowspan="9">MF04
(M386)</td><td>Slot 1:</td><td>PQ12 G2 or
PQ20 G2 or
PQ30 G2</td><td colspan="2">Combined System Controller and Power Supply board</td></tr>
<tr><td>Slot 2 - 4:</td><td>SC42 G2 and/or
SC42S G2</td><td colspan="2">Data acquisition</td></tr>
<tr><td>Number of channels (if 6 ch per Module):</td><td>72</td><td>Fan:</td><td>Yes</td></tr>
<tr><td>External surface cooling system:</td><td>Natural Convection</td><td>Internal board’s cooling system:</td><td>Conduction</td></tr>
<tr><td>Dimensions
(W H D):</td><td>307x 109x 287 mm</td><td>Volume:</td><td>9.6 liter</td></tr>
<tr><td>Mass fully populated with battery:</td><td>9.92 kg</td><td>Mass fully populated without battery:</td><td>9.12 kg</td></tr>
<tr><td colspan="2">Battery type:</td><td colspan="2">NiMh</td></tr>
<tr><td colspan="2">Battery cells:</td><td colspan="2">12</td></tr>
<tr><td colspan="2">Battery capacity:</td><td colspan="2">40 Wh</td></tr>
</table>

Table 6. MF04 Mainframe

MF06

<table>
<tr><td rowspan="9">MF06
(M382)</td><td>Slot 1:</td><td>PQ12 G2 or
PQ20 G2 or
PQ30 G2</td><td colspan="2">Combined System Controller and Power Supply board</td></tr>
<tr><td>Slot 2 - 6:</td><td>SC42 G2 and/or
SC42S G2</td><td colspan="2">Data acquisition</td></tr>
<tr><td>Number of channels (if 6 ch per Module):</td><td>120</td><td>Fan:</td><td>Yes</td></tr>
<tr><td>External surface cooling system:</td><td>Natural/Forced Convection</td><td>Internal board’s cooling system:</td><td>Conduction</td></tr>
<tr><td>Dimensions
(W H D):</td><td>307x 151x 287 mm</td><td>Volume:</td><td>13.3 liter</td></tr>
<tr><td>Mass fully populated with battery:</td><td>15.18 kg</td><td>Mass fully populated without battery:</td><td>12.58 kg</td></tr>
<tr><td colspan="2">Battery type:</td><td colspan="2">NiCd</td></tr>
<tr><td colspan="2">Battery cells:</td><td colspan="2">12</td></tr>
<tr><td colspan="2">Battery capacity:</td><td colspan="2">72 Wh</td></tr>
</table>

Table 7. MF06 Mainframe

MF10

<table>
<tr><td rowspan="10">MF10
(M395)</td><td>Slot 1:</td><td>PQ20 G2 or
PQ30 G2</td><td colspan="2">Combined System Controller and Power Supply board</td></tr>
<tr><td>Slot 2 - 9:</td><td>SC42 G2 and/or
SC42S G2</td><td colspan="2">Data acquisition</td></tr>
<tr><td>Slot 10:</td><td>SL21</td><td colspan="2">Synchronization option</td></tr>
<tr><td>Number of channels (if 6 ch per Module):</td><td>192 [1]</td><td>Fan:</td><td>Yes</td></tr>
<tr><td>External surface cooling system:</td><td>Forced Convection</td><td>Internal board’s cooling system:</td><td>Conduction</td></tr>
<tr><td>Dimensions
(W H D):</td><td>291x 231x 333 mm</td><td>Volume:</td><td>22.3 liter</td></tr>
<tr><td>Mass fully populated with battery:</td><td>22.68 kg</td><td>Mass fully populated without battery:</td><td>20.18 kg</td></tr>
<tr><td colspan="2">Battery type:</td><td colspan="2">NiCd</td></tr>
<tr><td colspan="2">Battery cells:</td><td colspan="2">12</td></tr>
<tr><td colspan="2">Battery capacity:</td><td colspan="2">72 Wh</td></tr>
</table>

Table 8. MF10 Mainframe

Note: Mainframe slots are numbered from the bottom.

[1] Measured with ICS42 G2 Module, ICP® sensors and external DC power supply of 12 V up to 30 V.

Fastening Points

6 threaded female fastening points are present on both the top and bottom faces of the PAK MKII enclosure. The bottom face refers to the face closest to slot 1 of the Mainframe.

Parameter	**Value**
Hole Size	M5 x 8 mm deep
Spacing between any 2 holes of the 3 holes running from front to rear	82 mm
Spacing between left and right sets of 3 holes	229.3 mm
Maximum shear/normal force applied to any screw	500 N

Table 9. Mainframe fastening points

Note: Numbering of VMEbus slots starts at the bottom.

Mainframe Dimensions

The dimensions of the various Mainframes are shown on the next few pages.

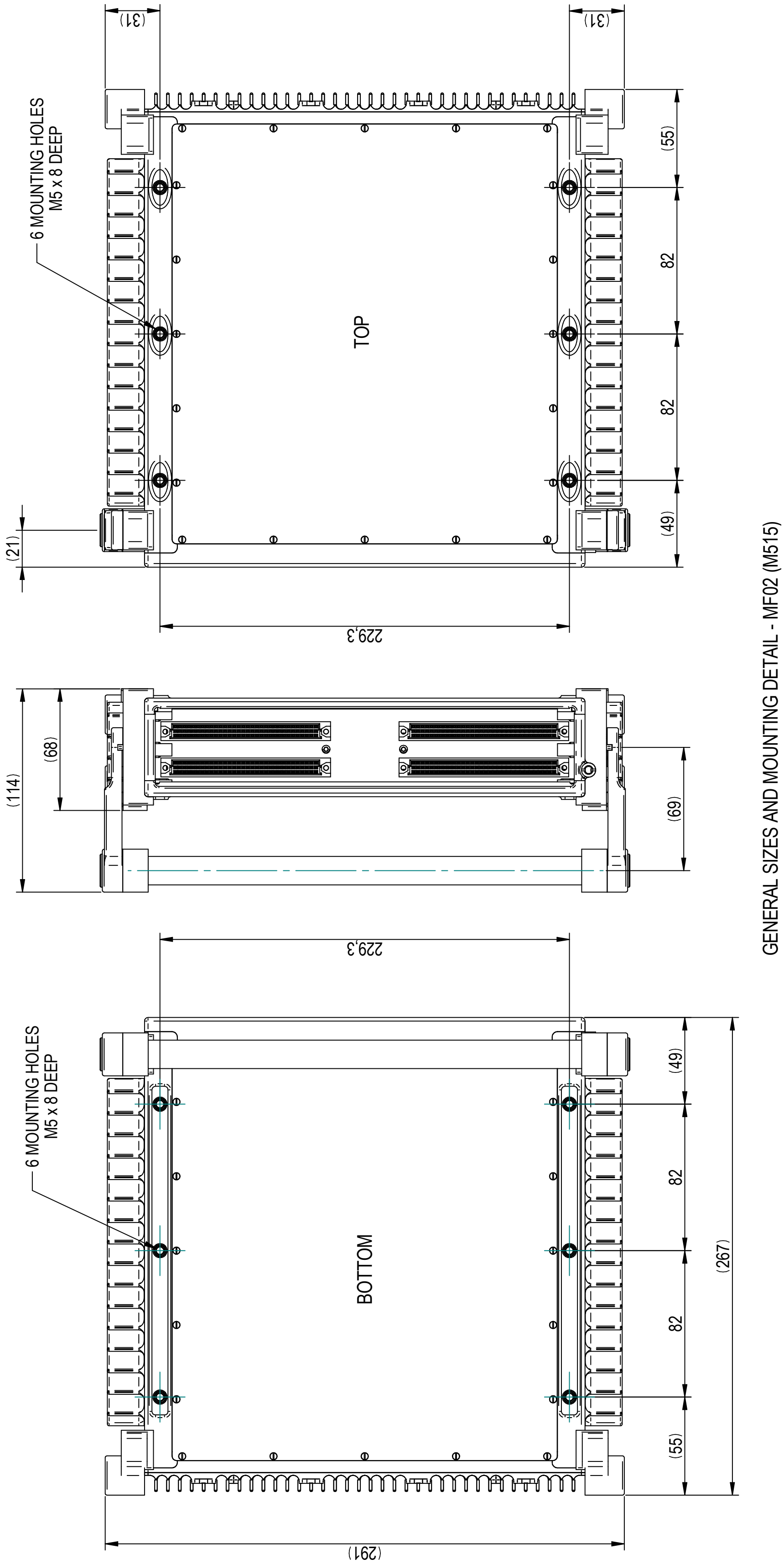


Figure 17. MF02 Dimensions

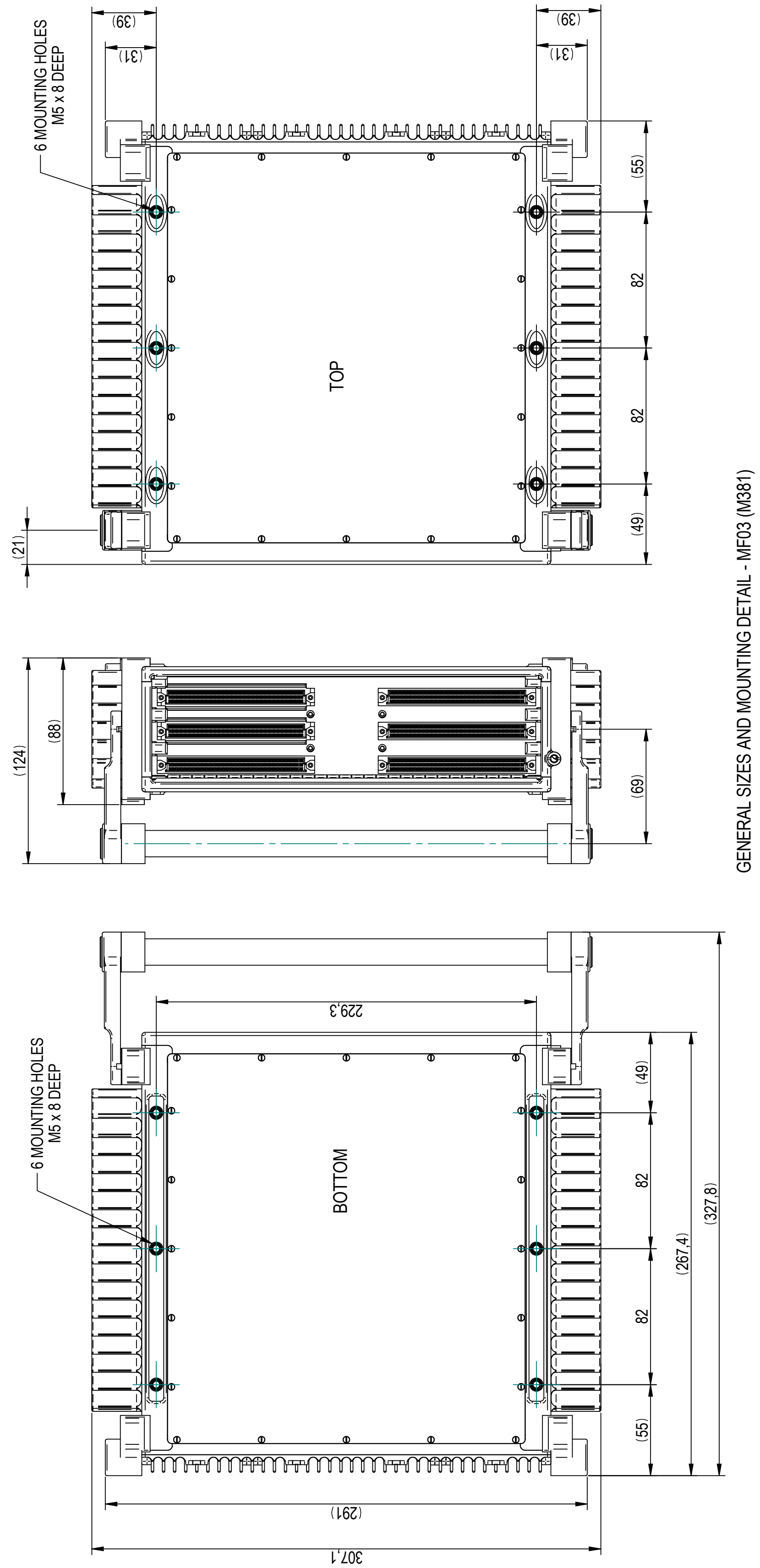


Figure 18. MF03 Dimensions

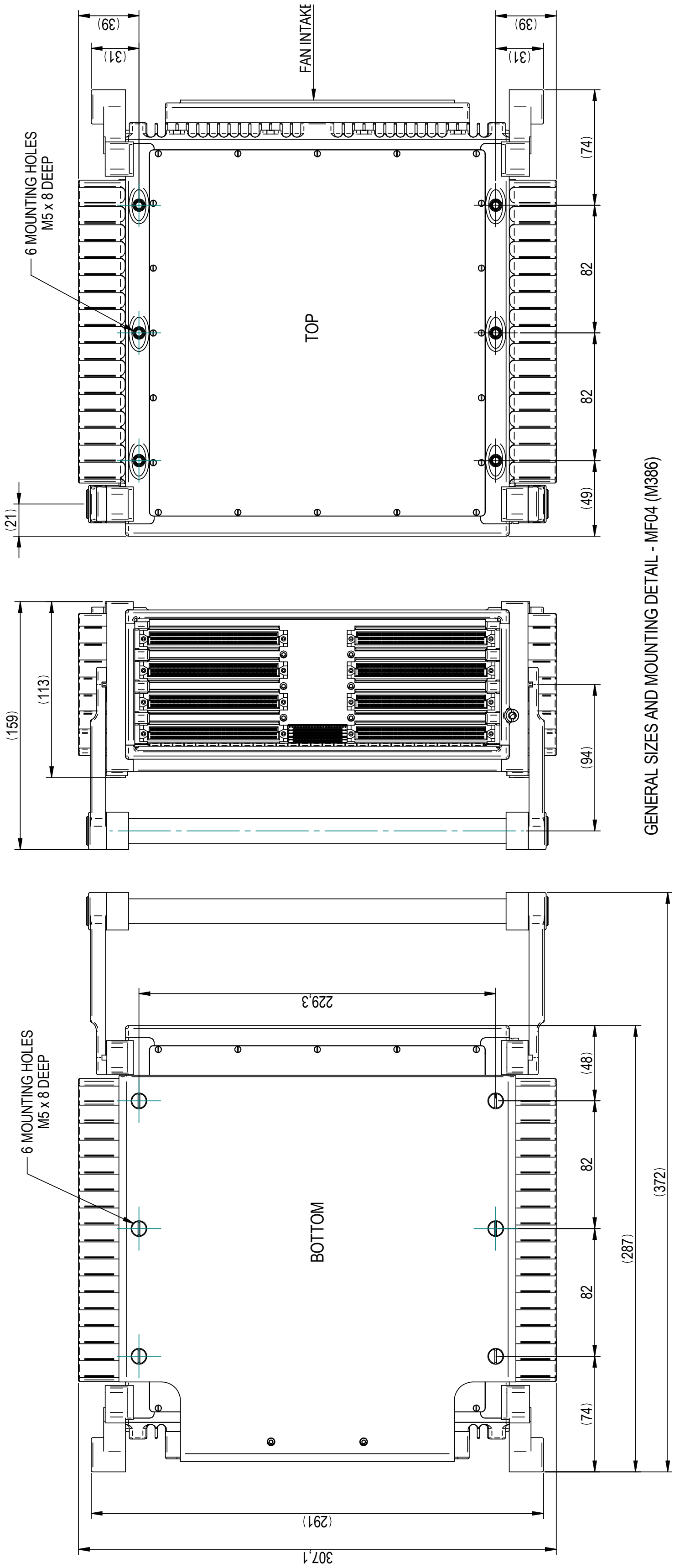


Figure 19. MF04 Dimensions

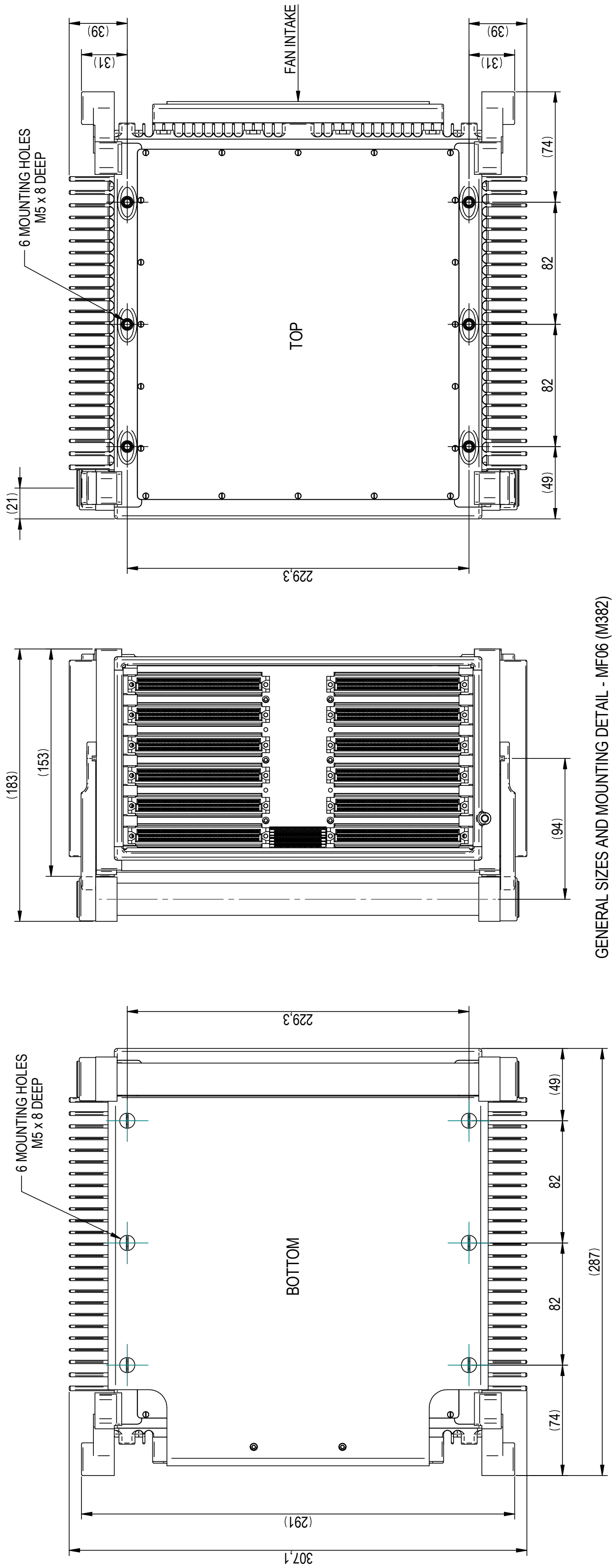


Figure 20. MF06 Dimensions

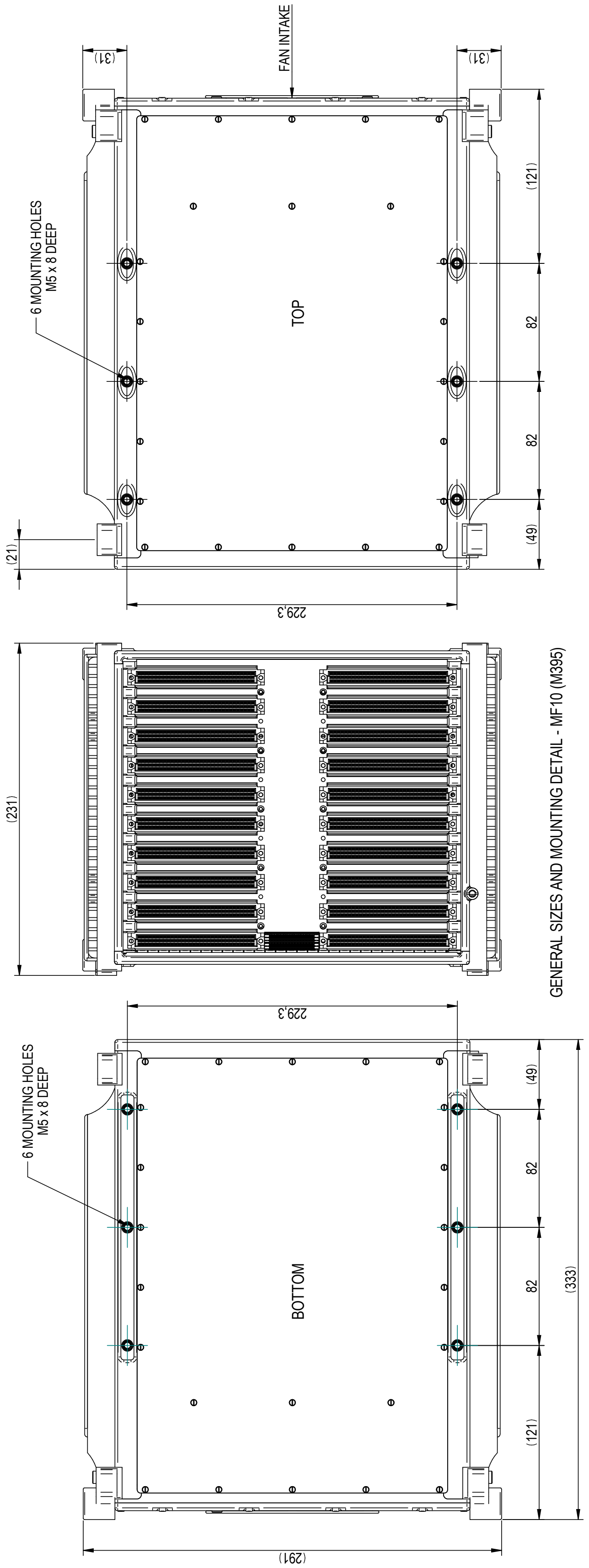


Figure 21. MF10 Dimensions

Mainframe Specifications

Class	Property	MF02	MF03	MF04	MF06	MF10
Physical	Maximum Environmental Temperature	62 °C	60 °C	58 °C	56 °C	55 °C
	Minimum Environmental Temperature	-20 °C	-20 °C	-20 °C	-20 °C	-20 °C
	Shock [1] (11 ms duration)	40 g	40 g	40 g	40 g	40 g
	Random Vibration [2] (10 to 2000 Hz)	0.1 g^2/Hz	0.1 g^2/Hz	0.1 g^2/Hz	0.1 g^2/Hz	0.1 g^2/Hz
Power [3]	Typical Power Input	External DC supply with an Internal Battery Pack				
	With most demanding Modules	30 W	50 W	75 W	120 W	200 W
	With most demanding Modules and Dynamic Charging on	70 W	90 W	115 W	160 W	240 W

Table 10. Temperature and Power Specifications

[1] According to MIL-STD-810G Method 516.6, Procedure I. 1 g = 9.8 m/s^2

[2] According to MIL-STD-810G Method 514.6, Procedure I. 1 g = 9.8 m/s^2

[3] These values are an indication of the power consumption for typical Mainframe configurations, and are not intended as an explicit specification for the external power supply

G2 Combined System Controller and Power Supply boards

Overview

The G2 Combined System Controller and Power Supply boards are multi-function boards combining a VMEbus System Controller, Master, Arbiter and Interrupt Handler with a VMEbus power supply. Options include WLAN IEEE 802.11n for communication to external devices (including smart hand-held devices) as well as an internal Solid-State Disk (SSD) for local storage.

Features include:

- Temperature-compensated, voltage-controlled crystal oscillator with a 5 ppm absolute accuracy
- 10-30 V DC voltage input from external power source
- Uninterrupted power supply (UPS) between external power and internal battery
- Input power protection circuitry with over-voltage and under-voltage lockout
- Fast battery charger for internal battery
- Comprehensive monitoring of internal power supply circuits
- Power on/off function via front panel or MiniTerminal
- Automatic power up on external power configurable setting
- Precision Time Protocol (PTP) synchronization through Ethernet port [1]
- SyncLink input for synchronization in a Cluster or SuperCluster
- Serial timing power (STP) port for use with the MiniTerminal
- Web server providing information and control functions
- Optional WLAN IEEE 802.11b/g/n
- Optional internal 128 GB Solid State Disk (SSD) for local storage
- Optional external eSATA port (with power) for use with an external SATA hard drive

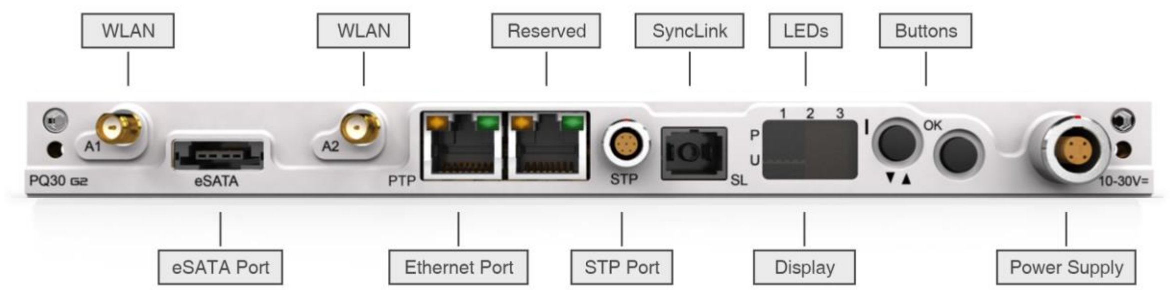


Figure 22. PQ30 G2 Front Panel

[1] Software-dependent

There are four types of G2 System Controllers, PQ11 G2, PQ12 G2, PQ20 G2 and PQ30 G2. Each was designed to be used in a system with a particular number of channels.

	Mainframes	SC Cards	Channels
PQ11 G2	MF02 – MF03	Max 2	Max 48
PQ12 G2	MF02 – MF06	Max 5	Max 120
PQ20 G2	MF02 – MF10	Max 8	Max 192 [1]
PQ30 G2	MF02 – MF10	Max 8	Max 192 [1]

Table 11. G2 PQ supported hardware

The table below shows the difference in maximum data throughput across the G2 Combined System Controller and Power Supply board range for data streaming over a LAN.

	Processor	Memory	Throughput [2]
	(MHz)	(MB DDR2)	(MB/s)
PQ11 G2	600	512	8
PQ12 G2	800	512	10
PQ20 G2	1000	512	20
PQ30 G2	1300	1024	45

Table 12. G2 PQ performance for data streaming over a LAN

[1] Measured with ICS42 G2 Module, ICP® sensors and external DC power supply of 12 V up to 30 V.
[2] To utilize the maximum capabilities of the controller cards they should be used in combination with SC42S G2, but is fully compatible with SC42 G2.

The default mode of a G2 Combined System Controller and Power Supply board is to stream data over a LAN using an Ethernet cable. There are three other data streaming modes available:

- Data streaming across a WLAN (IEEE 802.11b/g/n),
- Data streaming to a local storage device (either an internal SSD), and
- Data streaming to both the local storage device and across a WLAN (IEEE 802.11 b/g/n)

Table 13 shows a summary of the various options for each of the G2 Combined System Controller and Power Supply boards. All the PTP options are software-dependent.

	Type	LAN	WLAN	Internal SSD	External HDD
PQ11 G2	**PQ11 G2**	Yes	-	-	-
	PQ11 G2 PTP	Yes			
PQ12 G2	**PQ12 G2**	Yes	-	-	-
	PQ12 G2 PTP				
	PQ12 G2 11n	Yes	802.11n	-	-
	PQ12 G2 PTP 11n				
	PQ12 G2 128	Yes	-	128 GB	-
	PQ12 G2 PTP 128				
	PQ12 G2 11n 128	Yes	802.11n	128 GB	-
	PQ12 G2 PTP 11n 128				
PQ20 G2	**PQ20 G2**	Yes	-	-	-
	PQ20 G2 PTP				
	PQ20 G2 11n	Yes	802.11n	-	-
	PQ20 G2 PTP 11n				
	PQ20 G2 128	Yes	-	128 GB	-
	PQ20 G2 PTP 128				
	PQ20 G2 11n 128	Yes	802.11n	128 GB	-
	PQ20 G2 PTP 11n 128				

PQ30 G2	**PQ30 G2** **PQ30 G2 PTP**	Yes	-	-	-
	PQ30 G2 11n **PQ30 G2 PTP 11n**	Yes	-	-	Yes
	PQ30 G2 128 **PQ30 G2 PTP 128**	Yes	-	128 GB	Yes
	PQ30 G2 256 **PQ30 G2 PTP 256**	Yes	-	256 GB	Yes
	PQ30 G2 11n 128 **PQ30 G2 PTP 11n 128**	Yes	802.11n	128 GB	Yes
	PQ30 G2 11n 256 **PQ30 G2 PTP 11n 256**	Yes	802.11n	256 GB	Yes

Table 13. G2 PQ variations

External drive

An external drive formatted with the FAT32 file system standard can be used with a PQ30 G2.

The external drive serves as an alternate mechanism to read out data from the internal SSD other than through the Ethernet port. It is not intended for use as a local storage device.

An eSATAp connector has been provided to which the User can attach an external drive. This port is a powered version of a standard SATA port. It incorporates all of the standard SATA data pins as well as 5 V and GND pins. The eSATAp port is protected with a 1 A fuse. All USB functionality on the eSATAp port has been disabled so USB drives will not work when connected to the eSATAp port.

Power Supply Features

Take note of the recommended input voltage and current requirements when operating in one of the following two modes:

- High channel counts typically found in MF06 and MF10 Mainframe configurations
- Using the dynamic-charge feature

	DC Input Voltage	Input Current	Fuse
Min	10 V	-	25 A
Max	30 V	21 A [1]	-
Recommended	> 15 V	< 16 A	-

Table 14. G2 PQ power supply

The PAK MKII requires a special power cable. Do not attempt to use third party cables as this may damage your system. Please refer to *"Power Cables"* and *"Connecting Power"* sections in *PAK MKII User Manual revision 10.3* or later for available power cables.

The recommended power supply wattage depends on the Mainframe.

Mainframe	Recommended power supply
MF02	85 W
MF03	125 W
MF04	155 W
MF06	245 W
MF10	305 W

Table 15. G2 PQ recommended power supply ratings

[1] Absolute maximum ratings, permanent damage could occur.

Uninterruptible Power Supply (UPS)

All PAK MKII systems are optionally equipped with an internal battery pack. When the power input voltage to the PAK MKII drops below the threshold voltage (typically between 8.5 and 9.6 V, depending on the power supply technology used) the UPS on a PQxx will supply the PAK MKII with power via the battery pack.

If the PAK MKII runs for more than 4 s from its battery pack, the message `BACKUP` or `BKP` will appear on the PAK MKII display.

If thereafter the PAK MKII power input voltage rises above the threshold, the UPS will automatically switch back to the PAK MKII power input as the primary power supply for the PAK MKII.

The PAK MKII can run from the battery pack for the specified battery pack temperature of -20 °C to 65 °C, although battery capacity will decrease at low temperatures. No protection is provided should the PAK MKII attempt to run off the battery pack below -20 °C.

G2 System Controller Connector information and pin definitions

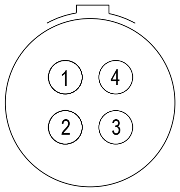


Figure 23. G2 Combined System Controller and Power Supply board Power Lemo pin definition (when looking into the front panel's connector or at the rear of the cable's connector)

Following are the Power Lemo connector pin definitions for each input of the G2 Combined System Controllers and Power Supply board:

- Pin 1: VSUP+
- Pin 2: VSUP-
- Pin 3: VSUP-
- Pin 4: VSUP+

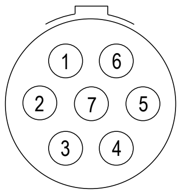


Figure 24. G2 Combined System Controller and Power Supply board STP Lemo pin definition (when looking into the front panel's connector or at the rear of the cable's connector)

Following are the Lemo connector pin definitions for each input of the G2 Combined System Controller and Power Supply boards:

- Pin 1: SyncLink Signal Input
- Pin 2: 12 V
- Pin 3: GND
- Pin 4: 5 V STDBY
- Pin 5: Tx
- Pin 6: Rx
- Pin 7: PSU Wake Up

PQ11 G2

Figure 25. PQ11 G2 PTP

Supported Hardware

The PQ11 G2 was designed to be used in an MF02 or MF03 Mainframe. It can be used with a maximum of 2 SC boards and can run up to 8 Modules. The maximum channel count of the PQ11 G2 is 48. The PQ11 G2 PTP is a new version[1] with an added Precision Time Protocol (PTP) synchronization feature.

Performance

The PQ11 G2 has a throughput of 8 MB/s. This is provided through a 600 MHz Freescale processor utilizing 512 MB of DDR2.

SSD and WLAN Options

The PQ11 G2 has no SSD or WLAN Options.

[1] Software-dependent

PQ12 G2

Figure 26. PQ12 G2 11n 128 PTP

Supported Hardware

The PQ12 G2 was designed to be used in an MF02, MF03, MF04 or MF06 Mainframe. It can be used with a maximum of 5 SC boards and can run up to 20 Modules. The maximum channel count of the PQ12 G2 is 120. The PQ12 G2 PTP is a new version[1] with an added Precision Time Protocol (PTP) synchronization feature.

Performance

The PQ12 G2 has a throughput of 10 MB/s. This is provided through an 800 MHz Freescale processor utilizing 512 MB of DDR2.

SSD and WLAN Options

The PQ12 G2 and PQ12 G2 PTP have four SSD/WLAN options:

- PQ12 G2/PQ12 G2 PTP – Data can only be streamed over LAN
- PQ12 G2 11n/PQ12 G2 11n PTP – WLAN is enabled. Data can be streamed over LAN or WLAN
- PQ12 G2 128 /PQ12 G2 128 PTP – Local storage (128 GB) is enabled. Data can be streamed to a local storage device or over a LAN
- PQ12 G2 11n 128/PQ12 G2 11n 128 PTP – Both WLAN and Local storage (128 GB) are enabled. Data can be streamed to a local storage device or to the LAN or WLAN

[1] Software-dependent

PQ20 G2

Figure 27. PQ20 G2 11n 128 PTP

Supported Hardware

The PQ20 G2 was designed to be used in all Mainframes (MF02, MF03, MF04, MF06 or MF10). It can be used with a maximum of 8 SC boards and can run up to 32 Modules. The maximum channel count of the PQ20 G2 is 192. The PQ20 G2 PTP is a new version[1] with an added Precision Time Protocol (PTP) synchronization feature.

Performance

The PQ20 G2 has a throughput of 20 MB/s. This is provided through a 1000 MHz Freescale processor utilizing 512 MB of DDR2.

SSD and WLAN Options

The PQ20 G2 and PQ20 G2 PTP have four SSD/WLAN options:

- PQ20 G2/PQ20 G2 PTP – Data can only be streamed over LAN
- PQ20 G2 11n/PQ20 G2 11n PTP – WLAN is enabled. Data can be streamed over LAN or WLAN
- PQ20 G2 128/PQ20 G2 128 PTP – Local storage (128 GB) is enabled. Data can be streamed to a local storage device or over a LAN
- PQ20 G2 11n 128/PQ20 G2 11n 128 PTP – Both WLAN and Local storage (128 GB) are enabled. Data can be streamed to a local storage device or to the LAN or WLAN

[1] Software-dependent

PQ30 G2

Figure 28. PQ30 G2 11n 128 PTP

Supported Hardware

The PQ30 G2 was designed to be used in all Mainframes (MF02, MF03, MF04, MF06 or MF10). It can be used with a maximum of 8 SC boards and can run up to 32 Modules. The maximum channel count of the PQ30 G2 is 192. The PQ30 G2 PTP is a new version[1] with an added Precision Time Protocol (PTP) synchronization feature.

Performance

The PQ30 G2 has a throughput of 45 MB/s. This is provided through a 1300 MHz Freescale processor utilizing 1024 MB of DDR2.

HDD, SSD and WLAN Options

The PQ30 G2 and PQ30 G2 PTP have four SSD/WLAN options:

- PQ30 G2/PQ30 G2 PTP – Data can only be streamed over LAN
- PQ30 G2 11n – WLAN is enabled. Data can be streamed over LAN or WLAN
- PQ30 G2 128/PQ30 G2 128 PTP – Local storage (128 GB) is enabled. Data can be streamed to a local storage device or over a LAN
- PQ30 G2 256/PQ30 G2 256 PTP – Local storage (256 GB) is enabled. Data can be streamed to a local storage device or over a LAN
- PQ30 G2 11n 128/PQ30 G2 11n 128 PTP – Both WLAN and Local storage (128 GB) are enabled. Data can be streamed to a local storage device or to the LAN or WLAN
- PQ30 G2 11n 256/PQ30 G2 11n 256 PTP – Both WLAN and Local storage (256 GB) are enabled. Data can be streamed to a local storage device or to the LAN or WLAN

The PQ30 G2 is the only G2 Combined System Controller and Power Supply Board that can be used with an external HDD. It is also the only G2 Combined System Controller and Power Supply Board with the option of having a 256 GB SSD. This further increases the capacity of the PQ30 G2.

[1] Software-dependent

User Interface

The User Interface allows the User to perform a series of control commands as well as to obtain specific system information. The User Interface consists of a four character display, 5 LEDs (1,2,3,P,U) and 2 buttons (I, OK) for scroll and select functions.

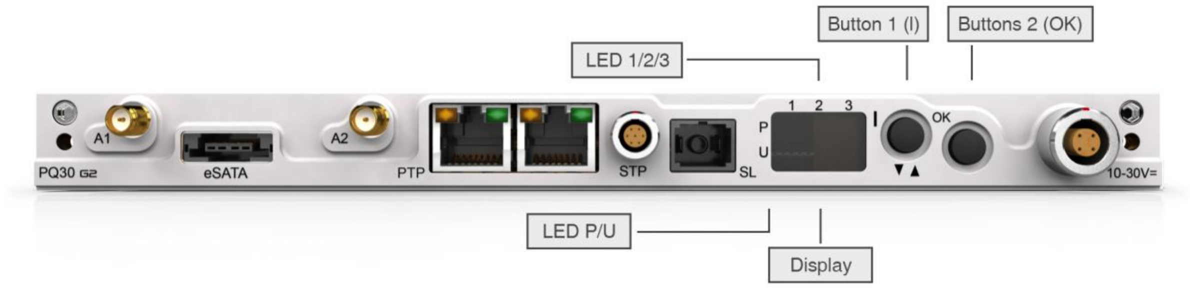


Figure 29. PQ30 G2 PTP User Interface

How to operate the User Interface

Two buttons are present on the User Interface. The 1st button, marked I, of the User Interface is used to scroll through the different menu items. The 2nd button, marked OK, is for making a selection on the User Interface and will execute the menu item command currently displayed. Some commands need to be acknowledged as a safety feature.

Increasing and decreasing display brightness

The brightness of the PAK MKII display is managed via the User Interface. Holding in button 2 (OK) will cycle through the brightness of the display. At the desired brightness release the button.

WARNING:

Never switch off or reset the PAK MKII while it is busy booting or while a firmware upgrade is in progress. This could permanently damage the system. Only when the PAK MKII display indicates **`Idle`**, **`live`**, **`Rec`**, or **`FAIL`** is further User interaction required.

The menu items when the PAK MKII is switched off

When the PAK MKII is switched off the User interface has five menu options:

ON?	Turn the PAK MKII on
OFF?	Leave the PAK MKII off
FCH?	Fast charges the battery
SCH?	Slow charges the battery
SVB?	Service the battery

The menu options on the User Interface cycle in a repetitive loop (the menu item following SVB? is ON?).

Turn the PAK MKII on

ON?	Switching on the PAK MKII
OFF?	
FCH?	
SCH?	
SVB?	

- Power-up by pressing and holding button 1
- LEDs will flash briefly to indicate their proper operation
- When **ON?** appears on the display press button 2 to select
- **SURE** is then displayed. Press button 2 again to select
- When **MKII** appears on the display the system has started to boot
- If running off the battery the display shows **BKup**
- When **Wait** appears on the display, the PAK MKII has started to initialize its SC4x boards and Modules. **Wait** is replaced with **xx%** boot and upgrade percentage
- When **Idle** appears on the display, the PAK MKII has powered up and booted successfully

Turn the PAK MKII off

ON?
OFF?
FCH?
SCH?
SVB?

To turn the PAK MKII off:

- Scroll using button 1 (I) until the display shows **OFF?**
- Press button 2 (OK) to select this menu item. The display shows **SURE**
- Press button 2 (OK) again. The display shows **OK** and the system switches itself off

Fast Charging (FCH)

ON?
OFF?
FCH?
SCH?
SVB?

Fast-charging (FCH) uses approximately an additional 60 W of electrical input power. If the input power supply cannot provide the additional power, the system might reset. Fast-charging can only be performed before the system boots. Furthermore, it is recommended that fast-charging be performed in an area where a free flow of cool air is present as fast-charging introduces additional heat into the system.

While the battery is being fast-charged, the PAK MKII system will remain off. This protects the PAK MKII from overheating.

To fast-charge the battery while the PAK MKII is **not operational:**

- Ensure the PAK MKII is powered-down
- Press button 1 (I) to power-up
- When **ON?** appears on the display, use button 1(I) to scroll through the menu until the display shows **FCH?** or **SCH?**
- Press button 2 (OK) to select this menu item. The display shows **SURE**
- Press button 2 (OK) again. It may take up to 5 min before charging commences
- LEDs 3, 2 and 1 will light up in sequence. (This sequence is slower for slow-charge)

Slow Charging (SCH)

ON?
OFF?
FCH?
SCH?
SVB?

Slow-charging (SCH) uses approximately 10 W of electrical input power. Slow-charge allows the User to continue working without overheating the PAK MKII since the slow-charge method only places a small additional load on the PSU. The drawback is that it can take up to 16 h to fully recharge the battery.

To slow-charge the battery while the PAK MKII is **operational:**

- Ensure the PAK MKII is powered-down
- Press button 1 (I) to power-up
- When **ON?** appears on the display, use button 1(I) to scroll through the menu until the display shows **FCH?** or **SCH?**
- Press button 2 (OK) to select this menu item. The display shows **SURE**
- Press button 2 (OK) again. It may take up to 5 min before charging commences
- LEDs 3, 2 and 1 will light up in sequence

Servicing the Battery (SVB)

ON?
OFF?
FCH?
SCH?
SVB?

The **SVB?** (Service Battery) menu option allows the User to fully deplete the battery after which it automatically begins a slow-charging cycle. This process can be ended at any time by selecting **ESB?** (End Servicing the Battery).

For optimum battery care, the battery on the PAK MKII should be depleted and then fully recharged every six months. This will ensure that the battery maintains its maximum energy capacity.

The menu items when the PAK MKII is switched on

When the PAK MKII has been switched on, the User interface has twelve menu options as shown below. Each menu option is discussed in the sections that follow.

Idle	The default text displayed on the G2 PQ User Interface
live	Displays when PAK live is running on the PAK MKII system
Rec	Displays when PAK live is running and a recording to local disk is started by user
Trig	Displays when PAK live is running and a trigger is armed
IP?	Displays the IP address of LAN and WLAN as well as firmware revisions
RST?	Resets the PAK MKII
OFF?	To power down the PAK MKII
BAT?	Battery information
PSU?	PQ power supply information
TMP?	Temperature
AOn?	The PAK MKII will automatically turn on when power is applied to the power Lemo
INF?	Information and firmware revisions of the PAK MKII
BTMx	The amount of time a test can run on battery backup before shutting down
SCH?	Slow charges the battery
DCH?	Dynamic charging of the battery
DFLT	Changes the boot parameters of the PAK MKII back to the default setting

The menu options on the User Interface cycle in a repetitive loop – (the menu item after DFLT is IP?).

Display the IP address of the PAK MKII: IP?

IP?
RST?
OFF?
BAT?
PSU?
TMP?
AOn?
INF?
BTMx
SCH?
DCH?
DFLT

To display the PAK MKII IP address:

- Scroll using button 1 (I) until the display shows **`IP?`**
- Press button 2 (OK) to select this menu item. The display shows **`SURE`**
- Press button 2 (OK) again. The display shows **`OK`** followed by 4 x 1 IP address groups for example **`192.`**, **`168.`**, **`1.`** and **`231`**. to give the complete IP address 192.168.1.231
- If a WLAN card is fitted it will also display its IP address before displaying the firmware versions
- After displaying the IP address, the PAK MKII displays other information on the Controller and SC4x firmware versions which are currently executing on the PAK MKII
  - The Controller firmware release number is displayed (e.g. **`1-4-a`**)
  - The Controller firmware release information is displayed (e.g. **`13582605`**)
  - The SC4x firmware release number is displayed (e.g. **`1-4-a`**)
  - The SC4x firmware release information is displayed (e.g. **`16230809`**)

Resetting the PAK MKII: RST?

IP?
RST?
OFF?
BAT?
PSU?
TMP?
AOn?
INF?
BTMx
SCH?
DCH?
DFLT

To reset the PAK MKII

- Press button 1 (I) until **`RST?`** is displayed
- Select using button 2 (OK). **`SURE`** is then displayed
- Select using button 2 (OK) again. **`OK`** and **`Boot`** is then displayed

With the above-mentioned procedure the User consciously follows a sequence to reset the PAK MKII. By following such a procedure, the PAK MKII will be reset irrespective of whether a test is running or not. Valuable data may be lost.

Switching off the PAK MKII: OFF?

IP?
RST?
OFF?
BAT?
PSU?
TMP?
AOn?
INF?
BTMx
SCH?
DCH?
DFLT

Switching off the PAK MKII

- Scroll using button 1 (I) until **OFF?** is displayed
- Select using button 2 (OK). **SURE** is then displayed
- Select using button 2 (OK) again. **OK** is then displayed

With the above-mentioned procedure the User consciously follows a sequence to switch off the PAK MKII. By following such a procedure, the PAK MKII will be switched off irrespective of whether a test is running or not. Valuable data may be lost.

Battery Information: BAT?

IP?
RST?
OFF?
BAT?
PSU?
TMP?
AOn?
INF?
BTMx
SCH?
DCH?
DFLT

For the status of the PAK MKII battery:

- Scroll using button 1 (I) until the display shows **BAT?**
- Press button 2 (OK) to select this menu item. The display shows **SURE**
- Press button 2 (OK) again. The display shows **OK** followed by **WAIT** and **Bon**[1]
  During this time, the system will run off the battery while measuring its voltage
- The display shows current battery voltage for example **15.1**
- A comment regarding the battery status is displayed based on the battery voltage for example **BOk+**
- The battery temperature will be displayed in degrees Celsius for example **+26C**

For a MF02 (8 cell battery) the voltage levels are as follows:

- **BFUL** (> 10 V)
- **BOk+** (9.4 V to 10 V)
- **BOk-** (8.6 V to 9.4 V)
- **BLOW** (< 8.6 V)

For a MF03, MF04, MF06 and MF10 (12 cell battery) the voltages levels are as follows:

- **BFUL** (> 15.6 V)
- **BOk+** (13.2 V to 15.6 V)
- **BOk-** (12.7 V to 13.2 V)
- **BLOW** (< 12.7 V)

[1] If no valid battery is fitted, the display will show **NO B**.

Power Supply Status: PSU?

IP?
RST?
OFF?
BAT?
PSU?
TMP?
AOn?
INF?
BTMx
SCH?
DCH?
DFLT

This menu item measures and displays the electrical voltage and/or current levels of the current PAK MKII power input. It also shows information regarding the internal power supplies.

If the battery is nearly or completely discharged the system might reset.

- Scroll using button 1 (I) until the display shows **PSU?**
- Press button 2 (OK) to select this menu item. The display shows **SURE**
- Press button 2 (OK) again. The display shows **OK** followed by the power supply status

The information displayed is:

- **PVxx** The PSU firmware version currently executing on the PQ G2
- **VP: xx.x** Primary input voltage (measured at the PAK MKII power input)
- **VS: x.xx** Secondary input voltage (battery)
- **VF: x.xx** Final input voltage used by UPS to supply the PAK MKII
- **V3: x.xx** Voltage of 3.3 V supply (3.2 V to 3.45 V)
- **V5: x.xx** Voltage of 5 V supply (4.85 V to 5.25 V)
- **V12: x.xx** Voltage of 12 V supply (11.7 V to 12.6 V)
- **V24: x.xx** Voltage of 20 V intermediate supply (20 V to 32 V)
- **IP: xx.x** Primary input current (measured at the PAK MKII power input)
- **IB: xx.x** Battery current
- **I5: xx.x** Current of 5 V supply
- **12: xx.x** Current of 12 V supply

Temperature: TMP?

IP?
RST?
OFF?
BAT?
PSU?
TMP?
AOn?
INF?
BTMx
SCH?
DCH?
DFLT

For the status of the Mainframes temperature: TMP?

- Scroll using button 1 (I) until the display shows **TMP?**
- Press button 2 (OK) to select this menu item. The display shows **SURE**
- Press button 2 (OK) again. The display shows **OK** followed by the temperature for example **+40C**

Auto or Manual On: AOn? / MOn?

IP?
RST?
OFF?
BAT?
PSU?
TMP?
AOn?
INF?
BTMx
SCH?
DCH?
DFLT

MOn? (Manual On) – The User switches the PAK MKII on using the User interface. Please note that the default mode is manual on whereby the User switches the PAK MKII on using the User interface.

AOn? (Automatic On) – The User can either switch the PAK MKII on using the User interface, or the PAK MKII will switch itself on when it detects a voltage is present at its power connector. Automatic On is intended for use when the location of the PAK MKII makes it difficult for the User to reach the User interface. In that instance, once external power has been switched on, the PAK MKII will power up[1].

To set the Automatic On option:

- Scroll using button 1 (I) until the display shows **AOn?**
- Press button 2 (OK) to select this menu item. The display shows **SURE**
- Press button 2 (OK) again. The display shows **OK.** The PAK MKII system will now turn on automatically when power is applied. When power is applied the display will show **ON?** and count down to 0 s before completely starting the system. During this count down the User can halt the count down by pressing any User interface button. Normal functions available before startup can then be selected in the usual manner. If left to count down the system will start

To set the Manual On option:

- Scroll using button 1 (I) until the display shows **MOn?**
- Press button 2 (OK) to select this menu item. The display shows **SURE**
- Press button 2 (OK) again. The display shows **OK.** This will restore the system power up option back to the manual on

[1] For automatic on to work, the PAK MKII must detect a change in voltage at its power connector. Typically, this change would be from 0 V to 12-30 V

Info: INF?

IP?
RST?
OFF?
BAT?
PSU?
TMP?
AOn?
INF?
BTMx
SCH?
DCH?
DFLT

This menu item shows information and firmware versions related to the PQ G2.

- Scroll using button 1 (I) until the display shows **INF?**
- Press button 2 (OK) to select this menu item. The display shows **SURE**
- Press button 2 (OK) again. The display shows **OK** followed by the information

The information displayed is (for example):

- The PSU firmware version currently executing on the PQ G2:
    - PSU Firmware : **PV17**
- The hardware version information for the PQ G2 that includes the name, revision and build number for the printed-circuit board (PCB):
    - PCB Name : **PCB PQ30**
    - PCB Rev : **Rev 06**
    - PCB Build : **Bld A*****
- The UPS, CPLD and FPGA firmware programmed onto the G2 which is not remotely upgradable and hence their current version is displayed here (note that this information is related to the G2 build number):
    - UPS Firmware : **UPS 07**
    - CPLD Firmware : **CPLD 01**
    - FPGA Firmware : **FPGA 01**
- The PQ serial number (shown without the ‘M’ character for space reasons):
    - Serial Number: **SrNo 03129032**

Backup Time Setting: BTMx

IP?
RST?
OFF?
BAT?
PSU?
TMP?
AOn?
INF?
BTMx
SCH?
DCH?
DFLT

Backup time setting is the amount of time that the PAK MKII will run from the battery pack before it powers itself down. This may be useful if the User does not want the battery pack to be fully drained before powering down.

There are seven options for the backup time setting:

- Off (BTimeOFF): The backup time setting is not active. The PAK MKII will immediately power down when external power is disconnected from a G2 System Controller
- 1-Min (BT01): The backup time setting is set to 1 minute. When backup starts the Battery Pack will provide power for a maximum of 1 minute before it powers itself down
- 2-Min (BT02): The backup time setting is set to 2 minutes
- 5-Min (BT05): The backup time setting is set to 5 minutes
- 10-Min (BT10): The backup time setting is set to 10 minutes
- 30-Min (BT30): The backup time setting is set to 30 minutes
- Max (BTMx): The backup time setting is set to Max. When backup starts the PAK MKII will run from backup power until the battery pack is empty

To change the backup time setting:

- Ensure the PAK MKII is powered up
- The current Backup Time setting is also the menu item which must be executed to change the Backup Time setting. Scroll using button 1 (I) until the display shows e.g. **BTMx**
- Press button 2 (OK) to select this menu item
- Scroll through the various settings using button 1 (I) until the display shows e.g. **BT02**
- Press button 2 (OK) again. The display shows **OK**

Note: If **BTimeOff** is selected **the UPS function is disabled**. It will not be possible to run from the Battery Pack. If the User wants to turn the system on without external power (i.e. from the Battery Pack) the following procedure must be executed:

- To turn the system on and run from the Battery Pack, keep button 1 (I) pressed for at least 3 s. The display will be blank during this time but thereafter **RST!** will be shown. Press button 2 (OK)
- The **BTimeOff** setting is now overridden and reset to **BTMx**

Slow Charging (SCH)

IP?
RST?
OFF?
BAT?
PSU?
TMP?
AOn?
INF?
BTMx
SCH?
DCH?
DFLT

Slow-charge allows the User to continue working without overheating the PAK MKII system since the slow-charge method only places a small additional load on the PSU. The drawback is that it can take up to 16 h to fully recharge the battery.

To slow-charge or dynamic-charge the battery while the PAK MKII is <u>operational</u>:

- If the PAK MKII is powered-down, first power-up the PAK MKII as usual. Wait for the PAK MKII to boot (i.e. until **`Idle`** is displayed)
- Scroll using button 1 (I) until the display shows **`SCH?`** or **`DCH?`**
- Press button 2 (OK) to select this menu item. The display shows **`SURE`**
- Press button 2 (OK) again. It may take up to 5 min before charging commences
- LEDs 3, 2 and 1 will light up in sequence. The sequence will be slow for slow-charge and faster for dynamic-charge
- The User may now continue to use the PAK MKII system

To end charging or deactivate dynamic-charging, scroll to select and execute the menu item **`eSCH`** or **`eDCH.`**

Dynamic Charging (DCH)

IP?
RST?
OFF?
BAT?
PSU?
TMP?
AOn?
INF?
BTMx
SCH?
DCH?
DFLT

Dynamic-charging (DCH) can use up to an additional 40 W of electrical input power. Dynamic charging can be used while the system is running. The battery charge current will change dynamically depending on the amount of system input current is available. Dynamic-charging (DCH) introduces additional heat into the system.

Once dynamic-charge has been set, the PQ will remember the setting and always attempt to automatically charge the battery. Dynamic-charge can be deactivated via the User Interface or Web Server; it will stay deactivated until activated again.

Dynamic-charge will also be deactivated (and stay deactivated) when slow-charging is selected. If dynamic-charge is selected whilst slow-charging, the slow-charge will be terminated and dynamic-charge activated.

Slow-charging and fast-charging functions which can be selected before the system boots does not affect or cancel dynamic-charging.

Dynamic-charge allows the User to charge the battery faster while working but the PAK MKII system will reach a higher temperature during dynamic-charging. Dynamic-charging requires that the total input current is less than 15 A before charging commences. If the input current to the system is less than 15 A, charging will commence. In this instance, battery charge current will increase until the maximum battery charge current is reached or until the input current rises above 15 A.

If total input current rises above 16 A during charging, the charge current will be reduced until the input current is below 16 A or until zero charge current is reached.

When zero charge current is reached, charge current will only increase again when input current to the system falls below 15 A. When zero charge current is reached, the dynamic-charge function will be in a “pending” status for a maximum of 16 hours.

Dynamic-charge will only attempt a charge cycle 100 seconds after system boot-up or when coming out of backup mode. If a dynamic-charge cycle is terminated (full battery reached), a new cycle will start only if the system was on backup for at least 3 minutes or when the system resets or restarts.

Dynamic-charge will automatically start a new charge cycle:

- 100 seconds after system boot
- 100 seconds after coming out of backup mode

- 3 minutes after coming out of backup mode if the charge cycle was terminated because a fully charged status was reached

Dynamic-charging will terminate if:

- The battery reached a fully charged status
- The main input power was lost and the system went into backup mode
- The charge cycle time of 16 hours expired
- A battery fault is detected

Dynamic-charge will be deactivated if:

- The User selects to deactivate the function via the User Interface or Web Server
- The slow-charge function is selected after the system has booted

Restore Default Settings (DFLT)

IP?
RST?
OFF?
BAT?
PSU?
TMP?
AOn?
INF?
BTMx
SCH?
DCH?
DFLT

The default boot parameters of the G2 PQ can be restored to their original settings by using the DFLT menu item.

- Scroll using button 1 (I) until the display shows **`DFLT`**
- Press button 2 (OK) to select this menu item. The display shows **`SURE`**
- Press button 2 (OK) again. The display shows **`OK`**

The default boot parameters are:

inet on ethernet (e)	: 192.168.100.5
WLAN IP Address	: 192.168.2.204
DHCP Mode	: Disabled
Bridged Mode	: Disabled
ftp password (pw)	: password

Boot-up Messages displayed on the User Interface

When the PAK MKII is switched on it will begin to boot-up with firmware stored in its internal Flash memory. There are three stages to booting up correctly:

- Boot-up the G2 System Controller and begin communications over the internal VMEbus as well as external LAN or WLAN
- Boot-up each G2 Signal Conditioner board in the system, and finally
- Boot-up each G2 Module in the system

During boot-up the device will show the following messages on the User interface:

- **`MKII`** The default message displayed at startup
- **`Boot`** This message is displayed while the G2 System Controller is booting
- **`PSU`** This message is displayed during the power supply firmware check
- **`36%`** Progress indicator, displayed during G2 Signal Conditioner and G2 Module boot-up
- **`Idle`** This message is displayed once boot-up is complete
- **`live`** This message is displayed once boot-up is complete and PAK live is running on the PAK MKII system. When PAK live is running on the system, measurements automatically start after boot-up.

Power Supply Firmware Upgrading

The power supply firmware is upgradable. If required, this upgrading will automatically occur during the boot-up of the PAK MKII and will therefore interrupt the normal boot-up procedure.

The power supply firmware upgrading can be identified by the message **`Load`** initially appearing on the PAK MKII display for a few seconds. Thereafter the symbols **`////`** rotate on the display. As an additional indication of this mode, LED 1 blinks on and off. After the upgrade process has completed successfully (which may take up to 1 minute) the message **`RST?`** will appear on the display. Boot the PAK MKII again by pressing button 2 (OK) and button 2 (OK) again to confirm.

If **`RST?`** does not appear after several minutes the PAK MKII may be powered-down and powered-up again to re-execute the power supply firmware upgrade procedure.

The power supply firmware upgrading can typically be expected after the PAK MKII has been programmed with new firmware.

Other Firmware Upgrade Messages

Once a PAK MKII system has booted successfully, the PAK software is able to upgrade the PAK MKII firmware over the ethernet network connection, should this be necessary. The PAK MKII firmware is further subdivided into 3 sections each corresponding to the target device i.e. Controller, SC4x and MiniTerminal. During an upgrade, a message indicating the firmware section currently being upgraded is displayed as follows:

- **`SCU`** This message is displayed while SC, Controller and MiniTerminal firmware is being upgraded from over the network
- **`UGS`** This message is displayed while SC firmware is being upgraded from over the network
- **`UGI`** This message is displayed while Controller firmware is being upgraded from over the network
- **`UGR`** This message is displayed while RTP firmware is being upgraded from over the network
- **`UMT`** This message is displayed while MiniTerminal firmware is being upgraded from over the network
- **`MDU`** This message is displayed while Module firmware is being upgraded from the SC4x

Messages when charging the Battery Pack

`BHOT` is displayed when the Battery Pack is hot (≥65°C) or has gone above 45°C while being charged:

- 45°C. When the Battery Pack is being charged, then the temperature at which the Battery Pack is defined as ‘hot’ is 45°C. This is for safety reasons as it is better for the Battery Pack to be charged at lower temperatures
- 65°C. If the Battery Pack is not being charged, then the temperature at which the Battery Pack is defined as being ‘hot’ is 65°C

Interpreting the LEDs

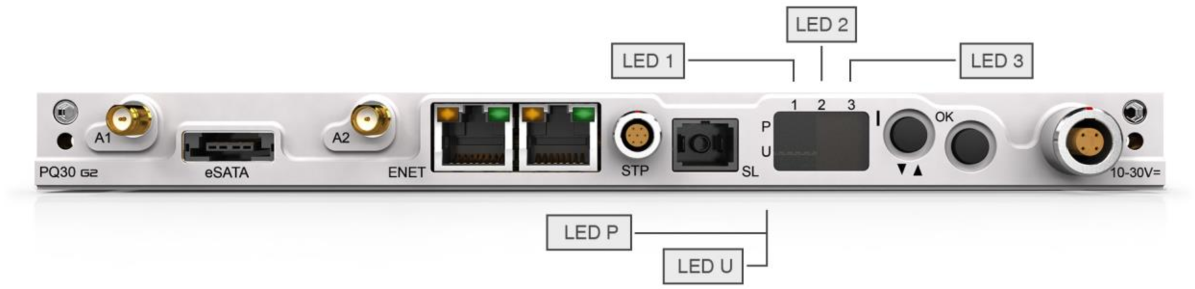


Figure 30. PQ30 G2 LED

The five LEDs on the User Interface are described below in the table to provide the meaning of each LED action:

LED 1 On:	System running from the battery
LED 1 Pulsing once every five seconds:	System is alive
LED 2 Flashing:	Battery low. `LOW` will appear on the display. When the capacity of the battery is exhausted, the system will switch off and valuable data may be lost. It is therefore important to halt all tests as quickly as possible or reconnect external power should this occur
LED 3 Flashing:	Battery error. Possible reasons include: • The battery temperature is out of the valid charging range [1] • The temperature sensor of the battery is malfunctioning • The maximum cell voltage exceeds 1.8 V • The input voltage to the battery charger of the PAK MKII power supply board is too low. This can either be caused by a fault on the PAK MKII power supply board or an unstable external input voltage supplied to the PAK MKII • No battery is present

[1]Charging will commence as soon as the battery temperature reaches the valid range.

LED 3, 2, 1 flashing in sequence:	Battery is being charged. Due to the properties of NiCd or NiMH rechargeable batteries, recharging can only be performed when the battery is in the temperature range of 10 °C to 45 °C
LED 3 and 2 flash simultaneously:	Battery charge is pending during dynamic-charge cycle
LED P on:	The polarity of the power input supplied to the PAK MKII is incorrect
LED U on:	The power input voltage is above or below the allowed voltages

Table 16. User interface LED descriptions

G2 Signal Conditioning boards

Overview

The G2 Signal Conditioning boards provide the isolated power, signal processing and mechanical infrastructure for up to 4 Modules.

The G2 Signal Conditioning boards have five powerful 24-bit DSPs to process large volumes of data transferred between the VMEbus and each Module. Four DSPs are dedicated to the specific Module slots and the fifth DSP is for administration and hosting tasks. The DSPs are used for anti-aliasing, smoothing, decimation, interpolation, digital filtering, event processing, etc.

The G2 Signal Conditioning boards provide:

- Isolated power for each Module
- A DC accurate calibration engine used to calibrate each Module
- Sample timing infrastructure
- Internal communication interfaces used to set parameters for each channel

Additionally, the G2 Signal Conditioning boards allow Modules to be interchanged within the same Mainframe or other Mainframes. This empowers Users to configure their PAK MKII measurement system to satisfy their measurement and control requirements. Modules are plugged in through the front panel of the SC42 G2 or SC42S G2 and can be inserted and removed without removing the SC42 G2 or SC42S G2 board itself.

SC42 G2 boards are used for standard measurements and SC42S G2 are selected for measurements with enhanced speed.

SC42 G2 Signal Conditioning and Analog-To-Digital Conversion

The Module slot connector forms the interface by which various types of data and control signals are passed between the Modules and the Signal Conditioning boards. The figures in the following sections detailing each Module will show the signal path from where it enters the Module at the front panel until the final sample value is available.

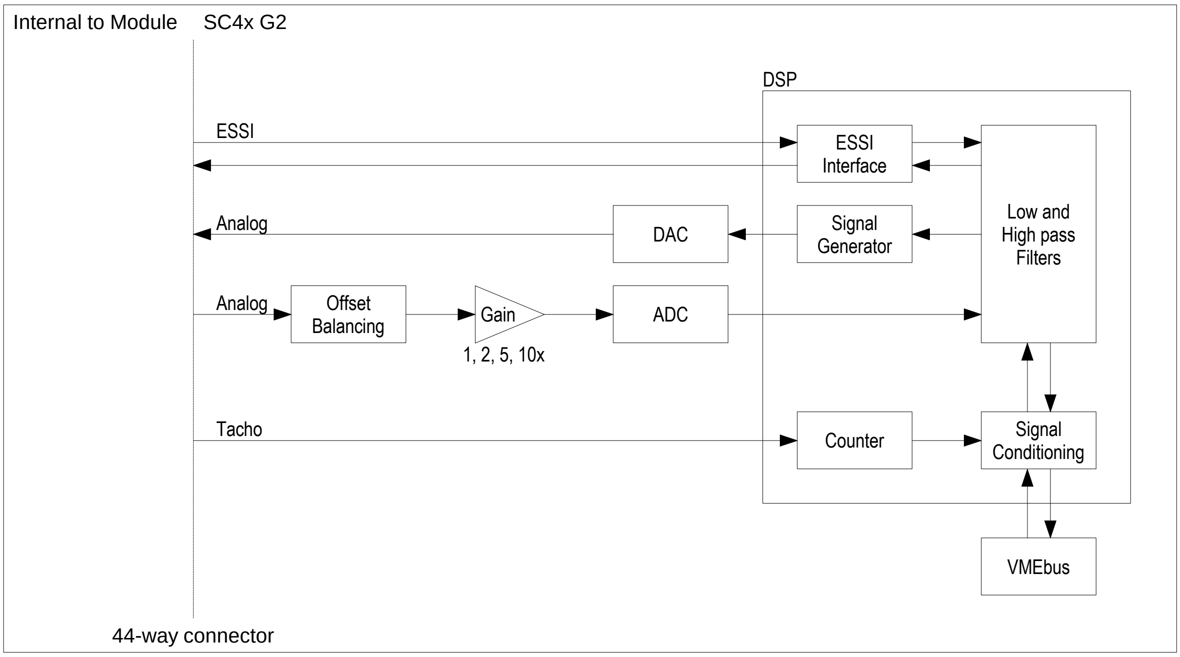


Figure 31. SC42 G2 functionality

The available functionality on the SC42 G2 per Module slot which can be summarized as:

- Analog offset balancing
- Analog programmable gain amplifier
- 16-bit Analog-to-Digital Converter (ADC)
- 16-bit Digital-to-Analog Converter (DAC)
- Digital signal processing

The DSP provides the following functionality:

- Digital low- and high-pass filters
- Signal conditioning
- Data resampler
- Counter with data compression
- Enhanced synchronous serial interface (ESSI) for high-speed serial communication with certain Modules
- Gain, offset and phase corrections

For all Modules that have an onboard ADC (e.g. ICP42 G2) the effective sampling rate per channel is determined by the ADC located on the Module in combination with the Signal Conditioning Board's digital data resampler.

The Module-SC42 G2 interface shows the different formats in which a data signal may be passed from a Module to the SC42 G2. The types are:

- Analog
- Tacho (Tacho input signals from an ICT42 G2 Module)
- ESSI (e.g. ICP42 G2)
- Digital (e.g. CAN42)

Data can also be passed from the SC42 G2 to a Module. Here there is only one type:

- ESSI (e.g. ALO42S G2)

SC42 G2

The SC42 G2 board is a VMEbus Signal Conditioning Board and is suitable for all PAK MKII Mainframes and G2 series Modules. In 24-bit mode it provides a sampling rate of 102.4 kSa/s per channel for a 4-channel Module or 204.8 kSa/s per channel for a 2-channel Module (e.g. MIC42X G2). In 16-bit mode, a sampling rate of 204.8 kSa/s per channel for a 4-channel Module is provided.

Figure 32. SC42 G2 front panel

Features include:

- 102.4 kSa/s per channel for a 4-channel Module (24-bit)
- VMEbus Slave and Interrupter
- Mechanics to accommodate 4 Modules
- Provides accurate timing infrastructure for 4 Modules
- 5 separate 24-bit DSPs, one per Module and one on the board
- 4 isolated power supplies (one per Module)
- Houses the Module’s self-calibration engine
- Thermally optimized and encased in aluminium

Note: Only G2 series Modules will work with an SC42 G2.

SC42S G2

The SC42S G2 board is a VMEbus Signal Conditioning Board and is suitable for all PAK MKII Mainframes and G2 series Modules but especially for the S-series Modules. In 24-bit mode it provides a sampling rate of 204.8 kSa/s per channel for a 4-channel Module. It is intended to be used with the PQ30 G2 System Controller for high-speed multi-channel measurements.

Figure 33. SC42S G2 front panel

Features include:

- 204.8 kSa/s per channel for a 4-channel Module (24-bit)
- VMEbus Slave and Interrupter
- Mechanics to accommodate 4 Modules
- Provides accurate timing infrastructure for 4 Modules
- 5 separate 24-bit DSPs, one per Module and one on the board
- 4 isolated power supplies (one per Module)
- Houses the Module’s self-calibration engine
- Thermally optimized and encased in aluminium

Note: Only G2 series Modules will work with an SC42S G2. For full use of features, S-Modules are required for the use together with an SC42S G2.

G2 Modules

As VMEbus boards are too large to provide a sufficient variety of signal conditioning amplifiers in a single Mainframe, a Sub-VMEbus conceptual tier exists where 4 Modules can be inserted into the front panel of an SC4x G2 VMEbus board.

All Modules can easily be inserted and extracted through the front panel of the SC4x G2 allowing the User complete freedom to configure the measurement system for a particular test. Typically, each Module contains 4 channels (some may contain 1, 2, 6 or 8).

Modules are packaged in an aluminium casing so as to optimize both size and thermal performance. The modules are optimized for a low power consumption. Most Modules are galvanically isolated allowing a 50 V difference between the ground potential of the Module and that of the Mainframe.

Figure 34. MF06 populated with the current range of Modules

ICP42 G2 Module

Description

The ICP42 G2 Module can be used with ICP® based accelerometers, force and pressure sensors as well as to measure analog voltages. All 4 channels operate independently of each other, each with their own setting of mode, gain and coupling. The Module can be used with:

- Any ICP® based sensor commonly used to measure vibration, acceleration, force or pressure
- Any voltage source up to ±10 V in voltage input mode

Front Panel

Figure 35. The ICP42 G2

Connector Information and Pin Definitions

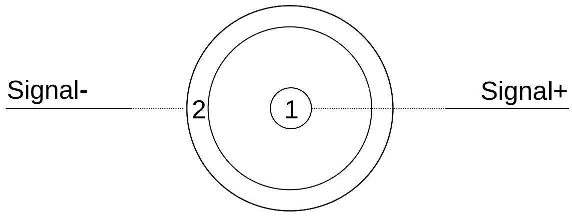


Figure 36. ICP42 G2 with male SMB connectors Module Pin Definition

(when looking into the front panel's connector or at the rear of the cable's connector)

Features

- 4 channels
- 2 input modes of operation:
  - ICP® mode with 4 mA constant current at ±12 V or 24 V excitation
  - Voltage input mode with AC or DC coupling
- Supports TEDS IEEE 1451.4 V0.9, V1.0 (Class 1)
- 24-bit resolution
- ±(10 V, 1 V and 100 mV) input ranges
- There are 3 distinctive input mode options for both ICP® and voltage input modes:
  - Differential or Balanced Float (ICP® mode provides ±12 V excitation)
  - Single-Ended or Unbalanced Float (ICP® mode provides 24 V excitation)
  - Single-Ended or Unbalanced Ground (ICP® mode provides 24 V excitation)
- Short and open circuit cable monitoring
- Signal integrity circuit continuously monitors the input and disconnects sensitive circuits during overload conditions
- Pre and post filter overflow monitoring
- Selectable low and high pass digital filters
- 2 MΩ differential and 1 MΩ single-ended input resistance
- Low power consumption
- SMB connectors

<table>
<tr><td rowspan="2">Interface</td><td>ICP®</td><td colspan="4">ICP® sensors</td></tr>
<tr><td>ALI</td><td colspan="4">For analog source voltages</td></tr>
<tr><td rowspan="2">Input Coupling</td><td>ICP®</td><td colspan="4">AC</td></tr>
<tr><td>ALI</td><td colspan="4">DC or AC</td></tr>
<tr><td rowspan="2">AC Coupling Frequency Response</td><td rowspan="2">ICP® / ALI</td><td>Attenuation</td><td>Min</td><td>Max</td><td>Unit</td></tr>
<tr><td>-3 dB</td><td>-</td><td>0.25</td><td>Hz</td></tr>
<tr><td colspan="2">Other Sampling Rates</td><td colspan="4">Available through digital LP filters and decimation</td></tr>
<tr><td colspan="2">Optional Programmable Digital IIR Filter</td><td colspan="4">Band pass/stop : 6 dB/octave
High/Low pass : 12 dB/octave</td></tr>
<tr><td colspan="2">Optional First Order High-Pass Filter</td><td colspan="4">-3 dB @ 1 Hz</td></tr>
<tr><td colspan="2">Module Calibration</td><td colspan="4">Internal amplitude and phase calibration</td></tr>
<tr><td rowspan="2">Protection</td><td>ICP® / ALI</td><td colspan="4">2 kV ESD</td></tr>
<tr><td>ICP®</td><td colspan="4">Short circuit between sensor case and ground</td></tr>
<tr><td colspan="2">Galvanic Isolation</td><td colspan="4">50 V</td></tr>
</table>

Table 17. ICP42 G2 Module Features

Specifications

Bandwidth		DC to 49 kHz	
Maximum Sampling Rate (fs) per Channel		102.4 kSa/s	
A/D Conversion		24-bit	
Data Transfer		16/24-bit	
Input Voltage Ranges (Peak)		±100 mV; ±1 V; ±10 V	
ICP® mode		4 mA constant current at ±12 V / 24 V excitation	
Input Biasing Settings	**Differential Float (Balanced Float)**	Both the positive and negative signal inputs are connected through 1 MΩ to floating ground	
	Single-Ended Float (Unbalanced Float)	Positive signal input connected through 1 MΩ to floating ground; Negative signal input connected to floating ground	
	Single-Ended GND (Unbalanced GND)	Positive signal input connected through 1 MΩ to ground; Negative signal input connected to ground	
Input Impedance	**Differential**	2 MΩ ǁ 200 pF	
	Single-Ended	1 MΩ ǁ 300 pF	
Digital Low-Pass Filter *Filter scales with sampling rate*		**Passband**	fs x 0.45 Hz
		Stopband	fs x 0.55 Hz
		Passband Ripple	±0.005 dB
		Stopband Attenuation	100 dB
Phase Accuracy *Channels in similar range*		**Typical**[1]	< 0.2 ° at 10 kHz

[1] Measured in 10 V range at 102.4 kSa/s

		Input Range (Peak)	% Range	
DC Voltage Accuracy		±100 mV	0.550 %	
		±1 V	0.085 %	
		±10 V	0.095 %	
Noise *Input terminated by 50 Ω resistor*		**Input Range (Peak)**	**Guaranteed**	**Typical**
	10 Hz to 23 kHz	±100 mV	< 3.5 µVrms	< 2.5 µVrms
	10 Hz to 49 kHz		< 4 µVrms	< 3 µVrms
	10 Hz to 23 kHz	±1 V	< 10 µVrms	< 7 µVrms
	10 Hz to 49 kHz		< 14 µVrms	< 10 µVrms
	10 Hz to 23 kHz	±10 V	< 50 µVrms	< 41 µVrms
	10 Hz to 49 kHz		< 85 µVrms	< 74 µVrms
Amplitude Flatness *Relative to 1 kHz* *Measured up to 0.39 x fs*	**Sampling Rate (fs)**	**Input Range (Peak)**	**Attenuation (Input signal level 100 % of full range)**	
	51.2 kSa/s	±100 mV	- 0.04 dB	
	102.4 kSa/s		- 0.10 dB	
	51.2 kSa/s	±1 V	- 0.05 dB	
	102.4 kSa/s		- 0.07 dB	
	51.2 kSa/s	±10 V	- 0.04 dB	
	102.4 kSa/s		- 0.05 dB	

	Input Range (Peak)	Guaranteed	Typical
Crosstalk	±100 mV	113 dB	118 dB
	±1 V	110 dB	115 dB
	±10 V	102 dB	107 dB

Table 18. ICP42 G2 Module Specification

Specification number: SP150601, Release 2.9. The Module settings and measurement conditions that were used during specification measurements are available on request.

Functionality per Channel

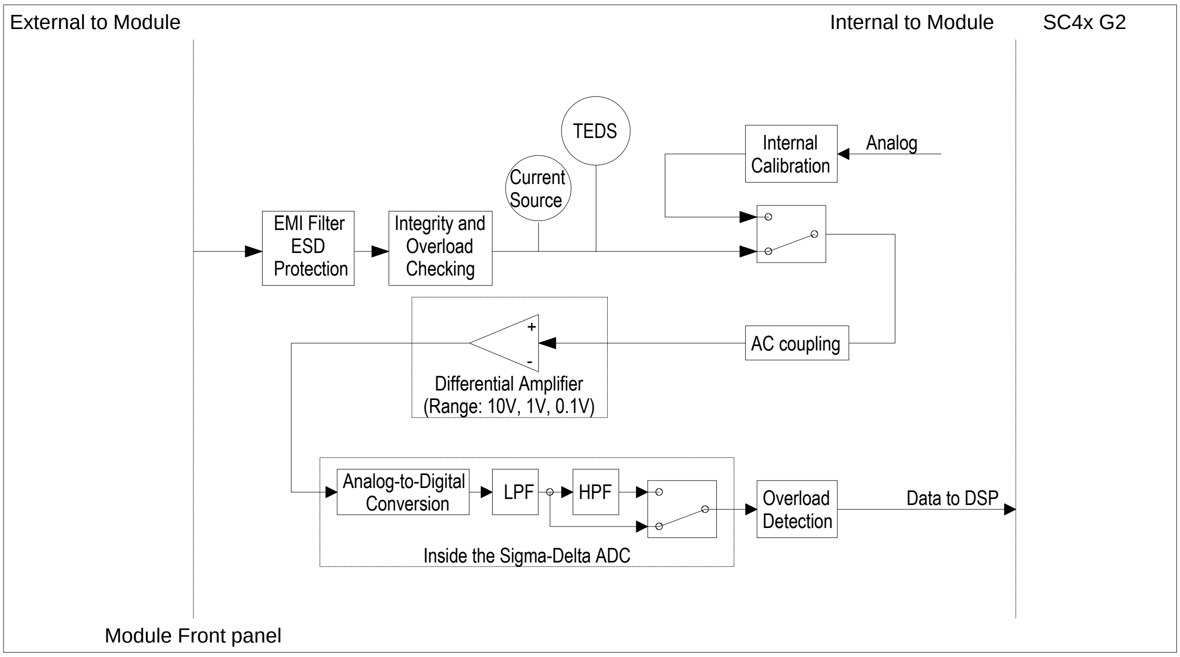


Figure 37. ICP42 G2 ICP® mode (per channel)

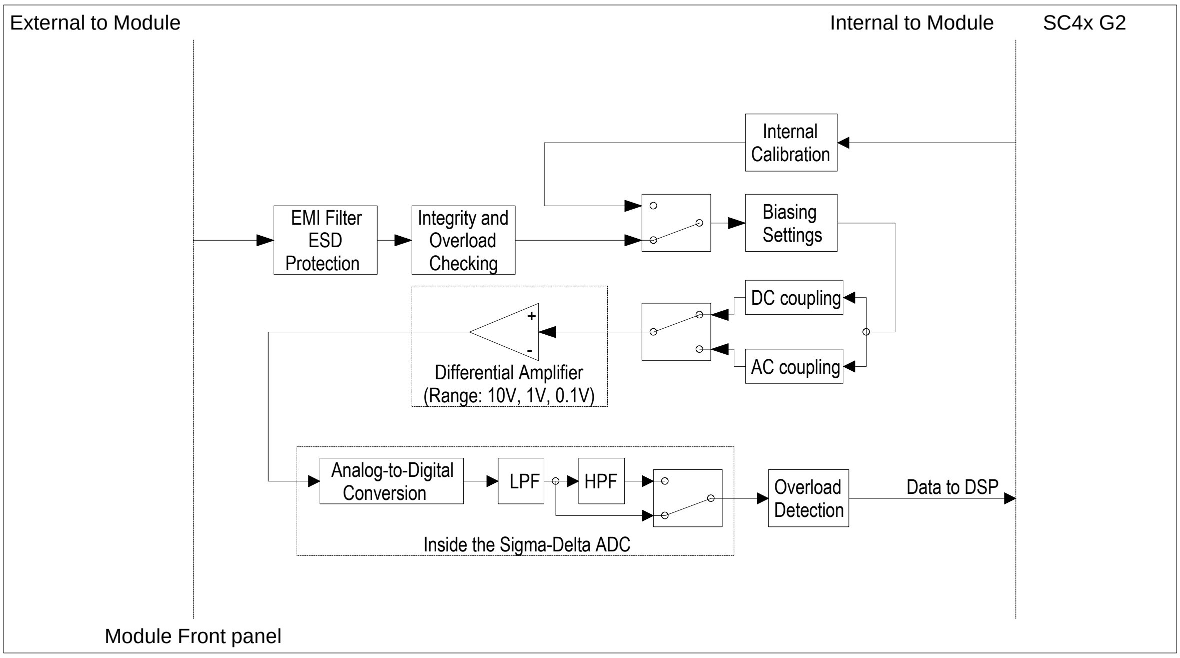


Figure 38. ICP42 G2 ALI mode (per channel)

Grounding options

The addition of a 24 V power rail to the ICP42 G2 assures advancement in the overall grounding of the Module:

- Differential float (Balanced float):
  - -12 V to 12 V excitation
  - Both inputs connected through 1 MΩ to a floating ground
- Single-Ended float (Unbalanced float):
  - 0 to 24 V excitation
  - One input connected through 1 MΩ to a floating ground the other directly to the floating ground
- Single-Ended ground (Unbalanced ground):
  - 0 to 24 V excitation
  - One input connected through 1 MΩ to a floating ground the other directly to ground

Grounding Diagrams: ALI mode (Voltage Input mode)

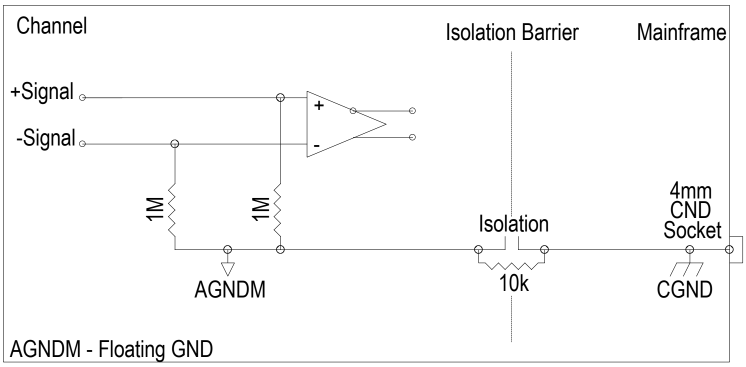


Figure 39. ICP42 G2 in ALI mode with differential float (per channel)

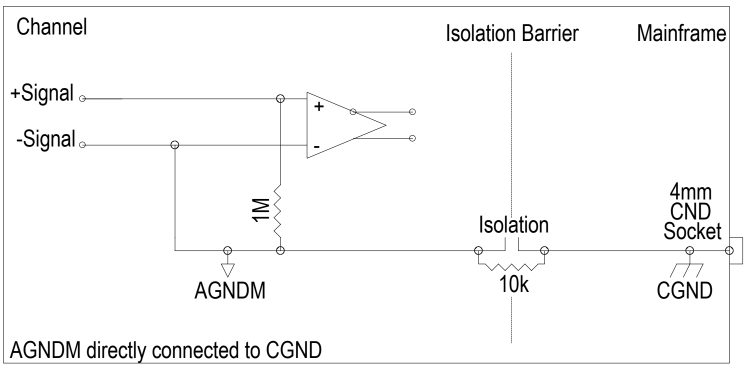


Figure 40. ICP42 G2 single-ended float (per channel)

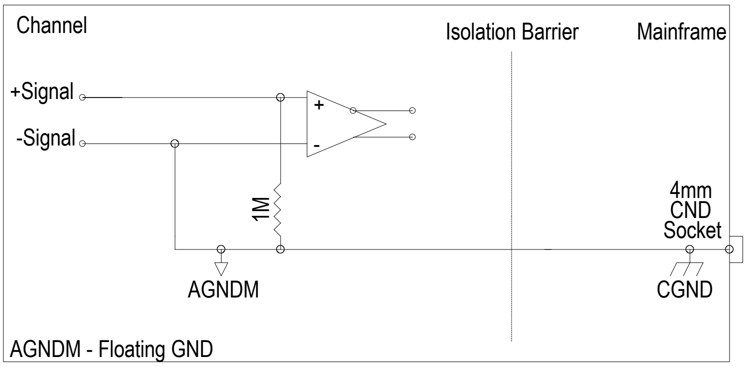


Figure 41. ICP42 G2 single-ended ground (will affect the whole Module)

Although each channel in the ICP42 G2 can be set individually as to its grounding type, enabling the single-ended ground option on any one channel will cause all four channels to be connected directly to ground. The PAK software will automatically set the grounding type to single-ended ground when one of the channels has been configured in this way.

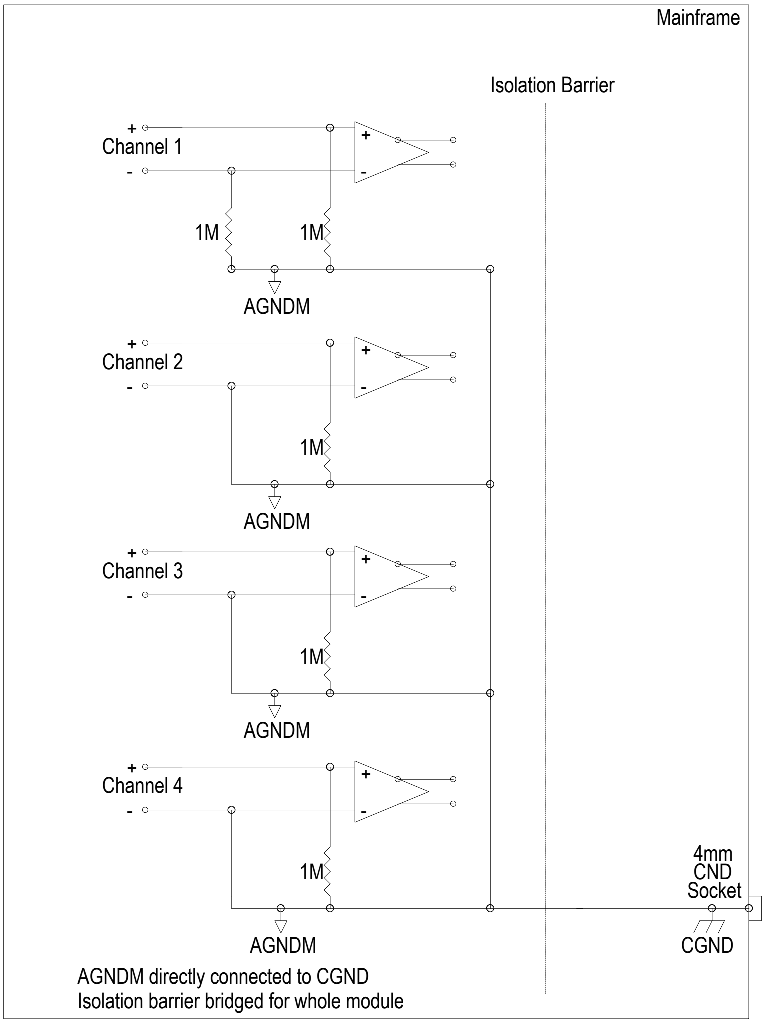


Figure 42. ICP42 G2 Single-ended ground affects all four channels

As with ALI mode, there are again three grounding types when using ICP® input mode:

- ICP42 G2 functionality in ICP® mode with 4 mA current excitation and differential float selected as grounding type
- ICP42 G2 functionality in ICP® mode with 4 mA current excitation and single-ended float selected as grounding type
- ICP42 G2 functionality in ICP® mode with 4 mA current excitation and single-ended ground selected as grounding type

Grounding Diagrams: ICP® mode

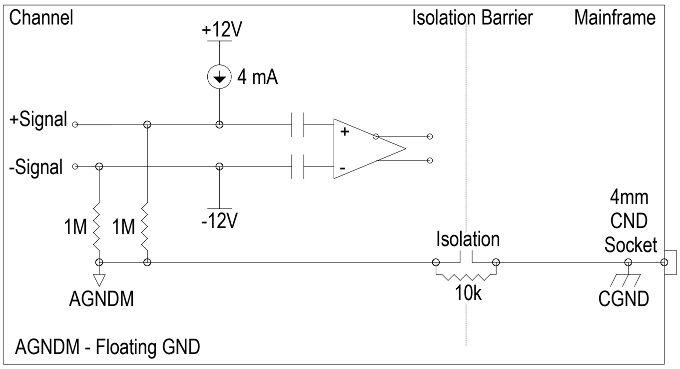


Figure 43. ICP42 G2 in ICP® mode with 4 mA current excitation and differential float

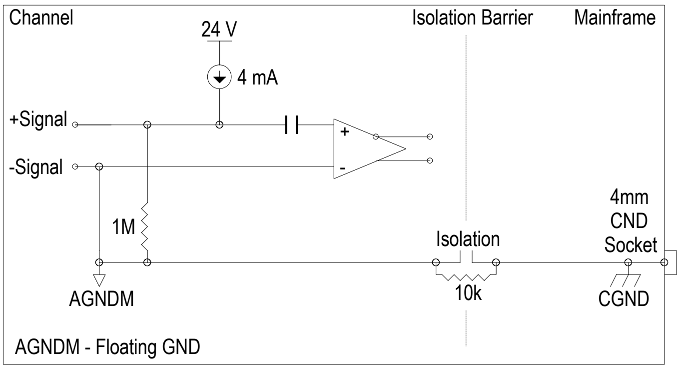


Figure 44. ICP42 G2 in ICP® mode with 4 mA current excitation and single-ended float

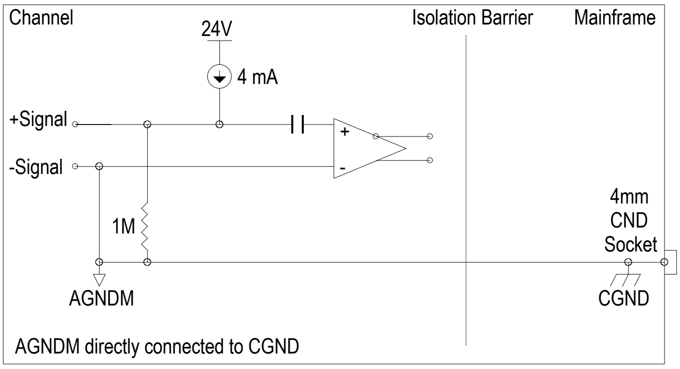


Figure 45. ICP42 G2 in ICP® mode with 4 mA current excitation and single-ended ground

ICP42S G2 Module

Description

The ICP42S G2 Module can be used with ICP® based accelerometers, force and pressure sensors as well as to measure analog voltages. All 4 channels operate independently of each other, each with their own setting of mode, gain and coupling. The ICP42S G2 furthers the ICP42 G2 by sharing many of the same features and advancing others. The Module can be used with:

- Any ICP® based sensor commonly used to measure vibration, acceleration, force or pressure
- Any voltage source up to ±60 V in voltage input mode

Front Panel

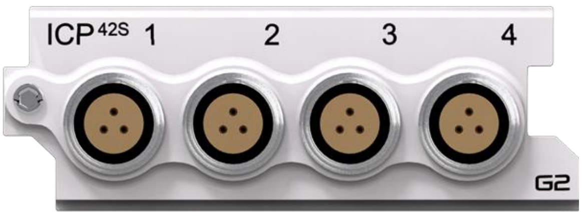


Figure 46. The ICP42S G2

Connector Information and Pin Definitions

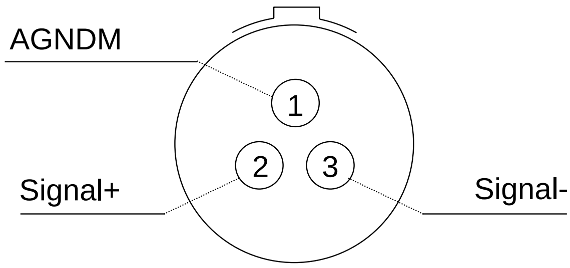


Figure 47. ICP42S G2 with Lemo 3-way EHG.0B connectors Module Pin Definition

(when looking into the front panel's connector or at the rear of the cable's connector)

Features

- 4 channels
- 2 input modes of operation:
  - ICP® mode with 4 mA, 8 mA or 12 mA constant current at ±12 V or 24 V excitation
  - Voltage input mode with AC or DC coupling
- Supports TEDS IEEE 1451.4 V0.9, V1.0 (Class 1)
- 24-bit resolution
- ±(60 V, 10 V, 1 V and 100 mV) input ranges
- There are 3 distinctive input mode options for both ICP® and voltage input modes:
  - Differential or Balanced Float (ICP® mode provides ±12 V excitation)
  - Single-Ended or Unbalanced Float (ICP® mode provides 24 V excitation)
  - Single-Ended or Unbalanced Ground (ICP® mode provides 24 V excitation)
- Short and open circuit cable monitoring
- Signal integrity circuit continuously monitors the input and disconnects sensitive circuits during overload conditions
- Pre and post filter overflow monitoring
- Selectable low and high pass digital filters
- 2 MΩ differential and 1 MΩ single-ended input resistance
- Low power consumption
- Lemo 3-way EHG.0B connectors

Interface	ICP®	ICP® sensors			
	ALI	For analog source voltages			
Input Coupling	ICP®	AC			
	ALI	DC or AC			
AC Coupling Frequency Response	ICP® / ALI	**Attenuation**	**Min**	**Max**	**Unit**
		-3 dB	-	0.25	Hz
Other Sampling Rates		Available through digital LP filters and decimation			
Optional Programmable Digital IIR Filter		Band pass/stop : 6 dB/octave High/Low pass : 12 dB/octave			
Optional First Order High-Pass Filter		-3 dB @ 1 Hz			
Module Calibration		Internal amplitude and phase calibration			
Protection	ICP® / ALI	2 kV ESD			
	ICP®	Short circuit between sensor case and ground			
Galvanic Isolation		50 V			

Table 19. ICP42S G2 Module Features

Specifications

Bandwidth		DC to 100 kHz
Maximum Sampling Rate (fs) per Channel		204.8 kSa/s
A/D Conversion		24-bit
Data Transfer		16/24-bit
Input Voltage Ranges (Peak)		±100 mV; ±1 V; ±10 V; ±60 V
ICP® Mode		4 mA; 8 mA or 12 mA constant current at ±12 V / 24 V excitation
Input Biasing Settings	**Differential Float (Balanced Float)**	Both the positive and negative signal inputs are connected through 1 MΩ to floating ground
	Single-Ended Float (Unbalanced Float)	Positive signal input connected through 1 MΩ to floating ground; Negative signal input connected to floating ground
	Single-Ended GND (Unbalanced GND)	Positive signal input connected through 1 MΩ to ground; Negative signal input connected to ground
Input Impedance	**Differential**	2 MΩ ǁ 200 pF
	Single-Ended	1 MΩ ǁ 300 pF
Digital Low-Pass Filter *Filter scales with sampling rate*	**Passband**	fs x 0.45 Hz
	Stopband	fs x 0.55 Hz
	Passband Ripple	±0.005 dB
	Stopband Attenuation	100 dB
Phase Accuracy *Channels in similar range*	**Typical**[1]	< 0.2° at 10 kHz

[1] Measured in 10 V range at 204.8 kSa/s

		Input Range (Peak)	% Range	
DC Voltage Accuracy		±100 mV	0.550 %	
		±1 V	0.085 %	
		±10 V	0.095 %	
		± 60 V	1.200 %	
Noise *Input terminated by 50 Ω resistor*		**Input Range (Peak)**	**Guaranteed**	**Typical**
	10 Hz to 23 kHz	±100 mV	< 3.5 µVrms	< 2.5 µVrms
	10 Hz to 49 kHz		< 4 µVrms	< 3 µVrms
	10 Hz to 100 kHz		< 12 µVrms	< 10 µVrms
	10 Hz to 23 kHz	±1 V	< 10 µVrms	< 7 µVrms
	10 Hz to 49 kHz		< 14 µVrms	< 10 µVrms
	10 Hz to 100 kHz		< 90 µVrms	< 85 µVrms
	10 Hz to 23 kHz	±10 V	< 50 µVrms	< 41 µVrms
	10 Hz to 49 kHz		< 85 µVrms	< 74 µVrms
	10 Hz to 100 kHz		< 870 µVrms	< 840 µVrms
	10 Hz to 23 kHz	± 60 V	< 580 µVrms	< 470 µVrms
	10 Hz to 49 kHz		< 780 µVrms	< 660 µVrms
	10 Hz to 100 kHz		< 4500 µVrms	< 4300 µVrms

	Sampling Rate (fs)	Input Range (Peak)	Attenuation (Input signal level 100 % of full range)	
Amplitude Flatness *Relative to 1 kHz* *Measured up to 0.39 x fs*	51.2 kSa/s	±100 mV	- 0.04 dB	
	102.4 kSa/s		- 0.10 dB	
	204.8 kSa/s		- 0.32 dB	
	51.2 kSa/s	±1 V	- 0.05 dB	
	102.4 kSa/s		- 0.07 dB	
	204.8 kSa/s		- 0.18 dB	
	51.2 kSa/s	±10 V	- 0.04 dB	
	102.4 kSa/s		- 0.05 dB	
	204.8 kSa/s		- 0.10 dB	
	51.2 kSa/s	± 60 V	- 0.05 dB	
	102.4 kSa/s		- 0.09 dB	
	204.8 kSa/s		- 0.26 dB	
Crosstalk		**Input Range (Peak)**	**Guaranteed**	**Typical**
		±100 mV	113 dB	118 dB
		±1 V	110 dB	115 dB
		±10 V	102 dB	107 dB
		± 60 V	84 dB	89 dB

Table 20. ICP42S G2 Module Specification

Specification number: SP150600, Release 2.8. The Module settings and measurement conditions that were used during specification measurements are available on request.

Functionality per Channel

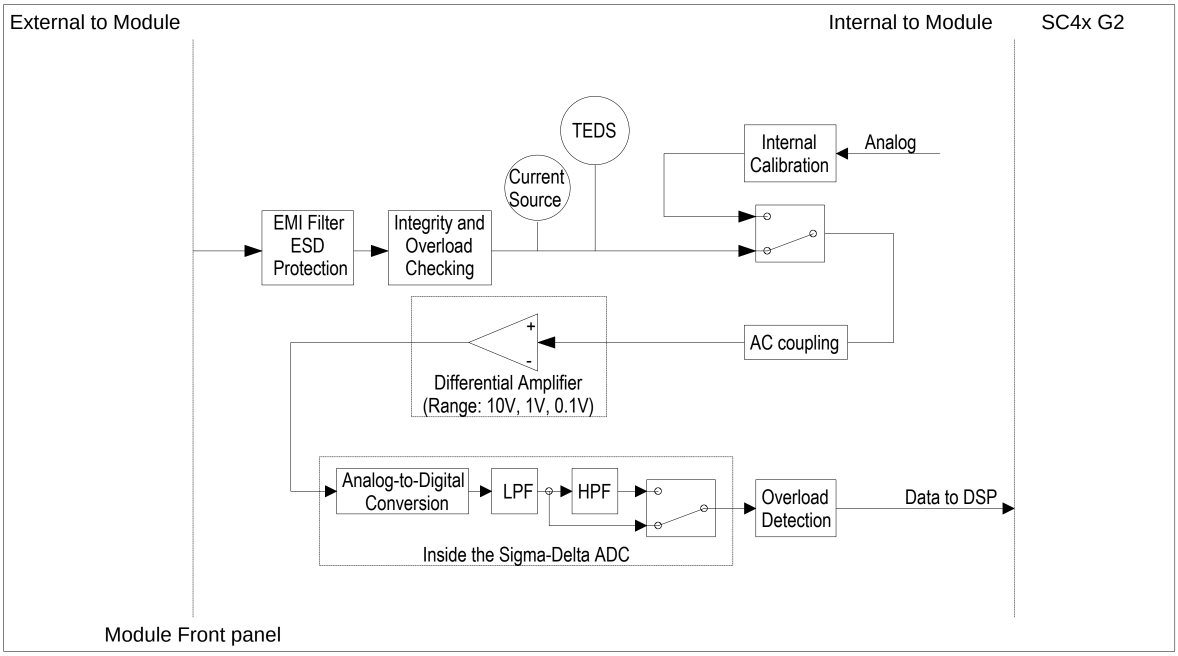


Figure 48. ICP42S G2 ICP® mode (per channel)

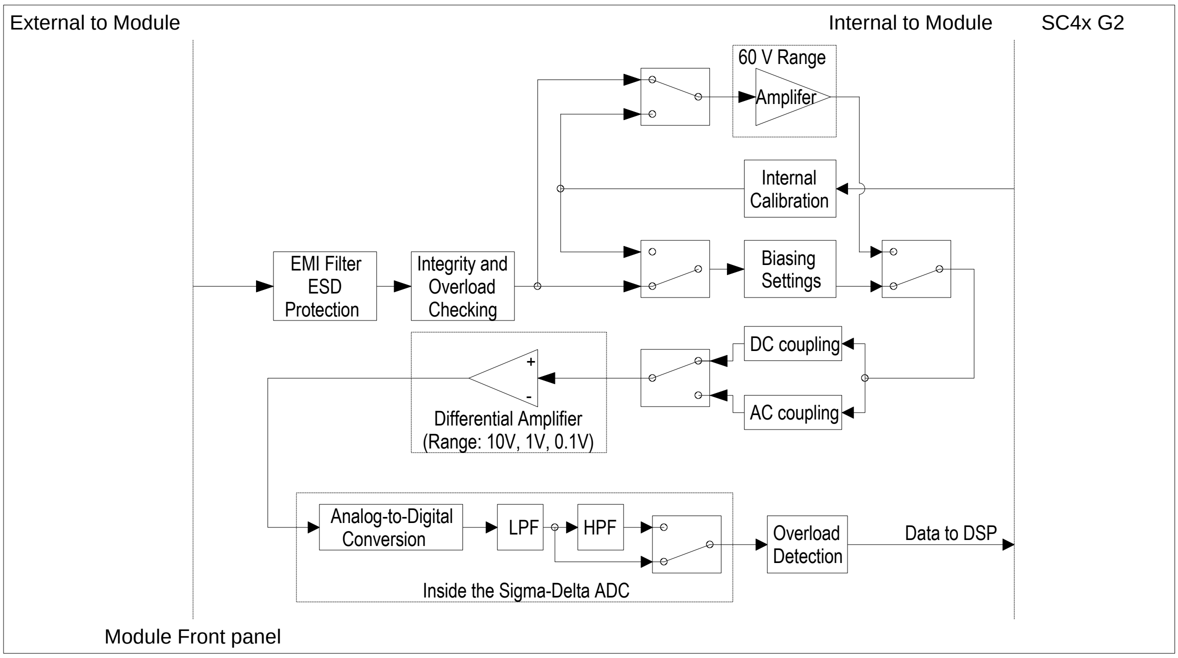


Figure 49. ICP42S G2 ALI mode (per channel)

Grounding options

The addition of a 24 V power rail to the ICP42S G2 assures an advanced overall grounding of the Module:

- Differential float (Balanced float):
    - -12 V to 12 V excitation
    - Both inputs connected through 1 MΩ to a floating ground
- Single-Ended float (Unbalanced float):
    - 0 V to 24 V excitation
    - One input connected through 1 MΩ to a floating ground the other directly to the floating ground
- Single-Ended ground (Unbalanced ground):
    - 0 V to 24 V excitation
    - One input connected through 1 MΩ to ground the other directly to ground

Grounding Diagrams: ALI mode (Voltage input mode)

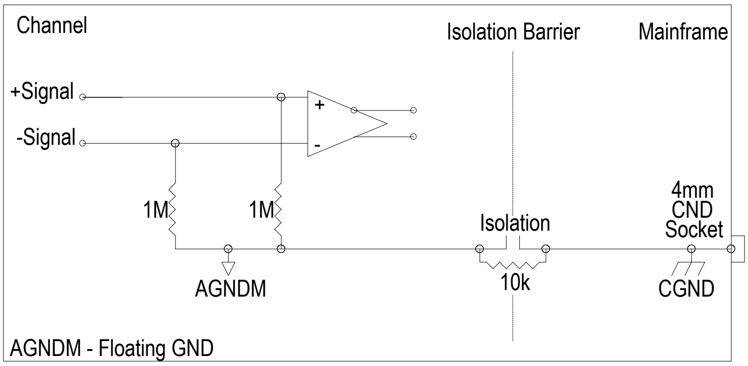


Figure 50. ICP42S G2 in ALI mode with differential float (per channel)

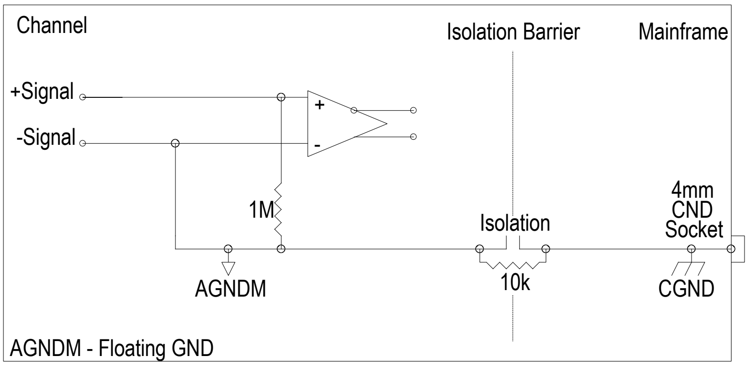


Figure 51. ICP42S G2 single-ended float (per channel)

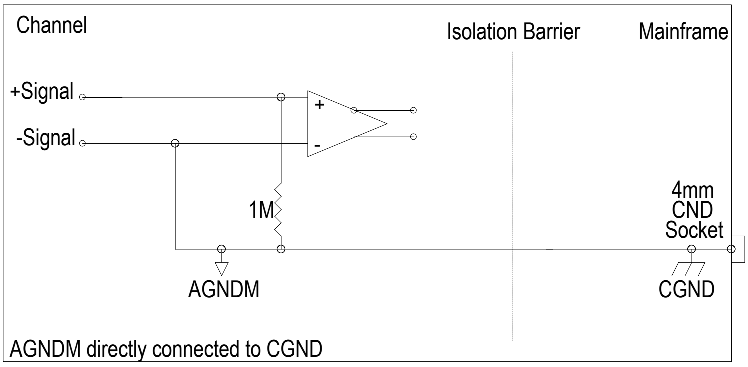


Figure 52. ICP42S G2 single-ended ground (will affect whole Module)

Although each channel in the ICP42S G2 can be set individually as to its grounding type, enabling the single-ended ground option on any one channel will cause all four channels to be connected directly to ground. The PAK software will automatically set the grounding type to single-ended ground when one of the channels has been configured in this way.

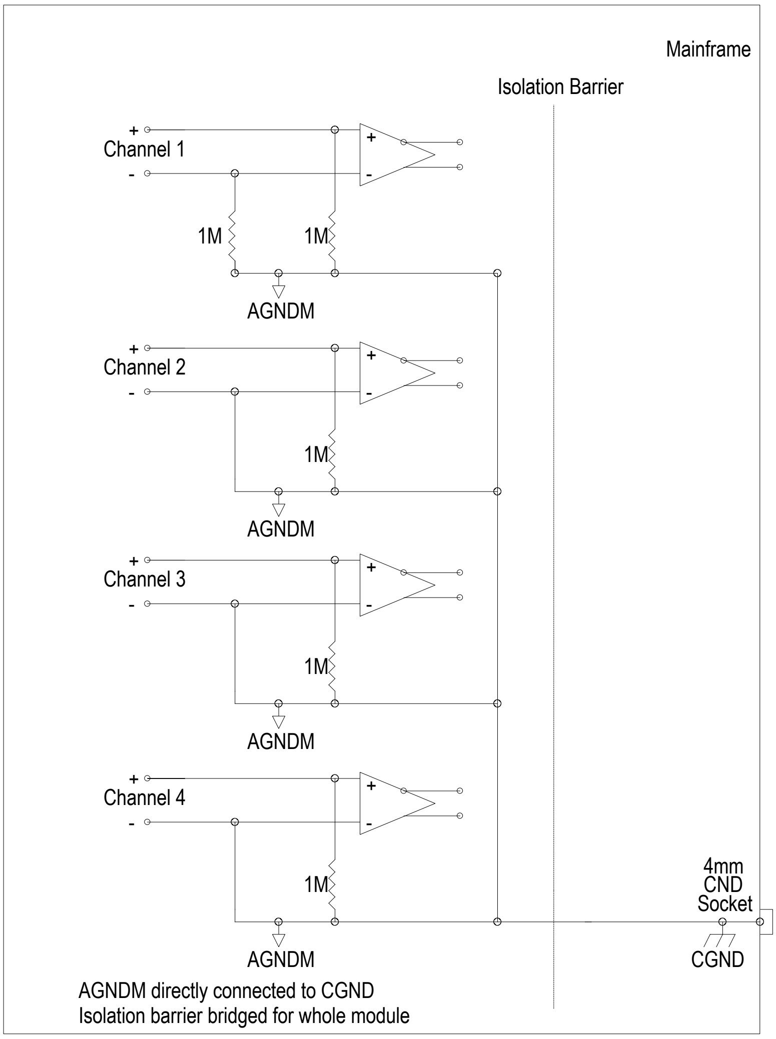


Figure 53. ICP42S G2 Single-ended ground affects all four channels

Similar to the ALI mode there are again three grounding types in ICP® input mode. With ICP® Input mode there is another configuration option, namely the amount of current excitation which can be provided to an attached sensor.

Grounding Diagrams: ICP® mode

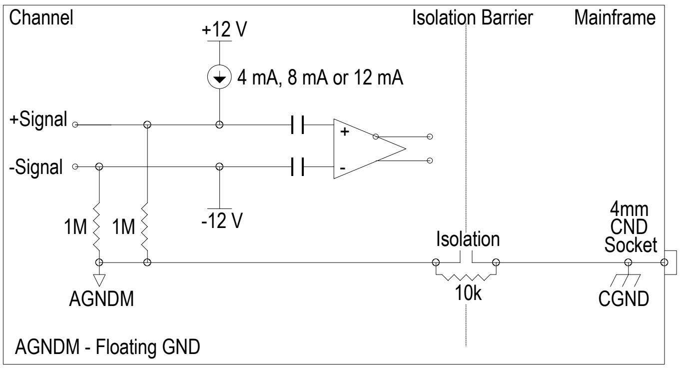


Figure 54. ICP42S G2 in ICP® mode with 4 mA, 8 mA or 12 mA current excitation and differential float

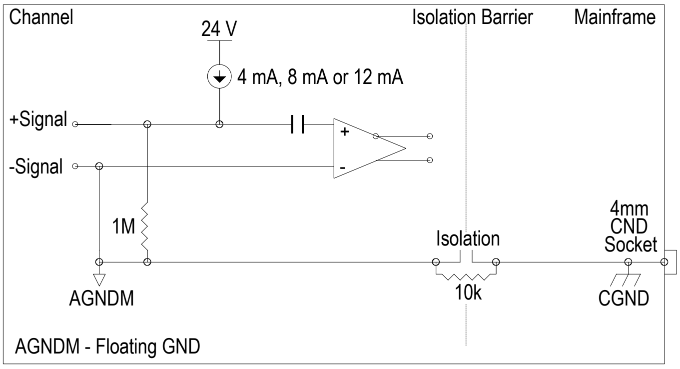


Figure 55. ICP42S G2 in ICP® mode with 4 mA, 8 mA or 12 mA current excitation and single-ended float

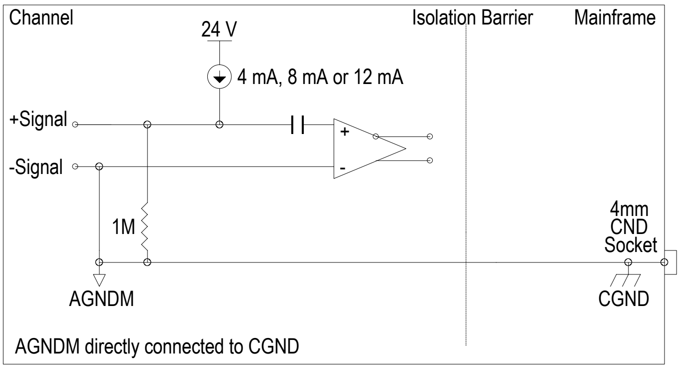


Figure 56. ICP42S G2 in ICP® mode with 4 mA, 8 mA or 12 mA current excitation, single-ended ground

ICT42 G2 Module

Description

The ICT42 G2 Module is a hybrid Module which combines 2 channels from the ICP42 G2 Module with 2 tacho input channels. The tacho channels provide tacho period measurements with a 20 ns resolution, sampled where the signal intersects its trigger level settings. Triggering of tacho signals can be set for rising or falling edges with adjustable hysteresis whilst additionally providing AC coupling for sensors with varying DC voltage offsets. A 204.8 kSa/s scope mode is provided to view the tacho signals in order to assist with the definition of trigger levels. The Module can be used:

- When measuring the pulse rate and time between pulses such as rpm and crank angle
- With any ICP® based sensor commonly used to measure vibration, acceleration, force or pressure
- With any voltage source up to ±10 V in voltage input mode

Front Panel

Figure 57. The ICT42 G2

Connector Information and Pin Definitions

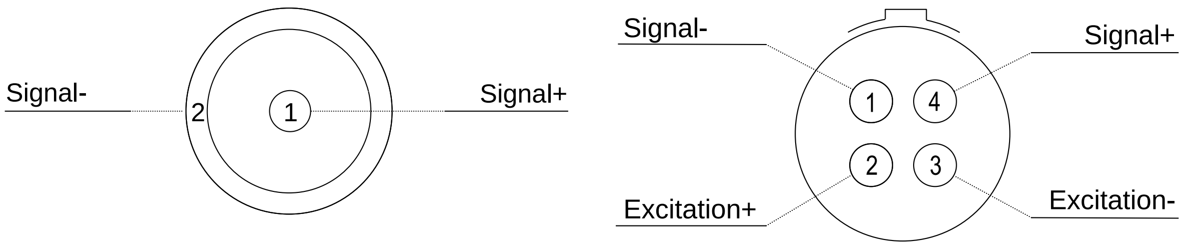


Figure 58. ICT42 G2 with male SMB and Lemo 4-way EHG.0B connectors Module Pin Definition (when looking into the front panel’s connector or at the rear of the cable’s connector)

Features

- 2 tacho channels
- Tacho input can be DC/AC coupled
- 20 ns tacho resolution
- 700 kPulse/s rate for the sum of the 2 tacho channels
- 16-bit tacho trigger level adjustment
- ±(60 V, 30 V, 12 V and 2 V) input ranges
- 2 MHz analog bandwidth for all input ranges
- Adjustable trigger level hysteresis (Schmitt trigger implementation)
- Triggering on the n’th edge
- Tacho trigger level self-calibration
- Scope mode for each tacho channel, sampled at 204.8 kSa/s
- ±12 V or 12 V voltage excitation output to tacho sensor
- Low power consumption
- Lemo 4-way EHG.0B connectors

Tacho Sensor	Voltage (Single-Ended or Differential)
Excitation Voltage Level	Single-Ended Isolated (0 to 12 V) Differential (±12 V)
Excitation Maximum Current	140 mA (fused)
Coupling	DC or AC
Input Resistance	Single-Ended 120 kΩ Differential 240 kΩ
Over-voltage range	±60 V
Trigger Accuracy	Threshold detection with hysteresis; 16-bit resolution
Minimum Pulse Width	800 ns
Scope Mode	2.048 kHz < fs < 204.8 kHz
Module Calibration	Internal amplitude and phase calibration
Protection	ESD 2 kV
Galvanic Isolation	50 V

Table 21. ICT42 G2 Module Features

Functionality per Tacho input channel

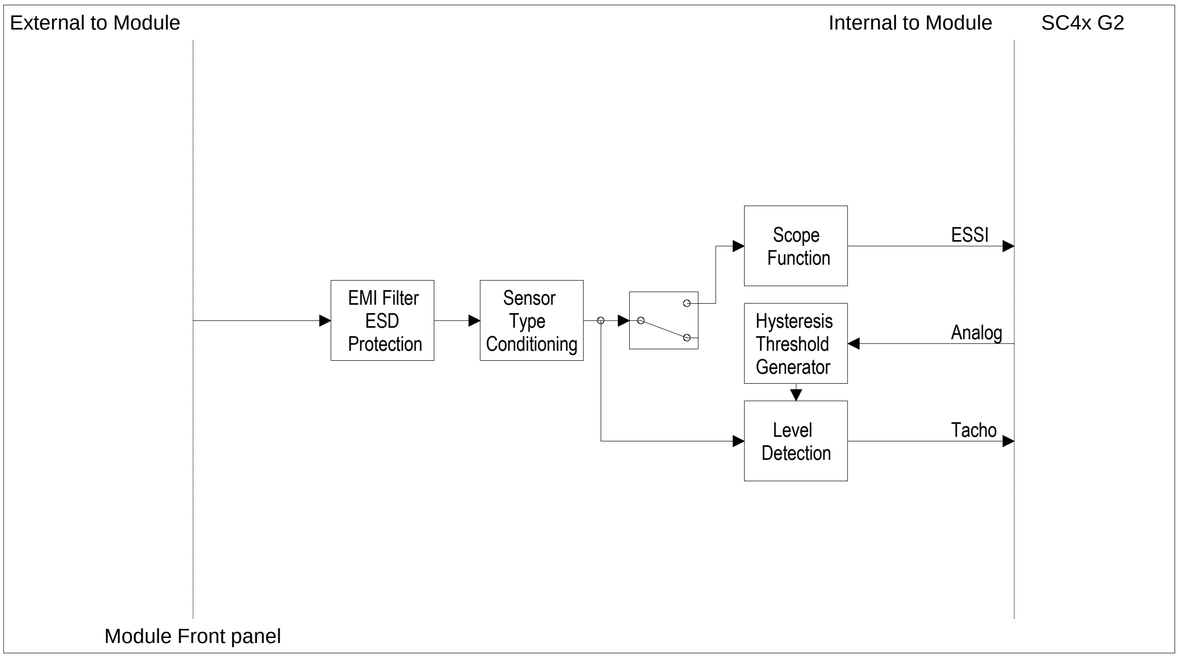


Figure 59. ICT42 G2 functionality per Tacho input channel

Channels 1 and 2 have the same performance parameters as each channel of the ICP42 G2 Module.

Note: Please refer to the ICP42 G2 Module for further details.

Channels 3 and 4 of the ICT42 G2 Module are both Tacho as well as scope input channels. Each Tacho channel functions separately and is connected to its own Tacho sensor. Each scope channel displays the input of the Tacho channels. The scope channels can be configured to display a single Tacho channel.

As a standard, the ICT42 G2 has a 4-pin Lemo connector for each Tacho input at the Module front panel. Two of the Lemo connector pins are for the Tacho signal. The two additional pins provide an excitation voltage that may be used as a power supply to external Tacho sensors. The Excitation+ and Excitation- lines are each protected against a current overload by a 140 mA self-resetting fuse. There are two options for the excitation output as shown in table below.

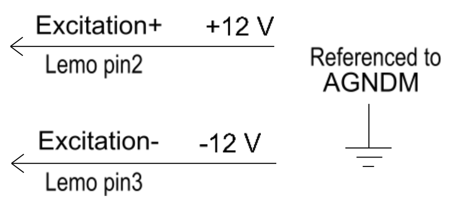
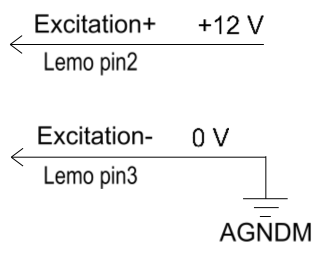
Excitation Mode	Description	Diagram
Differential excitation	The Excitation+ and Excitation- lines are connected to +12 V and -12 V respectively, both positive and negative rails use AGNDM as 0 V reference	
Single-Ended isolated excitation	Excitation+ is connected to +12 V and Excitation- to an isolated ground	

Table 22. ICT42 G2 Excitation description

Grounding options per Tacho input channel

Each Tacho input channel of the ICT42 G2 Module has the following grounding options:

- Differential float (Balanced float):
  - Both inputs connected through 120 kΩ to a floating ground
- Single-Ended float (Unbalanced float):
  - One input connected through 120 kΩ to a floating ground the other directly to the floating ground
- Single-Ended ground (Unbalanced ground):
  - One input connected through 120 kΩ to a floating ground the other directly to ground

Grounding diagrams

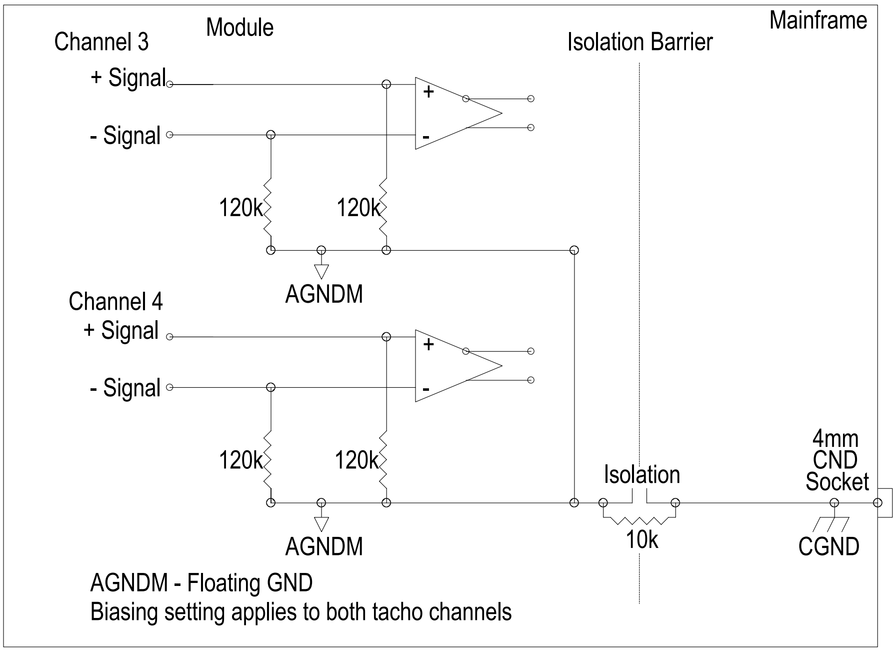


Figure 60. Differential float (Balanced float)

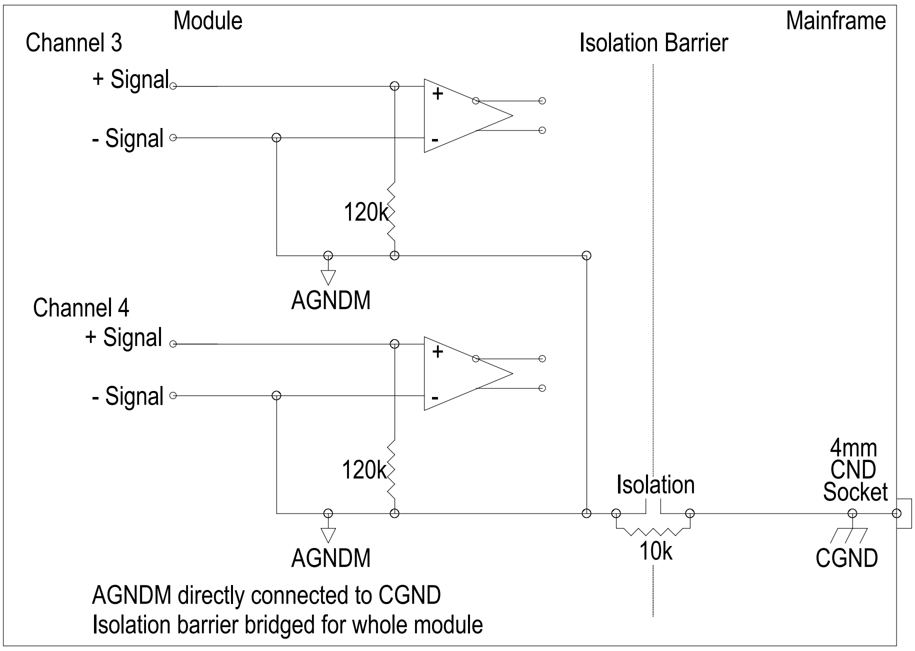


Figure 61. Single-Ended float (Unbalanced float)

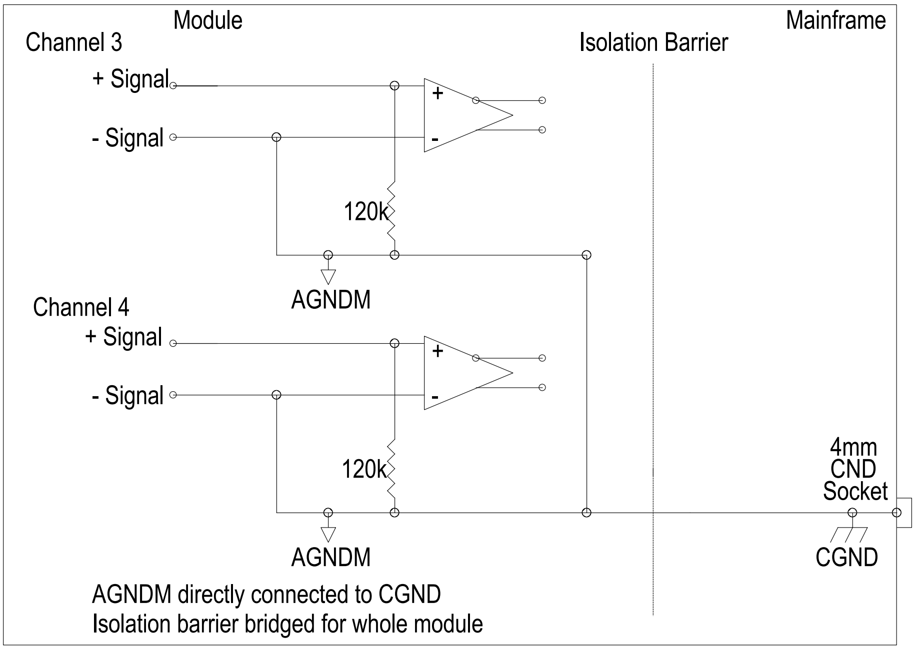


Figure 62. Single-Ended ground (Unbalanced ground)

ICT42S G2 Module

Description

The ICT42S G2 Module is a hybrid Module which combines 2 channels from the advanced ICP42S G2 Module with 2 advanced tacho input channels. The tacho channels provide tacho period measurements with a 14 ns resolution, sampled where the signal intersects its trigger level settings. Triggering of tacho signals can be set for rising or falling edges with adjustable hysteresis whilst additionally providing AC coupling for sensors with varying DC voltage offsets. A high speed 4.9 MSa/s scope mode is provided to view the tacho signals in order to assist with the definition of trigger levels. The Module can be used:

- When measuring the pulse rate and time between pulses such as rpm and crank angle
- With any ICP® based sensor commonly used to measure vibration, acceleration, force or pressure
- With any voltage source up to ±60 V in voltage input mode

Front Panel

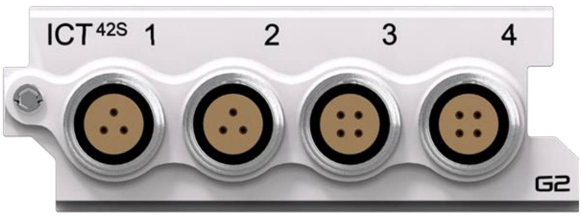


Figure 63. The ICT42S G2

Connector Information and Pin Definitions

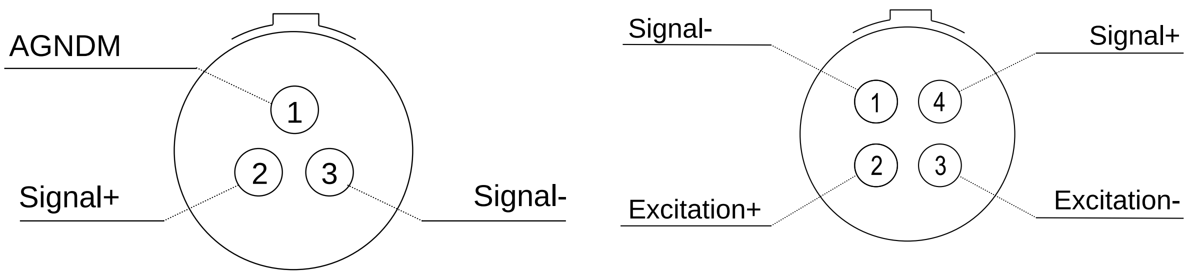


Figure 64. ICT42S G2 with Lemo 3-way and 4-way EHG.0B connectors Module Pin Definition (when looking into the front panel's connector or at the rear of the cable's connector)

Features

• 2 tacho channels • Tacho input can be DC/AC coupled • 14 ns tacho resolution • 1 MPulse/s rate for the sum of the 2 tacho channels when used with SC42S G2 • 16-bit tacho trigger level adjustment • ±(60 V, 30 V, 12 V and 2 V) input ranges • 2 MHz analog bandwidth for all input ranges • Adjustable trigger level hysteresis (Schmitt trigger implementation) • Triggering on the n'th edge • Tacho trigger level self-calibration • Scope mode for each tacho channel, sampled at 4.9 MSa/s • ±12 V or 12 V voltage excitation output to tacho sensor • Low power consumption • Lemo 4-way EHG.0B connectors	
Tacho Sensor	Voltage (Single-Ended or Differential)
Excitation Voltage Level	Single-Ended Isolated (0 to 12 V) Differential (±12 V)
Excitation Maximum Current	140 mA (fused)
Coupling	DC or AC
Input Resistance	Single-Ended 120 kΩ Differential 240 kΩ
Over-voltage range	±60 V
Trigger Accuracy	Threshold detection with hysteresis; 16-bit resolution
Minimum Pulse Width	800 ns
Scope Mode	2.048 kHz < fs < 4.9 MHz
Module Calibration	Internal amplitude and phase calibration
Protection	ESD 2 kV
Galvanic Isolation	50 V

Table 23. ICT42S G2 Module Features

Functionality per Tacho input channel

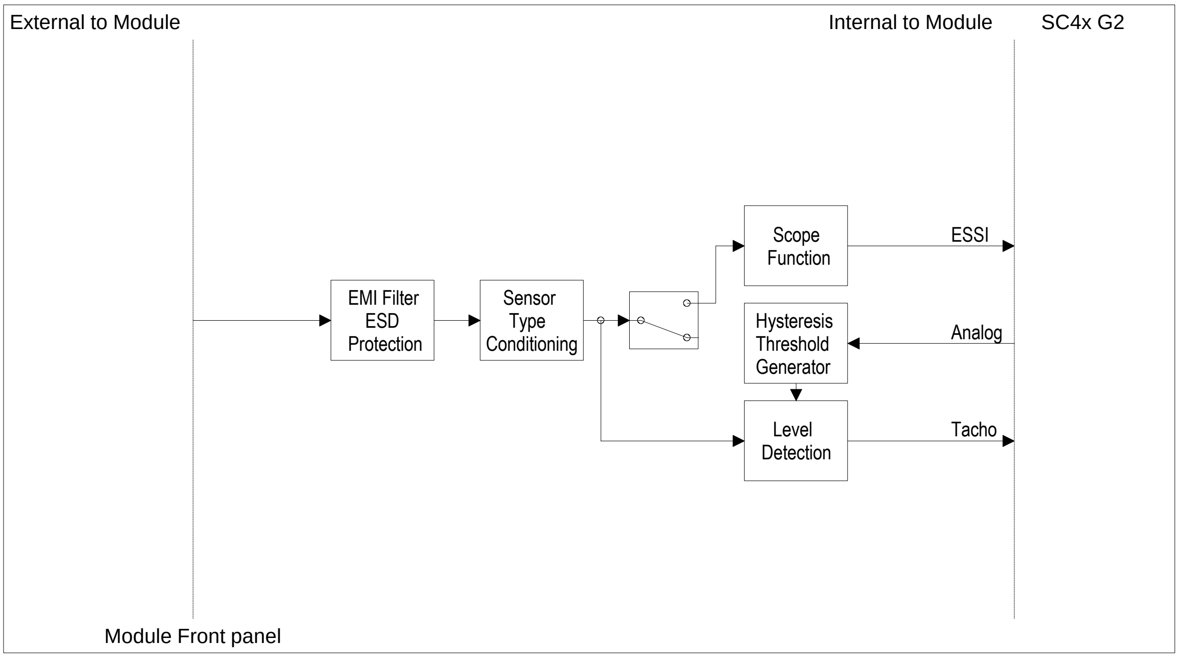


Figure 65. ICT42S G2 functionality per Tacho Input channel

Channels 1 and 2 have the same performance parameters as the first 2 channels of the ICP42S G2 Module.
Note: Please see the ICP42S G2 Module for more details about the two ICP® or voltage input mode channels.

Channels 3 and 4 of the ICT42S G2 Module are both Tacho as well as scope input channels. Each Tacho channel functions separately and is connected to its own Tacho sensor. Each scope channel displays the input of the Tacho channels. The scope channels can be configured to display a single Tacho channel.

As a standard, the ICT42S G2 has a 4-pin Lemo connector for each Tacho input at the Module front panel. Two of the Lemo connector pins are for the Tacho signal. The two additional pins provide an excitation voltage that may be used as a power supply to external Tacho sensors. The excitation+ and excitation- lines are each protected against a current overload by a 140 mA self-resetting fuse. There are two options for the excitation output as shown in table below.

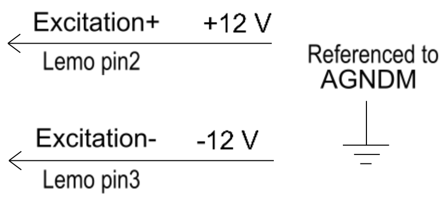
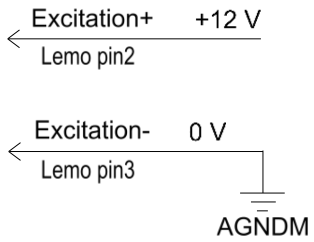
Excitation Mode	Description	Diagram
Differential excitation	The Excitation+ and Excitation- lines are connected to +12 V and -12 V respectively, both positive and negative rails use AGNDM as 0 V reference	
Single-Ended isolated excitation	Excitation+ is connected to +12 V and Excitation- to an isolated ground	

Table 24. ICT42S G2 Excitation description

Grounding options per Tacho input channel

Each Tacho input channel of the ICT42S G2 Module has the following grounding options:

- Differential float (Balanced float):
  - Both inputs connected through 120 kΩ to a floating ground
- Single-Ended float (Unbalanced float):
  - One input connected through 120 kΩ to a floating ground the other directly to the floating ground
- Single-Ended ground (Unbalanced ground):
  - One input connected through 120 kΩ to a floating ground the other directly to ground

Grounding diagrams

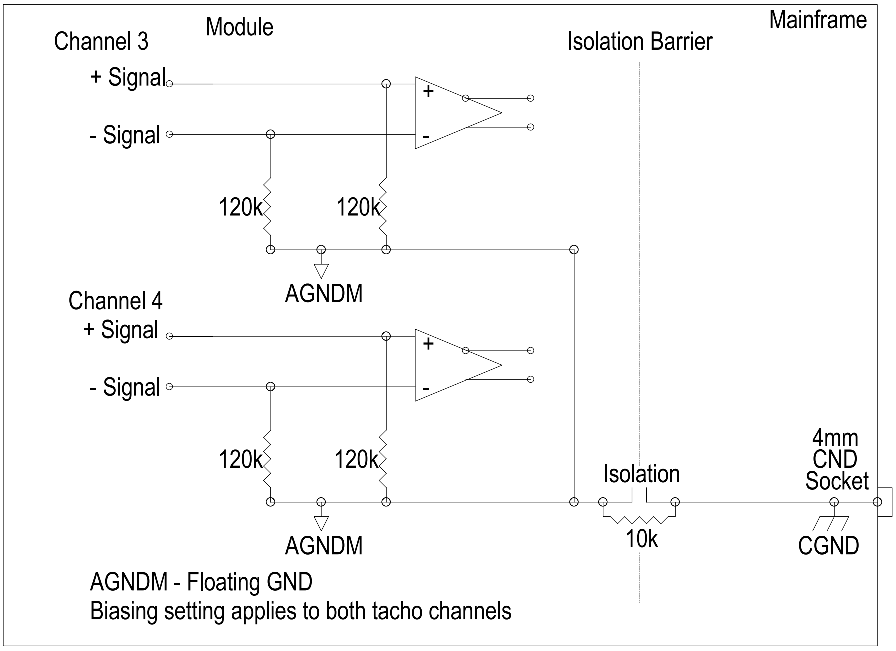


Figure 66. Differential float (Balanced float)

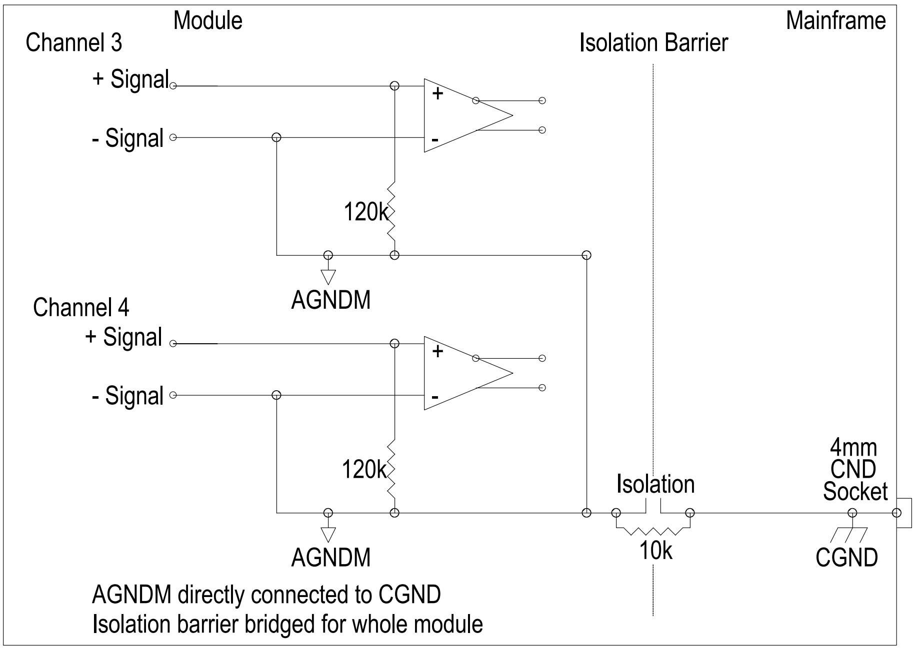


Figure 67. Single-Ended float (Unbalanced float)

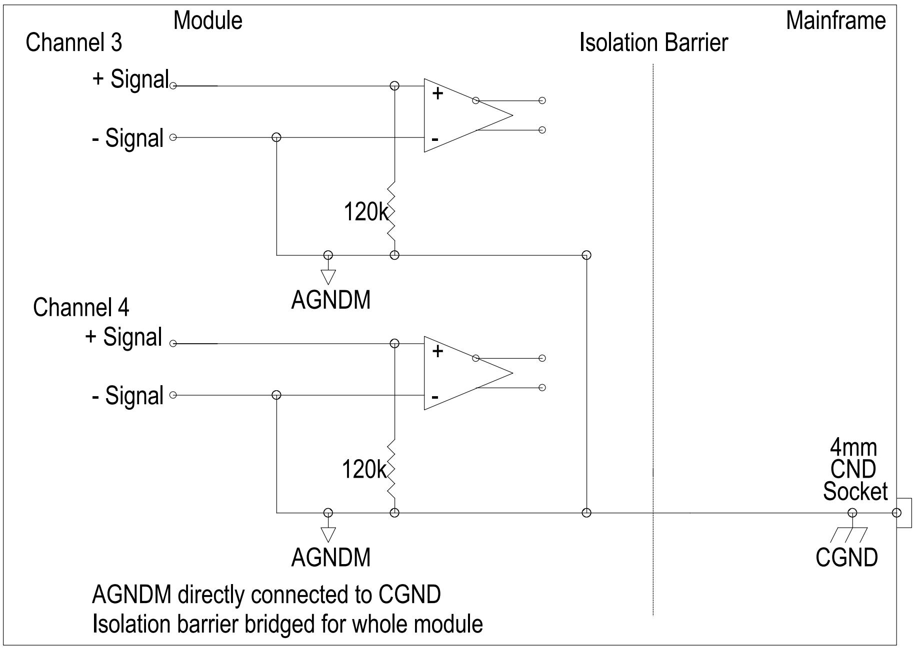


Figure 68. Single-Ended ground (Unbalanced ground)

ICS42 G2 Module

Description

The ICS42 G2 Module can be used with ICP® based accelerometers, force and pressure sensors as well as to measure analog voltages. All 6 channels operate independently of each other, each with their own setting of mode, gain and coupling. The Module can be used:

- With any ICP® based sensor commonly used to measure vibration, acceleration, force or pressure
- With any voltage source up to ±10 V in voltage input mode

Front Panel

Figure 69. The ICS42 G2

Connector Information and Pin Definitions

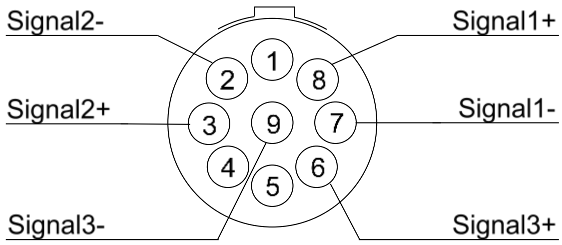


Figure 70. ICS42 G2 with Lemo 9-way EHG.0B connectors Module Pin Definition

(when looking into the front panel's connector or at the rear of the cable's connector)

Features

- 6 channels
- 2 input modes of operation:
    - ICP® mode with 4 mA constant current at ±12 V or 24 V excitation
    - Voltage input mode with AC or DC coupling
- Supports TEDS IEEE 1451.4 V0.9, V1.0 (Class 1)
- 24-bit resolution
- ±(10 V, 1 V and 100 mV) input ranges
- Highly configurable to accommodate single-ended and triaxial sensors
- Supports a number of known industry triaxial cables
- Short and open circuit cable monitoring
- Signal integrity circuit continuously monitors the input and disconnects sensitive circuits during overload conditions
- Pre and post filter overflow monitoring
- Selectable low and high pass digital filters
- Low power consumption
- Lemo 9-way EHG.0B connectors

<table>
<tr><td rowspan="2">Interface</td><td>ICP®</td><td colspan="4">ICP® sensors</td></tr>
<tr><td>ALI</td><td colspan="4">For analog source voltages</td></tr>
<tr><td rowspan="2">Input Coupling</td><td>ICP®</td><td colspan="4">AC</td></tr>
<tr><td>ALI</td><td colspan="4">DC or AC</td></tr>
<tr><td rowspan="2">AC Coupling Frequency Response</td><td rowspan="2">ICP® / ALI</td><td>Attenuation</td><td>Min</td><td>Max</td><td>Unit</td></tr>
<tr><td>-3 dB</td><td>-</td><td>0.16</td><td>Hz</td></tr>
<tr><td colspan="2">Other Sampling Rates</td><td colspan="4">Available through digital LP filters and decimation</td></tr>
<tr><td colspan="2">Optional Programmable Digital IIR Filter</td><td colspan="4">Band pass/stop : 6 dB/octave
High/Low pass : 12 dB/octave</td></tr>
<tr><td colspan="2">Optional First Order High-Pass Filter</td><td colspan="4">-3 dB @ 1 Hz</td></tr>
<tr><td rowspan="2">Protection</td><td>ICP® / ALI</td><td colspan="4">2 kV ESD</td></tr>
<tr><td>ICP®</td><td colspan="4">Short circuit between sensor case and ground</td></tr>
<tr><td colspan="2">Galvanic Isolation</td><td colspan="4">50 V</td></tr>
</table>

Table 25. ICS42 G2 Module Features

Specifications

<table>
<tr><td colspan="2">Bandwidth</td><td colspan="2">DC to 49 kHz</td></tr>
<tr><td colspan="2">Maximum Sampling Rate (fs) per channel</td><td colspan="2">102.4 kSa/s</td></tr>
<tr><td colspan="2">A/D Conversion</td><td colspan="2">24-bit</td></tr>
<tr><td colspan="2">Data Transfer</td><td colspan="2">16/24-bit</td></tr>
<tr><td colspan="2">Input Voltage Ranges (Peak)</td><td colspan="2">±100 mV; ±1 V; ±10 V</td></tr>
<tr><td colspan="2">ICP® mode</td><td colspan="2">4 mA constant current at ±12 V / 24 V excitation</td></tr>
<tr><td rowspan="4">Input Biasing Settings</td><td>Differential Float (Balanced Float)</td><td colspan="2">Both the positive and negative signal inputs are connected through 1 MΩ to floating ground</td></tr>
<tr><td>Differential GND (Balanced GND)</td><td colspan="2">Both the positive and negative signal inputs are connected through 1 MΩ to ground</td></tr>
<tr><td>Single-Ended Float (Unbalanced Float)</td><td colspan="2">Positive signal input connected through 1 MΩ to floating ground;
Negative signal input connected to floating ground</td></tr>
<tr><td>Single-Ended GND (Unbalanced GND)</td><td colspan="2">Positive signal input connected through 1 MΩ to ground; Negative signal input connected to ground</td></tr>
<tr><td rowspan="2">Input Impedance</td><td>Differential</td><td colspan="2">2 MΩ ǁ 80 pF</td></tr>
<tr><td>Single-Ended</td><td colspan="2">1 MΩ ǁ 100 pF</td></tr>
<tr><td colspan="2" rowspan="4">Digital Low-Pass Filter
Filter scales with sampling rate</td><td>Passband</td><td>fs x 0.45 Hz</td></tr>
<tr><td>Stopband</td><td>fs x 0.55 Hz</td></tr>
<tr><td>Passband ripple</td><td>±0.005 dB</td></tr>
<tr><td>Stopband attenuation</td><td>100 dB</td></tr>
<tr><td colspan="2">Phase Accuracy
Channels in similar range</td><td>Typical[1]</td><td>< 0.2° at 10 kHz</td></tr>
</table>

[1] Measured in 10 V range at 102.4 kSa/s

		Input Range (Peak)	% Range	
DC Voltage Accuracy		±100 mV	0.400 %	
		±1 V	0.088 %	
		±10 V	0.128 %	
		Input Range (Peak)	**Guaranteed**	**Typical**
Noise *Input terminated by 50 Ω resistor*	10 Hz to 23 kHz	±100 mV	< 2.6 µVrms	< 2.2 µVrms
	10 Hz to 49 kHz		< 4 µVrms	< 3 µVrms
	10 Hz to 23 kHz	±1 V	< 9 µVrms	< 6 µVrms
	10 Hz to 49 kHz		< 14 µVrms	< 10 µVrms
	10 Hz to 23 kHz	±10 V	< 45 µVrms	< 40 µVrms
	10 Hz to 49 kHz		< 113 µVrms	< 84 µVrms
	Sampling Rate (fs)	**Input Range (Peak)**	**Attenuation (Input signal level 100 % of full range)**	
Amplitude Flatness *Relative to 1 kHz* *Measured up to 0.39 x fs*	51.2 kSa/s	±100 mV	- 0.06 dB	
	102.4 kSa/s		- 0.10 dB	
	51.2 kSa/s	±1 V	- 0.04 dB	
	102.4 kSa/s		- 0.05 dB	
	51.2 kSa/s	±10 V	- 0.03 dB	
	102.4 kSa/s		- 0.04 dB	
		Input Range (Peak)	**Guaranteed**	**Typical**
Crosstalk		±100 mV	113 dB	118 dB
		±1 V	110 dB	115 dB
		±10 V	102 dB	107 dB

Table 26. ICS42 G2 Module Specification

Specification number: SP151000, Release 1.8. The Module settings and measurement conditions that were used during specification measurements are available on request.

Functionality per Channel

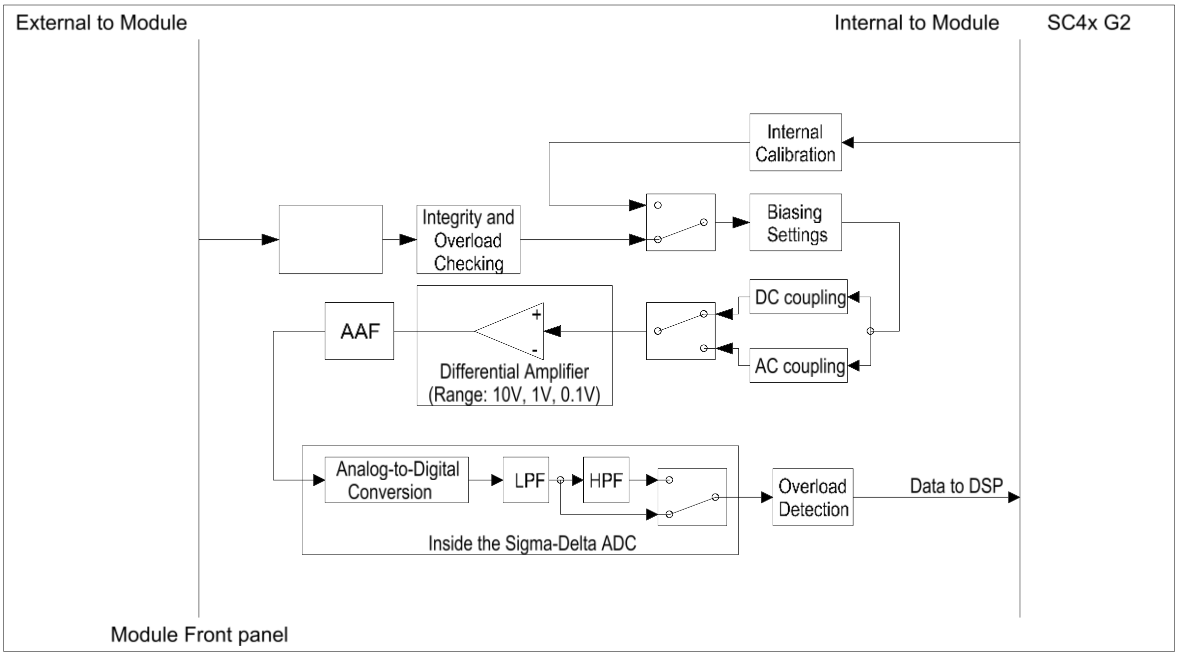


Figure 71. ICS42 G2 ALI mode (per channel)

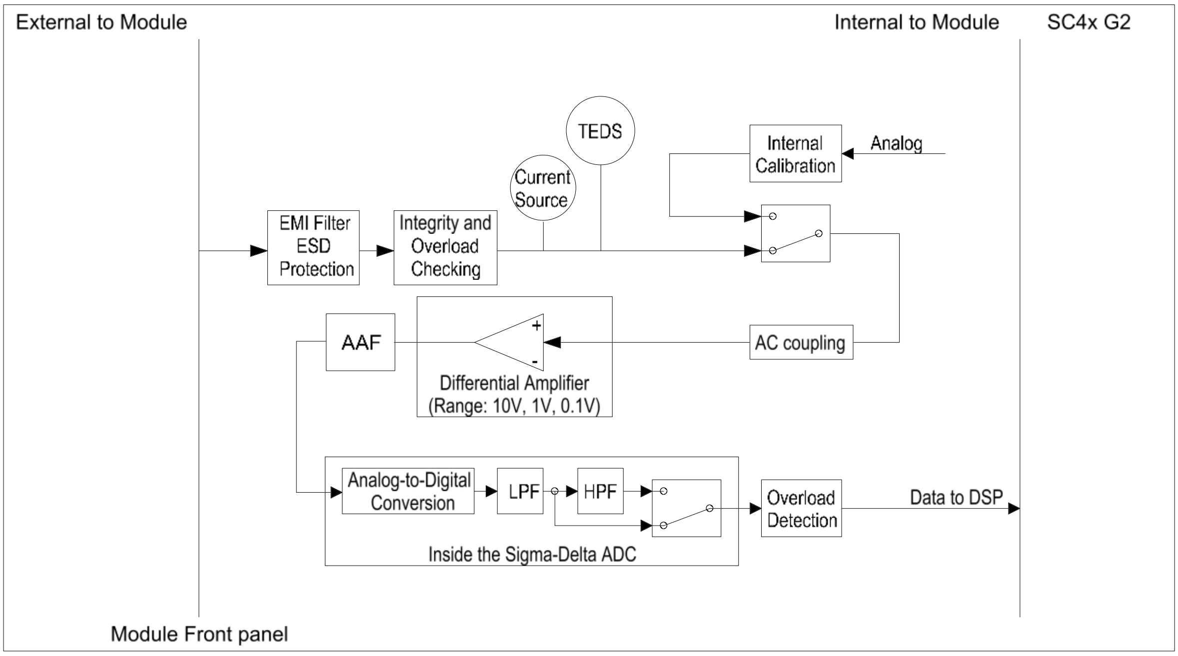


Figure 72. ICS42 G2 ICP® mode (per channel)

Accelerometer connections per Module

The ICS42 G2 can accept inputs from single ICP® accelerometers as well as triaxial ICP® accelerometers. The connectors on the front panel are ideally designed to connect to two triaxial sensors per Module. The Lemo 9-way EHG.0B connectors Module Pin Definition indicates where the signal connections of each X, Y and Z and the common return of the triaxial sensor can be connected.

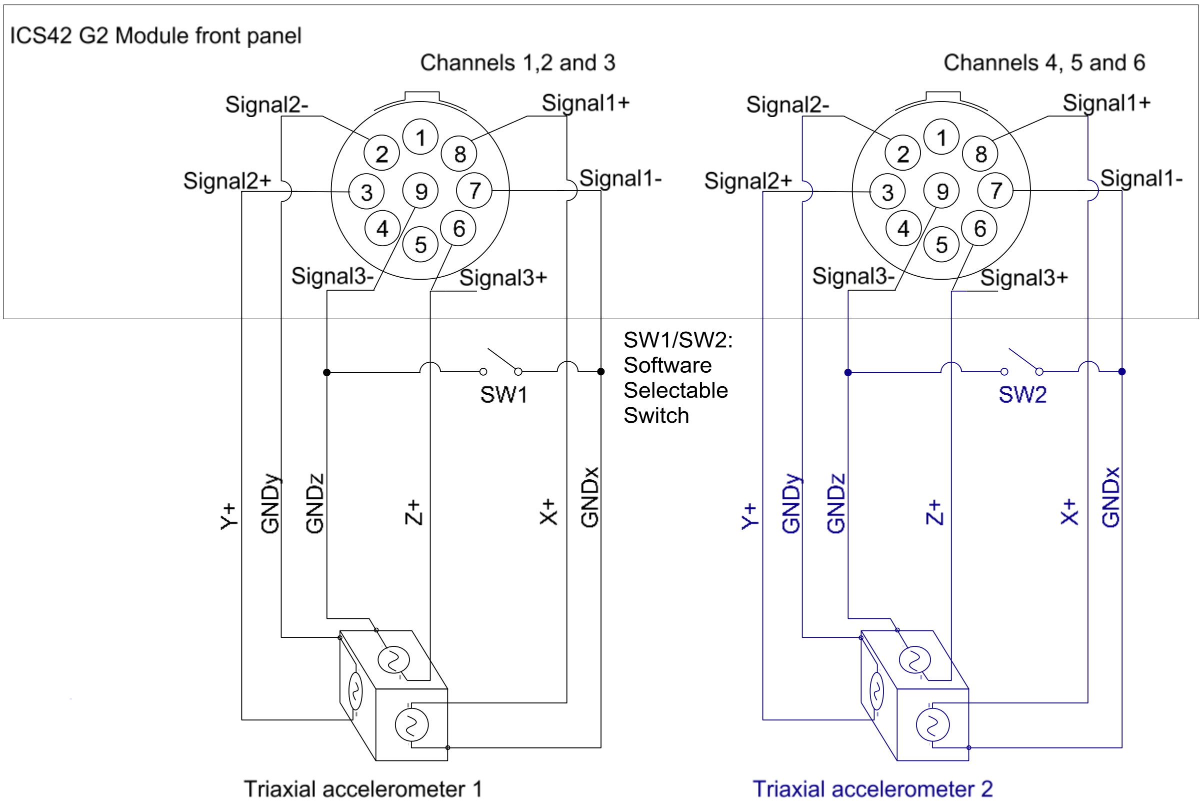


Figure 73. ICS42 G2 front panel connectors with two triaxial accelerometers

Grounding options

There are four ALI mode grounding options available on the ICS42 G2:

- Differential float (Balanced float):
    - Both inputs connected through 1 MΩ to a floating ground
- Differential ground (Balanced ground):
    - Both inputs connected through 1 MΩ directly to a ground
- Single-Ended float (Unbalanced float):
    - One input connected through 1 MΩ to a floating ground the other directly to the floating ground
- Single-Ended ground (Unbalanced ground):
    - One input connected through 1 MΩ to a floating ground the other directly to ground

Grounding Diagrams: ALI mode (Voltage Input mode)

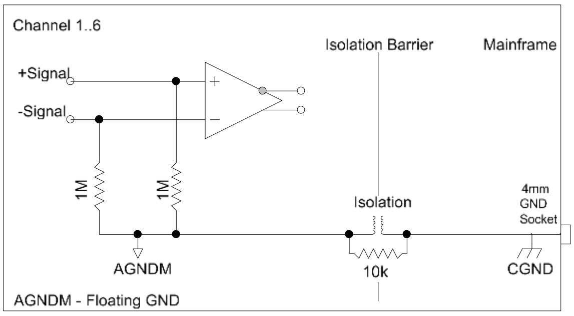


Figure 74. ICS42 G2 in ALI mode with differential float (per channel)

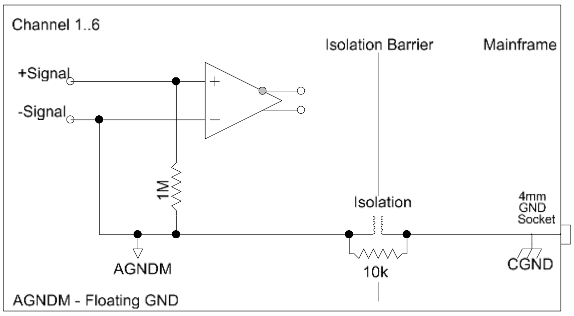


Figure 75. ICS42 G2 in ALI mode with single-ended float (per channel)

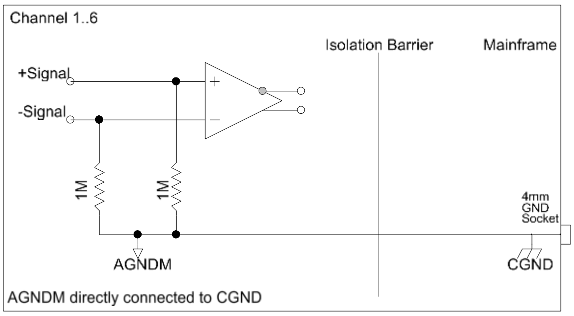


Figure 76. ICS42 G2 in ALI mode with differential ground (will affect the whole Module)

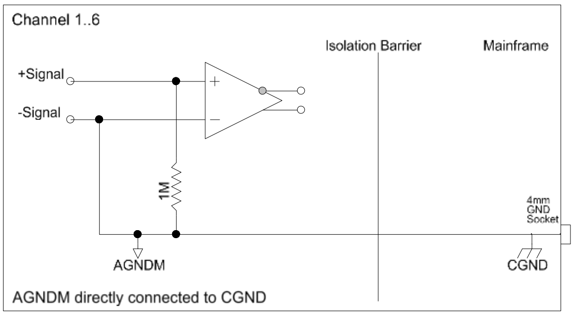


Figure 77. ICS42 G2 in ALI mode single-ended ground (will affect the whole Module)

Although each channel in the ICS42 G2 can be set individually as to its grounding type, enabling the ground option on any one channel will cause the isolation barrier of the module to be bridged (i.e. on all six channels AGNDM will be directly connected to CGND).

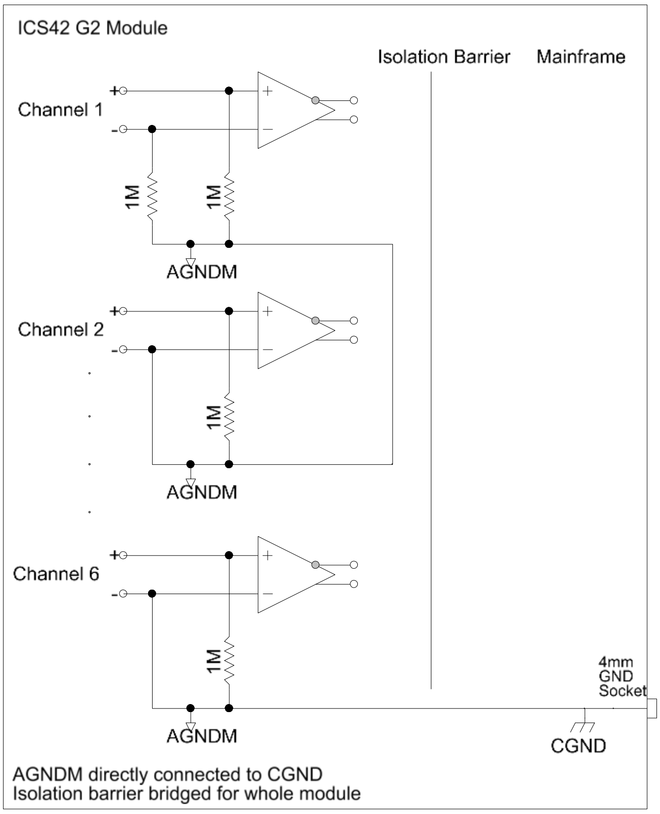


Figure 78. ICS42 G2 Ground setting affects all six channels

Excitation Diagrams: ICP® Mode

There are two biasing options when using ICP® input mode with 4 mA current excitation. The Biasing settings are independent of the grounding options. The following table shows the different possible settings for the ICS42 G2 Module in ICP® input mode:

Excitation voltage	Biasing settings	Grounding options
±12 V (Symmetrical)	Differential	Ground or Floating ground
24 V (Asymmetrical)	Differential or single-ended	Ground or Floating ground

Table 27. ICS42 G2 Module Settings in ICP® input mode with 4 mA current excitation

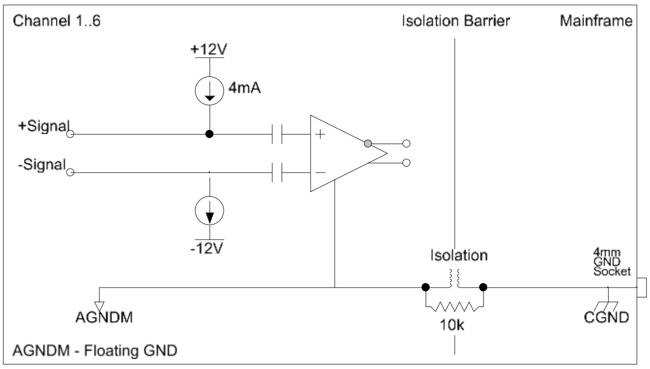


Figure 79. ICS42 G2 in ICP® mode with 4 mA current excitation, ±12 V excitation, differential biasing and floating ground selected

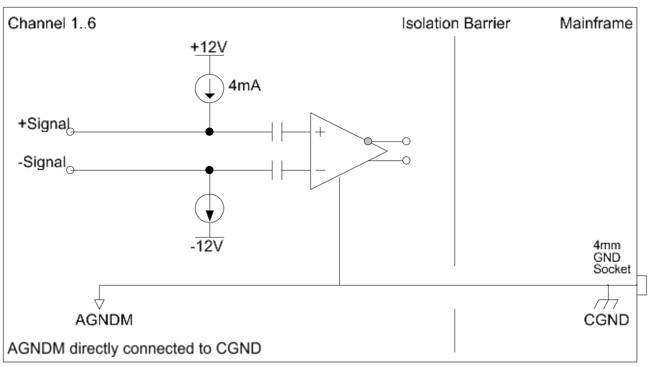


Figure 80. ICS42 G2 in ICP® mode with 4 mA current excitation, ±12 V excitation, differential biasing and ground selected

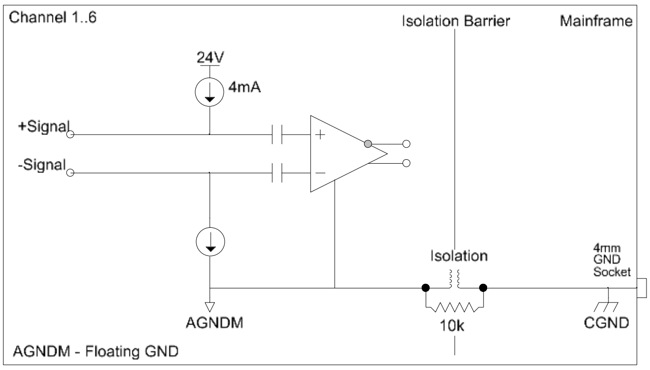


Figure 81. ICS42 G2 in ICP® mode with 4 mA current excitation, 24 V excitation, differential biasing and floating ground selected

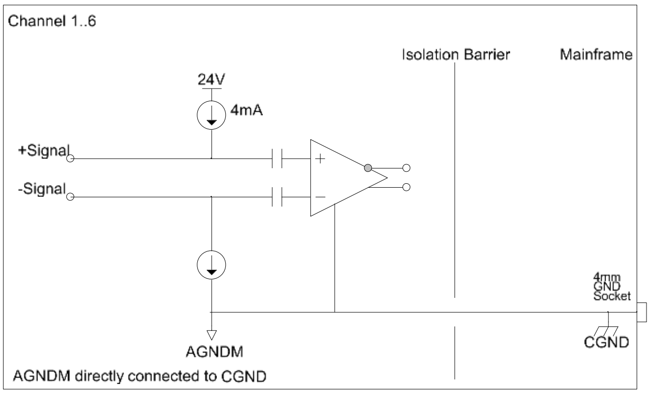


Figure 82. ICS42 G2 in ICP® mode with 4 mA current excitation, 24 V excitation, differential biasing and ground selected

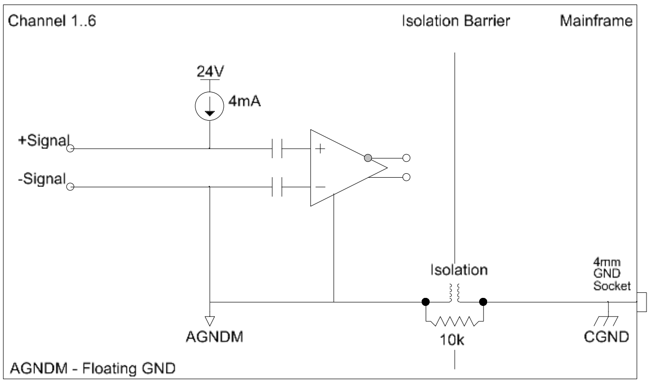


Figure 83. ICS42 G2 in ICP® mode with 4 mA current excitation, 24 V excitation, single-ended biasing and floating ground selected

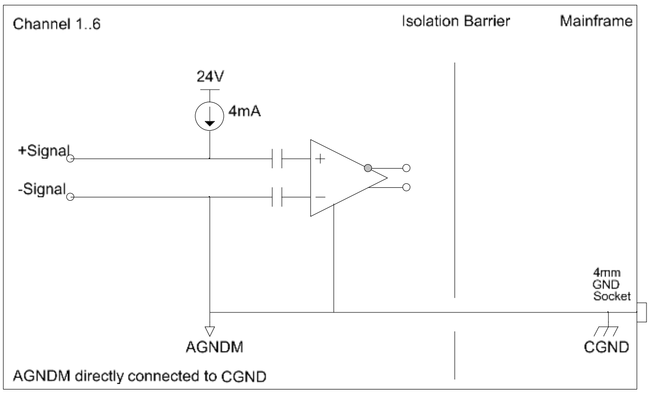


Figure 84. ICS42 G2 in ICP® mode with 4 mA current excitation, 24 V excitation, single-ended biasing and ground selected

CHG42S G2 Module

Description

The CHG42S G2 Module has 4 independent input channels for Quartz or Piezoelectric Ceramic sensors. These sensors are typically used when improved signal performance such as low noise and low distortion is required or where high temperature or nuclear radiation prevents the use of ICP® based sensors. Various grounding options allow for low noise measurements regardless of external grounding constraints. The Module can be used:

- With piezoelectric sensors commonly used to measure vibration, acceleration, force, torque and pressure

Front Panel

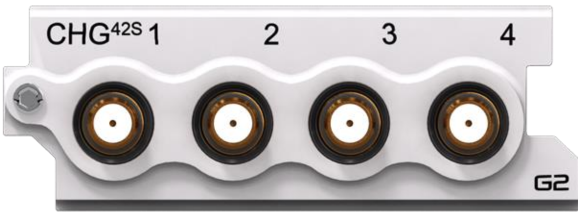


Figure 85. The CHG42S G2

Connector Information and Pin Definitions

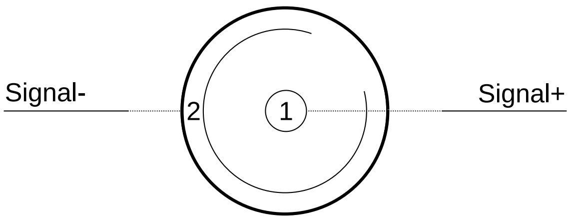


Figure 86. CHG42S G2 with 10-32 Microdot connectors Module Pin Definition

(when looking into the front panel's connector or at the rear of the cable's connector)

ESD WARNING

The CHG42S G2 Module inputs are sensitive to ESD damage. Always take care to discharge any additional static electricity that might have built up on a cable and connector before making contact with the CHG42S G2 Module.

Features

- 4 channels
- 24-bit resolution, 204.8 kSa/s sampling rate per channel, 90 kHz bandwidth
- Drift is lower than 4 mV/h at any sensitivity and gain
- The cable shield can be connected or disconnected from the module ground
- Selectable low and high pass digital filters
- Overvoltage detection on frontend input signals
- Low power consumption
- High input impedance
- 10-32 Microdot connectors

Interface		For piezoelectric sensors
Voltage Amplifier Range (Peak)		±100 mV, ±1 V, ±10 V
Input Charge Range (Peak)	**0.1 mV/pC**	±100,000 pC
	1 mV/pC	±10,000 pC
	10 mV/pC	±1,000 pC
-3 dB High Pass Frequency	**0.1 mV/pC**	0.016 Hz
	1 mV/pC	0.016 Hz
	10 mV/pC	0.16 Hz
Other Sampling Rates		Available through digital LP filters and decimation
Optional Programmable Digital IIR Filter		Band pass/stop : 6 dB/octave High/Low pass : 12 dB/octave
Optional First Order High-Pass Filter		-3 dB @ 1 Hz
Module Calibration		Internal amplitude calibration
Protection		1 kΩ series (inline)
Galvanic Isolation		50 V

Table 28. CHG42S G2 Module Features

Specifications

<table>
<tr><td colspan="2">Bandwidth</td><td colspan="3">DC to 90 kHz</td></tr>
<tr><td colspan="2">Maximum Sampling Rate (fs) per Channel</td><td colspan="3">204.8 kSa/s</td></tr>
<tr><td colspan="2">A/D Conversion</td><td colspan="3">24-bit</td></tr>
<tr><td colspan="2">Data Transfer</td><td colspan="3">16/24-bit</td></tr>
<tr><td colspan="2">Input Voltage Ranges (Peak)</td><td colspan="3">±100 mV; ±1 V; ±10 V</td></tr>
<tr><td colspan="2">Sensitivity Ranges (Peak)</td><td colspan="3">0.1 mV/pC; 1 mV/pC ;10 mV/pC</td></tr>
<tr><td rowspan="4">Input Biasing Settings</td><td rowspan="2">Single-Ended Float</td><td colspan="2">Cable Shield Disconnected</td><td>Negative signal input (cable shield) connected to floating ground through 1 MΩ</td></tr>
<tr><td colspan="2">Cable Shield Connected</td><td>Negative signal input (cable shield) connected to floating ground</td></tr>
<tr><td rowspan="2">Single-Ended GND</td><td colspan="2">Cable Shield Disconnected</td><td>Negative signal input (cable shield) connected to ground through 1 MΩ</td></tr>
<tr><td colspan="2">Cable Shield Connected</td><td>Negative signal input (cable shield) connected to ground</td></tr>
<tr><td colspan="2" rowspan="4">Digital Low-Pass Filter
Filter scales with sampling rate</td><td>Passband</td><td colspan="2">fs x 0.45 Hz</td></tr>
<tr><td>Stopband</td><td colspan="2">fs x 0.55 Hz</td></tr>
<tr><td>Passband Ripple</td><td colspan="2">±0.005 dB</td></tr>
<tr><td>Stopband Attenuation</td><td colspan="2">100 dB</td></tr>
<tr><td colspan="2">Phase Accuracy
Channels in similar range</td><td>Typical[1]</td><td colspan="2">< 0.5° at 10 kHz</td></tr>
</table>

[1] Measured in 10 V range at 204.8 kSa/s

		Input Range (Peak)	Guaranteed	Typical
Noise *Measured open input with 0.1 mV/pC sensitivity range*	10 Hz to 23 kHz	±100 mV	< 50 µVrms	< 46 µVrms
	10 Hz to 49 kHz		< 73 µVrms	< 68 µVrms
	10 Hz to 90 kHz		< 160 µVrms	< 144 µVrms
	10 Hz to 23 kHz	±1 V	< 109 µVrms	< 81 µVrms
	10 Hz to 49 kHz		< 140 µVrms	< 116 µVrms
	10 Hz to 90 kHz		< 1,085 µVrms	< 924 µVrms
	10 Hz to 23 kHz	±10 V	< 460 µVrms	< 409 µVrms
	10 Hz to 49 kHz		< 1,175 µVrms	< 859 µVrms
	10 Hz to 90 kHz		< 10,816 µVrms	< 9,114 µVrms

		Input Range (Peak)	Guaranteed	Typical
Noise *Measured open input with 1 mV/pC sensitivity range*	10 Hz to 23 kHz	±100 mV	< 8.8 µVrms	< 6.2 µVrms
	10 Hz to 49 kHz		< 10 µVrms	< 8 µVrms
	10 Hz to 90 kHz		< 17.8 µVrms	< 15.3 µVrms
	10 Hz to 23 kHz	±1 V	< 11.4 µVrms	< 8.5 µVrms
	10 Hz to 49 kHz		< 14.9 µVrms	< 12.1 µVrms
	10 Hz to 90 kHz		< 107 µVrms	< 92 µVrms
	10 Hz to 23 kHz	±10 V	< 46 µVrms	< 41 µVrms
	10 Hz to 49 kHz		< 125 µVrms	< 89 µVrms
	10 Hz to 90 kHz		< 1,077 µVrms	< 910 µVrms

		Input Range (Peak)	Guaranteed	Typical
Noise *Measured open input with 10 mV/pC sensitivity range*	10 Hz to 23 kHz	±100 mV	< 9.1 µVrms	< 4.4 µVrms
	10 Hz to 49 kHz		< 9 µVrms	< 4.6 µVrms
	10 Hz to 90 kHz		< 9.1 µVrms	< 5.1 µVrms
	10 Hz to 23 kHz	±1 V	< 8.9 µVrms	< 4.4 µVrms
	10 Hz to 49 kHz		< 8.8 µVrms	< 4.6 µVrms
	10 Hz to 90 kHz		< 8.2 µVrms	< 7.3 µVrms
	10 Hz to 23 kHz	±10 V	< 8.6 µVrms	< 5.8 µVrms
	10 Hz to 49 kHz		< 13.2 µVrms	< 9.3 µVrms
	10 Hz to 90 kHz		< 108 µVrms	< 91 µVrms

	Sampling Rate (fs)	Input Range (Peak)	Attenuation (Input signal level 100 % of full range)		
			0.1 mV/pC sensitivity range	**1 mV/pC sensitivity range**	**10 mV/pC sensitivity range**
Amplitude Flatness *Relative to 1 kHz* *Measured up to 0.39 x fs*	51.2 kSa/s	±100 mV	- 0.12 dB	- 0.19 dB	- 0.88 dB
	102.4 kSa/s		- 0.44 dB	- 0.70 dB	- 2.88 dB
	204.8 kSa/s		- 1.91 dB	- 2.40 dB	- 7.43 dB
	51.2 kSa/s	±1 V	- 0.15 dB	- 0.14 dB	- 0.86 dB
	102.4 kSa/s		- 0.47 dB	- 0.52 dB	- 2.82 dB
	204.8 kSa/s		- 1.57 dB	- 1.86 dB	- 7.07 dB
	51.2 kSa/s	±10 V	- 0.14 dB	- 0.14 dB	- 0.79 dB
	102.4 kSa/s		- 0.45 dB	- 0.51 dB	- 2.66 dB
	204.8 kSa/s		- 1.50 dB	- 2.81 dB	- 6.84 dB

	Input Range (Peak)	Guaranteed	Typical
Crosstalk *Measured with 0.1 mV/pC sensitivity range*	±100 mV	39 dB	44 dB
	±1 V	38 dB	43 dB
	±10 V	39 dB	44 dB
	Input Range (Peak)	**Guaranteed**	**Typical**
Crosstalk *Measured with 1 mV/pC sensitivity range*	±100 mV	38 dB	43 dB
	±1 V	38 dB	43 dB
	±10 V	38 dB	43 dB
	Input Range (Peak)	**Guaranteed**	**Typical**
Crosstalk *Measured with 10 mV/pC sensitivity range*	±100 mV	36 dB	41 dB
	±1 V	35 dB	40 dB
	±10 V	35 dB	40 dB

Table 29. CHG42S G2 Module Specification

Specification number: SP160200, Release 1.5. The Module settings and measurement conditions that were used during specification measurements are available on request.

Functionality per Channel

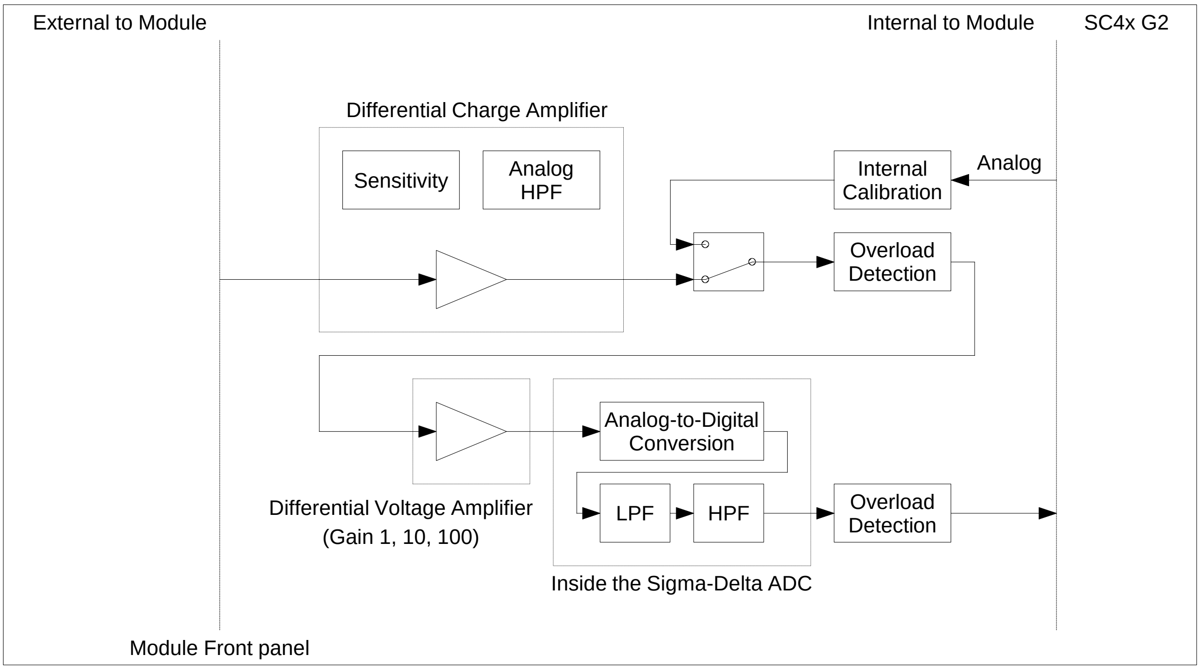


Figure 87. Functional overview of one CHG42S G2 channel

WARNING

When using Endevco cables it is recommended to remove the rubber O-ring on the CHG42S G2 Module 10-32 connector as this could cause an intermittent electrical connection between the pin on the cable and the Module connector.

Grounding Diagram

The CHG42S G2 offers 4 grounding options. The grounding options are provided for reducing electromagnetic interference (EMI) that might be present on the sensor cables.

Module	Cable Shield Connected	Industry Name	Shield to Chassis
*Floating	*No	Floating	1 MΩ + 10 kΩ
Floating	Yes	-	10 kΩ
Grounded	No	-	1 MΩ
Grounded	Yes	Single-Ended	~20 Ω

Table 30. Grounding options

*Default setting on Module startup. This combination provides a path for Electrostatic Discharge (ESD) to slowly discharge and will provide some protection against rapid ESD events that could damage the sensitive charge inputs.

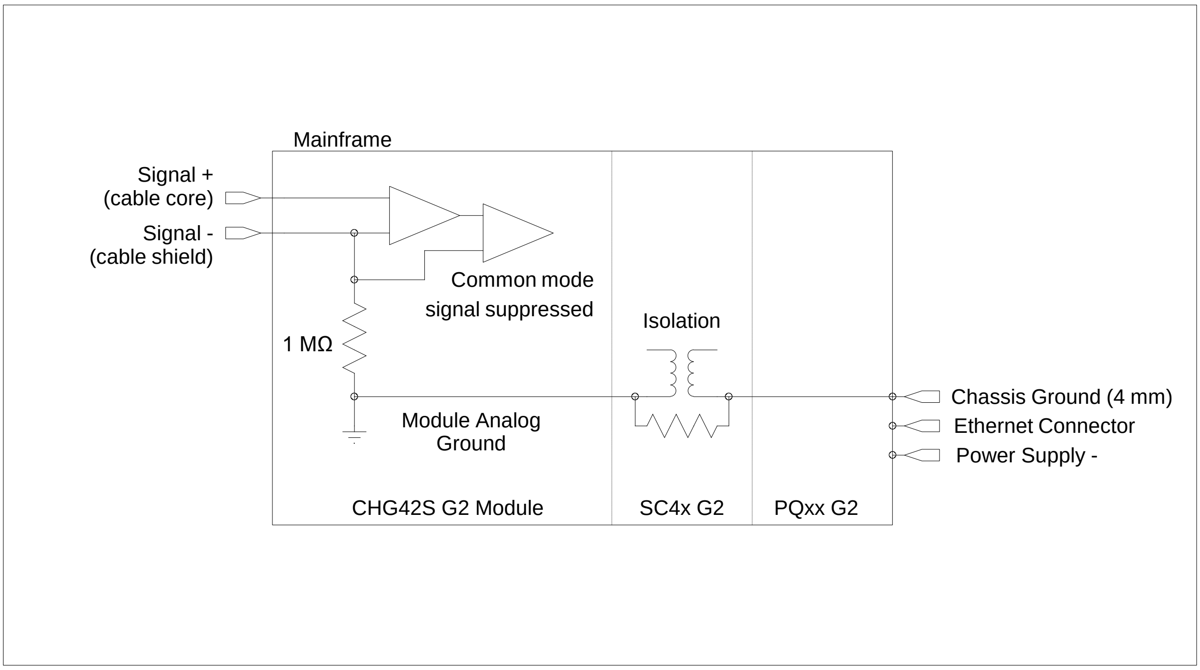


Figure 88. CHG42S G2 Grounding Diagram: Module floating and cable shield disconnected

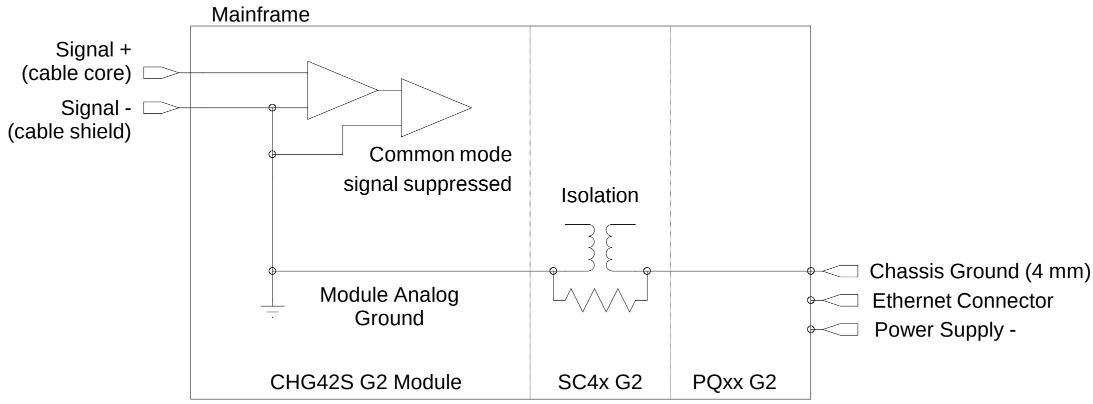


Figure 89. CHG42S G2 Grounding Diagram: Module floating and cable shield connected

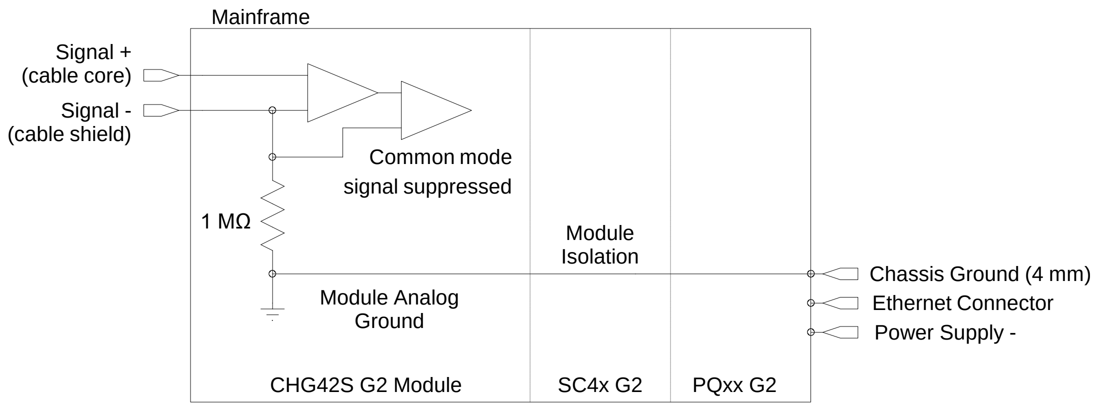


Figure 90. CHG42S G2 Grounding Diagram: Module grounded and shield disconnected

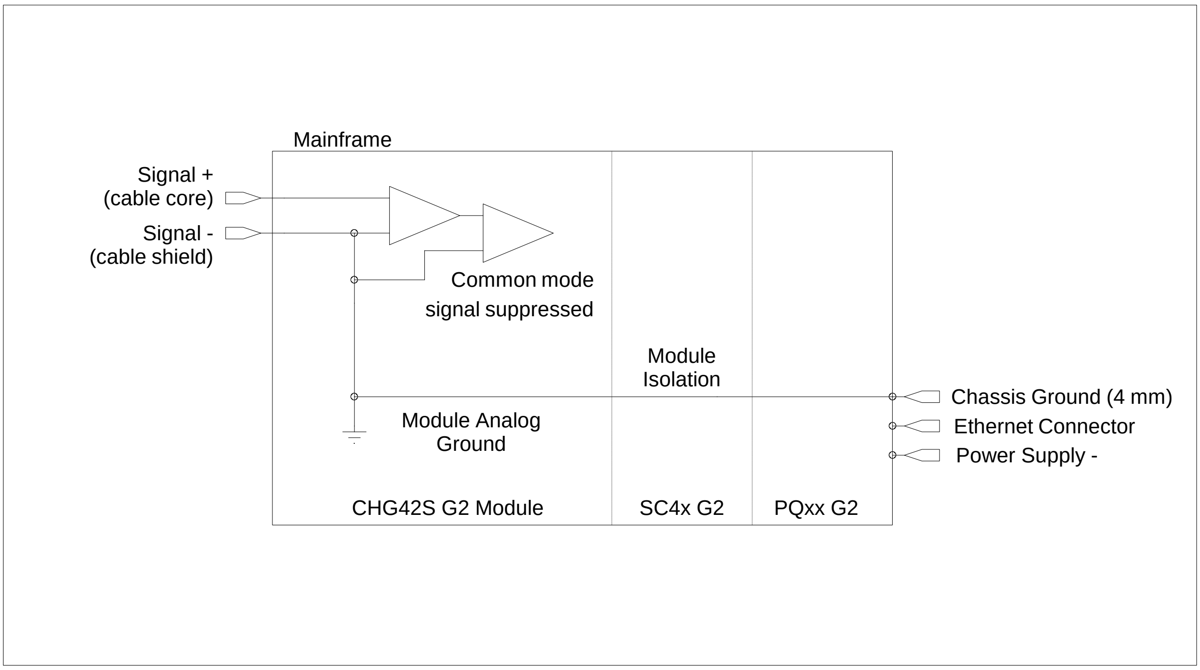


Figure 91. CHG42S G2 Grounding Diagram: Module grounded and shield connected

DCH42S G2 Module

Description

The DCH42S G2 Module has 2 independent differential input channels for Quartz or Piezoelectric Ceramic sensors. These sensors are typically used when improved signal performance such as low noise and low distortion is required or where high temperature and nuclear radiation prevents the use of ICP® based sensors. Additionally, a differential charge measurement offers further noise immunity and higher bandwidth and is particularly suited to applications using long cables. The Module can be used:

- With piezoelectric sensors commonly used to measure vibration, acceleration, force, torque and pressure
- Where long cables are required necessitating the use of balanced twisted pair cables

Front Panel

Figure 92. The DCH42S G2

Connector Information and Pin Definitions

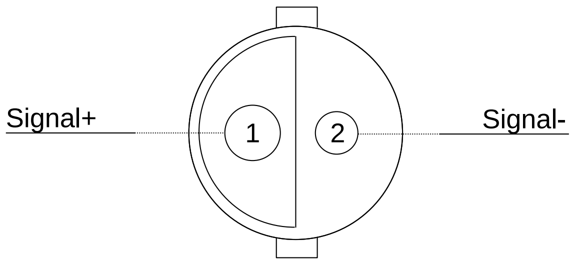


Figure 93. DCH42S G2 with 31-2225 twin BNC connectors Module Pin Definition

(when looking into the front panel's connector or at the rear of the cable's connector)

ESD WARNING

The DCH42S G2 Module inputs are sensitive to ESD damage. Always take care to discharge any additional static electricity that might have built up on a cable and connector before making contact with the DCH42S G2 Module.

Features

- 2 channels
- 24-bit resolution, 204.8 kSa/s sampling rate per channel, 90 kHz bandwidth
- 2 Sensitivity settings of 0.1 mV/pC and 1 mV/pC when in single-ended mode
- 2 Sensitivity settings of 0.2 mV/pC and 2 mV/pC when in differential mode
- 3 voltage gain ranges
- There are 2 distinctive input mode options:
    - Single-Ended
    - Differential
- Selectable low and high pass digital filters
- Overvoltage detection on frontend input signals
- Low power consumption
- Amphenol 31-2225 Twin BNC connectors

Interface		For piezoelectric sensors	
Voltage Amplifier Ranges		±100 mV, ±1 V, ±10 V (peak)	
Input Charge Ranges	**Single-Ended Mode**	**0.1 mV/pC**	±100 000 pC (peak)
		1 mV/pC	±10 000 pC (peak)
	Differential Mode	**0.2 mV/pC**	±5 000 pC (peak)
		2 mV/pC	±50 000 pC (peak)
-3dB High Pass Frequency	**Single-Ended Mode**	**0.1 mV/pC**	0.16 Hz or 0.016 Hz
		1 mV/pC	1.6 Hz or 0.16 Hz
	Differential Mode	**0.2 mV/pC**	0.16 Hz or 0.016 Hz
		2 mV/pC	1.6 Hz or 0.16 Hz
Phase Accuracy *Channels in similar range*		**Typical**[1]	< 0.5° at 10 kHz
Other Sampling Rates		Available through digital LP filters and decimation	
Optional Programmable Digital IIR Filter		Band pass/stop : 6 dB/octave High/Low pass : 12 dB/octave	
Optional First Order High-Pass Filter		-3 dB @ 1 Hz	
Module Calibration		Internal amplitude calibration	
Protection		1 kΩ series (inline)	
Galvanic Isolation		50 V	

Table 31. DCH42S G2 Module Features

[1] Measured in 10 V range at 204.8 kSa/s

Functionality per Channel

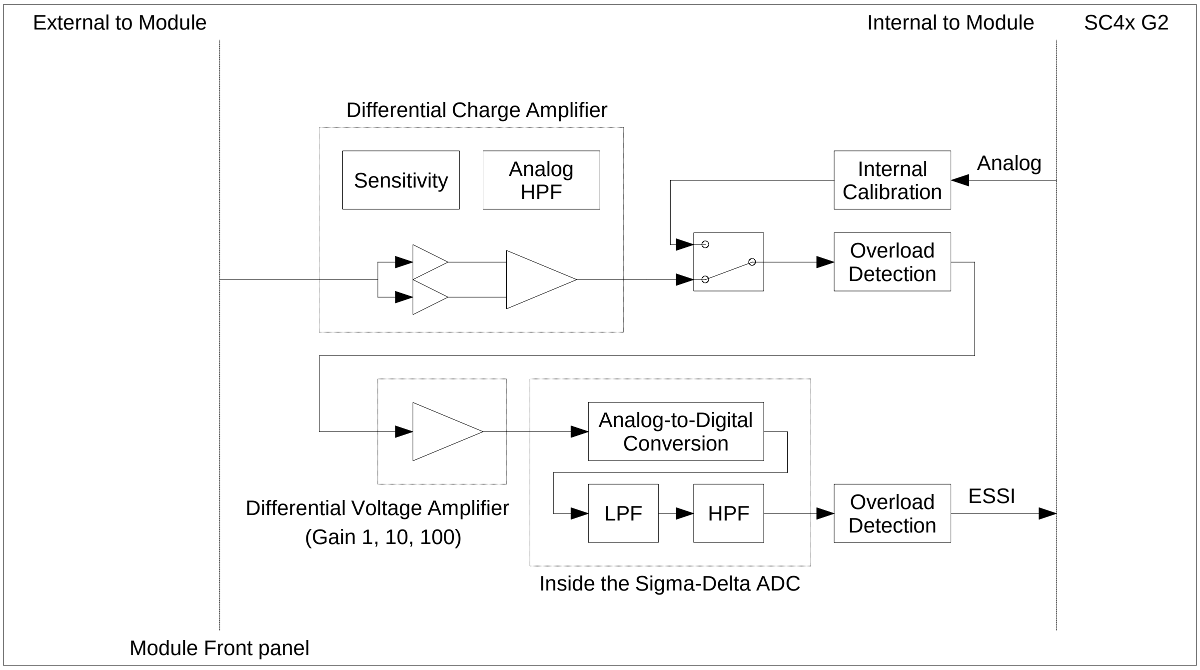


Figure 94. DCH42S G2 functionality per channel

Grounding diagram

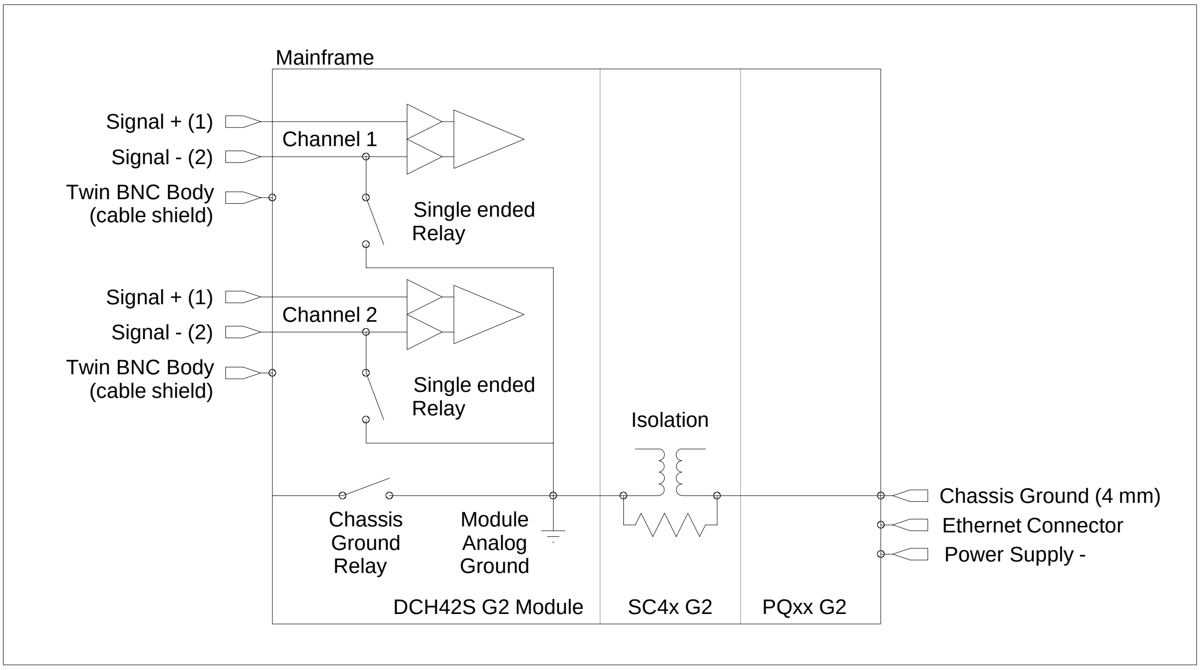


Figure 95. DCH42S G2 grounding

THM42 G2 Module

Description

The THM42 G2 Module contains 8 channels for use with any thermocouple type as well as Pt100 sensors. Remote cold junction compensation is provided through a SubModule (which is thermocouple type specific) whilst linearization is provided in the SC42 G2. The Module also includes a calibrated 0.2 mA current source for Pt100 sensor excitation.

SubModules are used with the Module which contains a pair of commonly used miniature E, J, K, and T thermocouple connectors (other types available upon request) with cold junction circuitry for thermocouple applications. Another SubModule contains a pair of Lemo connectors for Pt100 applications. Any combination of applicable SubModules can be connected to the THM42 G2 Module.

The THM42 G2 Module also includes 8 channels for measuring voltage inputs up to ±10 V. The Module can be used:

- When measuring E, J, K, and T thermocouples (other types available upon request)
- When measuring Pt100 sensors in constant current mode
- With any voltage source up to ±10 V in voltage input mode

Front Panel

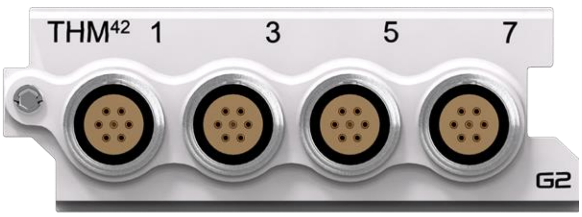


Figure 96. The THM42 G2

Connector Information and Pin Definitions

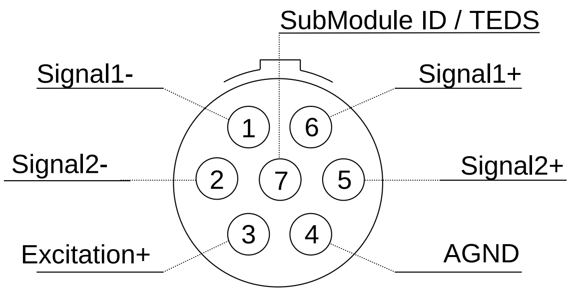


Figure 97. THM42 G2 with Lemo 7-way EHG.0B Module Pin Definition

(when looking into the front panel's connector or at the rear of the cable's connector)

Features

• 8 channels
• 3 input modes of operation:
  • Thermocouples
  • Pt100 based temperature measurement
  • Voltage input mode
• Supports TEDS IEEE 1451.4 V0.9, V1.0 (Class 2)
• 24-bit resolution, 6.4 kSa/s sampling rate per channel, 2.5 kHz bandwidth
• ±(10 V and 100 mV) input ranges
	• 0.2 mA Pt100 excitation current
	• Open circuit cable monitoring
	• Signal integrity circuit continuously monitors the input and disconnects sensitive circuits during overload conditions
	• Selectable low and high pass digital filters
	• 2 MΩ differential input resistance
	• Lemo 7-way EHG.0B connectors with 2 channels sharing one connector	

Input Modes	Thermocouple and Pt100	
Sensors	Any combination of thermocouple and Pt100 but the same type of sensor must be used for each channel pair	
Linearization	Thermocouple linearization for types: • Chromel®/Constantan (E, NiCr-CuNi) • Iron/Constantan (J, Fe-CuNi) • Chromel®/Alumel® (K, NiCr-NiAl) • Copper/Constantan (T, Cu-CuNi)	
Excitation	0.2 mA Excitation current for Pt100 and cold-junction-compensation. Monitored internally for drift and offset errors	
Maximum Common Mode Voltage	±7 V	
Other Sampling Rates	Available through digital LP filters and decimation	
SubModules	Cable between Module and sensor wire with housing containing TEDS, cold-junction-compensation and sensor connector. Color coded according to thermocouple type	
Module Calibration	Internal amplitude and phase calibration	
Phase Accuracy *Channels in similar range*	**Typical**[1]	< 1.5 ° at 1 kHz
Protection	2 kV ESD	
Galvanic Isolation	50 V	

Table 32. THM42 G2 Module Features

[1] Measured in 10 V range at 6.4 kSa/s

Functionality per Channel

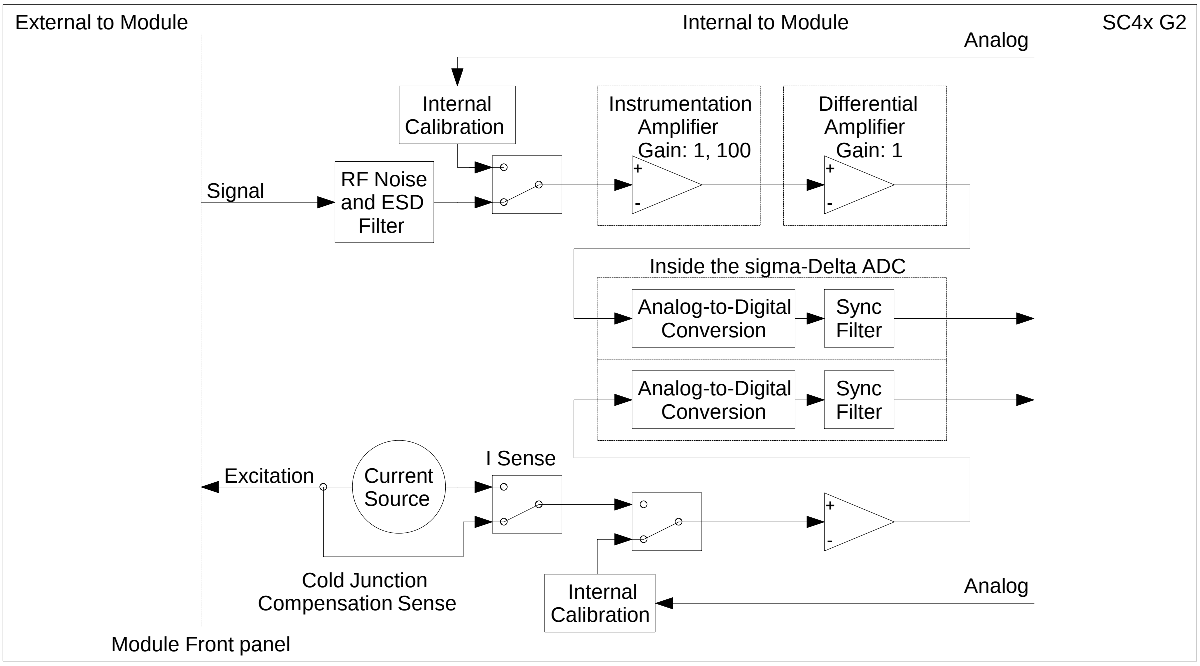


Figure 98. THM42 G2 Module Functionality

WSB42 G2 Module

Description

The WSB42 G2 Module is used with AC and DC bridge measurements including strain gauges configured as full, half or quarter bridges and inductive displacement transducers (LVDT). The Module offers numerous software selectable features such as constant voltage excitation (AC or DC), bridge sensing, bridge completion resistors and shunt calibration. The bridge can be balanced on command or a previous balance value can be recalled. The Module can be used with:

- Any strain gauge in quarter, half and full bridge, load cell and pressure transducer
- Inductive displacement transducer (LVDT)

Front Panel

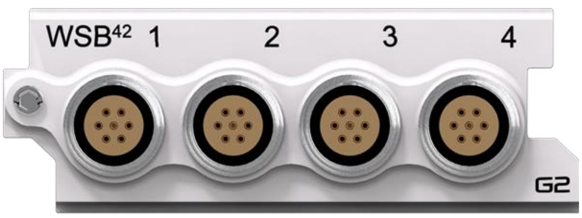


Figure 99. The WSB42 G2

Connector Information and Pin Definitions

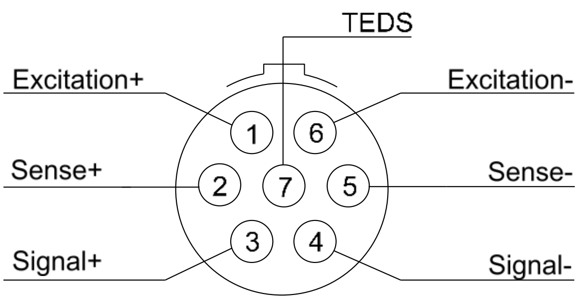


Figure 100. WSB42 G2 with Lemo 7-way EHG.0B connectors Module Pin Definition

(when looking into the front panel's connector or at the rear of the cable's connector)

Features

- 4 channels
- 3 input modes of operation:
  - Analog input mode
  - Wheatstone bridge voltage-excitation mode with 0-5 V (AC or DC) and limited to >90 Ω bridges
  - LVDT inductive displacement transducer mode
- Supports TEDS IEEE 1451.4 V0.9, V1.0 (Class 2)
- 24-bit resolution
- ±(200 mV, 20 mV, 2 mV) input ranges for bridge mode
- ≤10 kHz AC excitation
- Balanced differential signal input, differential voltage-excitation output and balanced sense input
- Full, half and quarter bridge configurations
- Internal half and quarter bridge completion resistors for 120 Ω and 350 Ω bridge elements
- Local and remote sense options
- 100 kΩ internal shunt calibration resistor
- Pre and post filter overflow monitoring
- Selectable low and high pass digital filters
- Lemo 7-way EHG.0B connectors

Bridge Type	Resistive or inductive

	Bridge Resistance	**Excitation Voltage**	**Minimum Resistance**	**Maximum Resistance**
Bridge Balancing Ranges for Voltage Excitation *Represents minimum or maximum resistance of a single element if other three bridge elements remain at their nominal value*	**120 Ω**	1 V	40 Ω	360 Ω
		2 V	72 Ω	200 Ω
		3 V	86 Ω	168 Ω
		4 V	93 Ω	154 Ω
		5 V	98 Ω	147 Ω
	350 Ω	1 V	117 Ω	1050 Ω
		2 V	210 Ω	583 Ω
		3 V	250 Ω	490 Ω
		4 V	272 Ω	450 Ω
		5 V	286 Ω	428 Ω

	Excitation Voltage	**Maximum Load Current**	**Voltage Resolution**	**Polarity**
Constant Voltage Excitation	0 – 5 V	< 90 mA	1.3 mV	Bipolar (Balanced)

Input Biasing Settings	**Differential Float (Balanced Float)**	Both the positive and negative signal inputs are referenced to floating ground
Other Sampling Rates	Available through digital LP filters and decimation	
Optional Programmable Digital IIR Filter	Band pass/stop : 6 dB/octave High/Low pass : 12 dB/octave	
Optional First Order High-Pass Filter	-3 dB @ 1 Hz	
Protection	2 kV ESD on all lines	
	Short circuit between excitation lines	
Galvanic Isolation	50 V	

Table 33. WSB42 G2 Module Features

Specifications

Bandwidth	DC to 49 kHz		
Maximum Sampling Rate (fs) per Channel	102.4 kSa/s		
A/D Conversion	24-bit		
Data Transfer	16/24-bit		
Input Voltage Ranges (Peak)	±2 mV; ±20 mV; ±200 mV		
Input Impedance	1 GΩ ‖ 60 pF		
	Resistance	**Tolerance**	**Temperature Drift**
Shunt Calibration Resistor *Between Signal- and Excitation+ / Sense+*	100 kΩ	0.1 %	5 ppm/°C
Internal Bridge Completion Resistors	120 Ω or 350 Ω	0.02 %	0.2 ppm/°C

<table>
<tr><td rowspan="4" colspan="2">Digital Low-Pass Filter
Filter scales with sampling rate</td><td>Passband</td><td colspan="2">fs x 0.45 Hz</td></tr>
<tr><td>Stopband</td><td colspan="2">fs x 0.55 Hz</td></tr>
<tr><td>Passband Ripple</td><td colspan="2">±0.005 dB</td></tr>
<tr><td>Stopband Attenuation</td><td colspan="2">100 dB</td></tr>
<tr><td colspan="2">Phase Accuracy
Channels in similar range</td><td>Typical[1]</td><td colspan="2">< 0.2° at 10 kHz</td></tr>
<tr><td rowspan="2" colspan="2">Wheatstone Bridge Voltage-Excitation</td><td>Excitation Voltage</td><td colspan="2">% Excitation Voltage</td></tr>
<tr><td>0 to 5 V</td><td colspan="2">0.34 %</td></tr>
<tr><td rowspan="4" colspan="2">DC Voltage Accuracy</td><td>Input Range (Peak)</td><td colspan="2">% Range</td></tr>
<tr><td>±2 mV</td><td colspan="2">To be determined</td></tr>
<tr><td>±20 mV</td><td colspan="2">0.54 %</td></tr>
<tr><td>±200 mV</td><td colspan="2">0.30 %</td></tr>
<tr><td rowspan="7">Noise
Input terminated by 50 Ω resistor</td><td></td><td>Input Range (Peak)</td><td>Guaranteed</td><td>Typical</td></tr>
<tr><td>10 Hz to 23 kHz</td><td rowspan="2">±2 mV</td><td>< 0.05 µVrms</td><td>< 0.04 µVrms</td></tr>
<tr><td>10 Hz to 49 kHz</td><td>< 0.06 µVrms</td><td>< 0.05 µVrms</td></tr>
<tr><td>10 Hz to 23 kHz</td><td rowspan="2">±20 mV</td><td>< 0.5 µVrms</td><td>< 0.4 µVrms</td></tr>
<tr><td>10 Hz to 49 kHz</td><td>< 0.6 µVrms</td><td>< 0.5 µVrms</td></tr>
<tr><td>10 Hz to 23 kHz</td><td rowspan="2">±200 mV</td><td>< 3.8 µVrms</td><td>< 3.3 µVrms</td></tr>
<tr><td>10 Hz to 49 kHz</td><td>< 5.5 µVrms</td><td>< 4.8 µVrms</td></tr>
</table>

[1] Measured in 200 mV range at 102.4 kSa/s

<table>
<tr><td rowspan="7">Amplitude Flatness
Relative to 1 kHz

Measured up to 0.39 x fs</td><td>Sampling Rate (fs)</td><td>Input Range (Peak)</td><td colspan="2">Attenuation
(Input signal level 100 % of full range)</td></tr>
<tr><td>51.2 kSa/s</td><td rowspan="2">±2 mV</td><td colspan="2">To be determined</td></tr>
<tr><td>102.4 kSa/s</td><td colspan="2">-</td></tr>
<tr><td>51.2 kSa/s</td><td rowspan="2">±20 mV</td><td colspan="2">- 0.04 dB</td></tr>
<tr><td>102.4 kSa/s</td><td colspan="2">- 0.13 dB</td></tr>
<tr><td>51.2 kSa/s</td><td rowspan="2">±200 mV</td><td colspan="2">- 0.04 dB</td></tr>
<tr><td>102.4 kSa/s</td><td colspan="2">- 0.13 dB</td></tr>
<tr><td rowspan="7">Amplitude Flatness
Relative to 1 kHz with 1 kΩ source

Measured up to 0.39 x fs</td><td>Sampling Rate (fs)</td><td>Input Range (Peak)</td><td colspan="2">Attenuation
(Input signal level 100 % of full range)</td></tr>
<tr><td>51.2 kSa/s</td><td rowspan="2">±2 mV</td><td colspan="2">To be determined</td></tr>
<tr><td>102.4 kSa/s</td><td colspan="2">-</td></tr>
<tr><td>51.2 kSa/s</td><td rowspan="2">±20 mV</td><td colspan="2">- 0.11 dB</td></tr>
<tr><td>102.4 kSa/s</td><td colspan="2">- 0.35 dB</td></tr>
<tr><td>51.2 kSa/s</td><td rowspan="2">±200 mV</td><td colspan="2">- 0.11 dB</td></tr>
<tr><td>102.4 kSa/s</td><td colspan="2">- 0.35 dB</td></tr>
<tr><td colspan="2" rowspan="4">Crosstalk</td><td>Input Range (Peak)</td><td>Guaranteed</td><td>Typical</td></tr>
<tr><td>±2 mV</td><td>64 dB</td><td>69 dB</td></tr>
<tr><td>±20mV</td><td>86 dB</td><td>91 dB</td></tr>
<tr><td>±200 mV</td><td>105 dB</td><td>110 dB</td></tr>
</table>

Table 34. WSB42 G2 Module Specification

Specification number: SP150700, Release 3.1. The Module settings and measurement conditions that were used during specification measurements are available on request.

Functionality per Channel

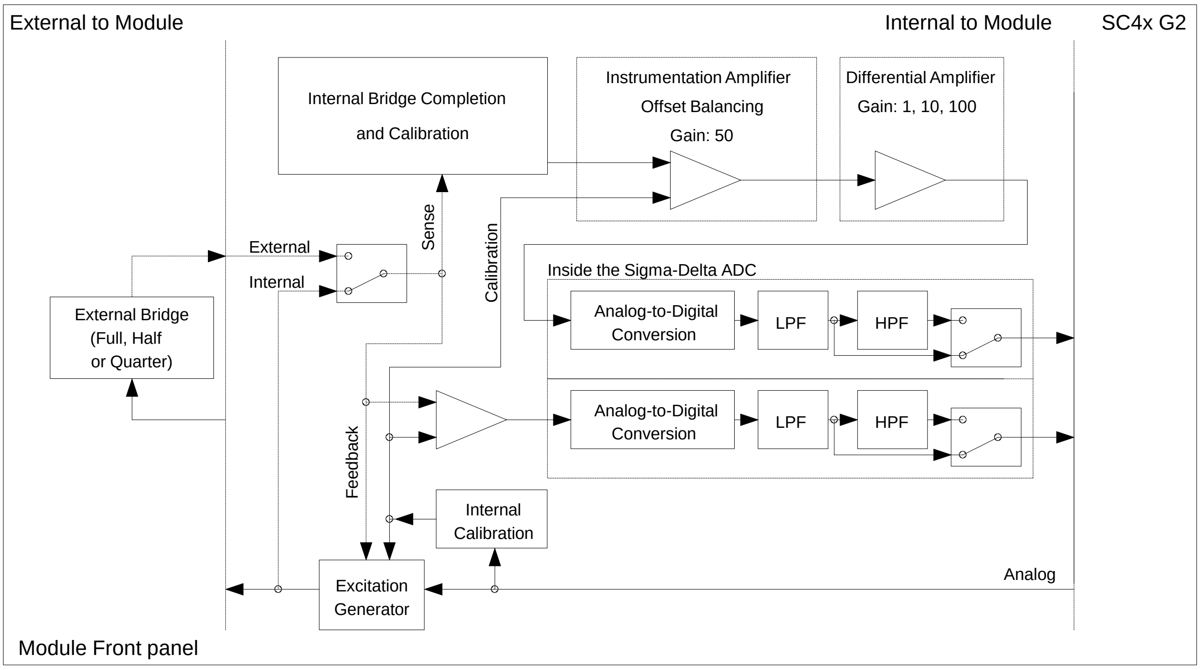


Figure 101. WSB42 G2 Module Functionality

The sense signals can be used internal to the PAK MKII to fine tune the excitation voltage.

The excitation frequency must be the same for all channels of a WSB Module that utilizes AC excitation

The different modes and parameter values mentioned in the specifications table are all software-selectable.

Operational Modes

The figures below show full, half and quarter bridge configurations for the WSB42 G2 Module and a bridge located externally to the Module.

Full Bridge Functionality

External connections and internal full bridge completion per WSB Module channel (6-wire bridges can be used with external sensing and 4-wire bridges with internal sensing)

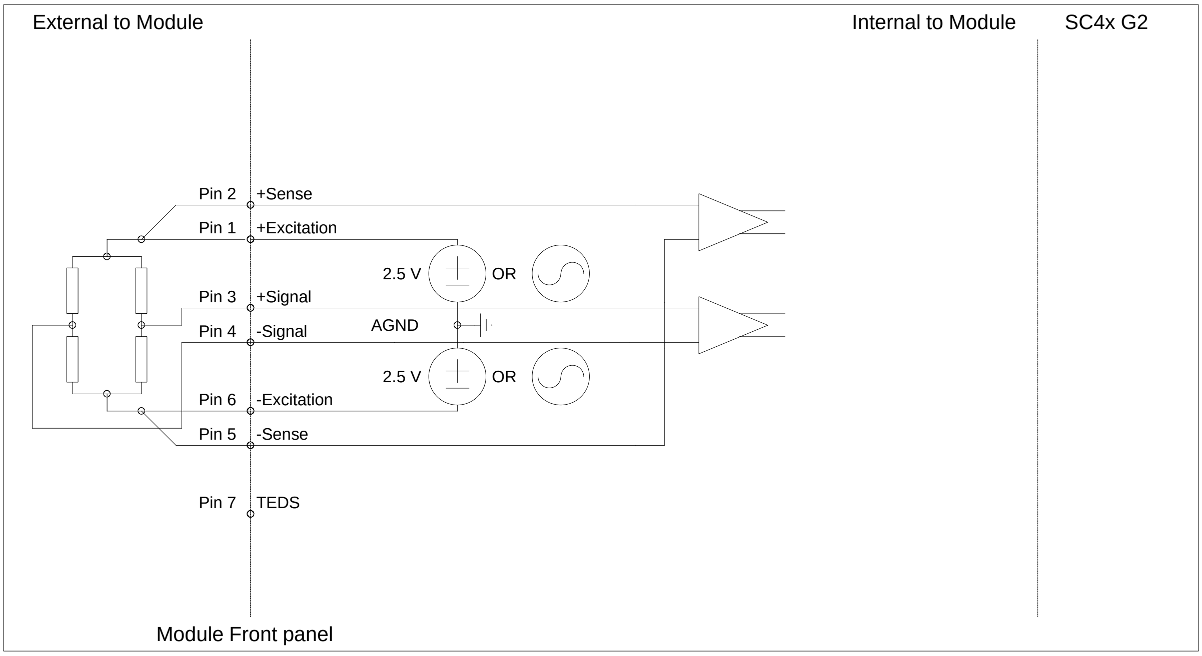


Figure 102. Full bridge functionality

Half Bridge Functionality

External connections and internal half bridge completion per WSB Module channel (5-wire bridges can be used with external sensing and 3-wire half bridges with internal sensing)

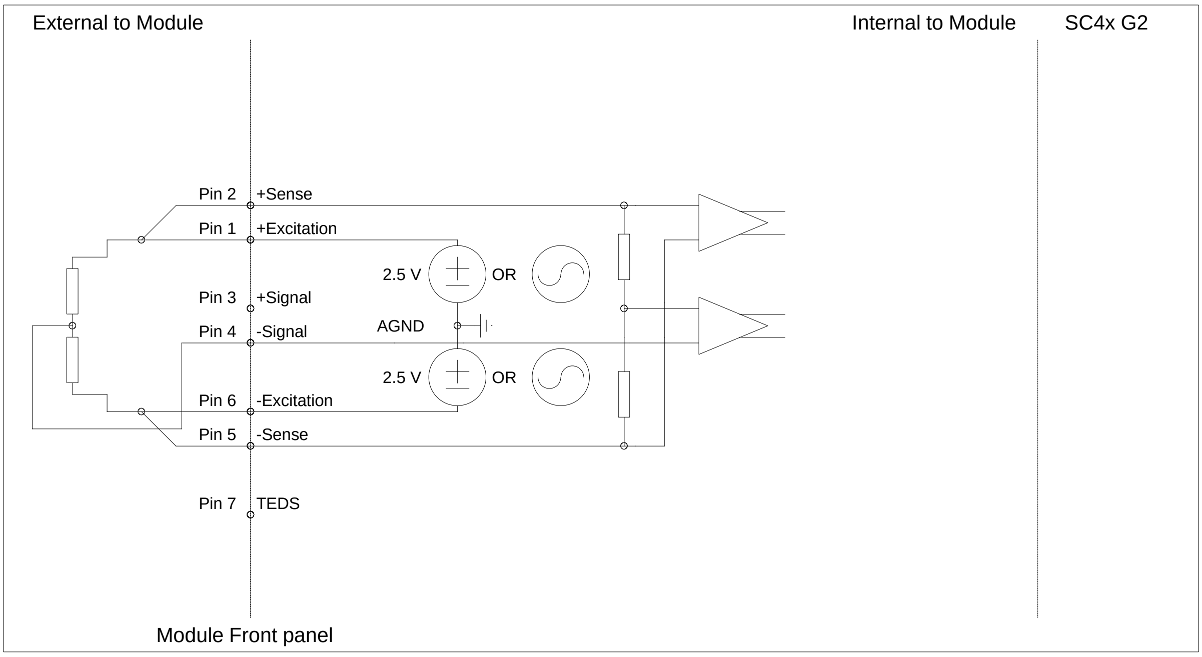


Figure 103. Half bridge functionality

Quarter Bridge Functionality

External connections and internal quarter bridge completion per WSB Module channel (3-wire quarter bridges can be used with internal sensing)

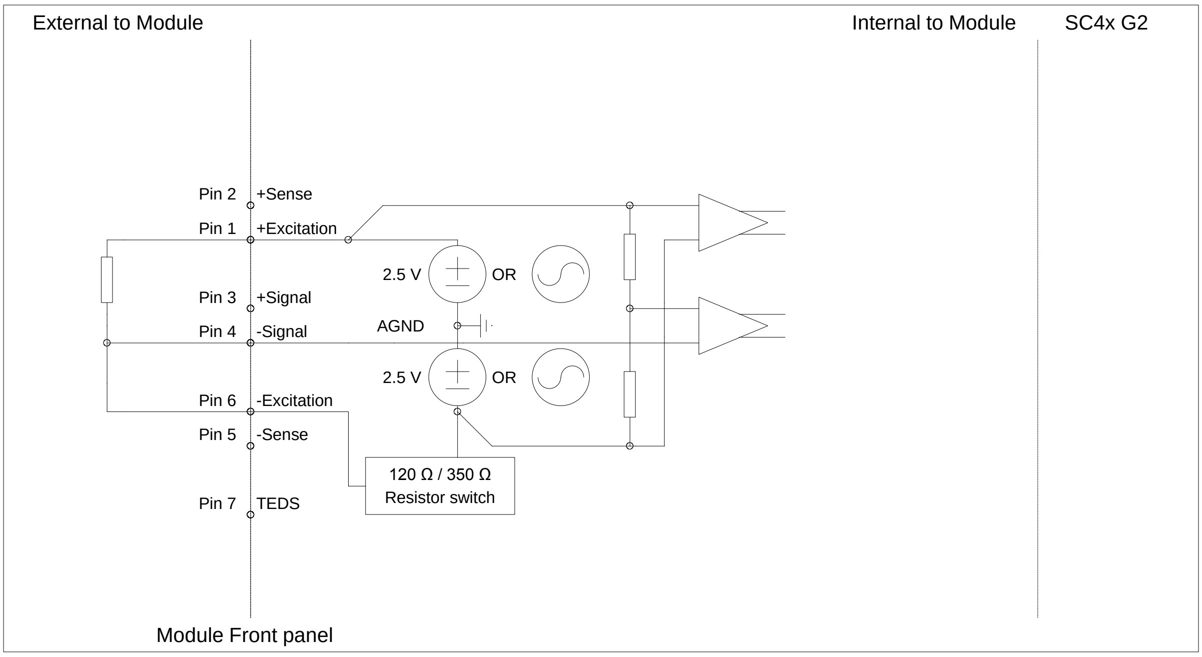


Figure 104. Quarter bridge functionality

Using a rope transducer

External connections to a rope transducer and internal half bridge completion per WSB Module channel (5-wire and 3-wire rope transducers).

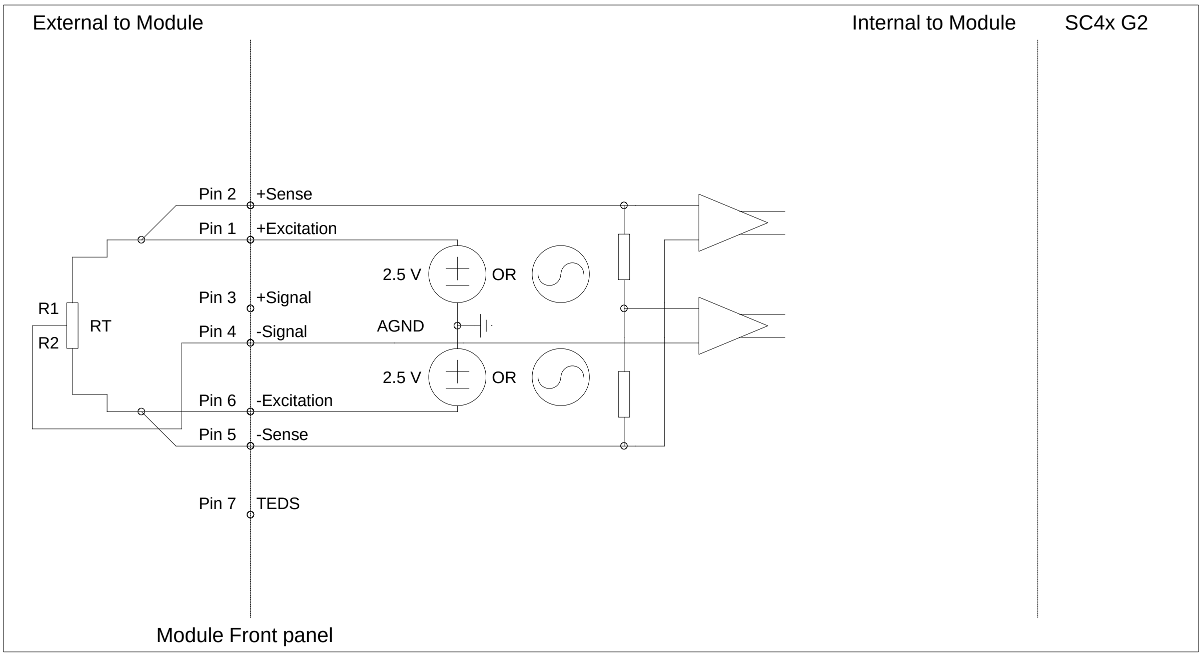


Figure 105. Rope transducer functionality

The rope transducer's potentiometer is such that RT = R1 + R2.
In terms of displacement, this is equal to LT = L1 + L2. Also ....L1/LT = R1/RT (1)

Now for the bridge above: if V_{in} is defined as the voltage difference between Signal+ and Signal- and V_{exc} is defined as the voltage difference between Excitation+ and Excitation- (in other words, the excitation voltage), then the following equation holds: .... $V_{in} = V_{exc}$ (R1/RT - ½) (2)

When (1) is substituted into (2), we get .... L1/LT = V_{in}/V_{exc} + ½ (3)

The only restriction with the above configuration is that V_{in} must stay within range of the input amplifier.
Hence V_{exc} is limited as follows:
WSB42 G2 Modules: V_{exc} = 500 mV

Shunt Calibration

Shunt calibration is a means of simulating strain in a bridge. It is an accepted and useful way of checking the gain and accuracy of instrumentation without the need to expose the transducer to known physical input values.

Shunt calibration works by shunting a known resistor across one arm of a Wheatstone bridge. The resulting deviation in bridge output is expressed in mV/V of excitation or mV/mA of excitation.

Practically, data obtained from a shunt calibration can be used to check that the instrumentation is operating as expected, that the correct input range is selected and that the correct gauge and scaling factors are used in subsequent calculations.

Shunt calibration can be performed for any bridge setup.

Table 35 summarizes the shunt calibration outputs for unloaded bridges with negligible lead wire resistance and gauge factor equal to 2.

Nominal Bridge Resistance (Ω)	Shunt Resistor (kΩ)	Voltage Excited Bridge Output (mV/V)	Current Excited Bridge Output (mV/mA)	Equivalent Microstrain	Simulation Type
120	100	0.30	0.04	599	Compression
350	100	0.87	0.31	1744	Compression
1000	100	2.49	2.49	4950	Compression

Table 35. Shunt calibration outputs

The equivalent shunt calibration circuit is illustrated in the figure below. The shunt resistor path is highlighted in red.

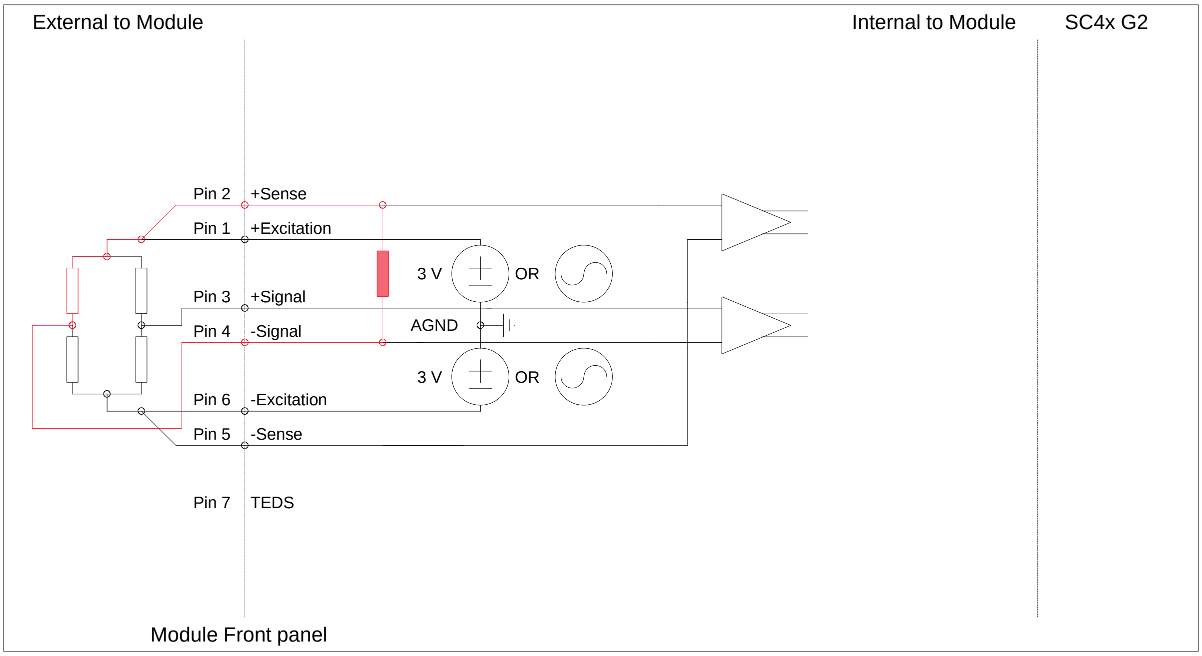


Figure 106. Shunt calibration for 6-wire bridge configuration with 4 external bridge elements

WSB42X G2 Module

Description

The WSB42X G2 Module is used with AC and DC bridge measurements including strain gauges configured as full, half or quarter bridges and inductive displacement transducers (LVDT). The Module offers numerous software selectable features such as constant voltage (AC or DC) and constant current excitation (DC), bridge sensing, bridge completion resistors, shunt calibration, dynamic strain mode and ICP® sensor support. The bridge can be balanced on command or a previous balance value can be recalled. The Module can be used with:

- Any strain gauge in quarter, half and full bridge, load cell and pressure transducer
- Inductive displacement transducer (LVDT)
- Any voltage source up to ±10 V in voltage input mode
- Current-excited sensors in 4-wire mode (Full bridge or 1 external element, DC and AC)
- Current-excited sensors in 2-wire mode (Dynamic strain only)
- Any ICP® based sensor commonly used to measure vibration, acceleration, force or pressure

Front Panel

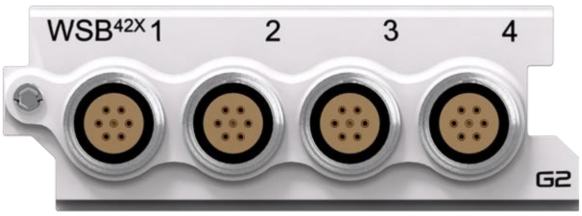


Figure 107. The WSB42X G2

Connector Information and Pin Definitions

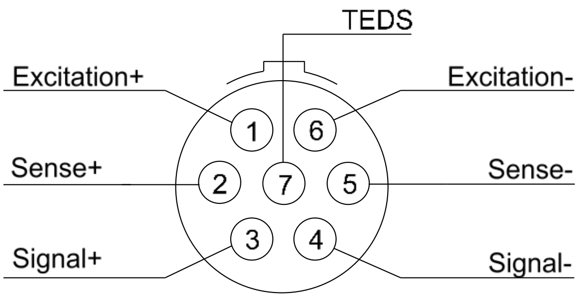


Figure 108. WSB42X G2 with Lemo 7-way EHG.0B connectors Module Pin Definition

(when looking into the front panel's connector or at the rear of the cable's connector)

Features

- 4 channels
- 7 modes of operation:
  - Analog input mode
  - ICP® mode with 4, 8 or 12 mA constant current at ±12 V excitation
  - Bridge voltage-excitation mode:
    - 0-6 V (AC or DC)
      - for 350 Ω full bridges
      - for 120 Ω and 350 Ω half or quarter bridges
    - 0-4 V (AC or DC) for 120 Ω full bridges
  - Bridge voltage-excitation mode:
    - 8-10 V (DC) for 1 kΩ bridges
  - Bridge current-excitation mode:
    - 4, 8 or 12 mA (DC)
  - 2 and 4 wire current-excitation strain mode:
    - 4, 8 or 12 mA (DC)
  - LVDT inductive displacement transducer mode (AC)
- Supports TEDS IEEE 1451.4 V0.9, V1.0 (Class 1 and 2)
- 24-bit resolution
- ±(10 V, 1 V, 100 mV, 10 mV) input ranges for all modes
- ≤ 10 kHz AC excitation
- Balanced differential signal input, differential voltage-excitation output and balanced sense input
- Full, half and quarter bridge configurations
- Internal half and quarter bridge completion resistors for 120 Ω and 350 Ω bridge elements
- Local and remote sense options
- 100 kΩ internal shunt calibration resistor
- Pre and post filter overflow monitoring
- Selectable low and high pass digital filters
- Lemo 7-way EHG.0B connectors

<table>
<tr><td colspan="2">Bridge Type</td><td colspan="4">Resistive or inductive</td></tr>
<tr><td rowspan="3">Interface</td><td>ICP®</td><td colspan="4">ICP® sensors</td></tr>
<tr><td>ALI</td><td colspan="4">For analog voltage sources</td></tr>
<tr><td>WSB</td><td colspan="4">Wheatstone bridge sensors</td></tr>
<tr><td rowspan="2">Input Coupling</td><td>ICP®</td><td colspan="4">AC</td></tr>
<tr><td>ALI / WSB</td><td colspan="4">DC or AC</td></tr>
<tr><td rowspan="2">AC Coupling Frequency Response</td><td rowspan="2">ICP® / ALI / WSB</td><td>Attenuation</td><td>Min</td><td>Max</td><td>Unit</td></tr>
<tr><td>-3 dB</td><td>-</td><td>1.5</td><td>Hz</td></tr>
</table>

	Bridge Resistance	Excitation Voltage	Minimum Resistance	Maximum Resistance
Bridge Balancing Ranges for Voltage Excitation *Represents minimum or maximum resistance of a single element if other three bridge elements remain at their nominal value*	**120 Ω**	0.5 - 5 V	0 Ω	Unlimited
		5.5 V	6 Ω	2520 Ω
		6 V	11 Ω	1320 Ω
	350 Ω	0.5 - 5 V	0 Ω	Unlimited
		5.5 V	17 Ω	7350 Ω
		6 V	32 Ω	3850 Ω
	1 kΩ	8.5 V	850 Ω	3850 Ω
		9 V	850 Ω	3500 Ω
		9.5 V	850 Ω	3220 Ω
		10 V	850 Ω	3000 Ω

	Bridge Resistance	Excitation Current	Minimum Resistance (2-wire and 4-wire)	Maximum Resistance (2-wire)	Maximum Resistance (4-wire)
Bridge Balancing Ranges for Current Excitation *Represents minimum or maximum resistance of a single element if other three bridge elements remain at their nominal value*	**120 Ω**	4 mA	0 Ω	Unlimited	Unlimited
		8 mA	0 Ω	Unlimited	Unlimited
		12 mA	0 Ω	Unlimited	Unlimited
	350 Ω	4 mA	0 Ω	Unlimited	Unlimited
		8 mA	0 Ω	12000 Ω	12000 Ω
		12 mA	0 Ω	2400 Ω	2400 Ω
	1 kΩ	4 mA	0 Ω	7660 Ω	7660 Ω
		8 mA	48 Ω	2810 Ω	2810 Ω
		12 mA	310 Ω	2050 Ω	1360 Ω

	Excitation Current	Voltage Compliance	Maximum Sensor Resistance
Constant Current Excitation 2-Wire *Signal± carries both signal and excitation* *AC coupled* *No current monitoring*	4 mA	20 V	5000 Ω

		8 mA	20 V	2500 Ω	
		12 mA	20 V	1660 Ω	
Constant Current Excitation 4-Wire *Signal± carries signal and Excitation± carries excitation* *AC or DC coupled* *Current monitoring across ultra-precision resistor*		4 mA	13 V	3250 Ω	
		8 mA	13 V	1620 Ω	
		12 mA	13 V	1080 Ω	
Constant Voltage Excitation		**Excitation Voltage**	**Maximum Load Current**	**Voltage Resolution**	**Polarity**
		< 6 V	< 90 mA	0.2 mV	Bipolar (Balanced)
		8 to 10 V	< 12 mA	0.1 mV	Unipolar (Unbalanced)
Other Sampling Rates		Available through digital LP filters and decimation			
Optional Programmable Digital IIR Filter		Band pass/stop : 6 dB/octave High/Low pass : 12 dB/octave			
Optional First Order High-Pass Filter		-3 dB @ 1 Hz			
Protection	ICP® / ALI / WSB	2 kV ESD on all lines			
		Overvoltage on signal lines			
	ICP®	Short circuit between sensor case and ground			
	WSB	Short circuit between excitation lines			
Galvanic Isolation		50 V			

Table 36. WSB42X G2 Module Features

Specifications (All builds preceding Build R)

Bandwidth	DC to 100 kHz
Maximum Sampling Rate (fs) per Channel	204.8 kSa/s
A/D Conversion	24-bit
Data Transfer	16/24-bit

Input Voltage Ranges (Peak)		±10 mV; ±100 mV; ±1 V; ±10 V		
ICP® Mode		4 mA; 8 mA or 12 mA constant current at ±12 V excitation		
Input Biasing Settings	**Differential Float (Balanced Float)**	Both the positive and negative signal inputs are connected through 1 MΩ to floating ground		
Input Impedance		2.1 MΩ ∥ 1200 pF		
		Resistance	**Tolerance**	**Temperature Drift**
Shunt Calibration Resistor *Between Signal- and Excitation+ / Sense+*		100 kΩ	0.1 %	5 ppm/°C
Internal Bridge Completion Resistors		120 Ω or 350 Ω	0.02 %	0.2 ppm/°C
Digital Low-Pass Filter *Filter scales with sampling rate*		**Passband**	fs x 0.45 Hz	
		Stopband	fs x 0.55 Hz	
		Passband Ripple	±0.005 dB	
		Stopband Attenuation	100 dB	
Phase Accuracy *Channels in similar range*		**Typical**[1]	< 0.2° at 10 kHz	
Wheatstone Bridge Current-Excitation		**Excitation Mode**	**% Excitation Mode + mA**	
	2-wire	4 mA	0.58 % + 0.025 mA	
		8 mA	0.38 % + 0.031 mA	
		12 mA	0.36 % + 0.042 mA	
	4-wire	4 mA	0.58 % + 0.011 mA	
		8 mA	0.38 % + 0.018 mA	
		12 mA	0.36 % + 0.029 mA	

[1] Measured in 10 V range at 204.8 kSa/s

Wheatstone Bridge Voltage-Excitation		**Excitation Voltage**	**Maximum Error Voltage**	
		< 6 V	± 4 mV	
		8 to 10 V	± 4 mV	
DC Voltage Accuracy		**Input Range (Peak)**	**% Range**	
		±10 mV	To be determined	
		±100 mV	0.30 %	
		±1 V	0.15 %	
		±10 V	0.15 %	
Noise *Input terminated by 50 Ω resistor*		**Input Range (Peak)**	**Guaranteed**	**Typical**
	10 Hz to 23 kHz	±10 mV	< 3.6 µVrms	< 2.9 µVrms
	10 Hz to 49 kHz		< 5.8 µVrms	< 4.3 µVrms
	10 Hz to 100 kHz		< 6.9 µVrms	< 5.6 µVrms
	10 Hz to 23 kHz	±100 mV	< 5.0 µVrms	< 4.4 µVrms
	10 Hz to 49 kHz		< 10 µVrms	< 7.8 µVrms
	10 Hz to 100 kHz		< 82 µVrms	< 72 µVrms
	10 Hz to 23 kHz	±1 V	< 5.0 µVrms	< 4.4 µVrms
	10 Hz to 49 kHz		< 10 µVrms	< 7.8 µVrms
	10 Hz to 100 kHz		< 86 µVrms	< 74 µVrms
	10 Hz to 23 kHz	±10 V	< 41 µVrms	< 37 µVrms
	10 Hz to 49 kHz		< 86 µVrms	< 68 µVrms
	10 Hz to 100 kHz		< 755 µVrms	< 700 µVrms

	Sampling Rate (fs)	Input Range (Peak)	Attenuation (Input signal level 100 % of full range)
Amplitude Flatness *Relative to 1 kHz* *Measured up to 0.39 x fs*	51.2 kSa/s	±10 mV	- 0.03 dB
	102.4 kSa/s		- 0.07 dB
	204.8 kSa/s		- 0.18 dB
	51.2 kSa/s	±100 mV	- 0.02 dB
	102.4 kSa/s		- 0.06 dB
	204.8 kSa/s		- 0.15 dB
	51.2 kSa/s	±1 V	- 0.02 dB
	102.4 kSa/s		- 0.06 dB
	204.8 kSa/s		- 0.11 dB
	51.2 kSa/s	±10 V	- 0.02 dB
	102.4 kSa/s		- 0.05 dB
	204.8 kSa/s		- 0.11 dB
	Sampling Rate (fs)	**Input Range (Peak)**	**Attenuation (Input signal level 100 % of full range)**
Amplitude Flatness *Relative to 1 kHz with 1 kΩ source* *Measured up to 0.39 x fs*	51.2 kSa/s	±10 mV	- 0.40 dB
	102.4 kSa/s		- 1.10 dB
	204.8 kSa/s		- 3.50 dB
	51.2 kSa/s	±100 mV	- 0.31 dB
	102.4 kSa/s		- 1.06 dB
	204.8 kSa/s		- 3.20 dB
	51.2 kSa/s	±1 V	- 0.30 dB
	102.4 kSa/s		- 1.06 dB
	204.8 kSa/s		- 3.21 dB
	51.2 kSa/s	±10 V	- 0.30 dB
	102.4 kSa/s		- 1.05 dB
	204.8 kSa/s		- 3.18 dB

	Input Range (Peak)	Guaranteed	Typical
Crosstalk	±10 mV	68 dB	73 dB
	±100 mV	62 dB	67 dB
	±1 V	102 dB	107 dB
	±10 V	83 dB	88 dB

Table 37. WSB42X G2 Module (All builds preceding Build R) Specifications

Specification number: SP150801, Release 2.8. The Module settings and measurement conditions that were used during specification measurements are available on request.

Low Capacitance (Build R onwards) Specifications

Bandwidth		DC to 100 kHz		
Maximum Sampling Rate (fs) per Channel		204.8 kSa/s		
A/D Conversion		24-bit		
Data Transfer		16/24-bit		
Input Voltage Ranges (Peak)		±10 mV; ±100 mV; ±1 V; ±10 V		
ICP® Mode		4 mA; 8 mA or 12 mA constant current at ±12 V excitation		
Input Biasing Settings	**Differential Float (Balanced Float)**	Both the positive and negative signal inputs are connected through 1 MΩ to floating ground		
Input Impedance		2.1 MΩ ǁ 80 pF		
		Resistance	**Tolerance**	**Temperature Drift**
Shunt Calibration Resistor *Between Signal- and Excitation+ / Sense+*		100 kΩ	0.1 %	5 ppm/°C
Internal Bridge Completion Resistors		120 Ω or 350 Ω	0.02 %	0.2 ppm/°C

Digital Low-Pass Filter *Filter scales with sampling rate*		**Passband**	fs x 0.45 Hz
		Stopband	fs x 0.55 Hz
		Passband Ripple	±0.005 dB
		Stopband Attenuation	100 dB
Phase Accuracy *Channels in similar range*		**Typical**[1]	< 0.2° at 10 kHz
Wheatstone Bridge Current-Excitation		**Excitation Mode**	**% Excitation Mode + mA**
	2-wire	4 mA	0.58 % + 0.025 mA
		8 mA	0.38 % + 0.031 mA
		12 mA	0.36 % + 0.042 mA
	4-wire	4 mA	0.58 % + 0.011 mA
		8 mA	0.38 % + 0.018 mA
		12 mA	0.36 % + 0.029 mA
Wheatstone Bridge Voltage-Excitation		**Excitation Voltage**	**Maximum Error Voltage**
		< 6 V	± 4 mV
		8 to 10 V	± 4 mV

[1] Measured in 10 V range at 204.8 kSa/s

DC Voltage Accuracy	Input Range (Peak)	% Range
	±10 mV	To be determined
	±100 mV	0.30 %
	±1 V	0.15 %
	±10 V	0.15 %

Noise *Input terminated by 50 Ω resistor*		Input Range (Peak)	Guaranteed	Typical
	10 Hz to 23 kHz	±10 mV	< 3.6 µVrms	< 2.9 µVrms
	10 Hz to 49 kHz		< 5.8 µVrms	< 4.3 µVrms
	10 Hz to 100 kHz		< 6.9 µVrms	< 5.6 µVrms
	10 Hz to 23 kHz	±100 mV	< 5.0 µVrms	< 4.4 µVrms
	10 Hz to 49 kHz		< 10 µVrms	< 7.8 µVrms
	10 Hz to 100 kHz		< 82 µVrms	< 72 µVrms
	10 Hz to 23 kHz	±1 V	< 5.0 µVrms	< 4.4 µVrms
	10 Hz to 49 kHz		< 10 µVrms	< 7.8 µVrms
	10 Hz to 100 kHz		< 86 µVrms	< 74 µVrms
	10 Hz to 23 kHz	±10 V	< 41 µVrms	< 37 µVrms
	10 Hz to 49 kHz		< 86 µVrms	< 68 µVrms
	10 Hz to 100 kHz		< 755 µVrms	< 700 µVrms

	Sampling Rate (fs)	Input Range (Peak)	Attenuation (Input signal level 100 % of full range)
Amplitude Flatness *Relative to 1 kHz* *Measured up to 0.39 x fs*	51.2 kSa/s	±10 mV	- 0.03 dB
	102.4 kSa/s		- 0.05 dB
	204.8 kSa/s		- 0.13 dB
	51.2 kSa/s	±100 mV	- 0.02 dB
	102.4 kSa/s		- 0.03 dB
	204.8 kSa/s		- 0.08 dB
	51.2 kSa/s	±1 V	- 0.02 dB
	102.4 kSa/s		- 0.03 dB
	204.8 kSa/s		- 0.08 dB
	51.2 kSa/s	±10 V	- 0.02 dB
	102.4 kSa/s		- 0.03 dB
	204.8 kSa/s		- 0.07 dB

	Sampling Rate (fs)	Input Range (Peak)	Attenuation (Input signal level 100 % of full range)
Amplitude Flatness *Relative to 1 kHz with 1 kΩ source* *Measured up to 0.39 x fs*	51.2 kSa/s	±10 mV	- 0.20 dB
	102.4 kSa/s		- 0.50 dB
	204.8 kSa/s		- 0.85 dB
	51.2 kSa/s	±100 mV	- 0.11 dB
	102.4 kSa/s		- 0.34 dB
	204.8 kSa/s		- 1.00 dB
	51.2 kSa/s	±1 V	- 0.12 dB
	102.4 kSa/s		- 0.35 dB
	204.8 kSa/s		- 1.00 dB
	51.2 kSa/s	±10 V	- 0.11 dB
	102.4 kSa/s		- 0.34 dB
	204.8 kSa/s		- 1.00 dB

	Input Range (Peak)	Guaranteed	Typical
Crosstalk	±10 mV	68 dB	73 dB
	±100 mV	62 dB	67 dB
	±1 V	102 dB	107 dB
	±10 V	83 dB	88 dB

Table 38. WSB42X G2 Module Low Capacitance (Build R onwards) Specification

Specification number: SP150701, Release 3.5. The Module settings and measurement conditions that were used during specification measurements are available on request.

Functionality per Channel

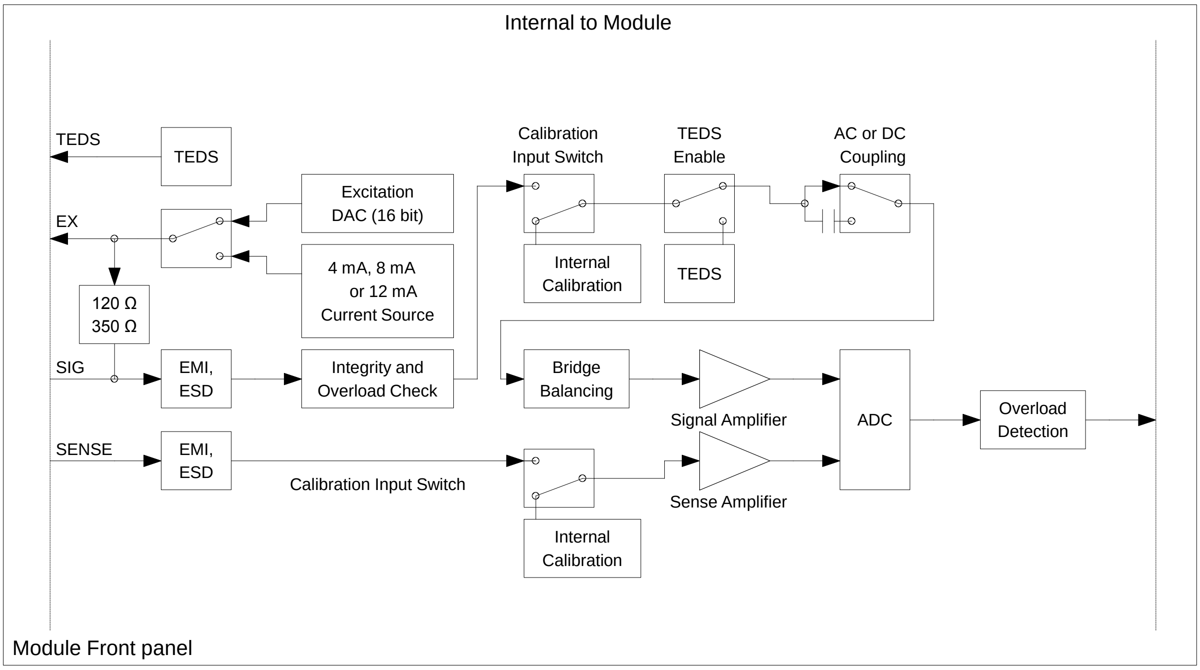


Figure 109. WSB42X G2 functionality

Module grounding

Input signals on the WSB42X G2 are referenced to the Module's internal ground only. In Figure 110 the Module's internal ground is labeled as AGND and the chassis ground of the PAK MKII Mainframe is labeled as CGND. A potential difference of up to 50 V may exist between AGND and CGND. Differences in excess of 50 V will activate the Module's protection circuits and clamp voltage differentials to within safe levels.

For shielded sensors connected to CGND, the positive and negative Signal lines can float to a maximum of 50 V above or below CGND.

A simplified diagram of the signal grounding is shown in Figure 110.

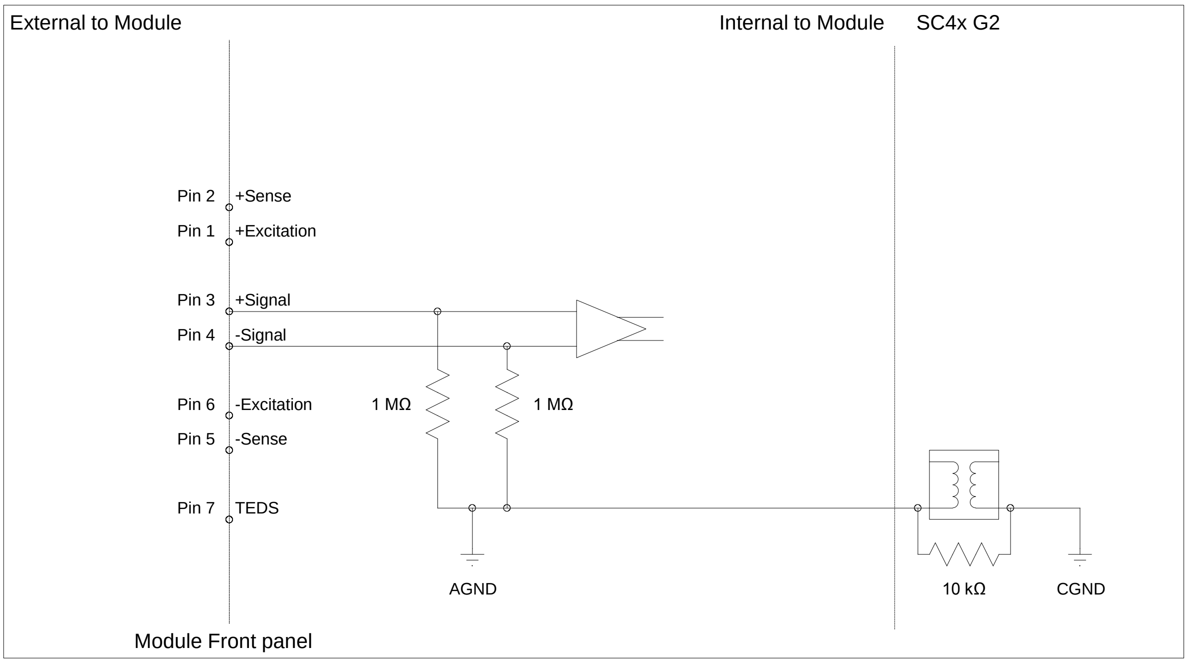


Figure 110. Differential float (balanced float) grounding

This grounding method is applicable to all interface modes, ALI, ICP® and WSB and their individual sub modes.

Voltage sensing

Voltage excitation can be sensed using the sense lines (+Sense and -Sense). Sensing can be performed externally by connecting two dedicated sense lines from the Module to the bridge. Internal sensing refers to the measurement of the excitation voltage within the Module, without the need for external sense wires.

Voltage excitation is measured and digitized to 24-bit resolution using a dedicated ADC. The maximum sampling rate for the sense channel is 204.8 kSa/s under most conditions and generally mirrors the sample rate set for the signal channels.

Voltage excitation sensing allows for accurate initial setting of the excitation voltage

The following diagrams illustrate voltage excited Wheatstone bridges with external and internal sensing for full, half and quarter bridges.

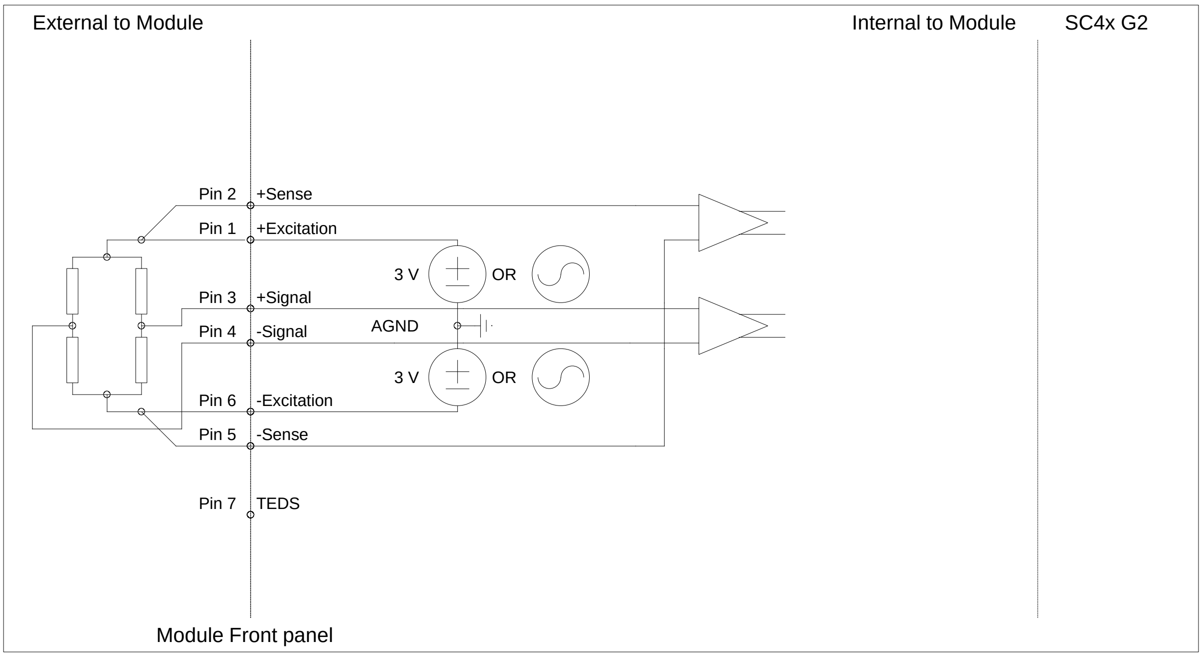


Figure 111. 6-wire bridge configuration with 4 external bridge elements (external sense)

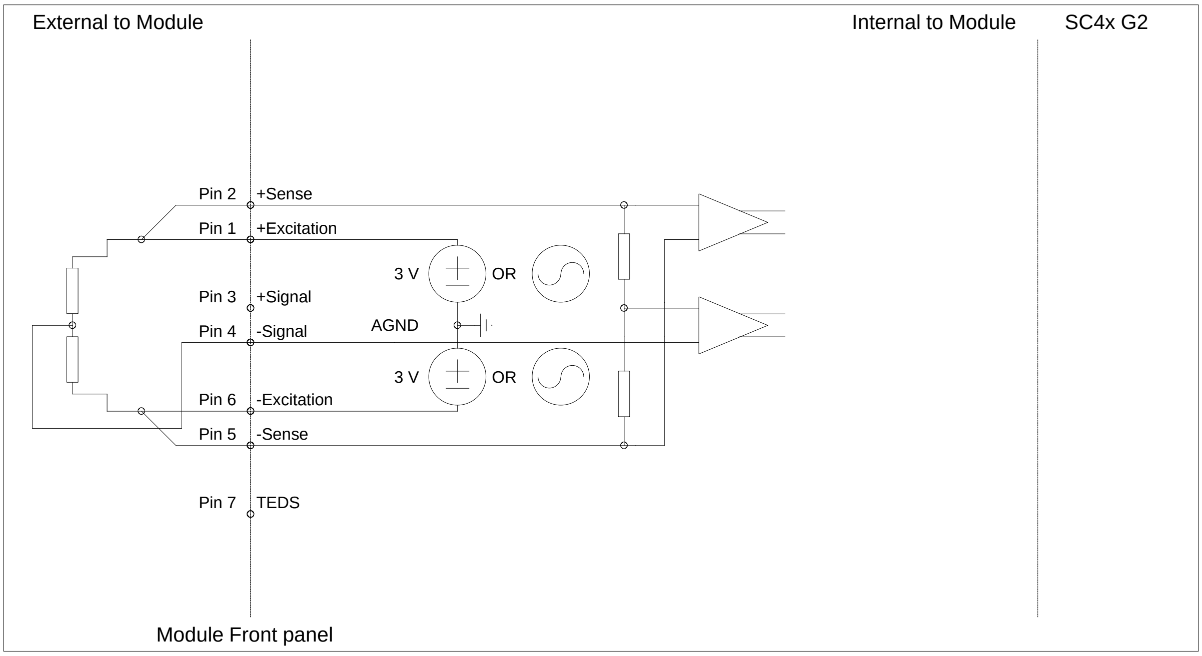


Figure 112. 5-wire bridge configuration with 2 external bridge elements (external sense)

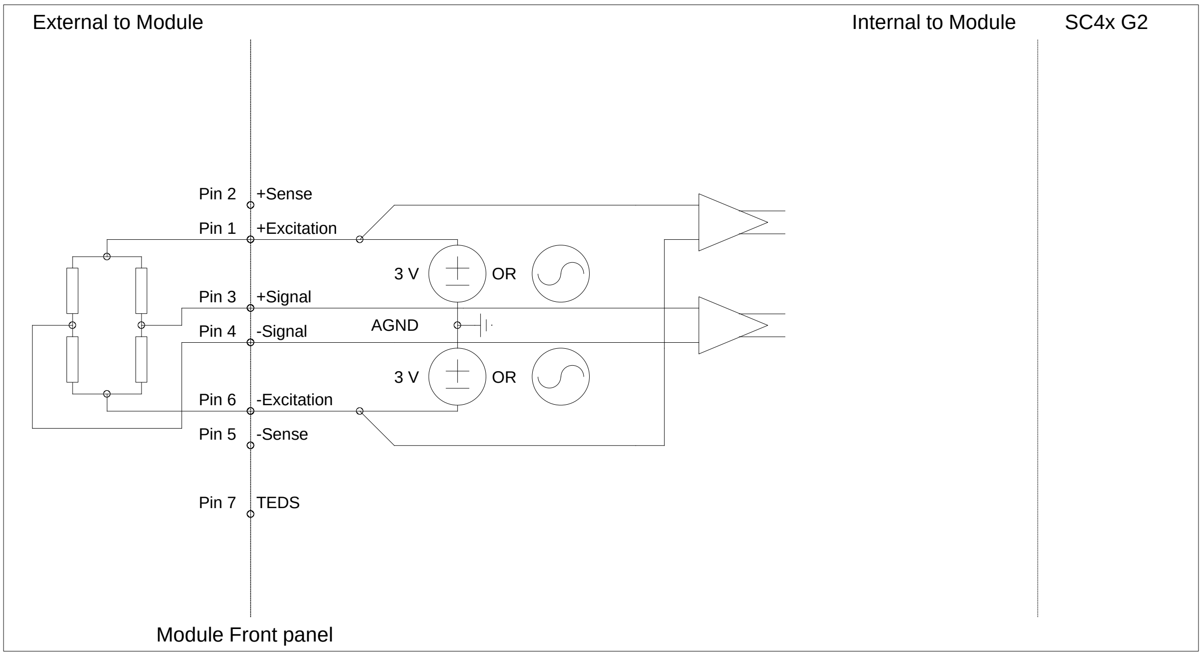


Figure 113. 4-wire bridge configuration with 4 external bridge elements (internal sense)

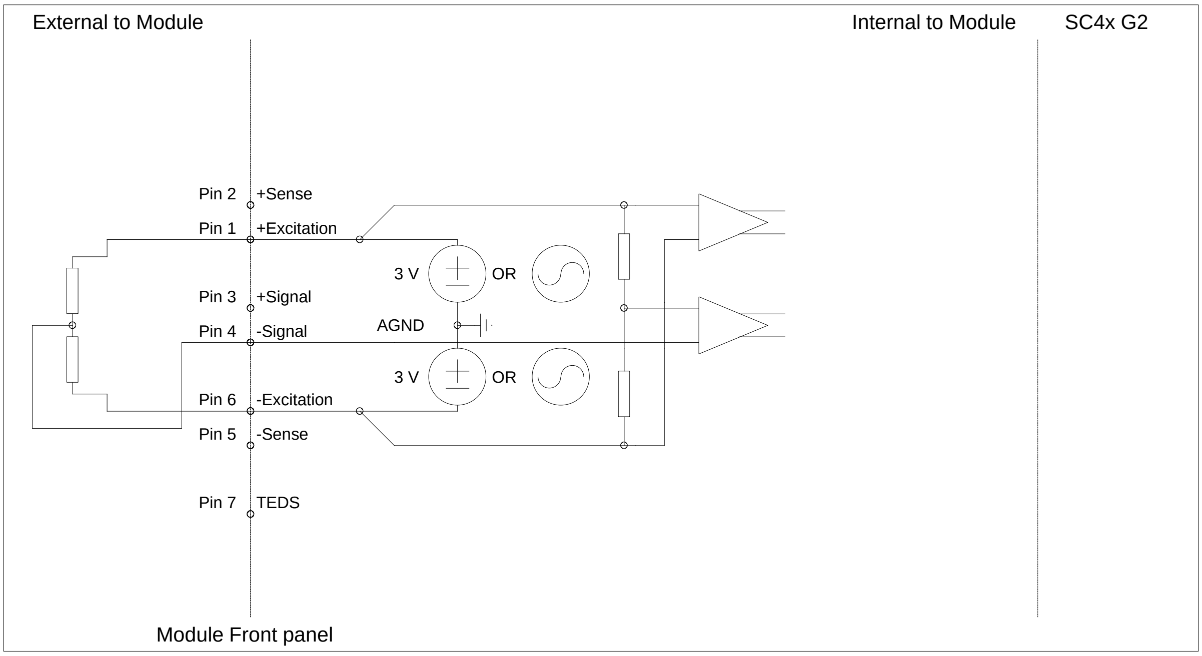


Figure 114. 3-wire bridge configuration with 2 external bridge elements (internal sense)

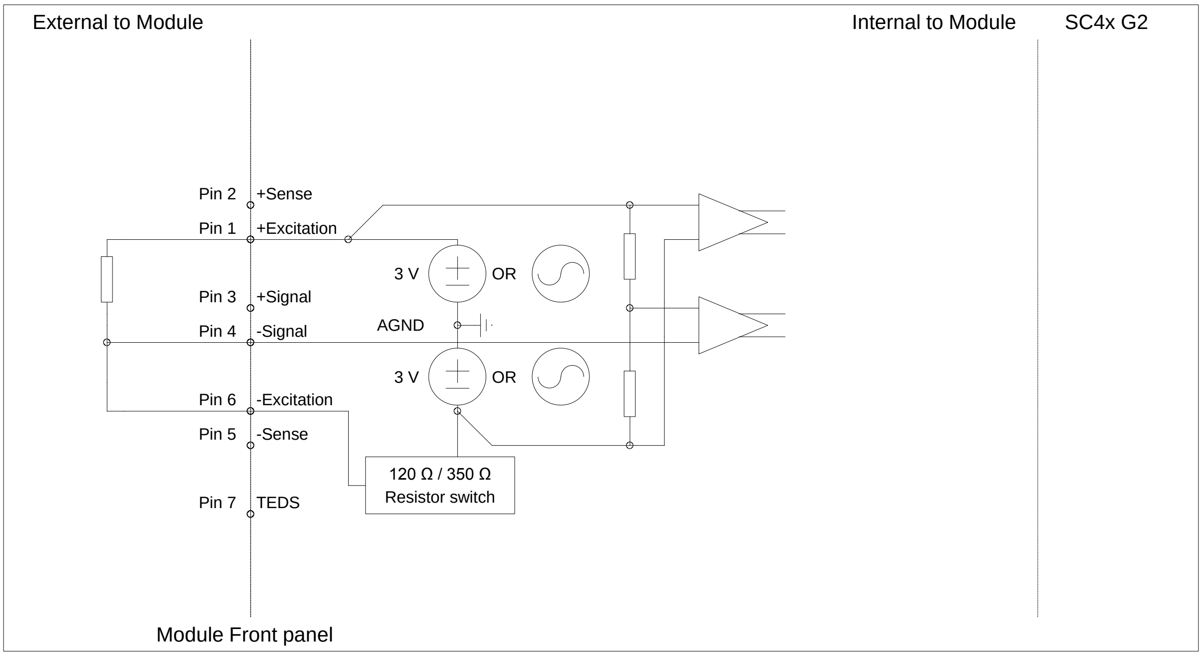


Figure 115. 3-wire bridge configuration with 1 external bridge element (always internal sense)

Constant current excitation

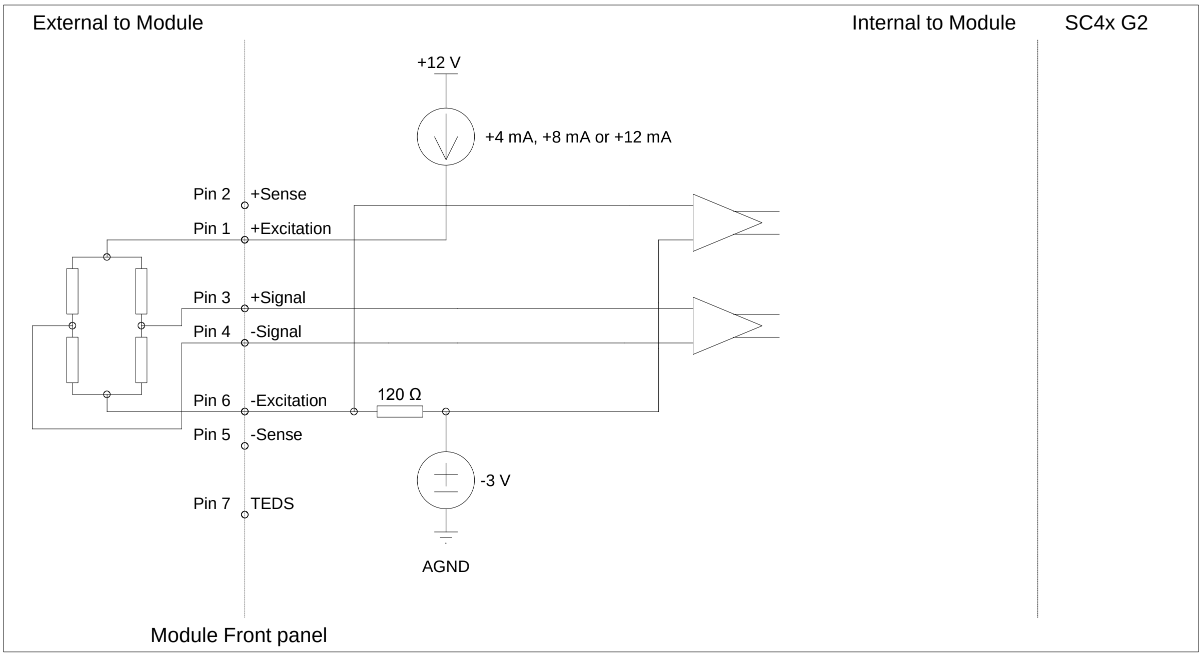


Figure 116. 4-wire bridge configuration with 4 external elements

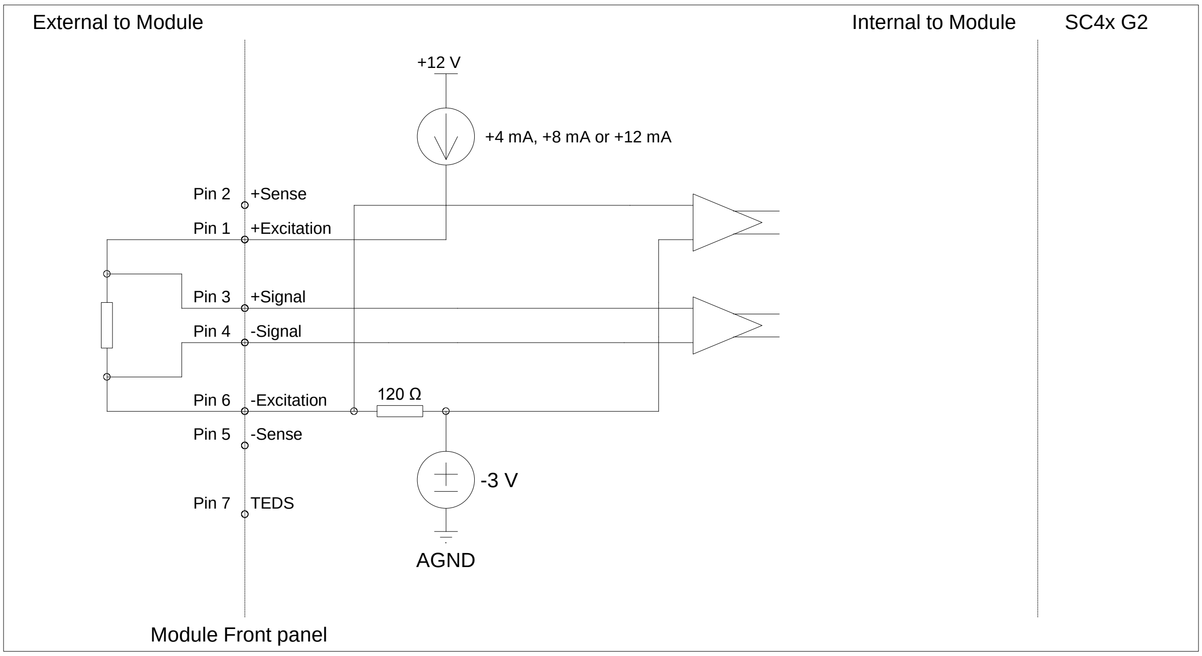


Figure 117. 4-wire configuration with 1 external element

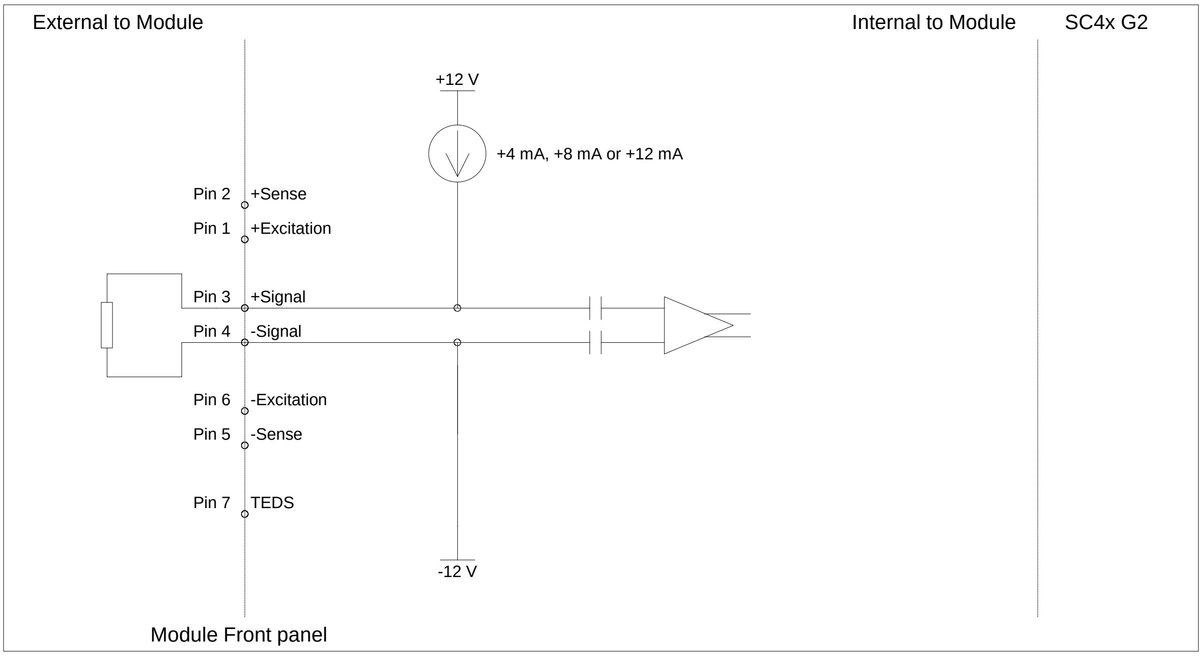


Figure 118. 2-wire configuration with 1 external element (no current monitoring)

Exciting sensors with 12 mA from ±12 V supplies will add substantially to the Module power consumption. It is recommended that 12 mA excitation only be used to drive long cables in cases where high signal bandwidth is required. The diagrams illustrate typical connection setups for constant current excitation.

Shunt Calibration

Shunt calibration is a means of simulating strain in a bridge. It is an accepted and useful way of checking the gain and accuracy of instrumentation without the need to expose the transducer to known physical input values.

Shunt calibration works by shunting a known resistor across one arm of a Wheatstone bridge. The resulting deviation in bridge output is expressed in mV/V or mV/mA of excitation.

Practically, data obtained from a shunt calibration can be used to check that the instrumentation is operating as expected, that the correct input range is selected and that the correct gauge and scaling factors are used in subsequent calculations.

Shunt calibration can be performed for any bridge setup.

Table 39 summarizes the shunt calibration outputs for unloaded bridges with negligible lead wire resistance and gauge factor equal to 2.

Nominal Bridge Resistance (Ω)	Shunt Resistor (kΩ)	Voltage Excited Bridge Output (mV/V)	Current Excited Bridge Output (mV/mA)	Equivalent Microstrain (For a Bridge Factor of 1)	Simulation Type
120	100	0.30	0.04	599	Compression
350	100	0.87	0.31	1744	Compression
1000	100	2.49	2.49	4950	Compression

Table 39. Shunt calibration outputs

An equivalent shunt calibration circuit for voltage excitation is illustrated in Figure 119. The shunt resistor path is highlighted in red.

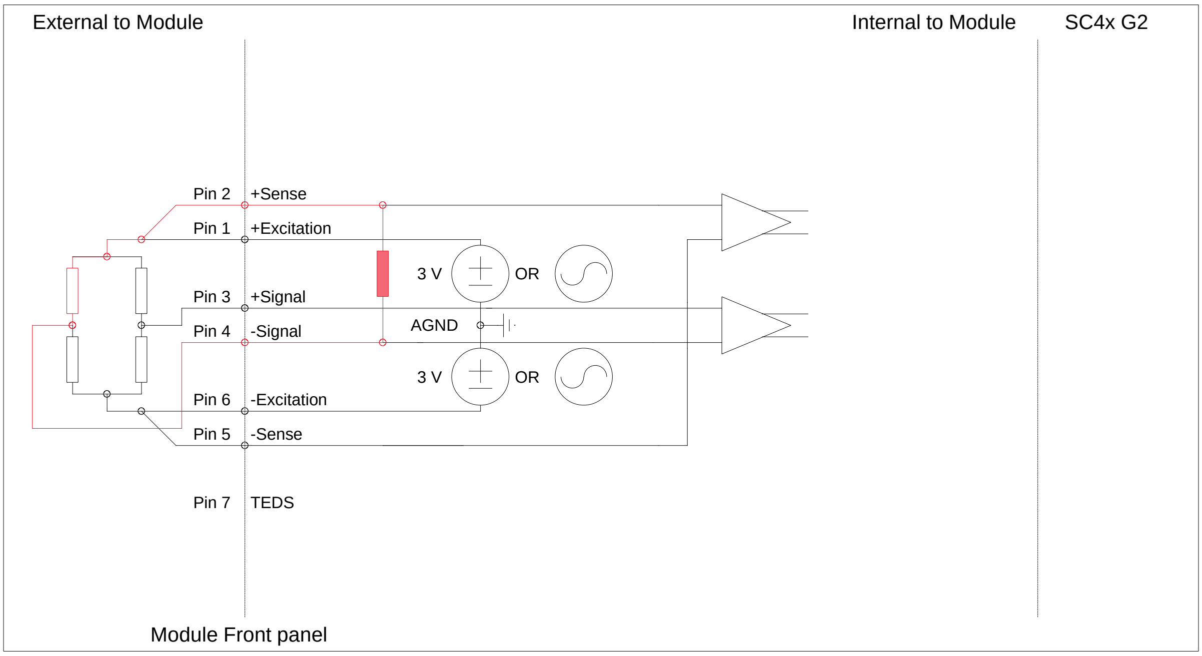


Figure 119. Shunt calibration for the case of a 6-wire bridge configuration with 4 external bridge elements in voltage excitation mode

An equivalent shunt calibration circuit for current excitation is illustrated in Figure 120. The shunt resistor path is highlighted in red.

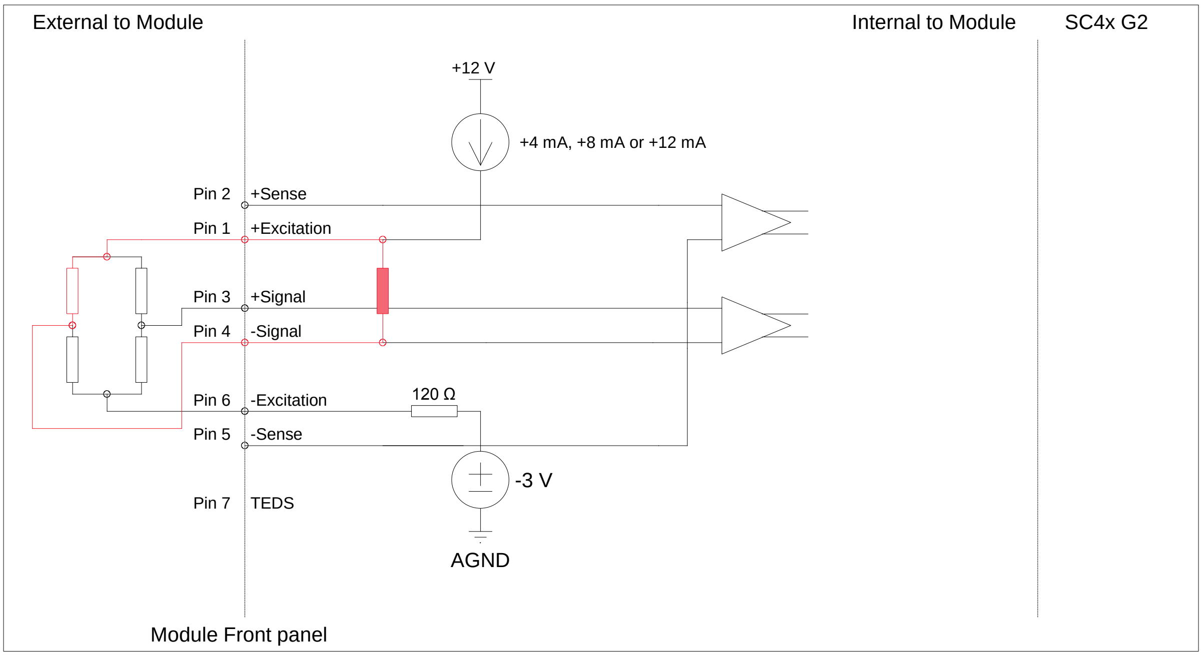


Figure 120. Shunt calibration for the case of a 4-wire bridge configuration with 4 external bridge elements in current excitation mode

ALI42 G2 Module

Description

The ALI42 G2 Module is a 2 channel high speed Module with sample rates up to 819.2 kSa/s and a bandwidth of 390 kHz. Both channels operate independently of each other, each with its own mode, gain, coupling, etc and with all settings done in software. The ALI42 G2 has two 7-pin Lemo connectors and can be used for both high bandwidth analog input as well as full bridge measurement applications. The Module can be used:

- With any voltage source up to ±10 V
- With any pressure transducer, load cell, strain gauge and other bridge based sensors

Front Panel

Figure 121. The ALI42 G2

Connector Information and Pin Definitions

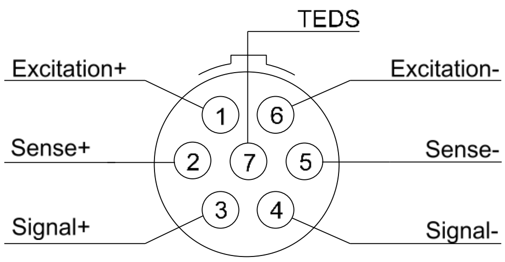


Figure 122. ALI42 G2 with Lemo 7-way connectors Module Pin Definition

(when looking into the front panel’s connector or at the rear of the cable’s connector)

Features

- 2 channels
- Operation modes include:
  - Analog input (ALI) mode
  - Bridge voltage-excitation mode:
    - 0-6 V (DC) for 350 Ω full bridges
    - 0-4 V (DC) for 120 Ω full bridges
  - Bridge voltage-excitation mode:
    - 8-10 V (DC) for 1 kΩ full bridges
- Supports TEDS IEEE 1451.4 V0.9, V1.0 (Class 1 & 2)
- 24-bit resolution
- ±(10 V, 1 V, 100 mV) input ranges for all modes
- DC or AC coupling
- Balanced differential signal input
- Sensors and bridges providing a full bridge only are supported
    - Local and Remote Sense options
    - 100 kΩ internal shunt calibration resistor
    - Differential voltage-excitation output and balanced sense input
- Signal integrity circuit continuously monitors the input and disconnects sensitive circuits during overload conditions
- Pre and post filter overflow monitoring
- Selectable low and high pass digital filters
- Lemo 7-way EHG.0B connectors

<table>
<tr><td colspan="2">Bridge Type</td><td colspan="4">Resistive or inductive</td></tr>
<tr><td rowspan="2">Interface</td><td>ALI</td><td colspan="4">For analog voltage sources</td></tr>
<tr><td>WSB</td><td colspan="4">Wheatstone bridge sensors</td></tr>
<tr><td>Input Coupling</td><td>ALI /
WSB</td><td colspan="4">DC or AC</td></tr>
<tr><td rowspan="2">AC Coupling Frequency Response</td><td rowspan="2">ALI /
WSB</td><td>Attenuation</td><td>Min</td><td>Max</td><td>Unit</td></tr>
<tr><td>-3 dB</td><td>-</td><td>1.5</td><td>Hz</td></tr>
</table>

<table>
<tr><td rowspan="11">Bridge Balancing Ranges for Voltage Excitation
Represents minimum or maximum resistance of a single element if other three bridge elements remain at their nominal value</td><td>Bridge Resistance</td><td>Excitation Voltage</td><td>Minimum Resistance</td><td>Maximum Resistance</td></tr>
<tr><td rowspan="3">120 Ω</td><td>0.5 - 5 V</td><td>0 Ω</td><td>Unlimited</td></tr>
<tr><td>5.5 V</td><td>6 Ω</td><td>2520 Ω</td></tr>
<tr><td>6 V</td><td>11 Ω</td><td>1320 Ω</td></tr>
<tr><td rowspan="3">350 Ω</td><td>0.5 - 5 V</td><td>0 Ω</td><td>Unlimited</td></tr>
<tr><td>5.5 V</td><td>17 Ω</td><td>7350 Ω</td></tr>
<tr><td>6 V</td><td>32 Ω</td><td>3850 Ω</td></tr>
<tr><td rowspan="4">1 kΩ</td><td>8.5 V</td><td>850 Ω</td><td>3850 Ω</td></tr>
<tr><td>9 V</td><td>850 Ω</td><td>3500 Ω</td></tr>
<tr><td>9.5 V</td><td>850 Ω</td><td>3220 Ω</td></tr>
<tr><td>10 V</td><td>850 Ω</td><td>3000 Ω</td></tr>
<tr><td rowspan="3">Constant Voltage Excitation</td><td>Excitation Voltage</td><td>Maximum Load Current</td><td>Voltage Resolution</td><td>Polarity</td></tr>
<tr><td>< 6 V</td><td>< 90 mA</td><td>0.2 mV</td><td>Bipolar (Balanced)</td></tr>
<tr><td>8 to 10 V</td><td>< 12 mA</td><td>0.1 mV</td><td>Unipolar (Unbalanced)</td></tr>
<tr><td colspan="2">Other Sampling Rates</td><td colspan="3">Available through digital LP filters and decimation</td></tr>
<tr><td colspan="2">Optional Programmable Digital IIR Filter</td><td colspan="3">Band pass/stop : 6 dB/octave
High/Low pass : 12 dB/octave</td></tr>
<tr><td colspan="2">Optional First Order High-Pass Filter</td><td colspan="3">-3 dB @ 1 Hz</td></tr>
<tr><td colspan="2">Module Calibration</td><td colspan="3">Internal amplitude and phase calibration</td></tr>
<tr><td colspan="2" rowspan="3">Protection</td><td rowspan="2">ALI / WSB</td><td colspan="2">2 kV ESD on all lines</td></tr>
<tr><td colspan="2">Overvoltage on signal lines</td></tr>
<tr><td>WSB</td><td colspan="2">Short circuit between excitation lines</td></tr>
<tr><td colspan="2">Galvanic Isolation</td><td colspan="3">50 V</td></tr>
</table>

Table 40. ALI42 G2 Module Features

Specifications

Bandwidth	**Using only 1 channel**	DC to 390 kHz
	Using 2 channels	DC to 195 kHz
Maximum Sampling Rate (fs) per channel	**Using only 1 channel**	819.2 kSa/s
	Using 2 channels	409.6 kSa/s
A/D Conversion	24-bit	
Data Transfer	16/24-bit	
Input Voltage Ranges (Peak)	±100 mV; ±1 V; ±10 V	
Input Biasing Settings	**Differential Float (Balanced Float)**	Both the positive and negative signal inputs are connected through 1 MΩ to floating ground
Input Impedance	2 MΩ ǁ 100 pF	
Digital Low-Pass Filter *Filter scales with sampling rate*	**Passband**	fs x 0.424 Hz
	Stopband	fs x 0.576 Hz
	Passband ripple	±0.005 dB
	Stopband attenuation	100 dB
Phase Accuracy *Channels in similar range*	**Typical**[1]	< 0.3 ° at 10 kHz

[1] Measured in 10 V range at 204.8 kSa/s

<table>
<tr><td rowspan="4" colspan="2">DC Voltage Accuracy</td><td>Input Range (Peak)</td><td colspan="2">% Range</td></tr>
<tr><td>±100 mV</td><td colspan="2">To be determined</td></tr>
<tr><td>±1 V</td><td colspan="2">0.16 %</td></tr>
<tr><td>±10 V</td><td colspan="2">0.15 %</td></tr>
<tr><td rowspan="16">Noise
Input terminated by 50 Ω resistor</td><td></td><td>Input Range (Peak)</td><td>Guaranteed</td><td>Typical</td></tr>
<tr><td>10 Hz to 24 kHz</td><td rowspan="5">±100 mV</td><td>< 6.1 µVrms</td><td>< 4.5 µVrms</td></tr>
<tr><td>10 Hz to 49 kHz</td><td>< 6.7 µVrms</td><td>< 5.6 µVrms</td></tr>
<tr><td>10 Hz to 99 kHz</td><td>< 8.0 µVrms</td><td>< 7.3 µVrms</td></tr>
<tr><td>10 Hz to 195 kHz</td><td>< 10.5 µVrms</td><td>< 9.9 µVrms</td></tr>
<tr><td>10 Hz to 390 kHz</td><td>< 25.6 µVrms</td><td>< 18.9 µVrms</td></tr>
<tr><td>10 Hz to 24 kHz</td><td rowspan="5">±1 V</td><td>< 5.9 µVrms</td><td>< 4.5 µVrms</td></tr>
<tr><td>10 Hz to 49 kHz</td><td>< 6.5 µVrms</td><td>< 5.5 µVrms</td></tr>
<tr><td>10 Hz to 99 kHz</td><td>< 8.2 µVrms</td><td>< 7.3 µVrms</td></tr>
<tr><td>10 Hz to 195 kHz</td><td>< 11.3 µVrms</td><td>< 10.2 µVrms</td></tr>
<tr><td>10 Hz to 390 kHz</td><td>< 25.0 µVrms</td><td>< 18.7 µVrms</td></tr>
<tr><td>10 Hz to 24 kHz</td><td rowspan="5">±10 V</td><td>< 56 µVrms</td><td>< 40 µVrms</td></tr>
<tr><td>10 Hz to 49 kHz</td><td>< 64 µVrms</td><td>< 49 µVrms</td></tr>
<tr><td>10 Hz to 99 kHz</td><td>< 72 µVrms</td><td>< 61 µVrms</td></tr>
<tr><td>10 Hz to 195 kHz</td><td>< 90 µVrms</td><td>< 81 µVrms</td></tr>
<tr><td>10 Hz to 390 kHz</td><td>< 117 µVrms</td><td>< 111 µVrms</td></tr>
</table>

	Sampling Rate (fs)	Input Range (Peak)	Attenuation (Input signal level 100 % of full range)	
Amplitude Flatness *Relative to 1 kHz* *Measured up to 0.39 x fs*	51.2 kSa/s	±100 mV	- 0.02 dB	
	102.4 kSa/s		- 0.02 dB	
	204.8 kSa/s		- 0.02 dB	
	409.6 kSa/s		- 0.07 dB	
	819.2 kSa/s		- 0.21 dB	
	51.2 kSa/s	±1 V	- 0.02 dB	
	102.4 kSa/s		- 0.03 dB	
	204.8 kSa/s		- 0.03 dB	
	409.6 kSa/s		- 0.08 dB	
	819.2 kSa/s		- 0.24 dB	
	51.2 kSa/s	±10 V	- 0.02 dB	
	102.4 kSa/s		- 0.02 dB	
	204.8 kSa/s		- 0.05 dB	
	409.6 kSa/s		- 0.07 dB	
	819.2 kSa/s		- 0.20 dB	
Crosstalk		**Input Range (Peak)**	**Guaranteed**	**Typical**
		±100 mV	62 dB	67 dB
		±1 V	99 dB	104 dB
		±10 V	83 dB	88 dB

Table 41. ALI42 G2 Module Specification

Specification number: SP151101, Release 2.2. The Module settings and measurement conditions that were used during specification measurements are available on request.

Functionality per Channel

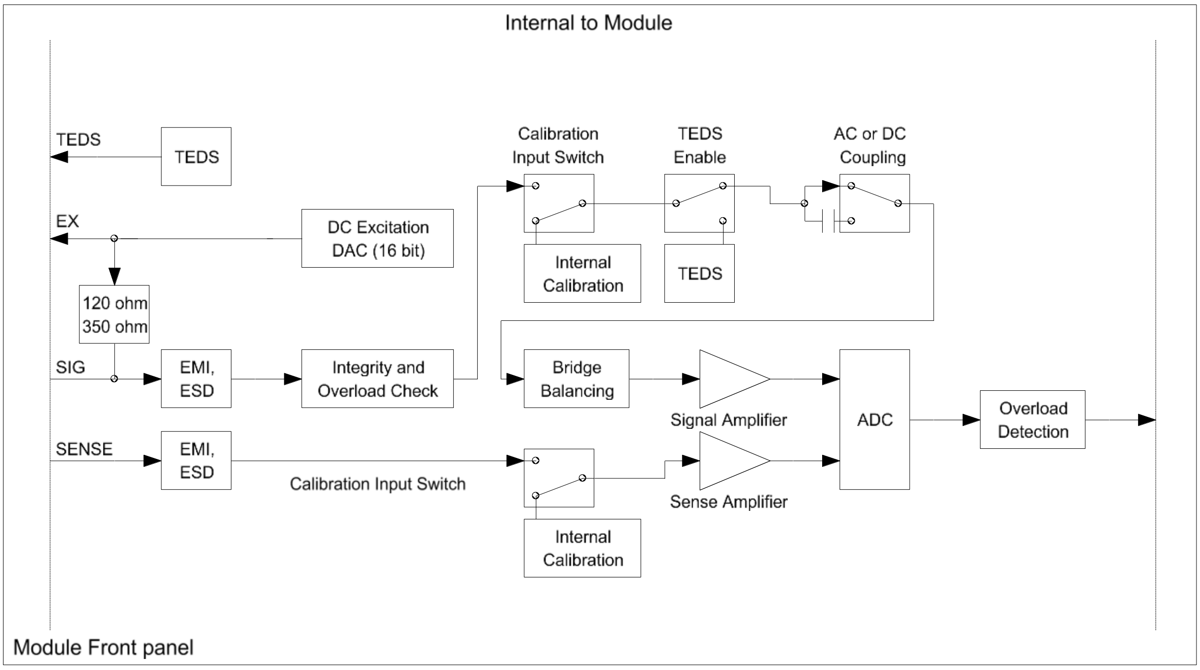


Figure 123. ALI42 G2 functionality

Module grounding

Input signals on the ALI42 G2 are referenced to the Module's internal ground only. In Figure 124 the Module's internal ground is labeled as AGND and the chassis ground of the PAK MKII Mainframe is labeled as CGND. A potential difference of up to 50 V may exist between AGND and CGND. Differences in excess of 50 V will activate the Module's protection circuits and clamp voltage differentials to within safe levels.

For shielded sensors connected to CGND, the positive and negative Signal lines can float to a maximum of 50 V above or below CGND.

A simplified diagram of the signal grounding is shown in Figure 124.

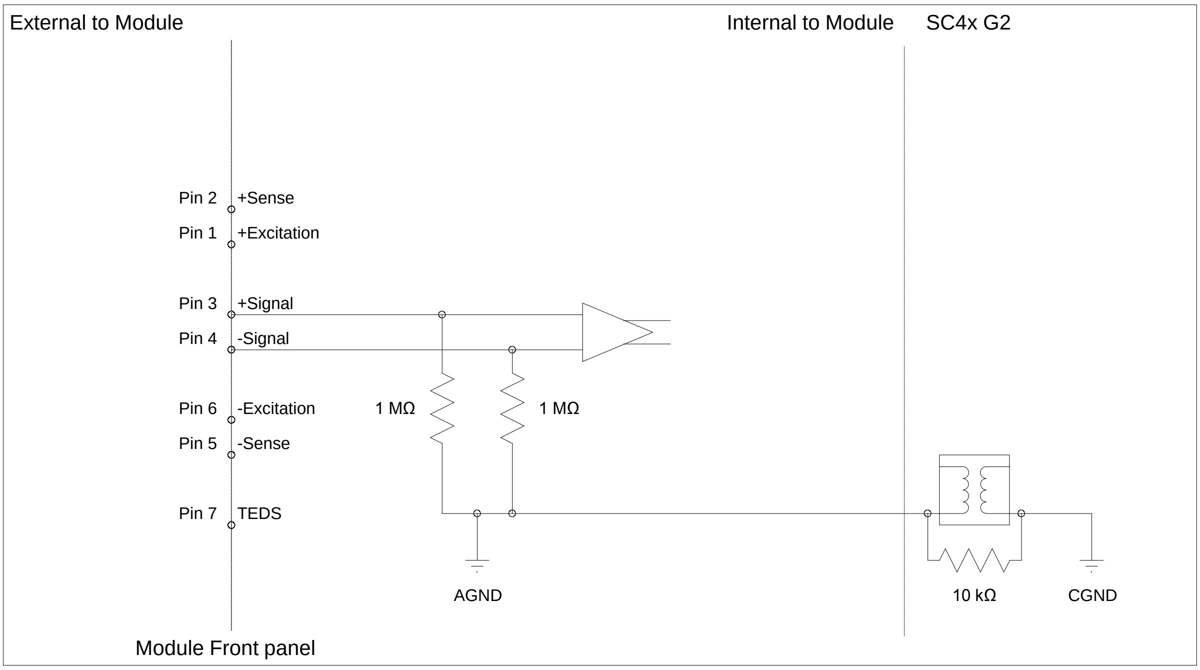


Figure 124. Differential float (balanced float) grounding

This grounding method is applicable to all interface modes, ALI and WSB and their individual sub modes.

Voltage sensing

Voltage excitation can be sensed using the sense lines (+Sense and -Sense). Sensing can be performed externally by connecting two dedicated sense lines from the Module to the bridge. Internal sensing refers to the measurement of the excitation voltage within the Module, without the need for external sense wires.

Voltage excitation is measured and digitized to 24-bit resolution using a dedicated ADC. The maximum sampling rate for the sense channel is 204.8 kSa/s under most conditions.

Voltage excitation sensing allows for accurate initial setting of the excitation voltage

The following diagrams illustrate voltage excited Wheatstone bridges with external and internal sensing for full bridges.

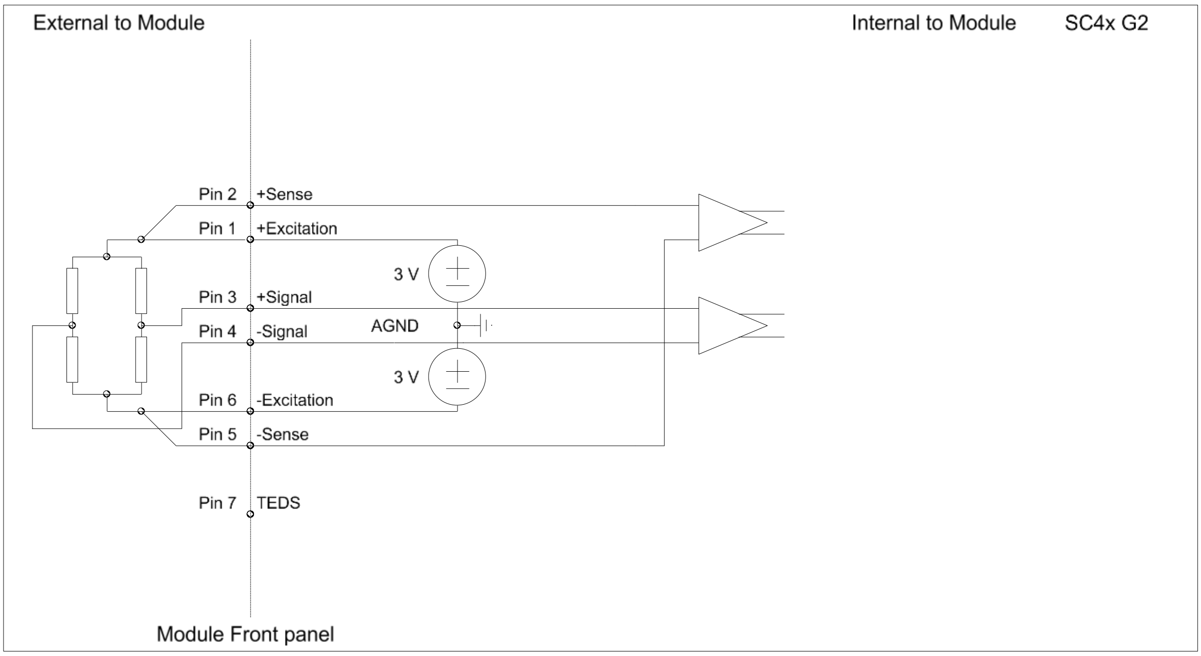


Figure 125. 6-wire bridge configuration with 4 external bridge elements (external sense)

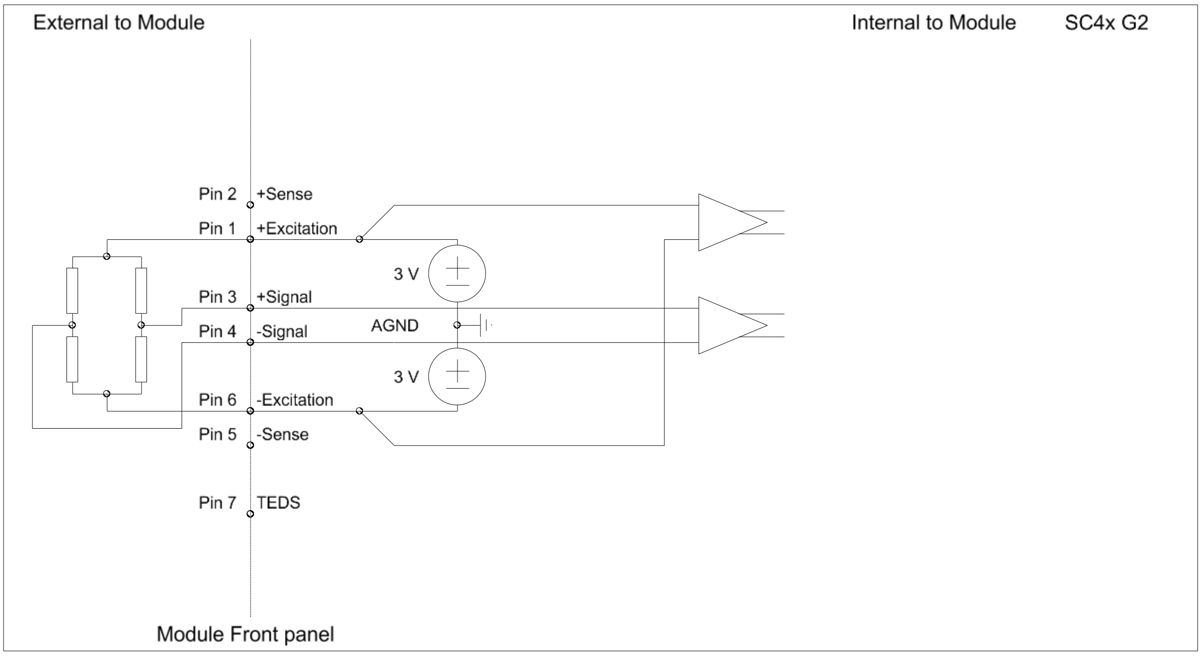


Figure 126. 4-wire bridge configuration with 4 external bridge elements (internal sense)

Shunt Calibration

Shunt calibration is a means of simulating strain in a bridge. It is an accepted and useful way of checking the gain and accuracy of instrumentation without the need to expose the transducer to known physical input values.

Shunt calibration works by shunting a known resistor across one arm of a Wheatstone bridge. The resulting deviation in bridge output is expressed in mV/V of excitation.

Practically, data obtained from a shunt calibration can be used to check that the instrumentation is operating as expected, that the correct input range is selected and that the correct gauge and scaling factors are used in subsequent calculations.

Shunt calibration can be performed for any bridge setup.

Table 42 summarizes the shunt calibration outputs for unloaded bridges with negligible lead wire resistance and gauge factor equal to 2.

Nominal Bridge Resistance (Ω)	Shunt Resistor (kΩ)	Voltage Excited Bridge Output (mV/V)	Equivalent Microstrain (For a Bridge Factor of 1)	Simulation Type
120	100	0.30	599	Compression
350	100	0.87	1744	Compression
1000	100	2.49	4950	Compression

Table 42. Shunt calibration outputs

An equivalent shunt calibration circuit for voltage excitation is illustrated in Figure 127. The shunt resistor path is highlighted in red.

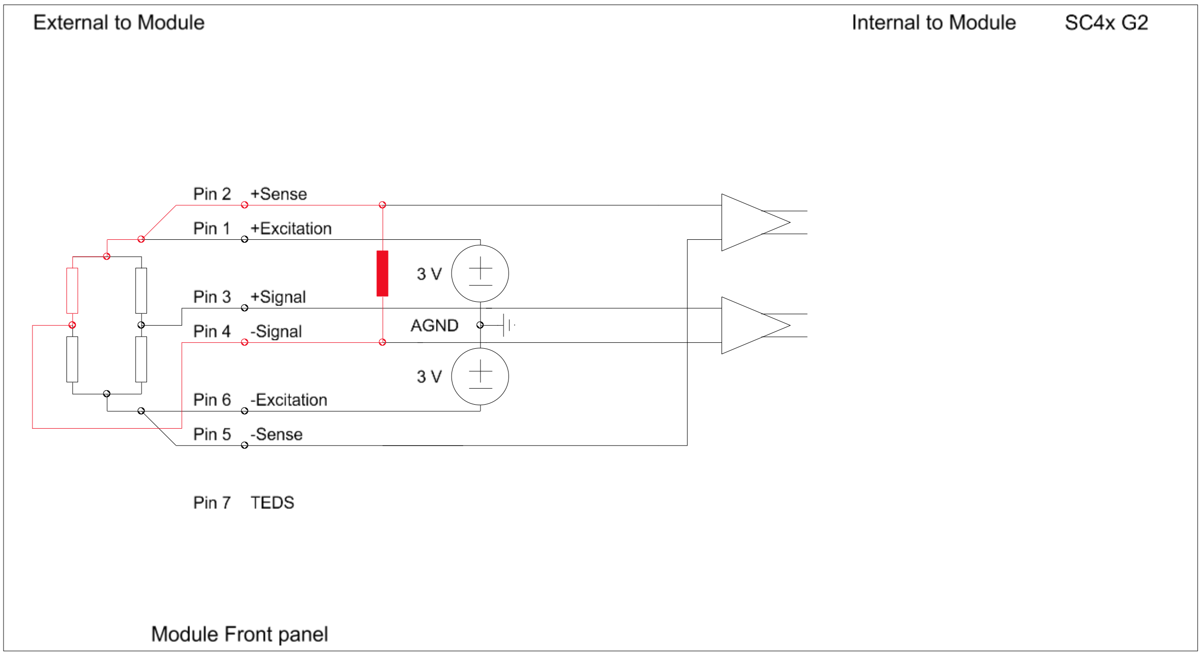


Figure 127. Shunt calibration for the case of a 6-wire bridge configuration with 4 external bridge elements in voltage excitation mode

ALI42B G2 Module

Description

The ALI42B G2 Module is a 2 channel high speed Module with sample rates up to 819.2 kSa/s and a bandwidth of 390 kHz. Both channels operate independently of each other, each with its own mode, gain, coupling, etc. and with all settings done in software. The ALI42B G2 has two BNC connectors and is specifically targeted to high bandwidth analog input applications requiring terminated or unterminated inputs. An option of the Module is available ideally for pyroshock or similar testing. The Module can be used:

- With any voltage source up to ±10 V
- With Signal sources requiring 50 Ω termination
- With Signal sources requiring high input resistance

Front Panel

Connector Information and Pin Definitions

Figure 128. The ALI42B G2

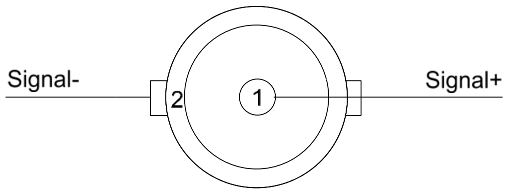


Figure 129. ALI42B G2 with BNC connectors Module Pin Definition

(when looking into the front panel’s connector or at the rear of the cable’s connector)

Features

- 2 channels
- Operation modes include:
  - Analog input (ALI) mode, terminated with 50 Ω
  - Analog input (ALI) mode, unterminated
- 24-bit resolution
- ±(10 V, 1 V, 100 mV) input ranges for all modes
- Input resistance: Software switchable between 50 Ω or 2 MΩ
- DC or AC coupling
- Balanced differential signal input
- Signal integrity circuit continuously monitors the input and disconnects sensitive circuits during overload conditions
- Pre and post filter overflow monitoring
- Selectable low and high pass digital filters
- 50 Ω BNC connectors

Other Sampling Rates	Available through digital LP filters and decimation
Optional Programmable Digital IIR Filter	Band pass/stop : 6 dB/octave High/Low pass : 12 dB/octave
Optional First Order High-Pass Filter	-3 dB @ 1 Hz
Module Calibration	Internal amplitude and phase calibration
Protection	2 kV ESD
Galvanic Isolation	50 V

Table 43. ALI42B G2 Module Features

Specifications (All builds preceding Build N)

Bandwidth	**Using only 1 channel**	DC to 390 kHz
	Using 2 channels	DC to 195 kHz
Maximum Sampling Rate (fs) per channel	**Using only 1 channel**	819.2 kSa/s
	Using 2 channels	409.6 kSa/s
A/D Conversion	24-bit	
Data Transfer	16/24-bit	
Input Voltage Ranges (Peak)	±100 mV; ±1 V; ±10 V	
Input Biasing Settings	**Differential Float (Balanced Float)**	Both the positive and negative signal inputs are connected through 1 MΩ to floating ground
Input Impedance	2 MΩ or 50 Ω ǁ 100 pF	
Digital Low-Pass Filter *Filter scales with sampling rate*	**Passband**	fs x 0.424 Hz
	Stopband	fs x 0.576 Hz
	Passband ripple	±0.005 dB
	Stopband attenuation	100 dB
Phase Accuracy *Channels in similar range*	**Typical**[1]	< 0.3 ° at 10 kHz

[1] Measured in 10 V range at 204.8 kSa/s

	Input Range (Peak)	% Range
DC Voltage Accuracy	±100 mV	To be determined
	±1 V	0.16 %
	±10 V	0.15 %

		Input Range (Peak)	Guaranteed	Typical
Noise *Input terminated by 50 Ω resistor*	10 Hz to 24 kHz	±100 mV	< 6.1 µVrms	< 4.5 µVrms
	10 Hz to 49 kHz		< 6.7 µVrms	< 5.6 µVrms
	10 Hz to 99 kHz		< 8.0 µVrms	< 7.3 µVrms
	10 Hz to 195 kHz		< 10.5 µVrms	< 9.9 µVrms
	10 Hz to 390 kHz		< 25.6 µVrms	< 18.9 µVrms
	10 Hz to 24 kHz	±1 V	< 5.9 µVrms	< 4.5 µVrms
	10 Hz to 49 kHz		< 6.5 µVrms	< 5.5 µVrms
	10 Hz to 99 kHz		< 8.2 µVrms	< 7.3 µVrms
	10 Hz to 195 kHz		< 11.3 µVrms	< 10.2 µVrms
	10 Hz to 390 kHz		< 25.0 µVrms	< 18.7 µVrms
	10 Hz to 24 kHz	±10 V	< 56 µVrms	< 40 µVrms
	10 Hz to 49 kHz		< 64 µVrms	< 49 µVrms
	10 Hz to 99 kHz		< 72 µVrms	< 61 µVrms
	10 Hz to 195 kHz		< 90 µVrms	< 81 µVrms
	10 Hz to 390 kHz		< 117 µVrms	< 111 µVrms

<table>
<tr><td rowspan="16">Amplitude Flatness
Relative to 1 kHz

Measured up to 0.39 x fs</td><th>Sampling Rate (fs)</th><th>Input Range (Peak)</th><th colspan="2">Attenuation
(Input signal level 100 % of full range)</th></tr>
<tr><td>51.2 kSa/s</td><td rowspan="5">±100 mV</td><td colspan="2">- 0.02 dB</td></tr>
<tr><td>102.4 kSa/s</td><td colspan="2">- 0.02 dB</td></tr>
<tr><td>204.8 kSa/s</td><td colspan="2">- 0.02 dB</td></tr>
<tr><td>409.6 kSa/s</td><td colspan="2">- 0.07 dB</td></tr>
<tr><td>819.2 kSa/s</td><td colspan="2">- 0.21 dB</td></tr>
<tr><td>51.2 kSa/s</td><td rowspan="5">±1 V</td><td colspan="2">- 0.02 dB</td></tr>
<tr><td>102.4 kSa/s</td><td colspan="2">- 0.03 dB</td></tr>
<tr><td>204.8 kSa/s</td><td colspan="2">- 0.03 dB</td></tr>
<tr><td>409.6 kSa/s</td><td colspan="2">- 0.08 dB</td></tr>
<tr><td>819.2 kSa/s</td><td colspan="2">- 0.24 dB</td></tr>
<tr><td>51.2 kSa/s</td><td rowspan="5">±10 V</td><td colspan="2">- 0.02 dB</td></tr>
<tr><td>102.4 kSa/s</td><td colspan="2">- 0.02 dB</td></tr>
<tr><td>204.8 kSa/s</td><td colspan="2">- 0.05 dB</td></tr>
<tr><td>409.6 kSa/s</td><td colspan="2">- 0.07 dB</td></tr>
<tr><td>819.2 kSa/s</td><td colspan="2">- 0.20 dB</td></tr>
<tr><td colspan="2" rowspan="4">Crosstalk</td><th>Input Range (Peak)</th><th>Guaranteed</th><th>Typical</th></tr>
<tr><td>±100 mV</td><td>62 dB</td><td>67 dB</td></tr>
<tr><td>±1 V</td><td>99 dB</td><td>104 dB</td></tr>
<tr><td>±10 V</td><td>83 dB</td><td>88 dB</td></tr>
</table>

Table 44. ALI42B G2 Module Specifications (All builds preceding Build N)

Specification number: SP151102, Release 2.0. The Module settings and measurement conditions that were used during specification measurements are available on request.

ALI42B G2 Specifications (Build N onwards)

The second order anti-aliasing filter is an option of the ALI42B G2 Module. This option is ideally suitable to use for pyroshock and similar testing.

Bandwidth	**Using only 1 channel**	DC to 390 kHz
	Using 2 channels	DC to 195 kHz
Maximum Sampling Rate (fs) per channel	**Using only 1 channel**	819.2 kSa/s
	Using 2 channels	409.6 kSa/s
A/D Conversion	24-bit	
Data Transfer	16/24-bit	
Input Voltage Ranges (Peak)	±100 mV; ±1 V; ±10 V	
Input Biasing Settings	**Differential Float (Balanced Float)**	Both the positive and negative signal inputs are connected through 1 MΩ to floating ground
Input Impedance	2 MΩ or 50 Ω ǁ 100 pF	
Digital Low-Pass Filter *Filter scales with sampling rate*	**Passband**	fs x 0.424 Hz
	Stopband	fs x 0.576 Hz
	Passband ripple	±0.005 dB
	Stopband attenuation	100 dB
Anti-Aliasing Filter *Second order Low-Pass filter* *>50 dB Attenuation of frequencies that can cause aliasing* *Ideal for Pyroshock sensors in accordance with MIL-STD-810G*	**Attenuation**	-0.1 dB @ 25.6 kHz
		-3 dB @ 390 kHz
	Passband flatness	±0.7 dB @ < 100 kHz
Phase Accuracy *Channels in similar range*	**Typical[1]**	< 0.3° at 10 kHz

[1] Measured in 10 V range at 204.8 kSa/s

		Input Range (Peak)	% Range	
DC Voltage Accuracy		±100 mV	To be determined	
		±1 V	0.15 %	
		±10 V	0.09 %	
Noise *Input terminated by 50 Ω resistor*		**Input Range (Peak)**	**Guaranteed**	**Typical**
	10 Hz to 24 kHz	±100 mV	< 2.2 µVrms	< 2.1 µVrms
	10 Hz to 49 kHz		< 3.0 µVrms	< 3.2 µVrms
	10 Hz to 99 kHz		< 4.2 µVrms	< 4.1 µVrms
	10 Hz to 195 kHz		< 5.9 µVrms	< 5.7 µVrms
	10 Hz to 390 kHz		< 55.4 µVrms	< 45.9 µVrms
	10 Hz to 24 kHz	±1 V	< 5.0 µVrms	< 4.0 µVrms
	10 Hz to 49 kHz		< 6.1 µVrms	< 5.2 µVrms
	10 Hz to 99 kHz		< 8.1 µVrms	< 7.0 µVrms
	10 Hz to 195 kHz		< 10.6 µVrms	< 9.5 µVrms
	10 Hz to 390 kHz		< 55.5 µVrms	< 46.0 µVrms
	10 Hz to 24 kHz	±10 V	< 42.7 µVrms	< 32.7 µVrms
	10 Hz to 49 kHz		< 57.1 µVrms	< 43.6 µVrms
	10 Hz to 99 kHz		< 56.4 µVrms	< 51.2 µVrms
	10 Hz to 195 kHz		< 76.0 µVrms	< 69.7 µVrms
	10 Hz to 390 kHz		< 110.8 µVrms	< 104.0 µVrms

	Input Range (Peak)	Guaranteed	Typical
Crosstalk	±100 mV	62 dB	67 dB
	±1 V	99 dB	104 dB
	±10 V	83 dB	88 dB

Table 45. ALI42B G2 Specifications (Build N onwards)

Specification number: SP160900, Release 1.7. The Module settings and measurement conditions that were used during specification measurements are available on request.

Functionality per Channel

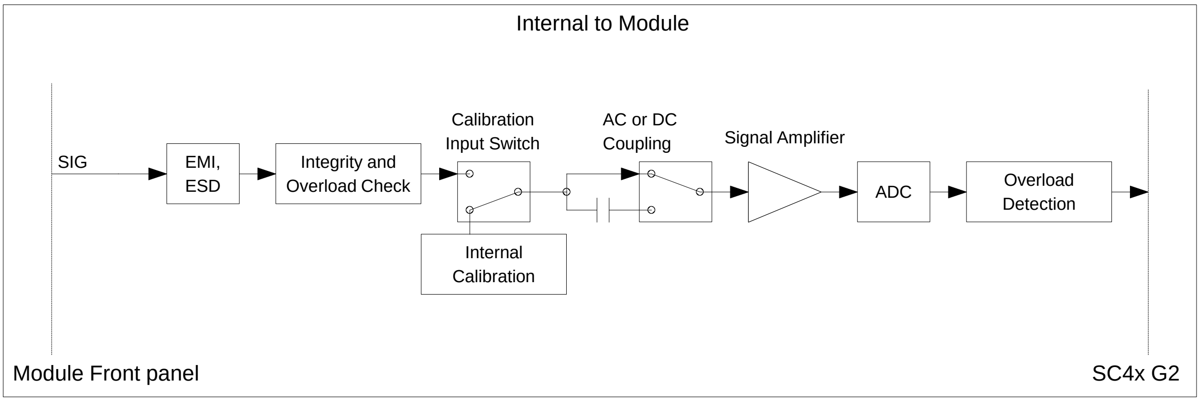


Figure 130. Signal flow of the ALI42B G2 Module

Grounding Diagram

Input signals on the ALI42B G2 are referenced to the Module's internal ground only. In Figure 131 the Module's internal ground is labeled as AGND and the chassis ground of the PAK MKII Mainframe is labeled as CGND. A potential difference of up to 50 V may exist between AGND and CGND. Differences in excess of 50 V will activate the Module's protection circuits and clamp voltage differentials to within safe levels.

For shielded sensors connected to CGND, the positive and negative SIG lines can float to a maximum of 50 V above or below CGND.

A simplified diagram of the signal grounding is shown in Figure 131.

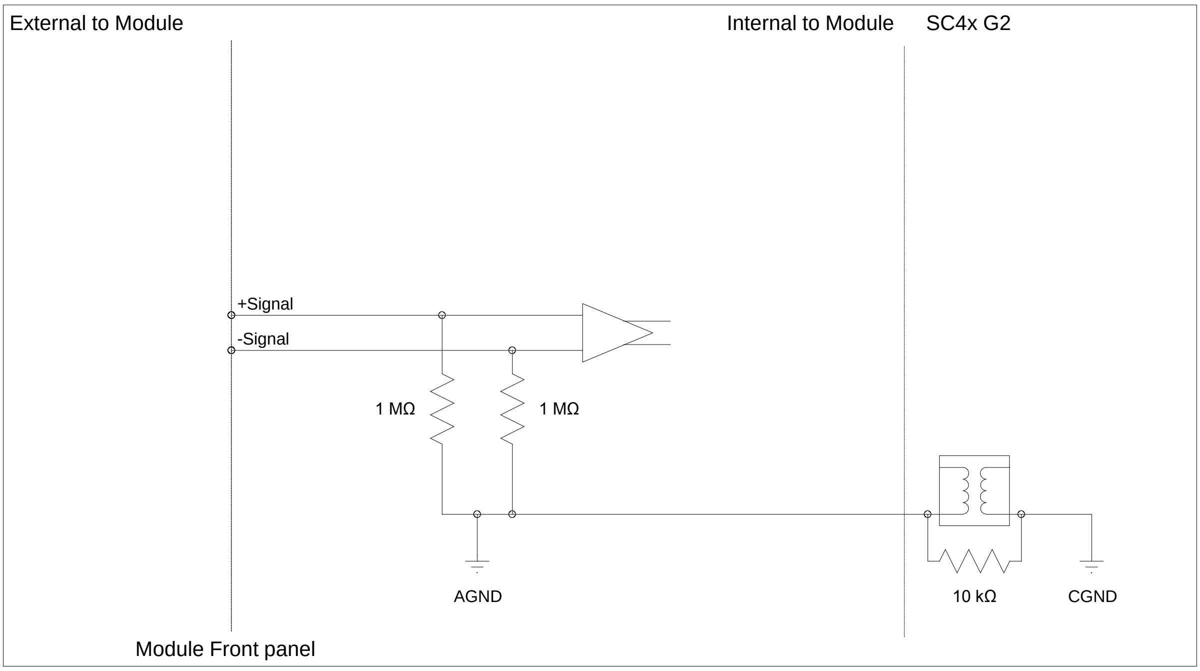


Figure 131. Differential Float (Balanced Float)

MIC42X G2 Module

Description

In addition to providing microphone measurements, the MIC42X G2 Module also offers ICP® and voltage input modes. The Module can be used:

- With any 200 V or self-polarized microphones with preamplifier
- With any ICP® based sensor commonly used to measure vibration, acceleration, force and pressure
- With any voltage source up to ±12 V in voltage input mode

Front Panel

Figure 132. The MIC42X G2

Connector Information and Pin Definitions

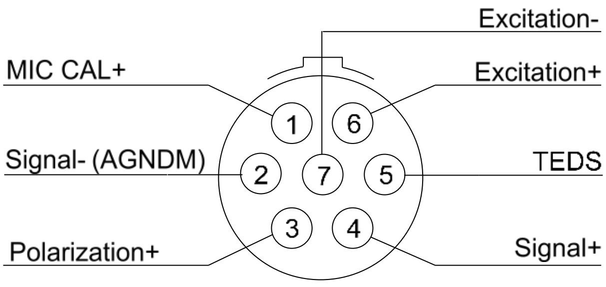


Figure 133. MIC42X G2 with Lemo 7-way EGG.1B connectors Module Pin Definition

(when looking into the front panel's connector or at the rear of the cable's connector)

Features

- 2 channels
- 3 input modes of operation
    - Microphone mode with 200 V or self-polarized microphone capsules with preamplifier
    - ICP® mode with 4 mA, 8 mA or 12 mA constant current at ±12 V or 24 V excitation
    - Voltage input mode with AC or DC coupling
- Supports TEDS IEEE 1451.4 V0.9, V1.0 (Class 1 and 2)
- 24-bit resolution
- ±(12 V, 1.2 V, 120 mV) input ranges
- ±14.5 V microphone pre-amplifier excitation voltage
- 0 or 200 V polarization output
- Microphone calibration output to inject test signals into microphone preamplifiers
- Exceptionally low distortion and noise design
- There are 3 distinctive input mode options for both ICP® and voltage input modes:
    - Differential or Balanced Float (±12 V excitation)
    - Single-Ended or Unbalanced Float (24 V excitation)
    - Single-Ended or Unbalanced Ground (24 V excitation)
- Software selectable connection of cable shield to Ground
- Short and open circuit cable monitoring
- Signal integrity circuit continuously monitors the input and disconnects sensitive circuits during overload conditions
- Pre and post filter overflow monitoring
- Low power consumption
- Lemo 7-way EGG.1B connectors
- Pre-amplifier Excitation Short Circuit protection

<table>
<tr><td rowspan="2">Interface</td><td>ICP®</td><td colspan="4">ICP® sensors</td></tr>
<tr><td>ALI/ MIC</td><td colspan="4">For analog source voltages or Microphones</td></tr>
<tr><td rowspan="2">Input Coupling</td><td>ICP®</td><td colspan="4">AC</td></tr>
<tr><td>ALI/ MIC</td><td colspan="4">DC or AC</td></tr>
<tr><td rowspan="2">AC Coupling Frequency Response</td><td rowspan="2">ICP®/
ALI/ MIC</td><td>Attenuation</td><td>Min</td><td>Max</td><td>Unit</td></tr>
<tr><td>-3 dB</td><td>-</td><td>0.25</td><td>Hz</td></tr>
<tr><td colspan="2">Other Sampling Rates</td><td colspan="4">Available through digital LP filters and decimation</td></tr>
<tr><td colspan="2">Optional Programmable Digital IIR Filter</td><td colspan="4">Band pass/stop : 6 dB/octave
High/Low pass : 12 dB/octave</td></tr>
<tr><td colspan="2">Optional First Order High-Pass Filter</td><td colspan="4">-3 dB @ 1 Hz</td></tr>
<tr><td colspan="2">Module Calibration</td><td colspan="4">Internal amplitude and phase calibration</td></tr>
<tr><td colspan="2">Protection</td><td colspan="4">2 kV ESD</td></tr>
<tr><td colspan="2">Galvanic Isolation</td><td colspan="4">50 V</td></tr>
</table>

Table 46. MIC42X G2 Module Features

Specifications

<table>
<tr><td colspan="2">Bandwidth</td><td colspan="3">DC to 100 kHz</td></tr>
<tr><td colspan="2">Maximum Sampling Rate (fs) per channel</td><td colspan="3">204.8 kSa/s</td></tr>
<tr><td colspan="2">A/D Conversion</td><td colspan="3">24-bit</td></tr>
<tr><td colspan="2">Data Transfer</td><td colspan="3">16/24-bit</td></tr>
<tr><td colspan="2">Input Voltage Ranges (Peak)</td><td colspan="3">±120 mV; ±1.2 V; ±12 V</td></tr>
<tr><td colspan="2">ICP® mode</td><td colspan="3">4 mA; 8 mA or 12 mA constant current at ±12 V / 24 V excitation</td></tr>
<tr><td rowspan="3">Input Biasing Settings</td><td>Differential Float (Balanced Float)</td><td colspan="3">Both the positive and negative signal inputs are connected through 1 MΩ to floating ground</td></tr>
<tr><td>Single-Ended Float (Unbalanced Float)</td><td colspan="3">Positive signal input connected through 1 MΩ to floating ground;
Negative signal input connected to floating ground</td></tr>
<tr><td>Single-Ended GND (Unbalanced GND)</td><td colspan="3">Positive signal input connected through 1 MΩ to ground; Negative signal input connected to ground</td></tr>
<tr><td rowspan="2">Input Impedance</td><td>Differential</td><td colspan="3">2 MΩ ǁ 570 pF</td></tr>
<tr><td>Single-Ended</td><td colspan="3">1 MΩ ǁ 290 pF</td></tr>
<tr><td colspan="2" rowspan="6">Digital Low-Pass Filter
Filter scales with sampling rate</td><td>Passband</td><td colspan="2">fs x 0.46 Hz</td></tr>
<tr><td>Stopband</td><td colspan="2">fs x 0.54 Hz</td></tr>
<tr><td rowspan="3">Passband ripple</td><td>fs = 48 kHz</td><td>±0.001 dB</td></tr>
<tr><td>fs = 96 kHz</td><td>±0.003 dB</td></tr>
<tr><td>fs = 192 kHz</td><td>±0.007 dB</td></tr>
<tr><td>Stopband attenuation</td><td colspan="2">120 dB</td></tr>
<tr><td colspan="2">Phase Accuracy
Channels in similar range</td><td>Typical[1]</td><td colspan="2">< 0.2° at 10 kHz</td></tr>
</table>

[1] Measured in 12 V range at 204.8 kSa/s

		Input Range (Peak)	% Range	
DC Voltage Accuracy		±120 mV	0.500 %	
		±1.2 V	0.085 %	
		±12 V	0.098 %	
Noise *Input terminated by 50 Ω resistor*		**Input Range (Peak)**	**Guaranteed**	**Typical**
	10 Hz to 23 kHz	±120 mV	< 1.9 µVrms	< 1.6 µVrms
	10 Hz to 49 kHz		< 2.4 µVrms	< 2.1 µVrms
	10 Hz to 100 kHz		< 3.1 µVrms	< 2.8 µVrms
	10 Hz to 23 kHz	±1.2 V	< 6.9 µVrms	< 4.8 µVrms
	10 Hz to 49 kHz		< 7.8 µVrms	< 5.9 µVrms
	10 Hz to 100 kHz		< 8.8 µVrms	< 7.3 µVrms
	10 Hz to 23 kHz	±12 V	< 19.7 µVrms	< 16.3 µVrms
	10 Hz to 49 kHz		< 26.2 µVrms	< 22.4 µVrms
	10 Hz to 100 kHz		< 48.0 µVrms	< 37.4 µVrms

	Sampling Rate (fs)	Input Range (Peak)	Attenuation (Input signal level 100 % of full range)
Amplitude Flatness *Relative to 1 kHz* *Measured up to 0.39 x fs*	51.2 kSa/s	±120 mV	- 0.03 dB
	102.4 kSa/s		- 0.10 dB
	204.8 kSa/s		- 0.35 dB
	51.2 kSa/s	±1.2 V	- 0.03 dB
	102.4 kSa/s		- 0.10 dB
	204.8 kSa/s		- 0.35 dB
	51.2 kSa/s	±12 V	- 0.03 dB
	102.4 kSa/s		- 0.10 dB
	204.8 kSa/s		- 0.35 dB

	Input Range (Peak)	Guaranteed	Typical
Crosstalk	±120 mV	101 dB	106 dB
	±1.2 V	113 dB	118 dB
	±12 V	117 dB	122 dB

Table 47. MIC42X G2 Module Specification

Specification number: SP151002, Release 1.7. The Module settings and measurement conditions that were used during specification measurements are available on request.

Functionality per Channel

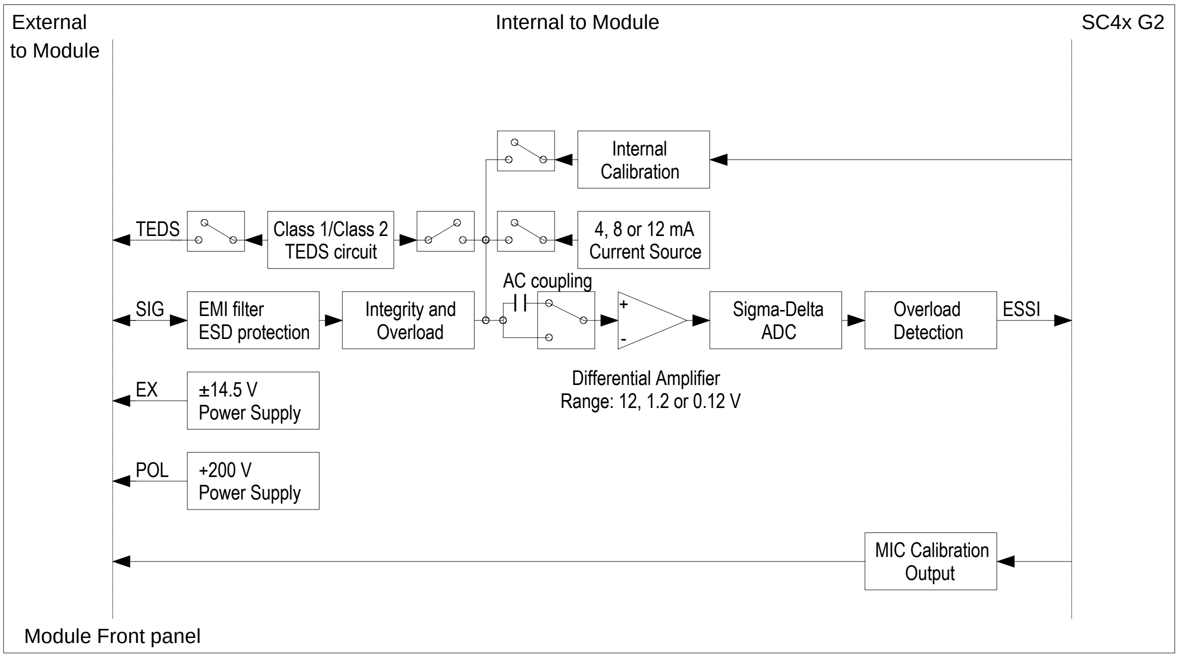


Figure 134. Signal flow of the MIC42X G2

Grounding diagrams for ALI mode

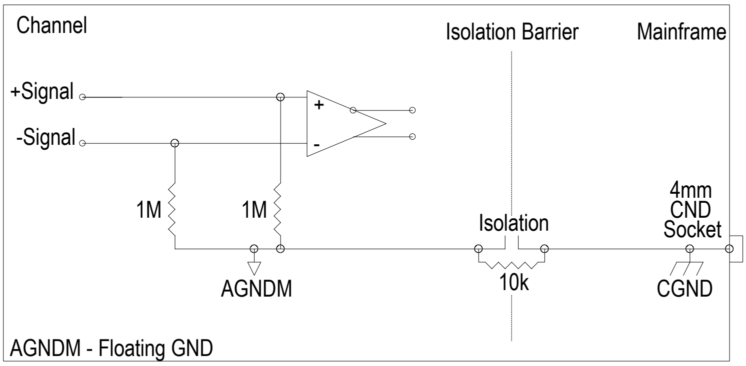


Figure 135. Differential float (balanced float)

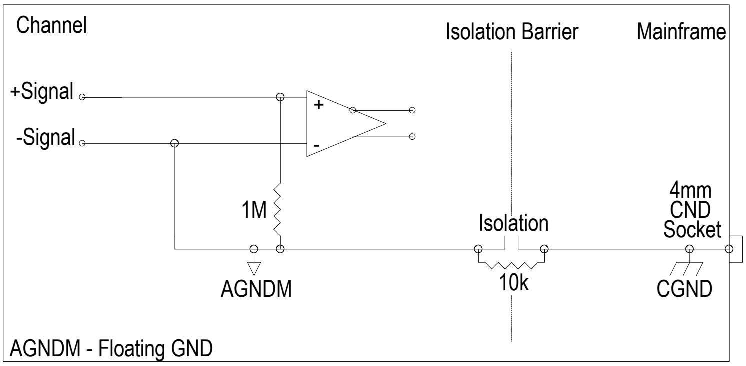


Figure 136. Single-Ended float (unbalanced float)

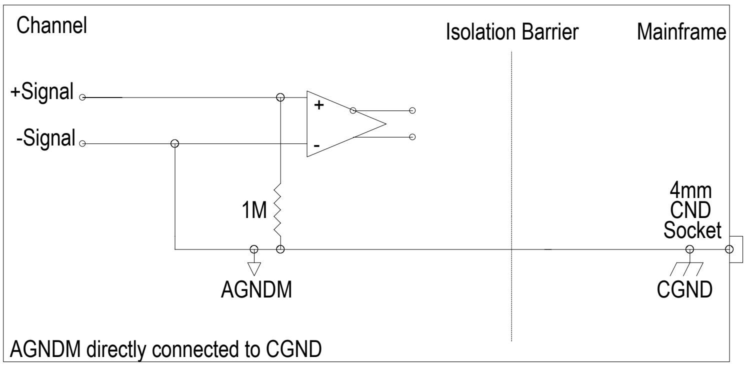


Figure 137. Single-Ended ground (unbalanced ground)

The figure below shows the effect on the Module input mode options when the CGND switch is closed. The isolation barrier will be bridged for the entire Module. Therefore any channel connected in differential coupling will measure 1 MΩ to CGND and any channel connected in single-ended coupling will be connected with the single-ended GND (unbalanced GND) option.

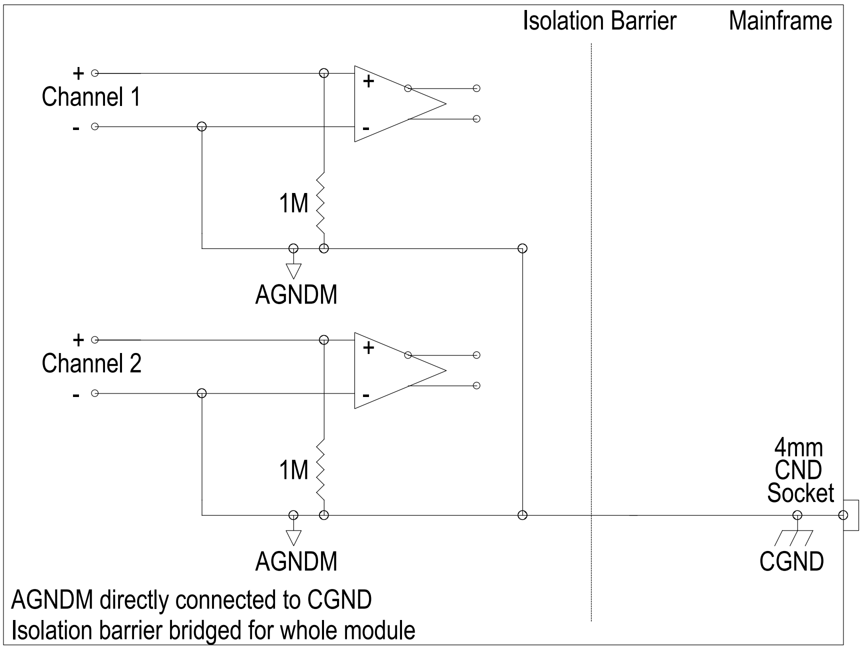


Figure 138. Input mode effect on the Module

Grounding diagrams for ICP® mode

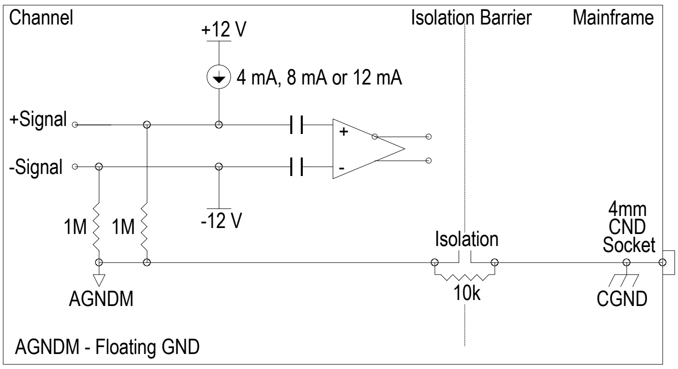


Figure 139. ICP® mode: Differential float with 4 mA, 8 mA or 12 mA current excitation

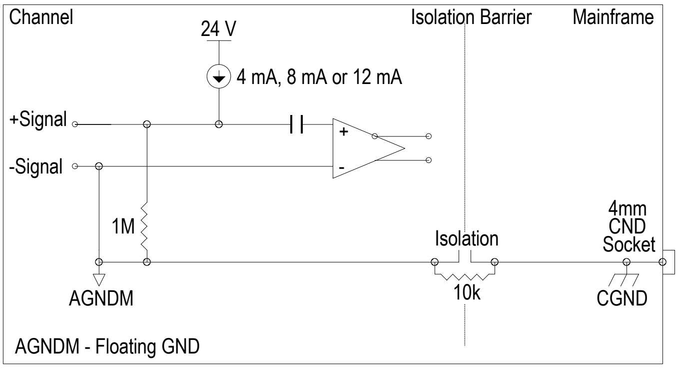


Figure 140. ICP® mode: Single-ended float with 4 mA, 8 mA or 12 mA current excitation

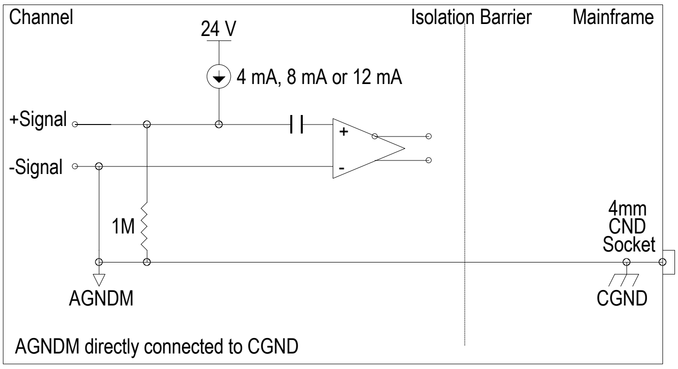


Figure 141. ICP® mode: Single-ended ground with 4 mA, 8 mA or 12 mA current excitation

ALO42S G2 Module

Description

The ALO42S G2 Module provides four independent output channels for the generation of analog signals. Each channel also incorporates Status Input and Output signals, enabling further communication with external equipment for applications such as test supervision or workflow control. The ALO42S G2 Module can be used for applications such as:

- Excitation signals for shaker / modal testing;
- Drive signals for acoustic testing;
- Arbitrary analog signals to feed into other circuits requiring ±10 V static or dynamic signals

Front Panel

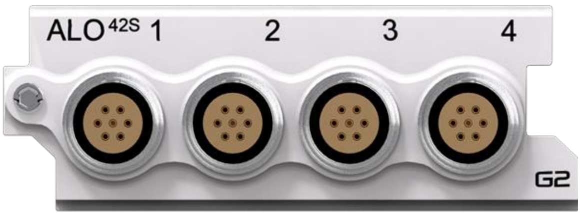


Figure 142. The ALO42S G2

Connector Information and Pin Definitions

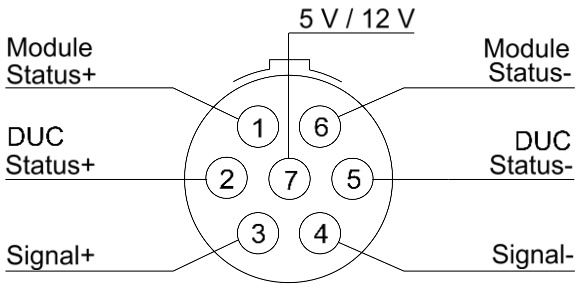


Figure 143. ALO42S G2 with Lemo 7-way EHG.0B connectors Module Pin Definition

(when looking into the front panel's connector or at the rear of the cable's connector)

Features

- 4 channels each with:
  - Analog Signal Output
  - Module Status Output
  - Device Under Control Status Input
  - 5 V or 12 V DC Voltage Output
- 24-bit resolution
- 20 kHz 0.1 dB pass band flatness
- Low noise and distortion performance
- DC gain and offset stability
- ±10 V @ 30 mA output
- Automatic safe shutdown upon fault condition
- 10 Ω output impedance
- Lemo 7-way EHG.0B connectors

<table>
<tr><td rowspan="4">Signal Pairs</td><td colspan="2">Module Status+</td><td colspan="2">Module Status-</td></tr>
<tr><td colspan="2">DUC Status+</td><td colspan="2">DUC Status-</td></tr>
<tr><td colspan="2">Signal+</td><td colspan="2">Signal-</td></tr>
<tr><td colspan="2">5 V or 12 V DC</td><td colspan="2">Signal-</td></tr>
<tr><td rowspan="2">Device Under Control Status Input
Input voltage range: 0 V to 24 V</td><td colspan="2">Sampling Rate</td><td colspan="2">15.6 kSa/s</td></tr>
<tr><td colspan="2">Resolution</td><td colspan="2">12 bits</td></tr>
<tr><td rowspan="3">Module Status Output Options</td><td>Status</td><td colspan="2">Relay
(max 24 V input)</td><td>DC Voltage Output
(5 or 12 V)</td></tr>
<tr><td>Good</td><td colspan="2">Closed relay</td><td>DC voltage output</td></tr>
<tr><td>Bad</td><td colspan="2">Open relay</td><td>No voltage output</td></tr>
<tr><td rowspan="2">DC Voltage Output</td><td>Output Voltage</td><td colspan="3">5 V or 12 V</td></tr>
<tr><td>Output Current</td><td colspan="3">15 mA (max)</td></tr>
</table>

SubModules	The Quad BNC (QBNC11) SubModule is used to split signals from a 7-way Lemo connector to 4 BNC connectors.
	The ALOP10 is a rack mountable SubModule for routing the analog output signals from up to eight ALO42S G2 Modules to individual male SMB connectors.
Other Sampling Rates	Available through digital LP filters and decimation
Module Calibration	Internal amplitude calibration
Output Biasing Settings	Single-Ended Float or Single-Ended GND (per Module)
Protection	2 kV ESD
Galvanic Isolation	50 V

Table 48. ALO42S G2 Module Features

Specifications

Maximum Sampling Rate (fs) per channel	204.8 kSa/s	
D/A Conversion	24-bit	
Output Voltage Ranges (Peak)	±10 V	
Phase Accuracy *Channels in similar range*	**Typical**[1]	< 0.5° at 10 kHz
DC Voltage Accuracy	**Output Range (Peak)**	**% Range**
	±10 V	0.27 %
Frequency Accuracy	**Output Frequency**	**% Output Frequency**
	> 100 Hz	0.025 %

Table 49. ALO42S G2 Module Specification

Specification number: SP151100, Release 1.4. The Module settings and measurement conditions that were used during specification measurements are available on request.

[1] Measured in 10 V range at 204.8 kSa/s

Functionality per Channel

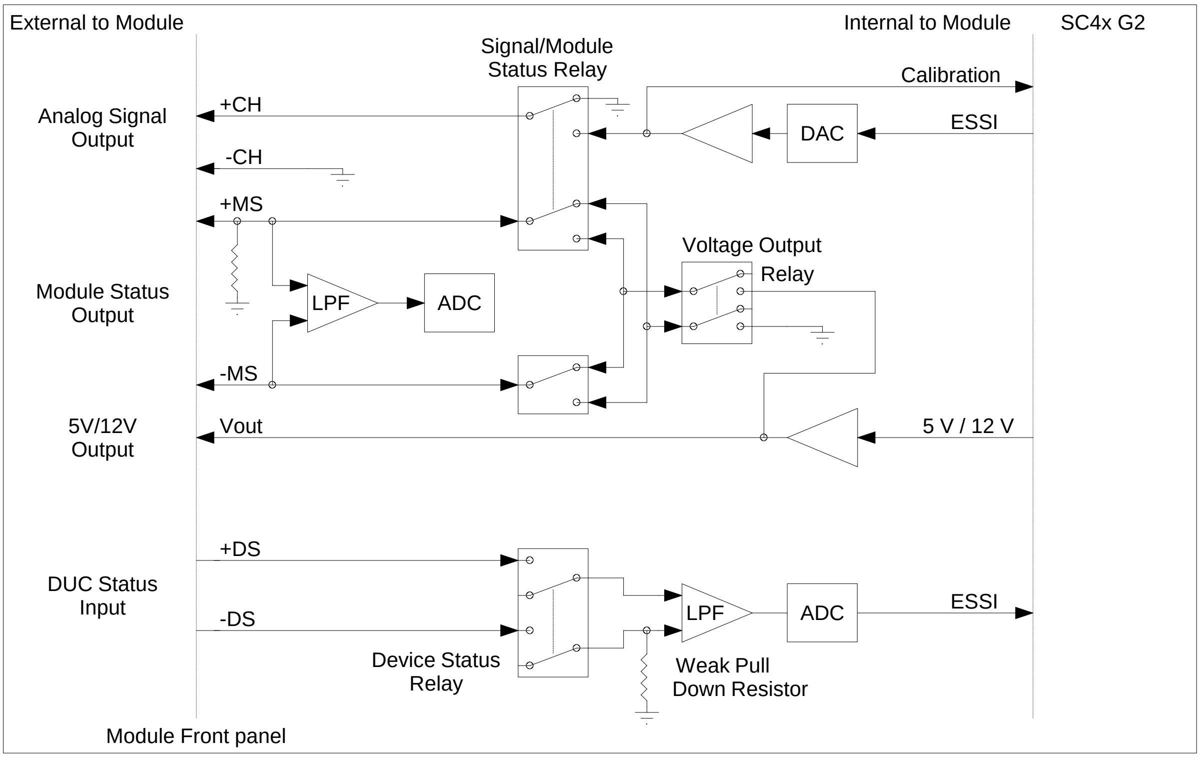


Figure 144. ALO42S G2 functionality per channel

The Device Under Control (DUC) is connected to the ALO42S G2 through a 7-pin Lemo connector.

- Two Analog Signal Output lines (+CH and -CH) provide analog information,
- Two Module Status Output lines (MS+ and MS-) provide the DUC with information from the ALO42S G2, and
- Two DUC Status Input lines (DS+ and DS-) provide the ALO42S G2 with information from the DUC
- 5 V / 12 V DC output

Grounding diagram

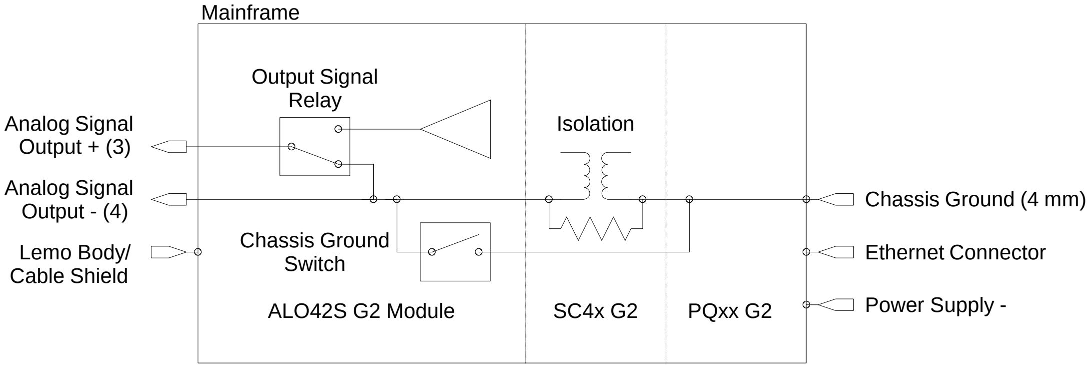


Figure 145. ALO42S G2 grounding

The Lemo connector on the ALO42S G2 makes contact with the cable shield connecting the DUC. Due to this fact, the shield should be broken on the DUC side, so that the DUC is not connected to the PAK MKII Chassis Ground.

This Lemo connector is also connected to the 4 mm Chassis Ground socket on the front right foot of the PAK MKII, the Ethernet connector shield and the negative PAK MKII power supply pin.

CAN42 G2 Module

Description

The CAN42 G2 Module provides interfaces to 2 independent Controller Area Networks or CAN. Messages received from CAN are time-stamped to synchronize their reception with analog and digital measurements from other Modules in the system. Features include Listen-Only mode, Self-Reception of CAN messages and transmission of Remote Frames. The CAN42 G2 Module provides independent channel filtering. The Module can be used:

- When monitoring CAN based messages
- When controlling CAN based devices

Front panel

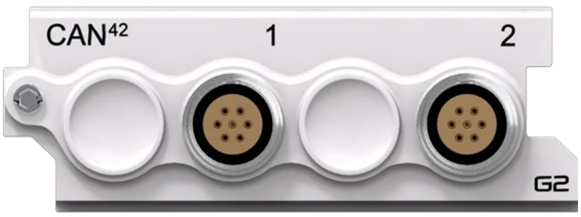


Figure 146. CAN42 G2

Connector Information and Pin Definitions

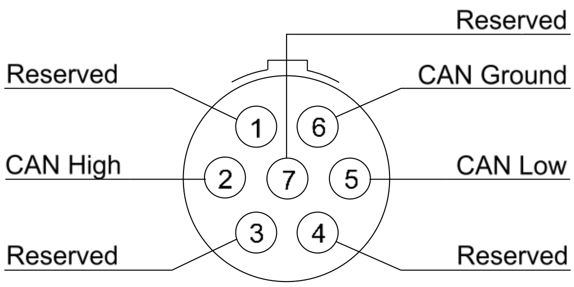


Figure 147. CAN42 G2 with Lemo 7-way EHG.0B connectors Module pin definition

(when looking into the front panel's connector or at the rear of the cable's connector)

Note: Pin 6 – CAN Ground Channel 1 and CAN Ground Channel 2 are isolated from each other.

The FLXB20 SubModule can be used to connect a CAN42 G2 Module to a CANbus network. Here it provides the interface between the 7-pin Lemo connector on the CAN42 G2 Module and the 9-pin D-sub connector on the CANbus network.

Two cable lengths are available when connecting to a CANbus network:

- 3000 mm cable length (for low bit rates), or
- 300 mm cable length (for high bit rates)

Features

- Compatible with ISO 11898-2 (High Speed) physical layer standard and with CAN 2.0B protocol (supports both 11-bit and 29-bit identifiers)
- 3 modes of operation:
  - Operational – transmit and receive CAN messages (active)
  - Listen only mode – only receive CAN messages (passive)
  - CAN bus simulator mode – simulates receiving CAN messages from CAN (no physical connection needed)
- 2 independent CAN channels each at 10 kbit/s to 1 Mbit/s data rate
- CAN messages are time stamped with a resolution of 62.5 ns
- Individually configurable identifier list per channel provides acceptance filtering
- Data and remote frames are supported
- Software selectable 120 Ω termination per Channel
- Lemo 7-way EHG.0B connectors
  9-way D-sub connectors are provided with FLXB20 SubModules

CAN Bus Bit Rate	**Bus Timing Registers**		**Description**	
	BTR0	**BTR1**		
10 kbit/s	0x31	0x1C	SJW BRP TSEG1 TSEG2 Single sample point at 87.5%	= 0x0 (1 $tscl$) = 49 ($fclk$ = 16 MHz) = 0xC (13 $tscl$) = 0x1 (2 $tscl$)
33.33 kbit/s	0x4E	0x1C	SJW BRP TSEG1 TSEG2 Single sample point at 87.5%	= 0x1 (2 $tscl$) = 14 ($fclk$ = 16 MHz) = 0xC (13 $tscl$) = 0x1 (2 $tscl$)
50 kbit/s	0x09	0x1C	SJW BRP TSEG1 TSEG2 Single sample point at 87.5%	= 0x0 (1 $tscl$) = 9 ($fclk$ = 16 MHz) = 0xC (13 $tscl$) = 0x1 (2 $tscl$)

83.33 kbit/s	0x05	0x1C	SJW BRP TSEG1 TSEG2 Single sample point at 87.5%	= 0x0 (1 $tscl$) = 5 ($fclk$ = 16 MHz) = 0xC (13 $tscl$) = 0x1 (2 $tscl$)
100 kbit/s	0x03	0x2F	SJW BRP TSEG1 TSEG2 Single sample point at 85.0%	= 0x0 (1 $tscl$) = 3 ($fclk$ = 16 MHz) = 0xF (16 $tscl$) = 0x2 (3 $tscl$)
125 kbit/s	0x03	0x1C	SJW BRP TSEG1 TSEG2 Single sample point at 87.5%	= 0x0 (1 $tscl$) = 3 ($fclk$ = 16 MHz) = 0xC (13 $tscl$) = 0x1 (2 $tscl$)
250 kbit/s	0x01	0x1C	SJW BRP TSEG1 TSEG2 Single sample point at 87.5%	= 0x0 (1 $tscl$) = 1 ($fclk$ = 16 MHz) = 0xC (13 $tscl$) = 0x1 (2 $tscl$)
500 kbit/s	0x00	0x1C	SJW BRP TSEG1 TSEG2 Single sample point at 87.5%	= 0x0 (1 $tscl$) = 0 ($fclk$ = 16 MHz) = 0xC (13 $tscl$) = 0x1 (2 $tscl$)
666 kbit/s	0x80	0xB6	SJW BRP TSEG1 TSEG2 Triple sample point	= 0x2 (1 $tscl$) = 0 ($fclk$ = 16 MHz) = 0x6 (7 $tscl$) = 0x2 (3 $tscl$)
800 kbit/s	0x40	0x16	SJW BRP TSEG1 TSEG2 Single sample point at 80%	= 0x1 (2 $tscl$) = 0 ($fclk$ = 16 MHz) = 0x6 (7 $tscl$) = 0x1 (2 $tscl$)

1000 kbit/s	0x00	0x14	SJW BRP TSEG1 TSEG2 Single sample point at 75.0%	= 0x0 (1 $tscl$) = 0 ($fclk$ = 16 MHz) = 0x4 (5 $tscl$) = 0x1 (2 $tscl$)

Table 50. CAN42 G2 Module Features

Functionality per Channel

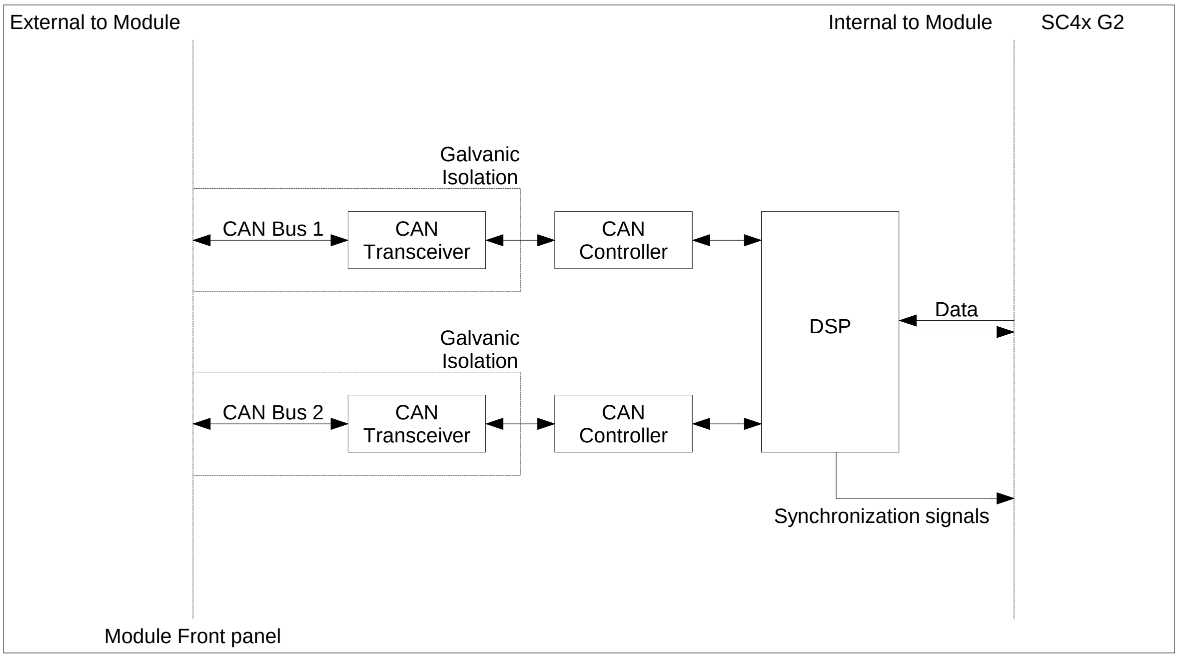


Figure 148. Functional block diagram of the CAN42 G2 Module

The CAN Module contains two channels that are implemented by its firmware to act as inputs or outputs (channel 1 – input/output 1; channel 2 – input/output 2).

The CAN42 G2 conforms to ISO 11898 and to CAN 2.0 A and B (with support for 11-bit and 29-bit identifiers). Time stamping is executed on each message received which allows CAN messages to be synchronized with the rest of the measurement data.

Grounding Diagram

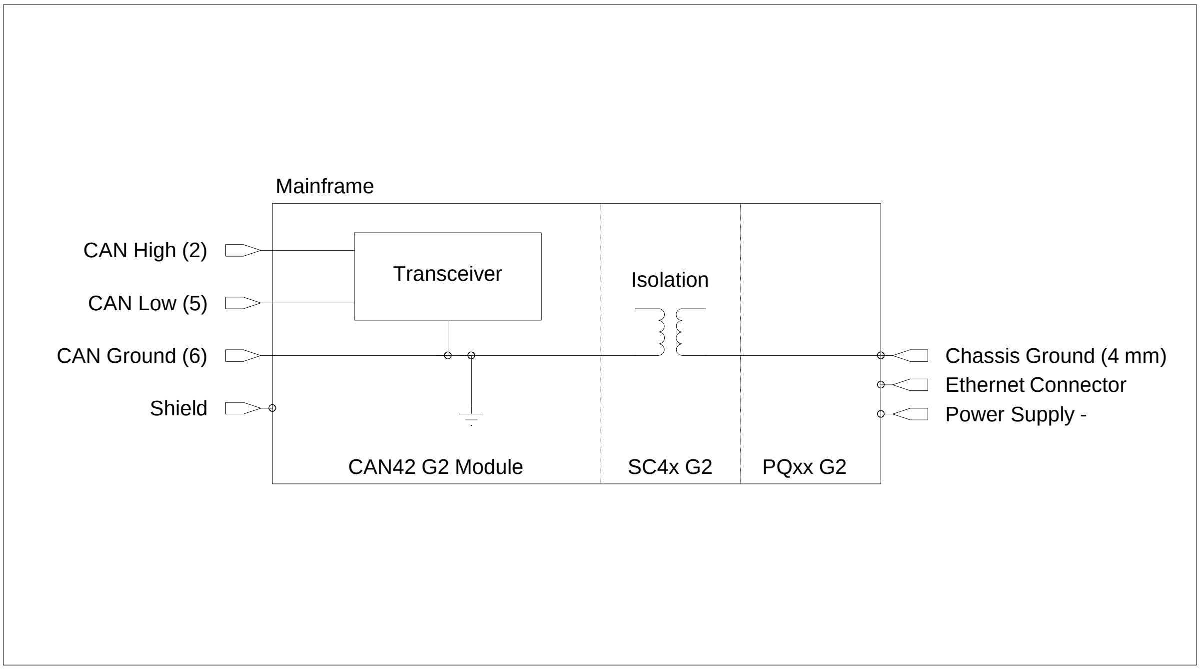


Figure 149. Grounding diagram of CAN42 G2 Module (only one channel)

FLX42 G2 Module

Description

The FLX42 G2 Module provides an interface to connect to a FlexRay™ network for the monitoring of FlexRay™ based messages and interfacing with FlexRay™ based sensors. The FLX42 G2 Module contains two dependent FlexRay™ channel interfaces to support either single channel or dual channel topologies. For the transmission and reception of FlexRay™ messages, selectable bit rates of 2.5, 5, 8 or 10 Mbit/s are available. The FLX42 G2 Module provides independent channel filtering and provides status and error information to the user. The Module can be used:

- When monitoring FlexRay™ based messages
- When interfacing with FlexRay™ based sensors

Front Panel

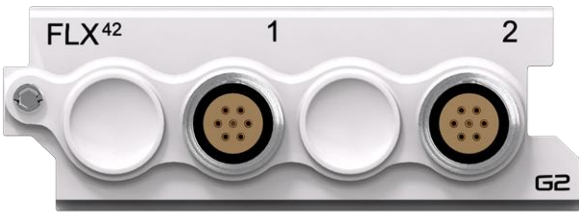


Figure 150. FLX42 G2

Connector Information and Pin Definitions

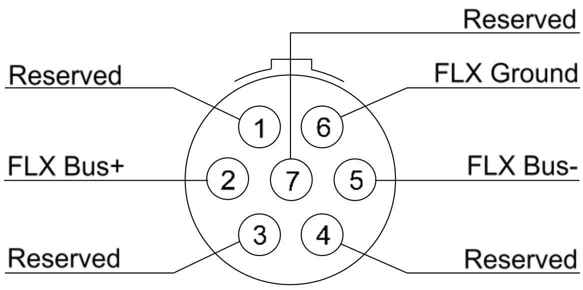


Figure 151. FLX42 G2 with Lemo 7-way EHG.0B connectors Module pin definition

(when looking into the front panel’s connector or at the rear of the cable’s connector)

Note: The FLXB20 SubModule can be used to connect the FLX42 G2 Module to a FlexRay™ network.

Features

• 2 dependent channels configured as:
  ◦ Dual Channel Device or
  ◦ Single Channel Device (connector 2 disabled)
• Configurable cold start
• 3 modes of operation:
  ◦ Operational mode – active network interaction (cold start, transmission and reception of messages enabled)
  ◦ Listen-only mode – passive network interaction (no transmission or cold start, only reception of messages)
  ◦ Simulation or self-test mode – used for Module debugging
• FlexRay™ Bit Rate Range of 2.5, 5, 8 or 10 Mbit/s
• FlexRay™ messages are time-stamped with a resolution of 59.6 ns
• Software selectable 110 Ω termination per channel
• Extensive firmware protection from EMI
• Lemo 7-way EHG.0B connectors
• 9-way D-sub connectors are provided with FLXB20 SubModules
• Compatible with FlexRay™ Protocol Specification V2.1A and FlexRay™ Electrical Physical Layer Specification V2.1A	

Module Connectors	Lemo EHG.0B.307
Channel Configuration	2 dependent channels – Dual Channel Device or Single Channel Device (connector 2 disabled)
Operational Modes	Listen-Only Mode / Operational Mode / Self-Test Mode
FlexRay™ Compliance	FlexRay™ Protocol Specification V2.1A. FlexRay™ Electrical Physical Layer Specification V2.1A
Termination	Software selectable (Use FLXB20)
FlexRay™ Transceivers	NXP TJA1080
FlexRay™ Controller	Freescale MFR4310
FlexRay™ Controller Clock Frequency	40 MHz
FlexRay™ Bit Rate Range	2.5, 5, 8 or 10 Mbit/s
Timestamp Resolution	38.1 ns to 59.6 ns
Galvanic Isolation	50 V
Operational Temperature	-25 °C to 80 °C

Table 51. FLX42 G2 Module Features

Functionality per Channel

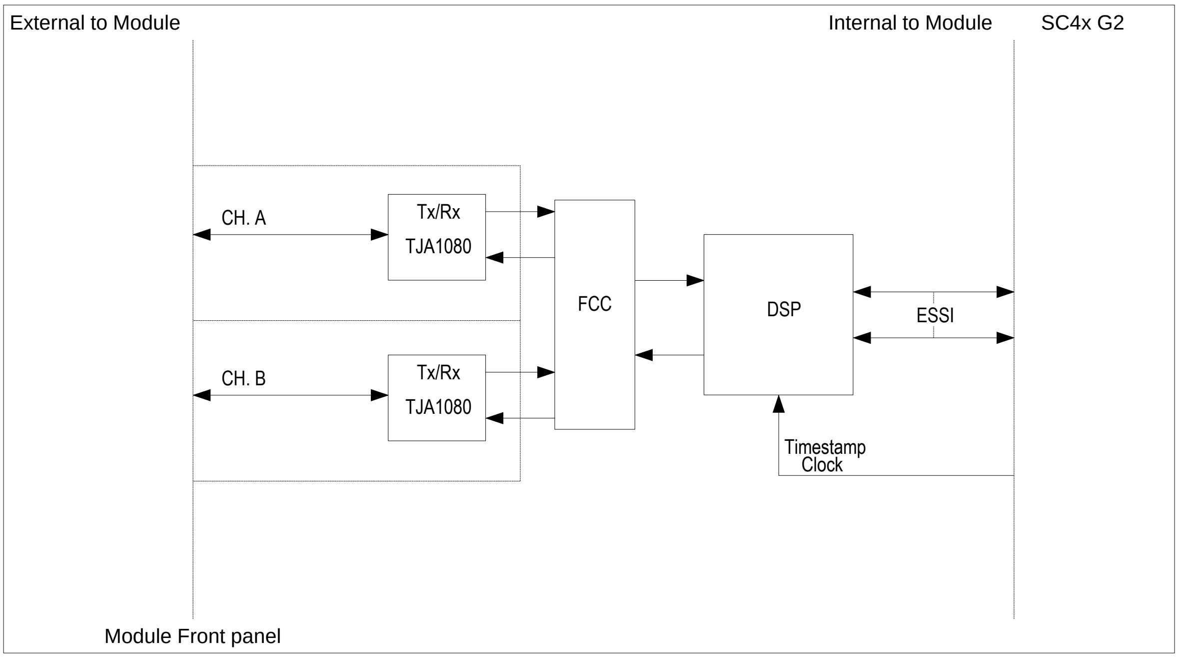


Figure 152. FLX42 G2 functionality

The FLX42 G2 Module contains two dependent FlexRay™ channel interfaces to support either the single or dual channel topologies.

The MFR4310 communication controller and TJA1080 transceivers are used on the FLX42 G2 Module. They support the transmission and reception of FlexRay™ messages over a FlexRay™ network with selectable bit rates of 2.5, 5, 8 or 10 Mbit/s.

The FLX42 G2 Module supports independent channel filtering and provides status and error information to the User.

The FLX42 G2 has:

- Conformance with FlexRay™ Protocol Specification V2.1A
- FlexRay™ Electrical Physical Layer Specification V2.1A
- Each FLX42 G2 interface is galvanically isolated from the PAK MKII
- Each message received and accepted by the FLX42 G2 Module will be time stamped in order to synchronize the received messages with the rest of the measurement data
- Individually configurable FlexRay™ Frame ID, Channel ID and Cycle Count filtering per channel

Grounding Diagram

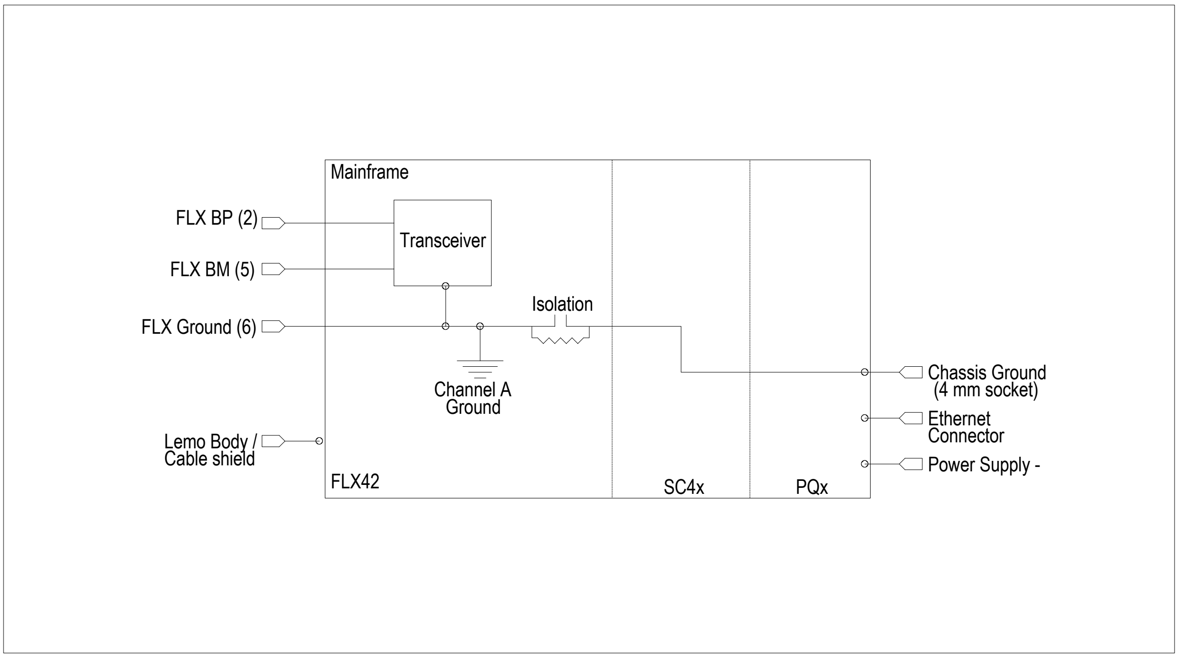


Figure 153. FLX42 G2 grounding

GPS42 G2 Module

Description

The GPS42 G2 provides accurate GPS time and position data to the PAK MKII. Accurate timing information is in the form of a pulse per second (pps) logical signal. The GPS42 G2 can also be used for synchronization purposes. Here the GPS42 G2 Module provides the G2 System Controller with the pps signal to align its internal clock. Mainframes with this capability are able to synchronize with one another without limitations as to their position or the total number of Mainframes. The Module can be used when:

- Synchronization of numerous channels over multiple Mainframes
- When requiring accurate time and position information

Front Panel

Figure 154. GPS42 G2

Connector Information and Pin Definitions

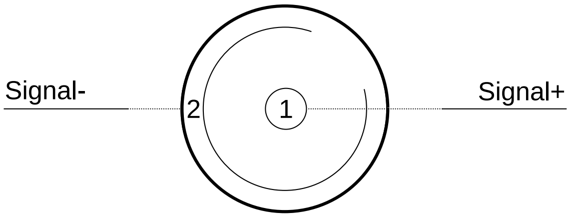


Figure 155. GPS42 G2 with an SMA connector Module pin definition

(when looking into the front panel’s connector or at the rear of the cable’s connector)

Features

• Internal GPS channel • All settings made by software • NMEA Protocol • 1 Hz and 4 Hz position updates • Time-stamping of received GPS time and position data to 5 μs resolution • 3.3 V or 5 V antenna voltage • GPS internal receiver accuracy of <3 m • GPS Synchronization of Mainframes in the same PAK MKII System is provided as an alternative to the fiber optic based SyncLink cables between Mainframes. A GPS42 G2 Module is required inside each Mainframe that forms part of a synchronized system • SMA connector for antenna

Number of Channels	1
Antenna Voltage	3.3 V or 5 V
Input Connector	SMA
Receiver Type	L1 frequency, C/A Code, 16 Channels
Max Update Rate	4 Hz
Accuracy (SA off)[1]	Position: 4.0 m CEP[2], 5.0 m SEP[3] Position DGPS/SBAS: < 2.0 m CEP, 3.0 m SEP
Acquisition Time	Cold Start: 45 s, Warm Start: 38 s, Hot Start: < 8 s
Available Protocols	NMEA
Operational Limits	Altitude: < 18000 m, Velocity < 515 m/s
Specified Antenna	ANN-ST-O-005-0 GPS antenna from u-blox AG, Switzerland
Time-Stamping of received GPS time and position data	5 μs

Table 52. GPS42 G2 Module Features

[1] SA: Selective Availability

[2] CEP: Circular Error Probability, the radius of a horizontal circle, centered at the antenna's true position, containing 50% of the fixes

[3] SEP: Spherical Error Probability, the radius of a sphere, centered at the true position, contains 50% of the fixes

Functionality

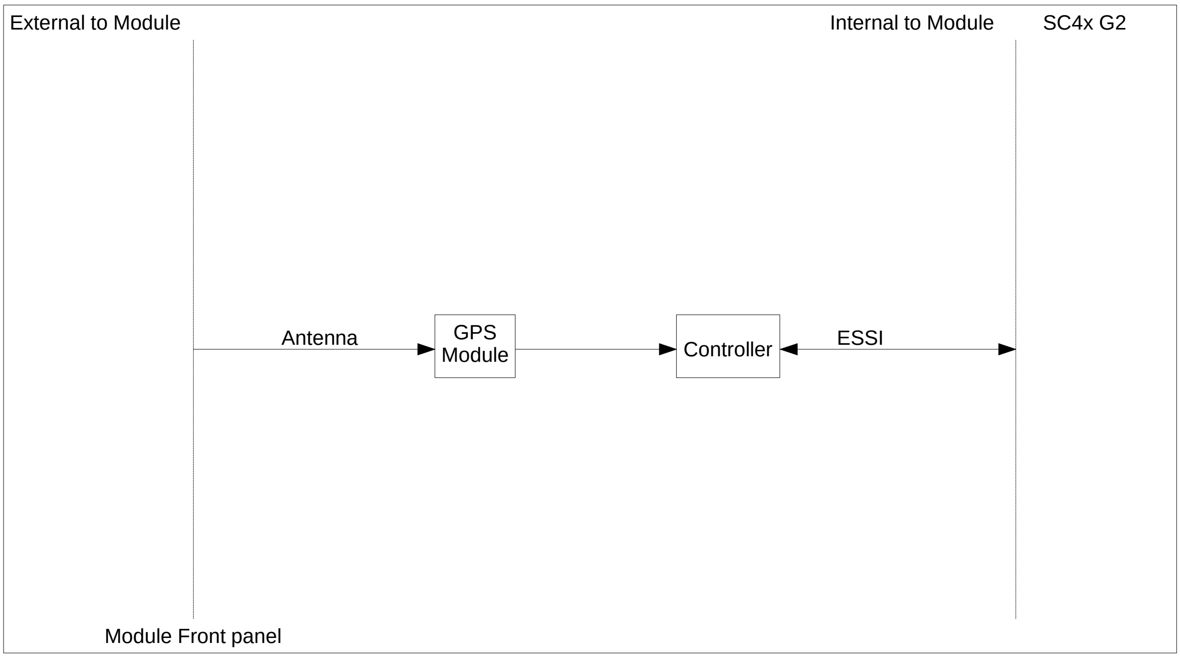


Figure 156. GPS42 G2 functionality

The GPS42 G2 is specified for use with the ANN-ST-0-005-0 GPS antenna[1]. This antenna is an active GPS antenna with a 5 m cable and an SMA Male connector.

The GPS42 G2 implements a real-time differential correction method known as SBAS (or Satellite-Based Augmentation System). SBAS provides correction data for visible satellites as follows:

- Corrections are computed from ground station observations and then uploaded to geostationary satellites
- This data is then cast on the L1 frequency and is tracked using a channel on the GPS receiver

Using SBAS will allow the GPS42 G2 to achieve an accuracy of <2.0 m when using circular error probability (CEP). CEP is the probability that 50% of the corrections to the position are within the radius of a horizontal circle centered on the antenna's true position.

The GPS42 G2 supports drift compensation as well as synchronized start over GPS.

[1] ANN-ST-O-005-0 GPS antenna from u-blox AG, Switzerland

IRG42 G2 Module

Description

In addition to the same internal GPS functionality as described in the GPS42 G2, the IRG42 G2 Module provides an additional functional unit of being able to interface to IRIG. Here IRIG-A and IRIG-B data (both analog and digital formats) are digitized by a high speed ADC and decoded. The external IRIG data is time-stamped to synchronize its data with other Modules in the same system. The IRG42 G2 can also be used for synchronization purposes. Here the IRG42 G2 Module provides the G2 System Controller with a signal to align its internal clock. Mainframes with this capability are able to synchronize with one another (limited only by the customer's installed IRIG facility). The Module can be used when:

- Synchronization of numerous channels over multiple Mainframes
- Requiring time and other IRIG based information to synchronize other measurements

Front Panel

Figure 157. IRG42 G2

Connector Information and Pin Definitions

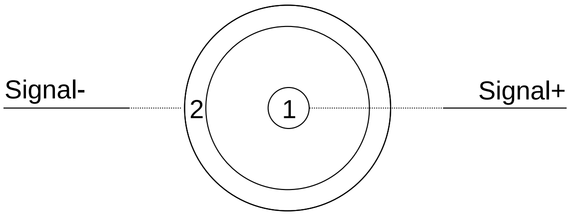


Figure 158. IRG42 G2 Module with male SMB connector for IRIG pin definition

(when looking into the front panel's connector or at the rear of the cable's connector)

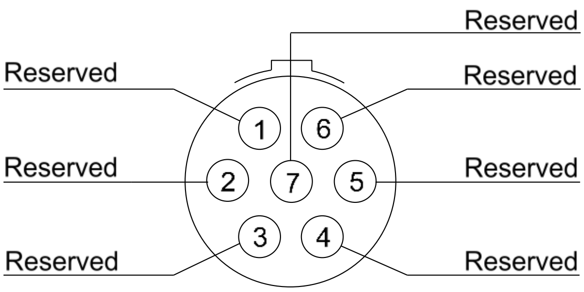


Figure 159. IRG42 G2 Module with Lemo 7-way EHG.0B connector External GPS pin definition

(when looking into the front panel's connector or at the rear of the cable's connector)

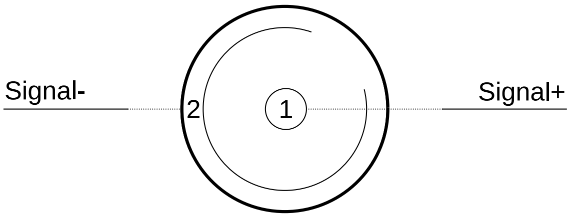


Figure 160. IRG42 G2 Module with SMA connector for Antenna pin definition

(when looking into the front panel's connector or at the rear of the cable's connector)

Features

- Internal GPS channel
- All settings made by software
- NMEA Protocol
- 1 Hz and 4 Hz position updates
- Time-stamping of received GPS time and position data to 5 µs resolution
- 3.3 V or 5 V antenna voltage
- GPS internal receiver accuracy of <3 m
- GPS Synchronization of Mainframes in the same PAK MKII System is provided as an alternative to the fiber optic based SyncLink cables between Mainframes. A GPS42 G2 Module is required inside each Mainframe that forms part of a synchronized system
- SMA connector for antenna
- Operation modes include:
  - Internal IRIG receiver mode
  - Serial data and timing interface for possible future application
- IRIG Formats supported:
  - A003
  - A133
  - B003
  - B123
- Time-stamping of IRIG messages to 5 µs resolution
- IRIG synchronization of Mainframes in the same PAK MKII System is provided as an alternative to the fiber optic based SyncLink cables between Mainframes. An IRG42 G2 Module is required inside each Mainframe that forms part of a synchronized system
- SMB connector for IRIG

Features in internal GPS receiver mode	
Number of Channels	1
Antenna Voltage	3.3 V or 5 V
Input Connector	SMA
Receiver Type	L1 frequency, C/A Code, 16 Channels
Max Update Rate	4 Hz
Accuracy (SA off)[1]	Position: 4.0 m CEP[2], 5.0 m SEP[3] Position DGPS/SBAS: < 2.0 m CEP, 3.0 m SEP
Acquisition Time	Cold Start: 45 s Warm Start: 38 s Hot Start: < 8 s

[1] SA: Selective Availability

[2] CEP: Circular Error Probability, the radius of a horizontal circle, centered at the antenna’s true position, containing 50% of the fixes

[3] SEP: Spherical Error Probability, the radius of a sphere, centered at the true position, contains 50% of the fixes

<table>
<tr><td>Available Protocols</td><td colspan="2">NMEA</td></tr>
<tr><td>Operational Limits</td><td colspan="2">Altitude: < 18000 m,
Velocity < 515 m/s</td></tr>
<tr><td>Specified Antenna</td><td colspan="2">ANN-ST-O-005-0 GPS antenna from u-blox AG, Switzerland</td></tr>
<tr><td>Time-Stamping of received GPS time and position data</td><td colspan="2">5 μs</td></tr>
<tr><td colspan="3">Features in internal IRIG mode</td></tr>
<tr><td>Number of Channels</td><td colspan="2">1</td></tr>
<tr><td>Input Connector</td><td colspan="2">SMB</td></tr>
<tr><td rowspan="4">IRIG Format Support</td><td>A003</td><td>PWM DC Signal,
no carrier BCD time of year,
SBS time of day</td></tr>
<tr><td>A133</td><td>AM Sine Wave Signal,
10 kHz carrier frequency BCD time of year,
SBS time of day</td></tr>
<tr><td>B003</td><td>PWM DC Signal,
no carrier BCD time of year,
SBS time of day</td></tr>
<tr><td>B123</td><td>AM Sine Wave Signal,
1 kHz carrier frequency BCD time of year,
SBS time of day</td></tr>
<tr><td>DC Input Impedance</td><td colspan="2">100 Ω</td></tr>
<tr><td colspan="3">Features in external GPS mode</td></tr>
<tr><td>Number of Channels</td><td colspan="2">1 x RS232, 1x PPS</td></tr>
<tr><td>Supply Voltage</td><td colspan="2">5 V, 1 A (max)</td></tr>
<tr><td>Input Connector</td><td colspan="2">Lemo EHG.0B.307</td></tr>
<tr><td>Available Baud Rates</td><td colspan="2">Default 9600. Thereafter set by User.</td></tr>
</table>

Table 53. IRG42 G2 Module Features

Functionality

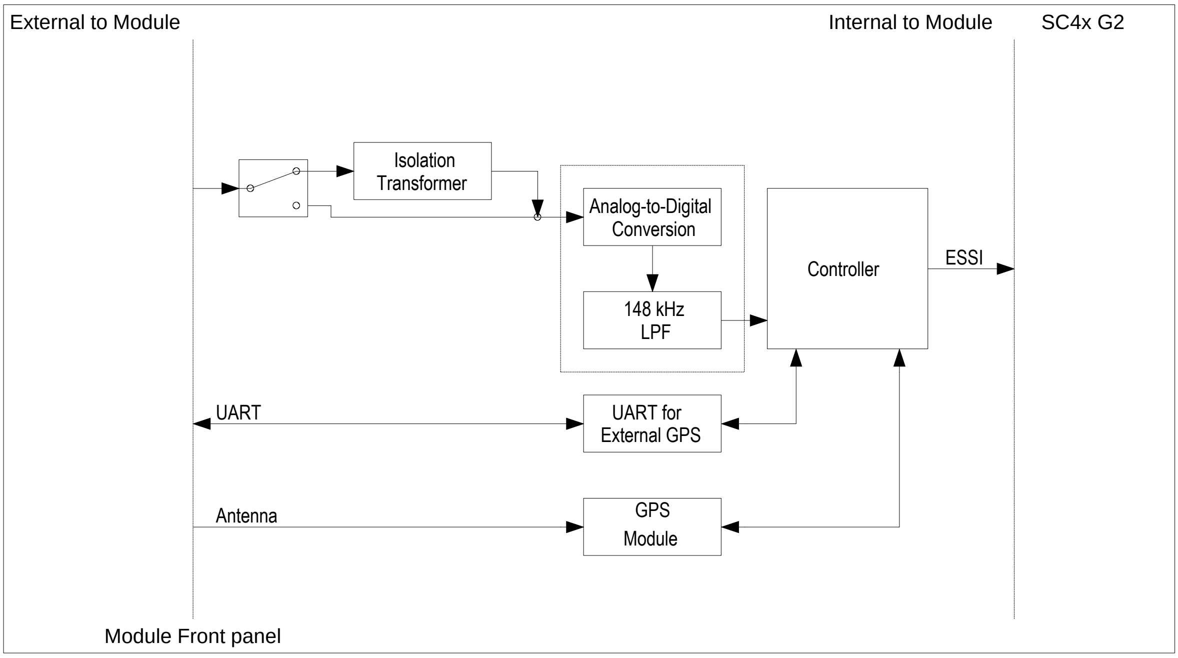


Figure 161. IRG42 G2 functionality

The IRG42 G2 has:

- An SMB Male connector - for use with the internal IRIG receiver. An external IRIG timing source is connected through the SMB connector
- An SMA Female connector - for use with the internal GPS receiver. An external GPS antenna is connected through the SMA connector
- A 7-pin Lemo connector - for use with the external GPS function. An external GPS device is connected through the 7-pin Lemo and communicates using the RS232 protocol
- Supported IRIG expressions:
  - Binary Coded Decimal (BCD) to display ‘time of year’ as well as ‘year’
  - Straight Binary Seconds (SBS) to display the’ time of day’ information
- IRIG accuracy in mode A of 1000 pps and mode B of 100 pps
- GPS accuracy < 2.0 m when using the Satellite Based Augmentation System (SBAS)
- Time-Stamping ≥ 5 μs on received GPS time and position data

ECT42 G2 Module

Description

Data which is acquired in the PAK MKII system can be shared synchronously with other EtherCAT® devices via the high speed Ethernet backbone using the EtherCAT® protocol and EtherCAT® system time. This data is presented along with miscellaneous parameters including units and scaling factors. The Module can be used to:

- Provides the ability to interface to other networked EtherCAT® slave devices within a factory, laboratory or test chamber environment
- When acquiring data via other networked EtherCAT® slave devices

Front Panel

Figure 162. ECT42 G2

Connector Information and Pin Definitions

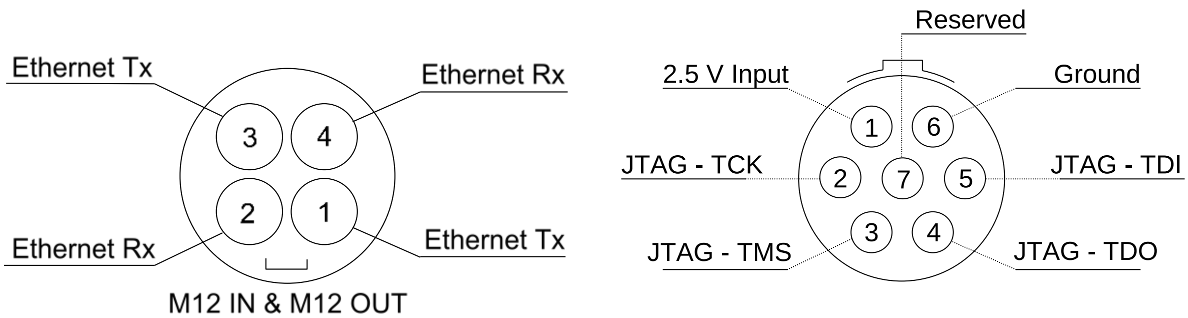


Figure 163. ECT42 G2 with ERNI M12 and Lemo 7-way EHG.0B connectors Module pin definitions (when looking into the front panel's connectors or at the rear of the cable's connector)

Features

- Supports slave-to-slave communication in passive mode
- Conforms to EtherCAT® standards IEC 61158, ISO 15745-4 and SEMI E54.20
- Supports CANopen over EtherCAT® (CoE) and Service Delivery Object (SDO) access
- Full duplex 100-BASE-TX in upstream and downstream directions, with galvanic isolation on each interface
- Time stamping of data in 64-bit EtherCAT® system time
- Distributed clocks synchronized to an absolute maximum error of 100 ns
- Supports hot-connect and slave alias addressing for high availability
- Cycle times across the entire EtherCAT® network less than 100 μs
- Slave Information Interface (SII) implemented for device description
- ERNI M12 connectors

Module Connectors	2x ERNI M12 Connectors (IP67 compliant)
Physical Channel Configuration	Flexible, topology-dependent
Logical Channel Configuration	Flexible; provision for up to forty 32-bit Float input channels
EtherCAT® Compliance	IEC 61158, ISO 15745-4, SEMI E54.20
Operational Modes	Passive Mode data acquisition. Full EtherCAT® state machine
EtherCAT® Controller	ET1100
EtherCAT® Clock Accuracy	15 ppm (Rx queue delay of 0)
Typical Synchronization Accuracy	10-20 ns
Effective Bit Rate	135-400 kB/s (dependent on input configuration)

Table 54. ETC42 G2 Module Features

ECT42 G2 In-System Operation

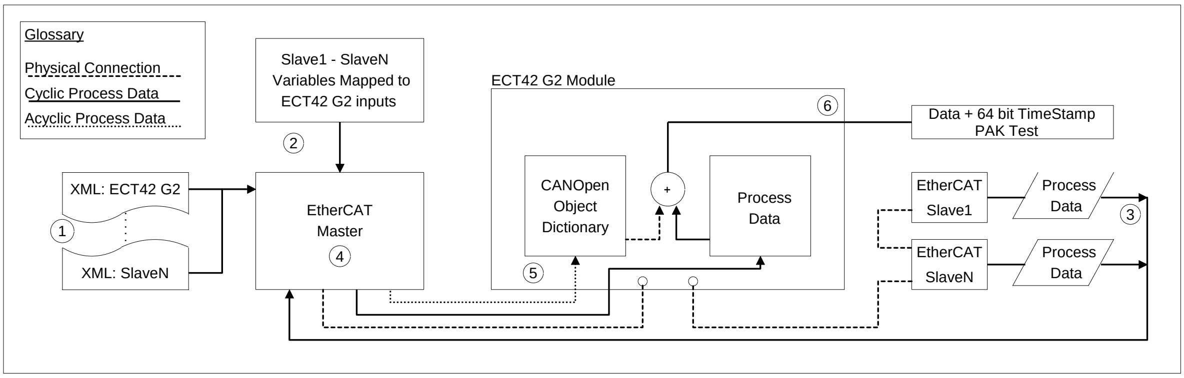


Figure 164. ECT42 G2 in-system operation

A typical mode of operation is described in the block diagram above.

- The XML descriptions of the slave devices on the network are processed by the master, and the EtherCAT® network is brought online
- The output variables from other slave nodes are then mapped to the inputs of the ECT42 Module
- As slave devices become operational, their output data is validated, and is made available on the network
- Cyclic data transfer of data from networked slaves to the ECT42 Module is affected by the master forwarding the process data as defined by the slave-to-slave mappings
- Acyclic data transfer of parameter data corresponding to the networked slave devices is brought about by the master through writing the relevant entries in the DS404 object dictionary
- The cyclic data is presented along with the corresponding parameter data from the object dictionary, as well as the 64-bit EtherCAT® system timestamp within PAK

Distributed clocks are supported by the Module and handled entirely by the EtherCAT® Master. If used and activated, the master will ensure that all the nodes are in sync.

ECT42 G2 Functionality

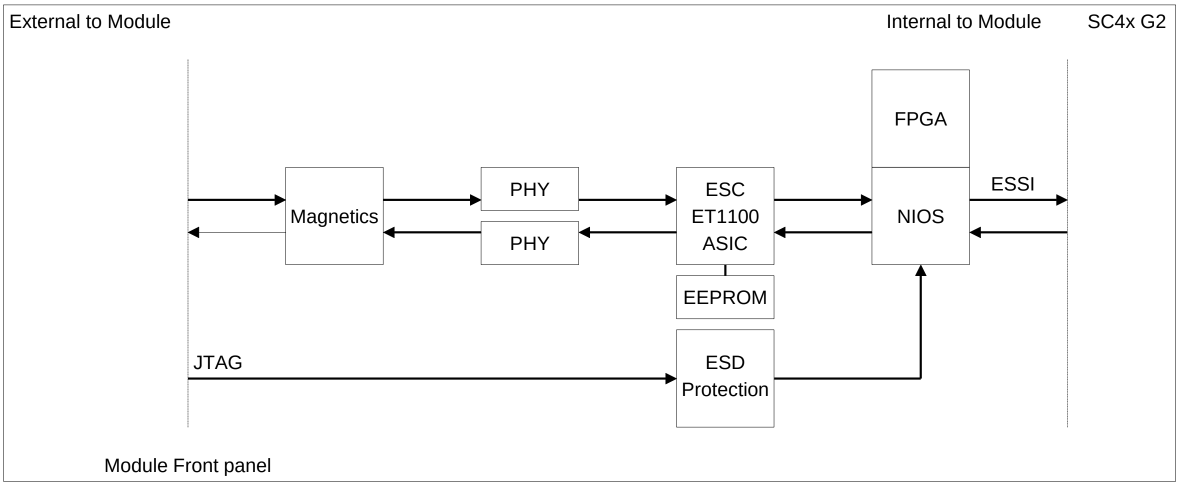


Figure 165. ECT42 G2 functionality

The Module interfaces with the EtherCAT® network by means of two M12 connector ports, although basic network architecture requires only one port need be connected. A Lemo connector is also present through which the Module can be programmed within the PAK MKII system using JTAG. The EtherCAT® network is isolated from the Module by means of magnetics/transformers. Each port has a dedicated Ethernet Physical Layer Chip (PHY) which is in turn connected to a PAK MKII.

ECT42 G2 Grounding Diagram

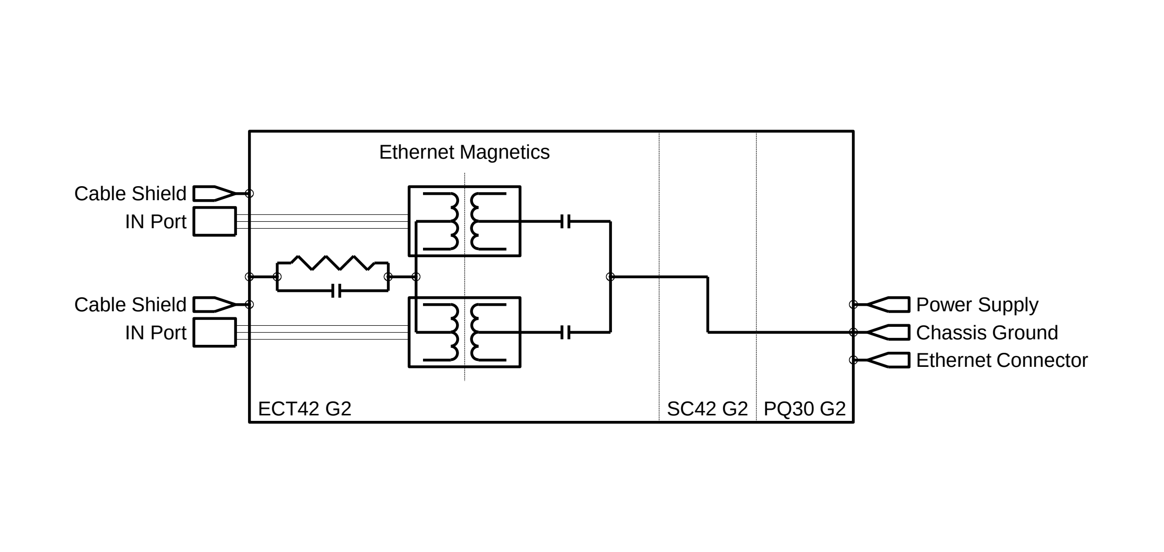


Figure 166. ECT42 G2 grounding

DAR42 G2 Module

Description

The DAR42 G2 Module provides interfaces to receive two stereo AES3 digital audio streams. For synchronization between the DAR42 G2 and external digital audio transmission equipment, the DAR42 transmits a synchronization signal which can be selected to be either an AES3 output signal (data at digital zero) or word clock signal. The Module can be used:

- With measuring devices which provide an AES3 based digital audio signal, such as a digital artificial head

Front panel

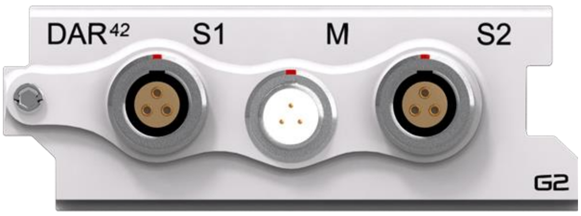


Figure 167. DAR42 G2

Connector Information and Pin Definitions

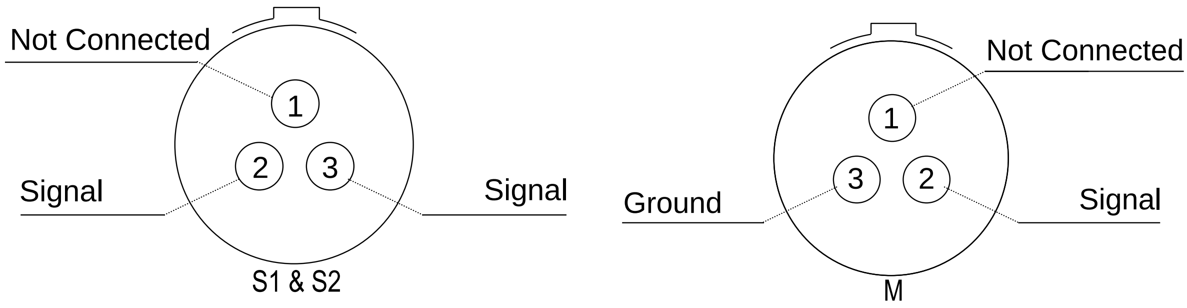


Figure 168. DAR42 G2 with Lemo 3-way EGG.0B and FAG.0B connectors Module pin definition (when looking into the front panel's connectors or at the rear of the cable's connector)

Features

- Two stereo input channels
- Frame rates of 44.1, 48.0, 88.2 and 96.0 kHz
- Single AES3 or master word clock output
- Lemo 3-way EGG.0B connectors for AES3 input and Lemo 3-way FAG.0B connector for synchronization output

DAR42 G2 Module AES3 Input Features		
Module Connector		Lemo EGG.0B.303.CLN
Channel		2 inputs
Interface		AES3
Termination		110 Ω
Differential Input Voltage Range		200 mV p-p minimum
Common Mode Input Range		±7 V
Frame Rate	**4 CH mode**	44.1, 48 kHz
	2 CH mode	44.1, 48, 88.2, 96 kHz
Sample Width		16 / 20 / 24-bit
Protection		2 kV ESD
Galvanic Isolation		50 V, through capacitive coupling
Word Clock Delay		30 ns (maximum)
AES3 Delay		600 ns (typical)

DAR42 G2 Module SYNC Output Features		
Module Connector		Lemo FAG.0B.303.CLA
Channel		1
Interface	**Word Clock**	TTL low-impedance output, single-ended
	AES3	AES transformer-coupled
Voltage Output	**Word Clock**	5.5 V (peak-to-peak, cable unterminated)
	AES3	3.5 V (peak-to-peak, cable unterminated)
Termination	**Word Clock**	75 Ω
	AES3	110 Ω
Frequency Range	**Word Clock**	44.1, 48, 88.2, 96 kHz
	AES3	44.1, 48 kHz
Protection		2 kV ESD
Galvanic Isolation	**Word Clock**	No
	AES3	50 V, through transformer coupling

Table 55. DAR42 G2 Module Features

Functionality per Channel

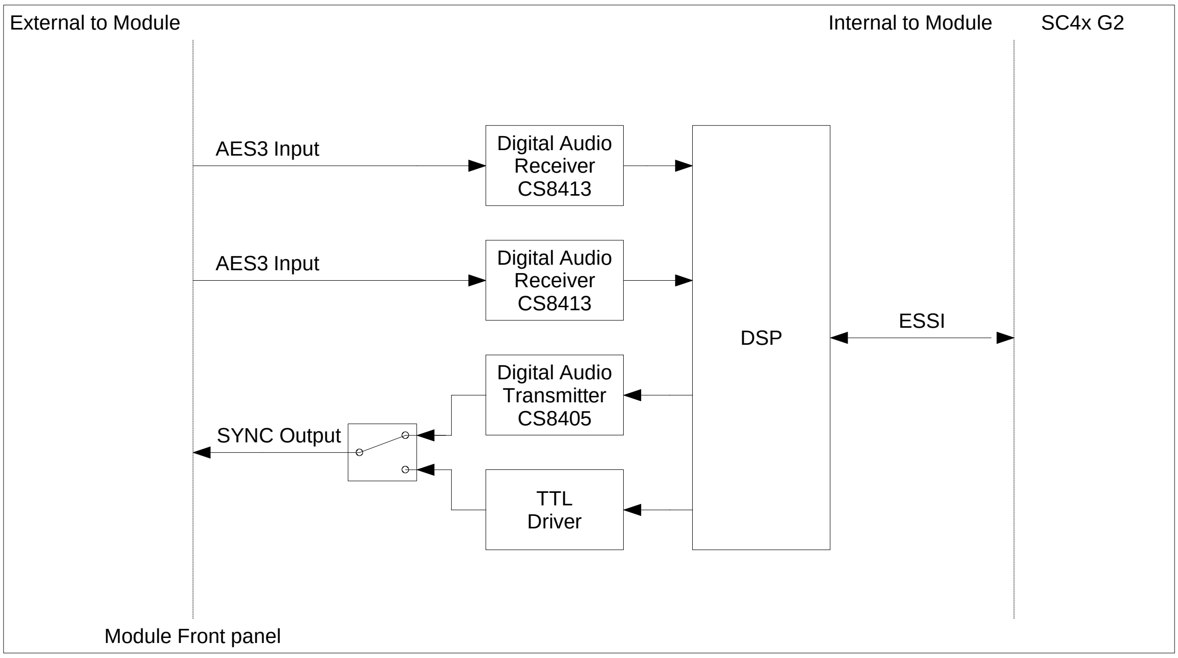


Figure 169. DAR42 G2 Module Functionality

Synchronization

The PAK MKII is a real-time data acquisition system. It acquires data from a number of channels in real-time and then allows the User to perform analysis on the data. To ensure that data acquired from a number of channels on different Mainframes are sampled at the same time, Mainframes must be synchronized.

The PAK MKII has three methods of synchronizing multiple Mainframes together:

- Using fiber optics to provide a common clock between the Mainframes,
- Using a GPS pulse-per-second (pps) signal to train the local clock in each Mainframe to compensate for drift, or
- Using the Ethernet interface as the communications medium to synchronize with the Precision Time Protocol (PTP)

Common clock synchronization

In a PAK MKII system, the term ‘synchronization’ refers to using a common clock to sample data on multiple channels.

For two or more Mainframes to be synchronized together, they need to be able to sample data at the same time. In order for them to sample correctly their clocks need to match one another in both frequency as well as phase. Using SyncLink or PTP, all Mainframes are given the same clock and so all the rising edges will automatically align. This is termed ‘Common Clock Synchronization’.

Clock Tuning Synchronization

In the case of GPS synchronization, there is no longer a common clock to each Mainframe. Instead the GPS pulse-per-second signal is used to train the local oscillator in each Mainframe using a control loop. This is termed ‘Clock Tuning Synchronization’. The control loop takes a small number of cycles to achieve a lock with the pulse-per-second signal. Once lock is achieved, GPS synchronization requires the control loop to continuously train the local oscillator with small increments.

Clock tuning synchronization does not distribute a physical clock signal, but rather information about the timing. This information can be used to tune each Mainframe’s local oscillator to keep the system synchronized. Two standardized parameters need to be extracted from these timing protocols, namely ‘Absolute Time’ and ‘Relative Time’. On the SL21 and G2 Controller Cards there is a tunable oscillator circuit and hence each of these cards can be the root clock of a PAK MKII system.

The two standardized parameters of ‘Absolute Time’ and ‘Relative Time’ allow any system to be synchronized. A control loop compares the ‘Relative Time’ value to the value of the tunable oscillator. Over time the difference between the two values is brought close to zero.

Fiber optic (SyncLink) synchronization

In a fiber optic system, one of the Mainframes is selected to contain a Synchronization Engine which provides the clocks to all the other Mainframes. This SL21 board contains an accurate clock and four fiber optic outputs. Fiber optic cables are then used to connect the SyncLink outputs with the Combined Controller and Power Supply board in each Mainframe. More than four Mainframes can be synchronized by using multiple SL21 boards.

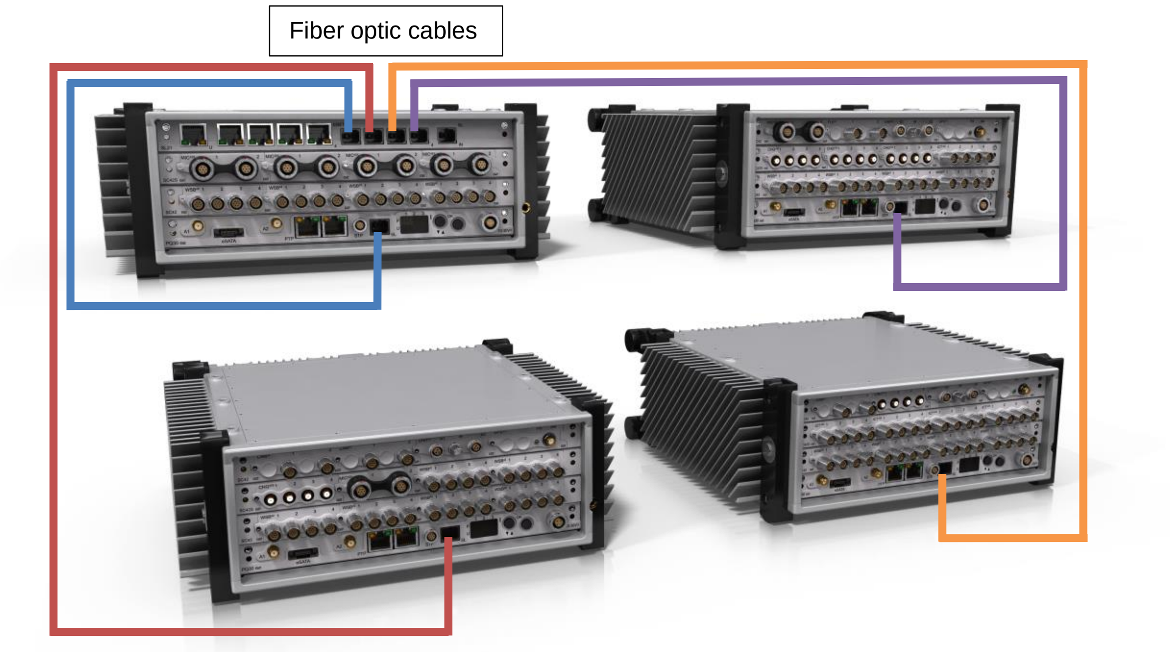


Figure 170. SyncLink synchronization forming cluster of Mainframes (up to four Mainframes synchronized together)

A group of up to four Mainframes is termed a ‘cluster’ of Mainframes. A single SL21 can provide the clock sources and Gigabit Ethernet for this cluster.

SyncLink

SyncLink uses fiber optics to provide the common clock between multiple Mainframes.

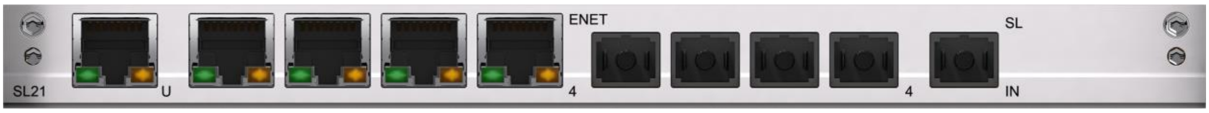


Figure 171. The SL21, a VMEbus synchronization card

The figure above shows the front panel of the SL21. The SL21 is a combined Gigabit Ethernet hub and fiber optic clock source which can provide the Ethernet and clocks for four Mainframes:

- A five port Gigabit Ethernet hub (4 to connect to Mainframes and 1 to the network), and
- A five port SyncLink hub (4 clock outputs and 1 clock input)

Starting from the left hand side of the card:

- The first port is the Gigabit Ethernet Upload port and is marked with a ‘U’. This is to attach the SL21 to an existing Gigabit Ethernet network (e.g. the laboratory network)
- The next four ports are Ethernet ports and are marked with ‘ENET’. These ports are used to connect Mainframes #1, #2, #3 and #4 to a Gigabit Ethernet network
- The next four ports are SyncLink output ports. These are intended to provide the fiber optic clocks to Mainframes #1, #2, #3 and #4
- The final port is the ‘SL IN’ port. This is a SyncLink input port and is to attach the SL21 to a larger SyncLink network

It is important to note that although there are five SyncLink ports, only four of them are output ports. The fifth is an input port and cannot be used as a SyncLink clock source. It is intended to be used when more than four Mainframes need to be connected together.

More than 4 Mainframes synchronized via SyncLink

If there are more than four Mainframes in a system, then multiple SL21 cards will need to be used. Figure 172 below shows a configuration of eight Mainframes which have been linked together using three SL21 cards. The top SL21 card can be inserted into any one of the eight Mainframes.

Figure 172. Eight Mainframes synchronized together using three SL21 cards

Note: When using multiple SL21 cards, it is important to keep cable length in mind. The length of fiber optic cable from the initial SL21 card to each Mainframe should be kept to within 10 m. Table 56 below shows the recommended number of SL21 cards to be used in a SyncLink system.

Mainframes	SL21 Cards	Configuration
1-4	1	Main SL21 feeds all Mainframes
5-8	3	Main SL21 feeds two SL21 boards below
9-12	4	Main SL21 feeds three SL21 boards below
13-16	5	Main SL21 feeds four SL21 boards below

Table 56. Number of SL21 cards to be used per Mainframe

Note: The maximum number of Mainframes that can be connected together using SyncLink is 16.

GPS synchronization

In a GPS synchronized system, each Mainframe must contain a GPS42 G2 Module. This Module provides a timing signal which is used by the Combined Controller and Power Supply board in each Mainframe to train the local clock to compensate for drift.

The Global Positioning System (GPS) set of satellites is used to provide the common pulse-per-second signal to multiple Mainframes.

When synchronizing over GPS, the GPS42 G2 Module is used to provide accurate time and position data to the PAK MKII. This accurate timing information is in the form of a pulse-per-second (pps) signal as well as a timestamp. For synchronization purposes, the G2 System Controller uses this pps signal to align its internal clock.

The process of training a local clock to a pps signal takes some time. If a Mainframe is immediately required to use GPS synchronization from a cold start (if the PAK MKII has been powered down), then this time period could be as long as 45 seconds. Once the internal clock has been aligned to the 1 pps signal it is continuously monitored and adjusted to maintain lock.

Figure 173. GPS synchronization

Mainframes synchronized via GPS

Any number of Mainframes can form part of the same system using GPS synchronization. The only criterion is that each Mainframe must be connected to the same network and be able to get a good GPS signal (clear line of sight to the satellites).

Figure 174. Six Mainframes form a system using GPS synchronization

Advantages of GPS synchronization

- The Mainframes do not need to be in close proximity of one another. They only need to be able to connect to the GPS network of satellites
- No need for cables or SL21 cards in the system

PTP synchronization

In a PTP synchronized system, each Mainframe must contain a PQxx G2 PTP. This Combined Controller and Power Supply board provides synchronized clocks for the Mainframe. No special GPS Module or SyncLink board and cables are required, only the connected Ethernet interface on the Mainframe. The Ethernet switch should be PTP aware and an external PTP Master Clock can be used.

Figure 175. PQ30 G2 11n 128 PTP

The Precision Time Protocol (PTP) synchronization engine of the Combined Controller and Power Supply board achieves clock frequency and phase synchronization between multiple Mainframes on the same network. The protocol is an IEEE 1588-2008 standard with high precision, accuracy and robustness which makes it perfect for synchronizing measurement systems.

All the different Mainframes are connected to a single network with Ethernet as communication medium. The PTP master clock is then identified using the best master algorithm, where after all the other clocks synchronize directly to the master clock.

Mainframes synchronized via PTP

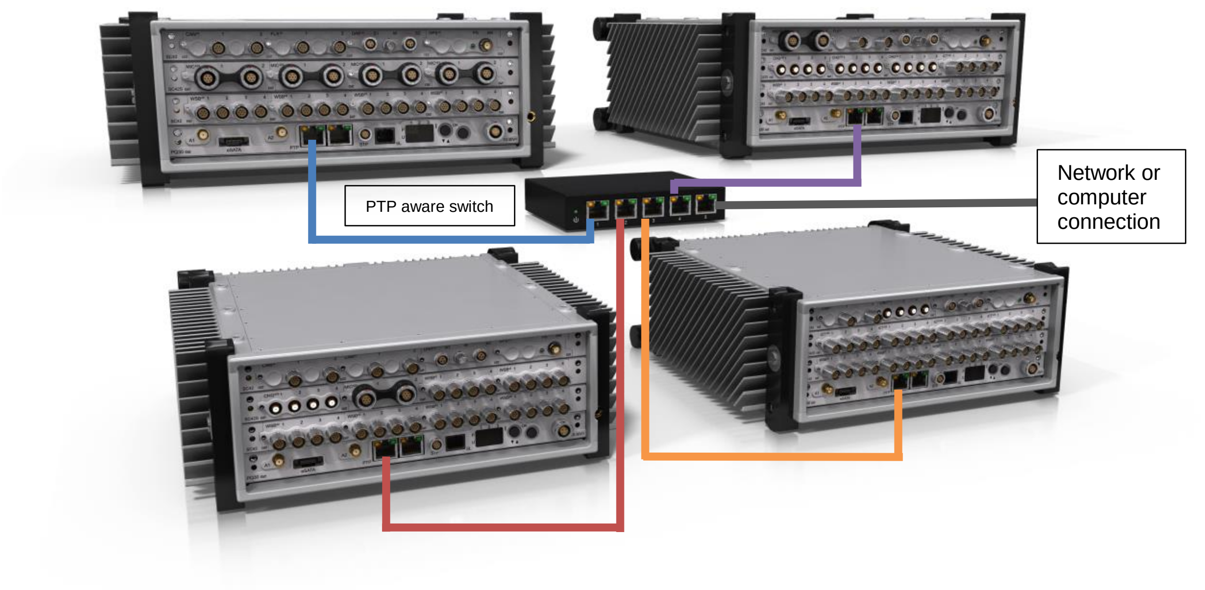


Figure 176. PTP synchronization

Any number of Mainframes, containing a PTP enabled Combined System Controller and Power Supply board can form part of the same system using PTP synchronization. The only criterion is that each Mainframe must be connected to the same network with Ethernet communication. When an Ethernet switch (PTP aware) is used to synchronize the Mainframes, an unlimited number of Mainframes can form a Cluster depending on the Ethernet switch ports. It is important to use a PTP switch for the Ethernet connections. This solution is suited when Mainframes should be synchronized, but not more than 100 m apart from each other.

Advantages of PTP synchronization

- No need for Optic Fiber cables or SyncLink boards in the system
- Easy to configure the synchronization setup
- Synchronize to other PTP aware hardware

Power Cables

Combined System Controller and Power Supply Board	Power Source					
	Bench / Battery	**Bench / Battery**	**Cigarette Lighter Socket 214K**	**Mean Well (15 V, 144 W)**	**Mean Well (15 V, 201 W)**	**TDK Lambda (26 V, 260 W)**
PQ11 G2	213K	216K, 221K	214K	230K, 231K	230K, 231K	213K, 216K, 221K
PQ12 G2	213K	216K, 221K	214K	230K, 231K	230K, 231K	213K, 216K, 221K
PQ20 G2	213K	216K, 221K	214K	230K, 231K	230K, 231K	213K, 216K, 221K
PQ30 G2	-	216K, 221K	214K	230K, 231K	230K, 231K	216K, 221K

Table 57. Power cables to be used per combined System Controller and Power Supply board

Termination	Max. Current	Length	Name
Mean Well AC-DC Adapters	15.0 A	1.0 m	230K
		Variable	231K
Banana Plugs		2.0 m	213K
Cigarette Lighter Plug		2.0 m	214K
Banana Plugs	20.0 A	2.0 m	216K
		Variable	221K

Table 58. Power cable details

System Accessories

This section highlights the accessories available to the User for use with the PAK MKII.

- SubModules provide enhanced functionality to the Modules they cater for,
- the MiniTerminal provides an easy way to display test information,
- the SeatFrame provides a method of securely fastening a PAK MKII within a car, and
- the RackMounts provide a way of fastening the PAK MKII to 19 inch racks

SubModules
A SubModule is sometimes required to provide a special interface to an individual sensor. SubModules are thus used to personalize a Module as the final interface to a sensor or provide features like cold junction temperature sensing.

MiniTerminal
The MT12 MiniTerminal provides a large, bright LED display as a practical solution to show test information as well as to receive commands from a user such as start or stop.

Transportation
The SF10 SeatFrame optimally secures a 2, 3, 4 or 6-slot Mainframe and notebook onto a car seat for mobile measurements.

Rack Mounted
The RM04, RM06 and RM10 RackMounts are compact, machined aluminum Rack Mounting Kits which house 4, 6 and 10-slot PAK MKII Mainframes in 19 inch racks.

SubModules

SubModules provide enhanced functionality to the Modules they cater for and are described in table below:

BBOX10	A 48 channel SubModule used with the ICM42S Module. Each input is routed to 5 independent outputs
ALOP10	A 32 channel SubModule used with 8 ALO42S G2 Module. Each channel is routed to SMB connectors
OSMB10	An 8 channel SubModule used with ICM42S or a BBOX10. Each channel is routed to SMB connectors
ICPM10	A 32 channel SubModule used with 8 ICP42 G2 Modules. Each channel is routed to one of two 50-pin D-sub connectors
ICPM10S	A 32 channel SubModule used with 8 ICP42S G2 or ICP42 G2 Modules. Each channel is routed to one of two 50-pin D-sub connectors
TBNC10	The Tri-BNC (TBNC) SubModule is used to split signals from a 9-way Lemo connector to 3 BNC connectors
TSMB10	The Tri-SMB (TSMB) SubModule is used to split signals from a 9-way Lemo connector to 3 SMB connectors
TMDT10	The Tri-MDT (TMDT) SubModule is used to split signals from a 9-way Lemo connector to 3 Microdot connectors
ICMA10	A 16 channel SubModule used with the ICM42S Module. Each input is routed to SMB connectors
ICTV11	A single channel SubModule used with an ICT42 G2 or ICT42S G2 Module. It protects a Tacho channel from high voltages
FLXB20	A SubModule which connects a FLX42 G2 Module to a FlexRay™ network, or a CAN42 G2 Module to a CANbus network
SMRM10	A panel designed to house SubModules
PSDP10	A multiport power panel used to supply power for up to 12 PAK MKII Mainframes
PSDP20	A multiport power panel used to supply power for up to 12 BBOX10/ALOP10s
THMx10	A single channel SubModule used with a THM42 G2 Module. It is used to connect two thermocouples to a single channel
THMP10	A single channel SubModule used with a THM42 G2 Module. It is used to connect two Pt100 sensors to a single channel

THMS10	A single channel SubModule used with a THM42 G2 Module. It provides 2 sets of 4-way general purpose screw terminals to connect to a pair of E, J, K or T thermocouples or a pair of Pt100 sensors
THMS10/250	The THMS10/250 SubModule is used in conjunction with a THM42 G2 Module. It converts constant current signals between 4 mA and 20 mA to voltages between 1 V and 5 V
QBNC11	A single channel SubModule used with an ALO42S G2 or ICM42S Module. It is used to expand the capacity of the Modules
VICP10	An interface board used to provide 10 V excitation to ICP® sensors

Table 59. SubModule details

BBOX10

The BBOX10 is a 48 channel Buffer Box, accepting an input signal from 3 ICM42S boards and providing 5 independent outputs of the input signal. One output is routed to the front patch panel for easy access and monitoring while the other four outputs are routed to 37-pin D-sub connectors at the back of the BBOX10. The buffer box has 3 identical blades of 16 input channels - each totaling 48 input channels. The BBOX10 includes a self-test feature that tests and verifies if all input and output channels are still functional. The inputs of the BBOX10 are differential and the outputs are single-ended.

Where used:

- Supports the outputs of up to three ICM42S
- Designed according to a 1.5 U form factor for rack-mounting in 19” racks
- Accepts 48 SMB connector inputs from 3 ICM42S boards
- Provides 5 independent outputs of the input signal:
    - 1 to each front patch panel
    - 4 to 37-pin D-sub connectors at the back of the BBOX10

Connection diagram per ICM42S

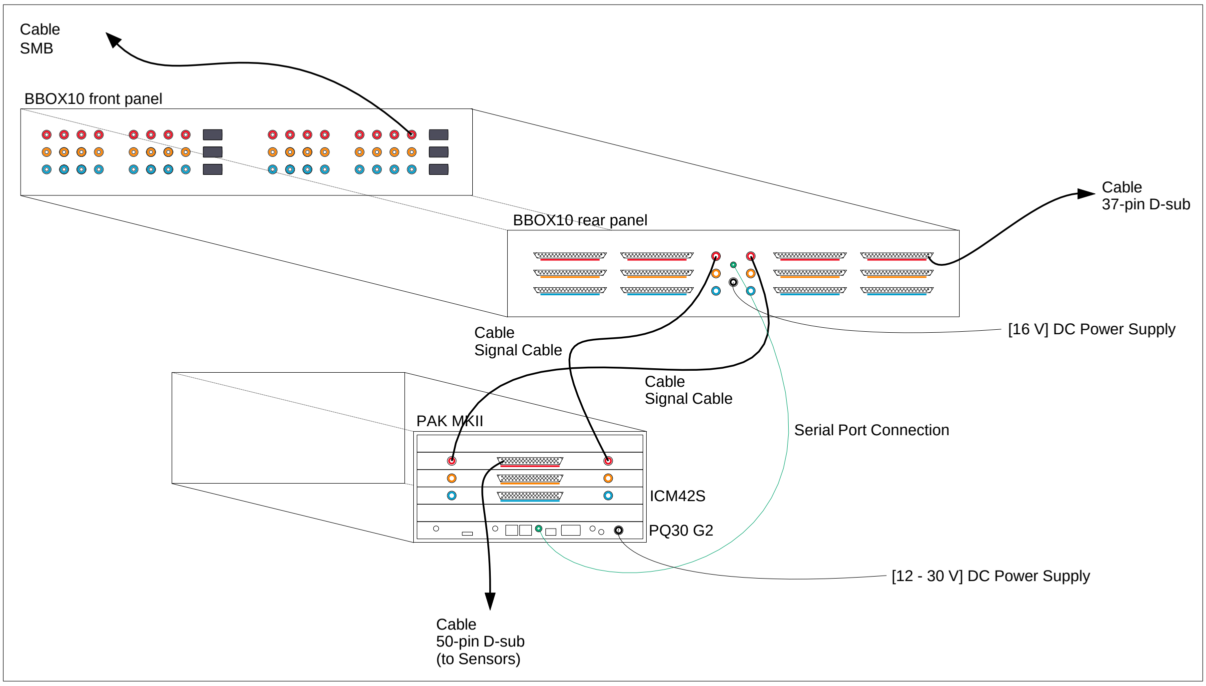


Figure 177. Implementing the BBOX10

Connector Information and Pin Definitions

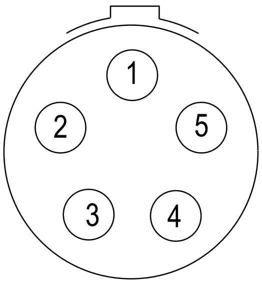


Figure 178. Pinout of the 5-pin Lemo connector

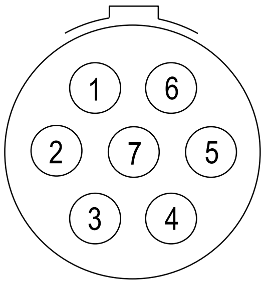


Figure 179. Pinout of the 7-pin Lemo connector

- Pin 1: +16 V
- Pin 2: +5 V
- Pin 3: GND
- Pin 4: -16 V
- Pin 5: AGND

- Pin 1: RS232 Rx
- Pin 2: RS232 Tx
- Pin 3: Not connected
- Pin 4: GND
- Pin 5: Not connected
- Pin 6: Not connected
- Pin 7: Not connected

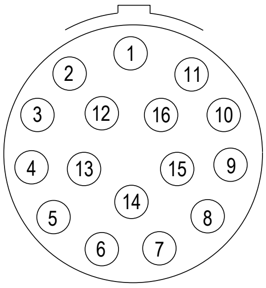


Figure 180. Pinout of the 16-pin Lemo connectors

- Pin 1: Channel 5-
- Pin 2: Channel 4+
- Pin 3: Channel 3-
- Pin 4: Channel 3+
- Pin 5: Channel 2-
- Pin 6: Channel 1+
- Pin 7: Channel 8+
- Pin 8: Channel 8-
- Pin 9: Channel 7+
- Pin 10: Channel 6-
- Pin 11: Channel 5+
- Pin 12: Channel 4-
- Pin 13: Channel 2+
- Pin 14: Channel 1-
- Pin 15: Channel 7-
- Pin 16: Channel 6+

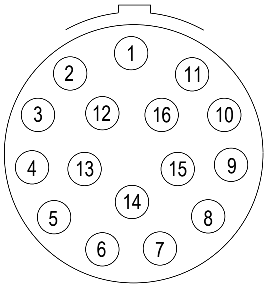


Figure 181. Pinout of the 16-pin Lemo connectors

- Pin 1: Channel 13-
- Pin 2: Channel 12+
- Pin 3: Channel 11-
- Pin 4: Channel 11+
- Pin 5: Channel 10-
- Pin 6: Channel 9+
- Pin 7: Channel 16+
- Pin 8: Channel 16-
- Pin 9: Channel 15+
- Pin 10: Channel 14-
- Pin 11: Channel 13+
- Pin 12: Channel 12-
- Pin 13: Channel 10+
- Pin 14: Channel 9-
- Pin 15: Channel 15-
- Pin 16: Channel 14+

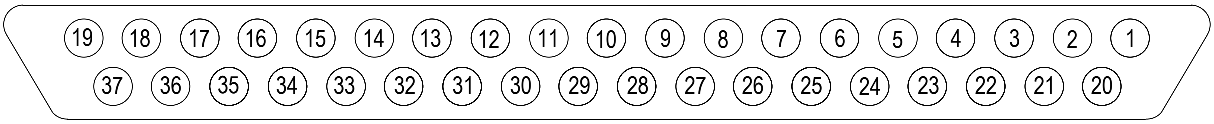


Figure 182. Pinout of the 37-pin D-sub connectors

- Pin 1: Channel 1+
- Pin 2: Channel 2+
- Pin 3: Channel 3+
- Pin 4: Channel 4+
- Pin 5: Channel 5+
- Pin 6: Channel 6+
- Pin 7: Channel 7+
- Pin 8: Channel 8+
- Pin 9: Reserved
- Pin 10: Reserved
- Pin 11: Reserved
- Pin 12: Channel 9+
- Pin 13: Channel 10+
- Pin 14: Channel 11+
- Pin 15: Channel 12+
- Pin 16: Channel 13+
- Pin 17: Channel 14+
- Pin 18: Channel 15+
- Pin 19: Channel 16+
- Pin 20: Channel 1-
- Pin 21: Channel 2-
- Pin 22: Channel 3-
- Pin 23: Channel 4-
- Pin 24: Channel 5-
- Pin 25: Channel 6-
- Pin 26: Channel 7-
- Pin 27: Channel 8-
- Pin 28: Reserved
- Pin 29: Reserved
- Pin 30: Channel 9-
- Pin 31: Channel 10-
- Pin 32: Channel 11-
- Pin 33: Channel 12-
- Pin 34: Channel 13-
- Pin 35: Channel 14-
- Pin 36: Channel 15-
- Pin 37: Channel 16-

ALOP10

The ALOP10 is a rack mountable SubModule for routing the analog output signals from up to eight ALO42S or ALO42S G2 Modules to individual male SMB connectors. The four 7-pin Lemo connectors of one ALO42S or ALO42S G2 Module are connected to a 023K cable, which is in turn plugged into the ALOP10 by means of a 37-pin D-sub connector. The analog output signals are routed to a corresponding section of the ALOP10 front panel. Reprogrammable channel numbering is provided for every eighth channel.

Where used:

- One ALOP10 can support the outputs of up to eight ALO42S or ALO42S G2 Modules
- Designed according to a 1.5 U form factor for rack-mounting in 19” racks
- Accepts eight 37-pin D-sub connector inputs
- Provides outputs in the form of 32 male SMB connectors

Connection diagram per channel

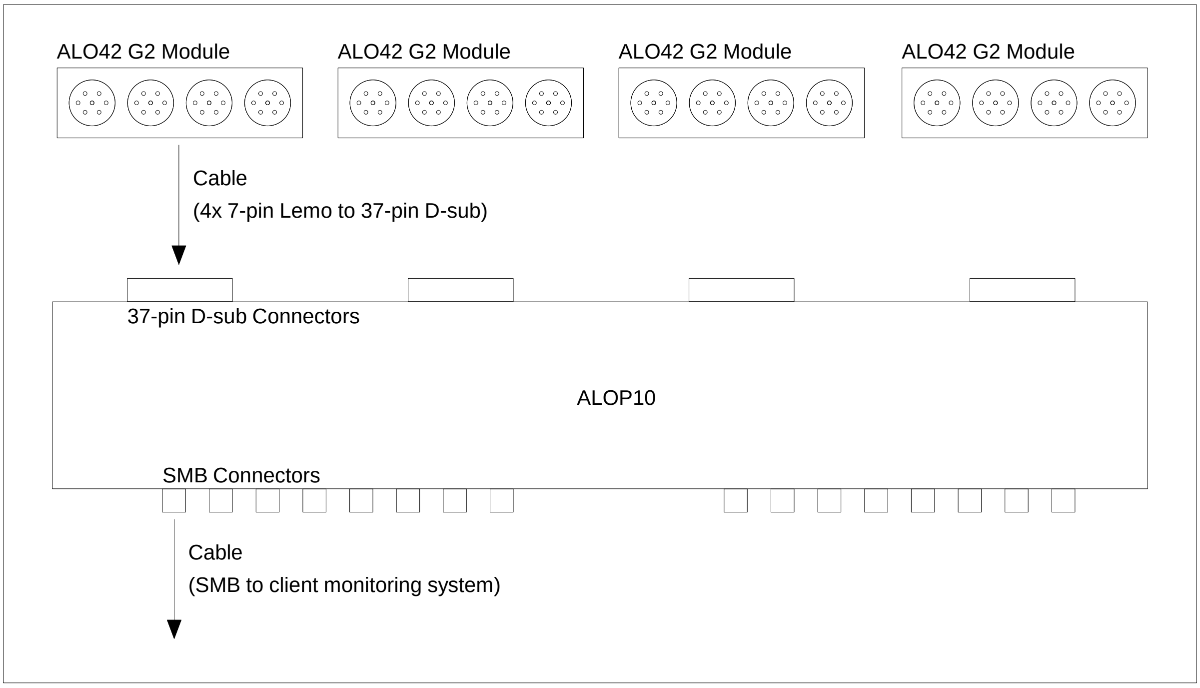


Figure 183. Implementing the ALOP10

Connector Information and Pin Definitions

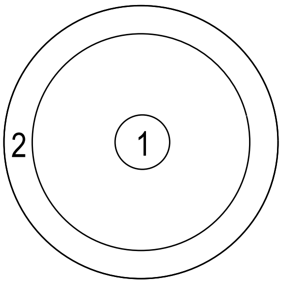


Figure 184. Pinout of the SMB connector

- Pin 1: Signal+
- Pin 2: Signal-

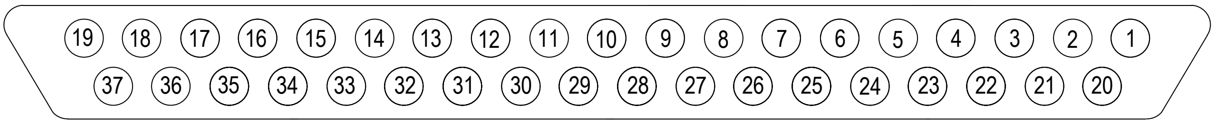


Figure 185. Pinout of the 37-pin D-sub connectors

- Pin 1: Signal 1+
- Pin 2: Reserved
- Pin 3: Reserved
- Pin 4: Reserved
- Pin 5: Signal 2+
- Pin 6: Reserved
- Pin 7: Reserved
- Pin 8: Reserved
- Pin 9: Reserved
- Pin 10: Reserved
- Pin 11: Reserved
- Pin 12: Signal 3+
- Pin 13: Reserved
- Pin 14: Reserved
- Pin 15: Reserved
- Pin 16: Signal 4+
- Pin 17: Reserved
- Pin 18: Reserved
- Pin 19: Reserved
- Pin 20: Signal 1-
- Pin 21: Reserved
- Pin 22: Reserved
- Pin 23: Reserved
- Pin 24: Signal 2-
- Pin 25: Reserved
- Pin 26: Reserved
- Pin 27: Reserved
- Pin 28: Reserved
- Pin 29: Reserved
- Pin 30: Signal 3-
- Pin 31: Reserved
- Pin 32: Reserved
- Pin 33: Reserved
- Pin 34: Signal 4-
- Pin 35: Reserved
- Pin 36: Reserved
- Pin 37: Reserved

OSMB10

The OSMB10 is a SubModule that is used to break out signals from a 16-pin Lemo connector to 8 SMB connectors. The SubModule can not only be used to break out the monitor output signals from the 16-pin Lemo of the ICM42S but also from the BBOX10.

Where used:

- One OSMB10 is to be used with either an ICM42S or a BBOX10
- Designed to break out the monitor output signals from the ICM42S or BBOX10
- Accepts an input connection from a 16-way Lemo FGG 1B connector
- Provides 8 SMB output connections

Connection diagram per channel

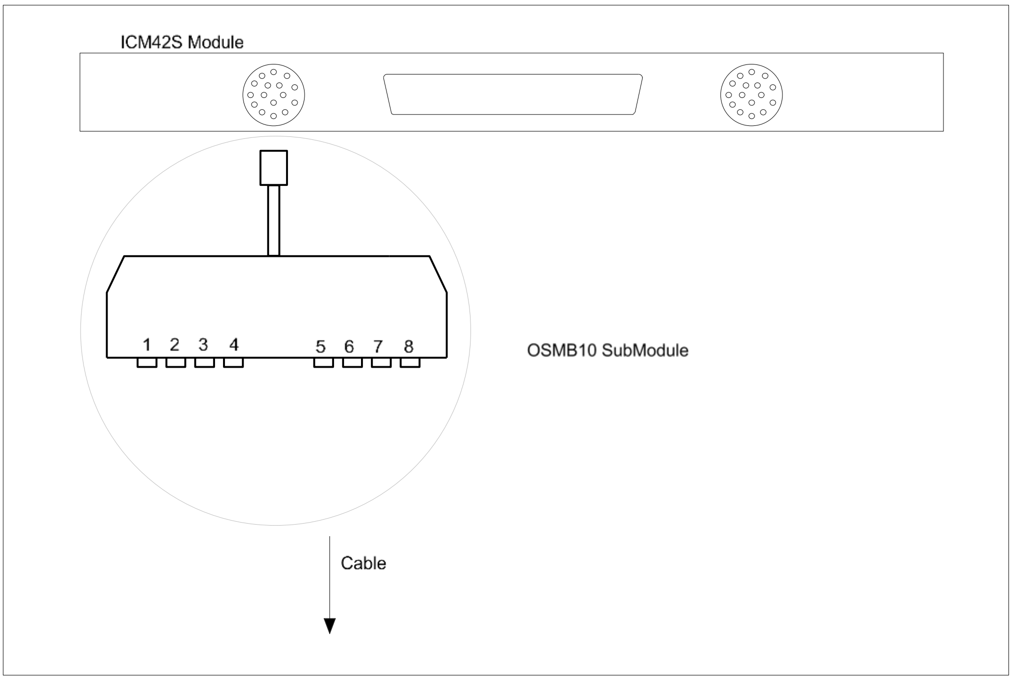


Figure 186. Implementing the OSMB10

Connector Information and Pin Definitions

The OSMB10 can be connected to the left hand side 16-way Lemo for the first 8 Monitor output channels and to the second 16-way Lemo for Monitor output channels 9 to 16.

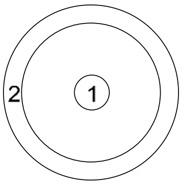


Figure 187. SMB1 of OSMB10 subModule

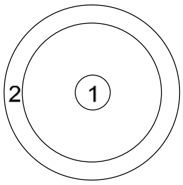


Figure 188. SMB2 of OSMB10 subModule

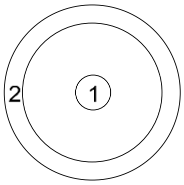


Figure 189. SMB3 of OSMB10 subModule

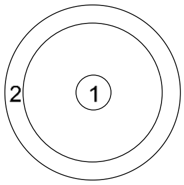


Figure 190. SMB4 of OSMB10 subModule

Pin 1: CH1 Monitor + Pin 2: CH1 Monitor -	Pin 1: CH2 Monitor + Pin 2: CH2 Monitor -	Pin 1: CH3 Monitor + Pin 2: CH3 Monitor -	Pin 1: CH4 Monitor + Pin 2: CH4 Monitor -

Table 60. OSMB10 Pinouts when connected to an ICM42S Module

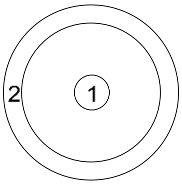


Figure 191. SMB5 of OSMB10 subModule

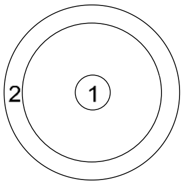


Figure 192. SMB6 of OSMB10 subModule

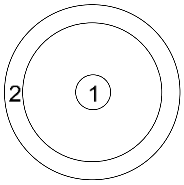


Figure 193. SMB7 of OSMB10 subModule

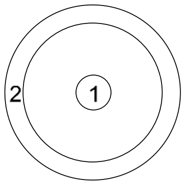


Figure 194. SMB8 of OSMB10 subModule

Pin 1: CH5 Monitor +	Pin 1: CH6 Monitor +	Pin 1: CH7 Monitor +	Pin 1: CH8 Monitor +
Pin 2: CH5 Monitor -	Pin 2: CH6 Monitor -	Pin 2: CH7 Monitor -	Pin 2: CH8 Monitor -

Table 61. OSMB10 Pinouts when connected to an ICM42S Module

ICMA10

The ICMA10 is a SubModule that is used to break out signals from a 50-pin D-sub connector to 16 SMB connectors. The SubModule is designed for use with the ICM42S Module.

Where used:

- One OSMB10 is to be used with the ICM42S
- Designed to be connected to the front panel of the ICM42S
- Accepts an input connection from a 50-pin D-sub connector
- Provides 16 SMB output connections

Connection diagram per channel

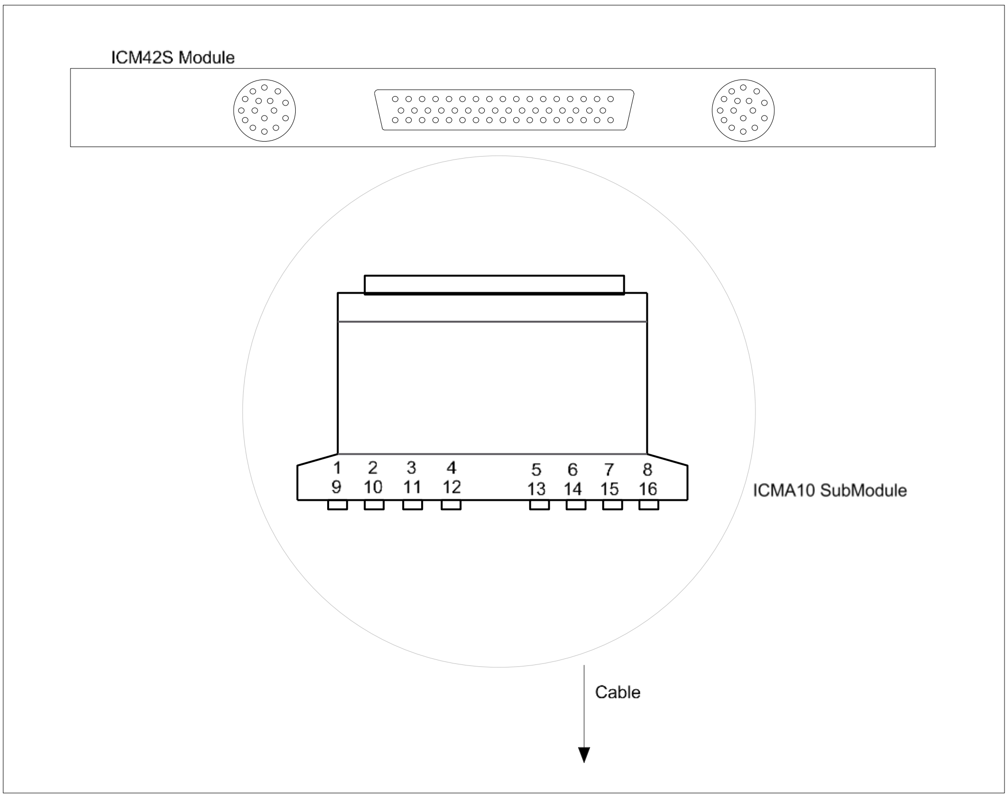


Figure 195. Implementing the ICMA10

Connector Information and Pin Definitions

The signal connections for all 16 SMB connectors on the ICMA10 have the same pin definitions

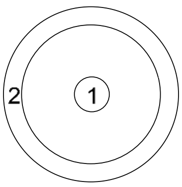


Figure 196. SMBs on ICMA10

SMB1	Pin 1: CH1 Monitor + Pin 2: CH1 Monitor -	SMB9	Pin 1: CH9 Monitor + Pin 2: CH9 Monitor -
SMB2	Pin 1: CH2 Monitor + Pin 2: CH2 Monitor -	SMB10	Pin 1: CH10 Monitor + Pin 2: CH10 Monitor -
SMB3	Pin 1: CH3 Monitor + Pin 2: CH3 Monitor -	SMB11	Pin 1: CH11 Monitor + Pin 2: CH11 Monitor -
SMB4	Pin 1: CH4 Monitor + Pin 2: CH4 Monitor -	SMB12	Pin 1: CH12 Monitor + Pin 2: CH12 Monitor -
SMB5	Pin 1: CH5 Monitor + Pin 2: CH5 Monitor -	SMB13	Pin 1: CH13 Monitor + Pin 2: CH13 Monitor -
SMB6	Pin 1: CH6 Monitor + Pin 2: CH6 Monitor -	SMB14	Pin 1: CH14 Monitor + Pin 2: CH14 Monitor -
SMB7	Pin 1: CH7 Monitor + Pin 2: CH7 Monitor -	SMB15	Pin 1: CH15 Monitor + Pin 2: CH15 Monitor -
SMB8	Pin 1: CH8 Monitor + Pin 2: CH8 Monitor -	SMB16	Pin 1: CH16 Monitor + Pin 2: CH16 Monitor -

Table 62 ICMA10 Pinouts when connected to an ICM42S Module

ICPM10 and ICPM10S

The ICPM10 personalizes ICP42 G2 Modules by providing two 50-pin D-sub Connectors. (Similarly, the ICPM10S personalizes ICP42S G2 Modules). As a compound SubModule, it takes the form of a breakout box which is secured on the top of any Mainframe. These breakout boxes are stackable with the option to secure two compound Modules on top of each other. The strength of the SubModule concept lies in its flexibility, as the ICPM10 with its 50-pin D-sub Interface may be easily removed if not required for certain tests.

Where used:

- One ICPM10 can support the outputs of up to 8 ICP42 G2 Modules
- The ICPM10S can support the outputs of up to 8 ICP42S G2 Modules
- Designed in the form of a breakout box which is secured to the top of any Mainframe
- Accepts 32 SMB connector inputs
- Provides outputs in the form of two 50-pin D-sub connectors

Connection diagram per channel

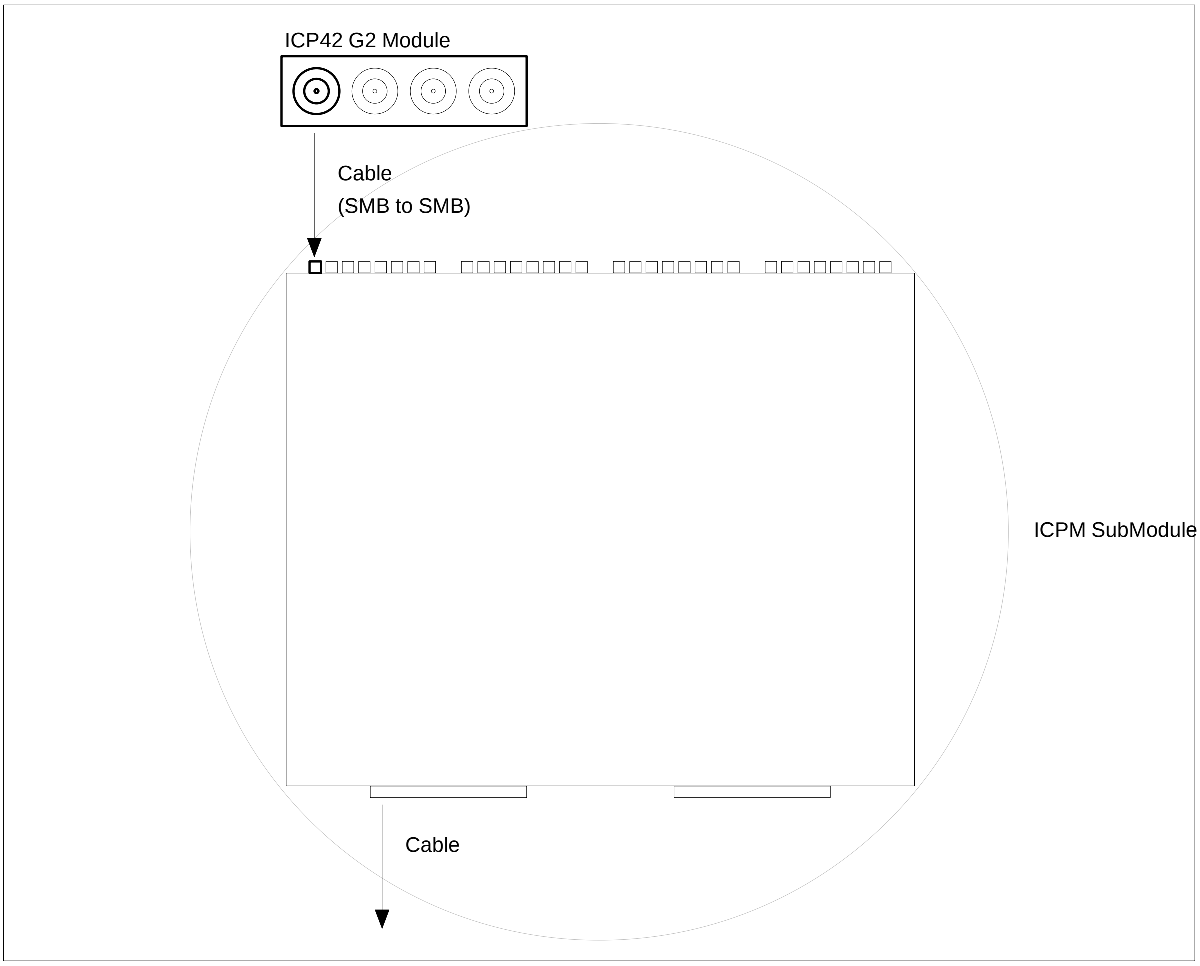


Figure 197. Implementing the ICPM SubModule

Connector Information and Pin Definitions

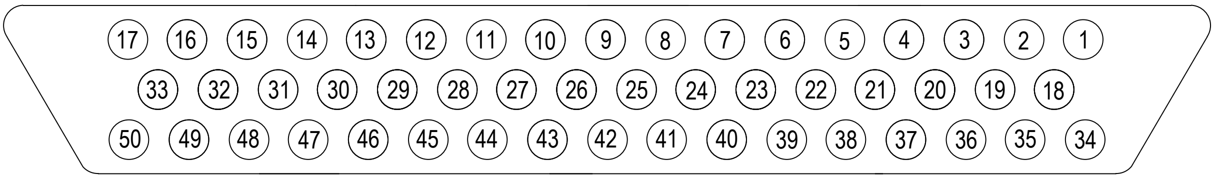


Figure 198. Pinout of each DB50 connector

DB50 1 pin	Description	DB50 2 pin	Description
1	Channel 1+	1	Channel 17+
2	Channel 2-	2	Channel 18-
3	Channel 3+	3	Channel 19+
4	Channel 4-	4	Channel 20-
5	Channel 5+	5	Channel 21+
6	Channel 6-	6	Channel 22-
7	Channel 7+	7	Channel 23+
8	Channel 8-	8	Channel 24-
9	No connect	9	No connect
10	Channel 9 shield	10	Channel 25 shield
11	Channel 10+	11	Channel 26+
12	Channel 11 shield	12	Channel 27 shield
13	Channel 12+	13	Channel 28+
14	Channel 13 shield	14	Channel 29 shield
15	Channel 14+	15	Channel 30+
16	Channel 15 shield	16	Channel 31 shield
17	Channel 16+	17	Channel 32+
18	Channel 1-	18	Channel 17-
19	Channel 2 shield	19	Channel 18 shield
20	Channel 3-	20	Channel 19-
21	Channel 4 shield	21	Channel 20 shield
22	Channel 5-	22	Channel 21-
23	Channel 6 shield	23	Channel 22 shield
24	Channel 7-	24	Channel 23-
25	Channel 8 shield	25	Channel 24 shield

Table 63. Pinouts (1 to 25) of the ICPM SubModule

DB50 1 pin	Description	DB50 2 pin	Description
26	Channel 9+	26	Channel 25+
27	Channel 10-	27	Channel 26-
28	Channel 11+	28	Channel 27+
29	Channel 12-	29	Channel 28-
30	Channel 13+	30	Channel 29+
31	Channel 14-	31	Channel 30-
32	Channel 15+	32	Channel 31+
33	Channel 16-	33	Channel 32-
34	Channel 1 shield	34	Channel 17 shield
35	Channel 2+	35	Channel 18+
36	Channel 3 shield	36	Channel 19 shield
37	Channel 4+	37	Channel 20+
38	Channel 5 shield	38	Channel 21 shield
39	Channel 6+	39	Channel 22+
40	Channel 7 shield	40	Channel 23 shield
41	Channel 8+	41	Channel 24+
42	No connect	42	No connect
43	Channel 9-	43	Channel 25-
44	Channel 10 shield	44	Channel 26 shield
45	Channel 11-	45	Channel 27-
46	Channel 12 shield	46	Channel 28 shield
47	Channel 13-	47	Channel 29-
48	Channel 14 shield	48	Channel 30 shield
49	Channel 15-	49	Channel 31-
50	Channel 16 shield	50	Channel 32 shield

Table 64. Pinouts (26 to 50s) of the ICPM SubModule

TBNC10

The TBNC10 is used to connect to the ICS42 G2 Module. The Tri-BNC10 SubModule splits signals, from a 9-way Lemo connector on the Module's front panel, to 3 BNC connectors to easily connect sensors. Three BNC connectors are provided on the SubModule to interface to the appropriate triaxial or single axis accelerometer. The SubModule connects to the ICS42 G2 Module through a 500 mm fly-lead.

Where used:

- With any ICP® based sensor commonly used to measure vibration, acceleration, force or pressure
- With any voltage source up to ±10 V in voltage input mode

Connection diagram per channel

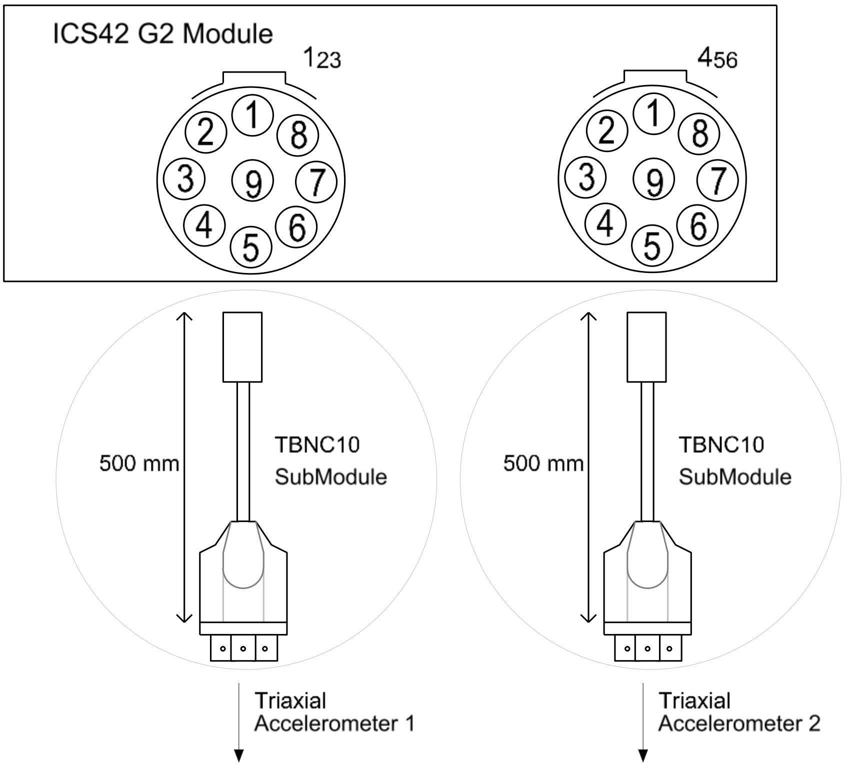


Figure 199. Implementing the TBNC10

Connector Information and Pin Definitions

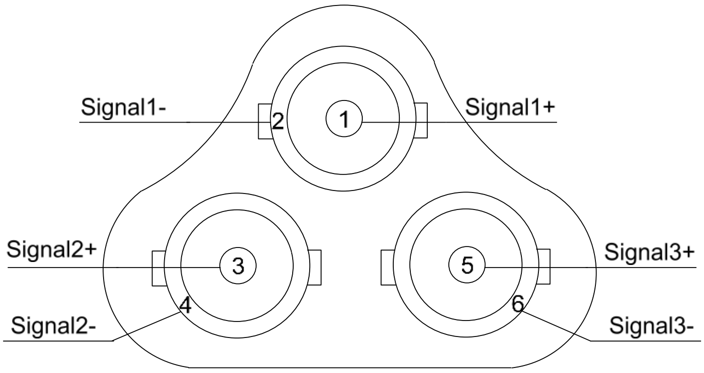


Figure 200. TBNC10 Pinout

Pin Number of TBNC10	Signal name	Channel on ICS42 G2		Triaxial Accelerometer pin
		Left Lemo	Right Lemo	
1	Signal 1+	Channel 1+	Channel 4+	X+
2	Signal 1-	Channel 1-	Channel 4-	GNDx
3	Signal 2+	Channel 2+	Channel 5+	Y+
4	Signal 2-	Channel 2-	Channel 5-	GNDy
5	Signal 3+	Channel 3+	Channel 6+	Z+
6	Signal 3-	Channel 3-	Channel 6-	GNDz

Table 65. Pin descriptions of TBNC10, ICS42 G2 and triaxial accelerometer

TSMB10

The TSMB10 is used to connect to the ICS42 G2 Module. The Tri-SMB10 SubModule splits signals, from a 9-way Lemo connector on the Module's front panel, to 3 SMB connectors to easily connect sensors. Three SMB connectors are provided on the SubModule to interface to the appropriate triaxial or single axis accelerometer. The SubModule connects to the ICS42 G2 Module through a 500 mm fly-lead.

Where used:

- With any ICP® based sensor commonly used to measure vibration, acceleration, force or pressure
- With any voltage source up to ±10 V in voltage input mode

Connection diagram per channel

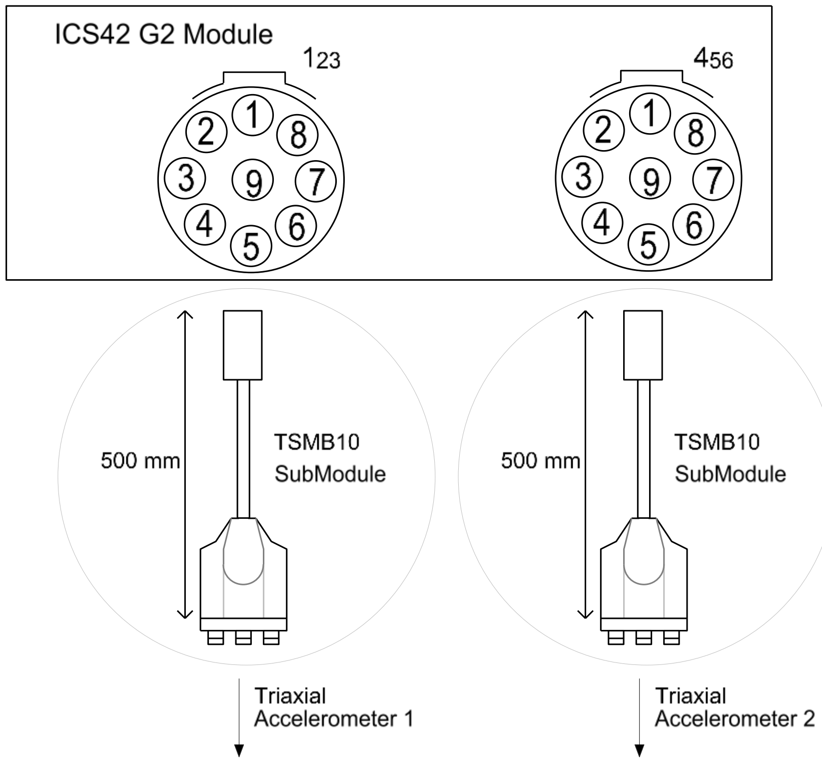


Figure 201. Implementing the TSMB10

Connector Information and Pin Definitions

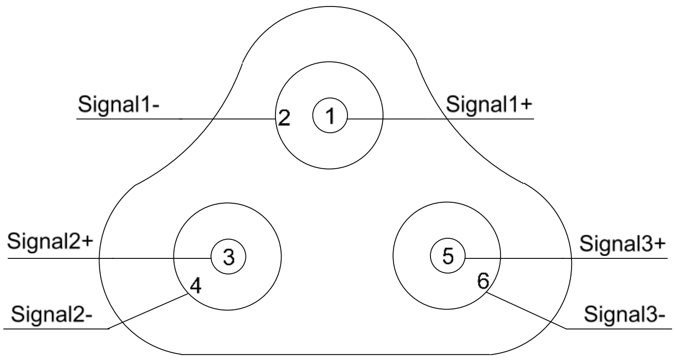


Figure 202. TSMB10 Pinout

Pin Number of TSMB10	Signal name	Channel on ICS42 G2		Triaxial Accelerometer pin
		Left Lemo	Right Lemo	
1	Signal 1+	Channel 1+	Channel 4+	X+
2	Signal 1-	Channel 1-	Channel 4-	GNDx
3	Signal 2+	Channel 2+	Channel 5+	Y+
4	Signal 2-	Channel 2-	Channel 5-	GNDy
5	Signal 3+	Channel 3+	Channel 6+	Z+
6	Signal 3-	Channel 3-	Channel 6-	GNDz

Table 66. Pin descriptions of TSMB10, ICS42 G2 and triaxial accelerometer

ICTV11

The ICTV11 is used to protect the ICT42 G2, ICT42S G2 Module’s tacho inputs from excessively high voltages. These may occur when inductive devices are discharged or when measuring close to high voltage circuitry. The SubModule contains high energy over-voltage dissipation devices. These devices limit the output voltage to reasonable values which will not destroy the internal circuitry of the ICT42 G2, ICT42S G2 Modules. A BNC connector is provided on the SubModule to interface to the appropriate tacho sensor. The SubModule connects to the ICT42 G2, ICT42S G2 Module through a 300 mm fly-lead ending with a 4-pin Lemo FGG 0B connector.

Where used:

- Supports one tacho channel on an ICT42 G2 or ICT42S G2 Module
- Designed as a SubModule used to protect a Tacho channel from excessively high voltages
- Accepts one 4-pin Lemo FGG 0B connector
- Provides a BNC connector to interface to the appropriate Tacho sensor

Connection diagram per channel

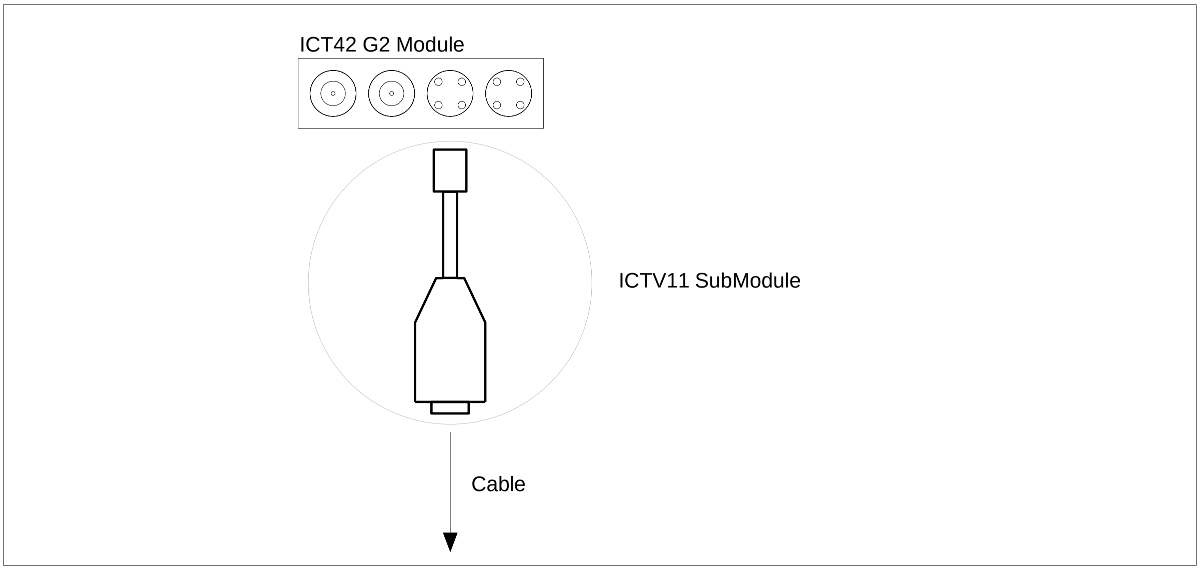


Figure 203. Implementing the ICTV11

Connector Information and Pin Definitions

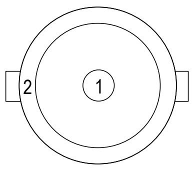


Figure 204. ICTV11 Pinout

- Pin 1: Signal +
- Pin 2: Signal -

FLXB20

The FLXB20 SubModule provides an interface to a 9-pin D-sub connection. The FLXB20 SubModule is used to connect a FLX42 G2 Module to a FlexRay™ network. It provides the interface between the 7-pin Lemo connector on the FLX42 G2 Module and the 9-pin D-sub connector on the FlexRay™ network.

Where used (FlexRay™):

- One FLXB20 SubModule can connect a FLX42 G2 Module to a FlexRay™ network (3 m cable length)
- Designed as a SubModule used to connect one channel of a FLX42 G2 Module to a FlexRay™ network
- Accepts a single 7-pin Lemo FGG 0B connector
- The FLXB20 provides the interface to the 9-pin D-sub connector on the FlexRay™ network over a 3 m cable

The FLXB20 SubModule can also be used to connect a CAN42 G2 Module to a CANbus network. Here it provides the interface between the 7-pin Lemo connector on the CAN42 G2 Module and the 9-pin D-sub connector on the CANbus network. Where Used (CANbus):

- Connects a CAN42 G2 Module to a CANbus network (3 m cable length or 300 mm cable length for high-speed)
- Accepts a single 7-pin Lemo FGG 0B connector
- Provides the interface to the 9-pin D-sub connector on the CANbus network over a 3 m cable

Connection diagram per channel

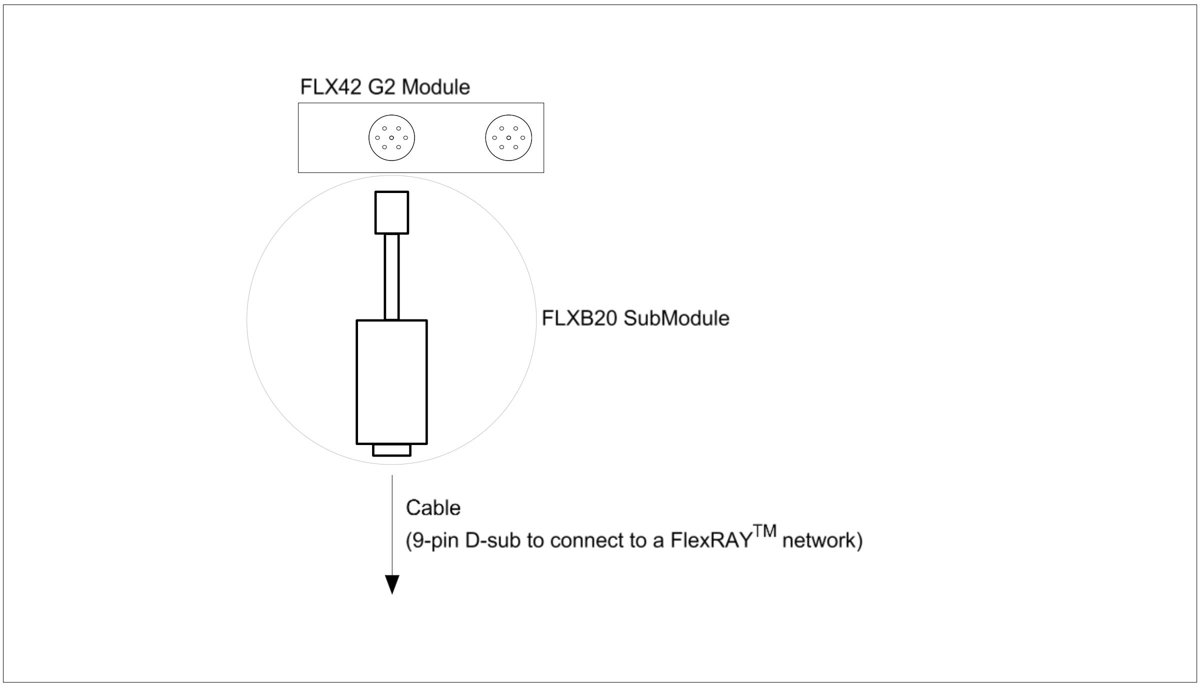


Figure 205. Implementing the FLXB20

Connector Information and Pin Definitions

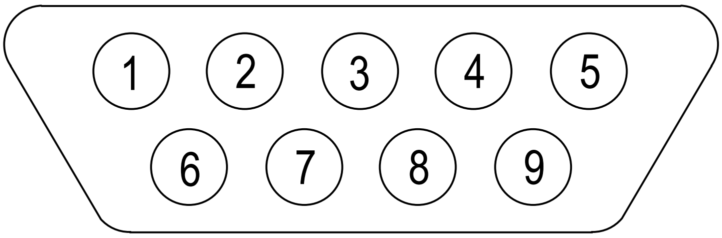


Figure 206. Pinout of the 9-pin D-sub connector

- Pin 1: Not connected
- Pin 2: FLX Bus Minus
- Pin 3: FLX Ground (network ground or common ground)
- Pin 4: Not connected
- Pin 5: Chassis ground (cable shield) – not used
- Pin 6: Optional FLX Ground – not used
- Pin 7: FLX Bus Plus
- Pin 8: Not connected
- Pin 9: VBAT – not used

SMRM10

The SMRM10 is a panel designed to house SubModules. It can be used to house any of the various SubModules as all SubModules have the same height. The SMRM10 has been designed to be mounted in a 19 inch rack.

Where used:

- Provides the housing for up to 7 SubModules
- Designed according to a 1.5 U form factor for rack-mounting in 19” racks
- Accepts any SubModule type
- Enables a convenient and neat location for where to place SubModules connected to a PAK MKII Mainframe

Connection diagram per channel

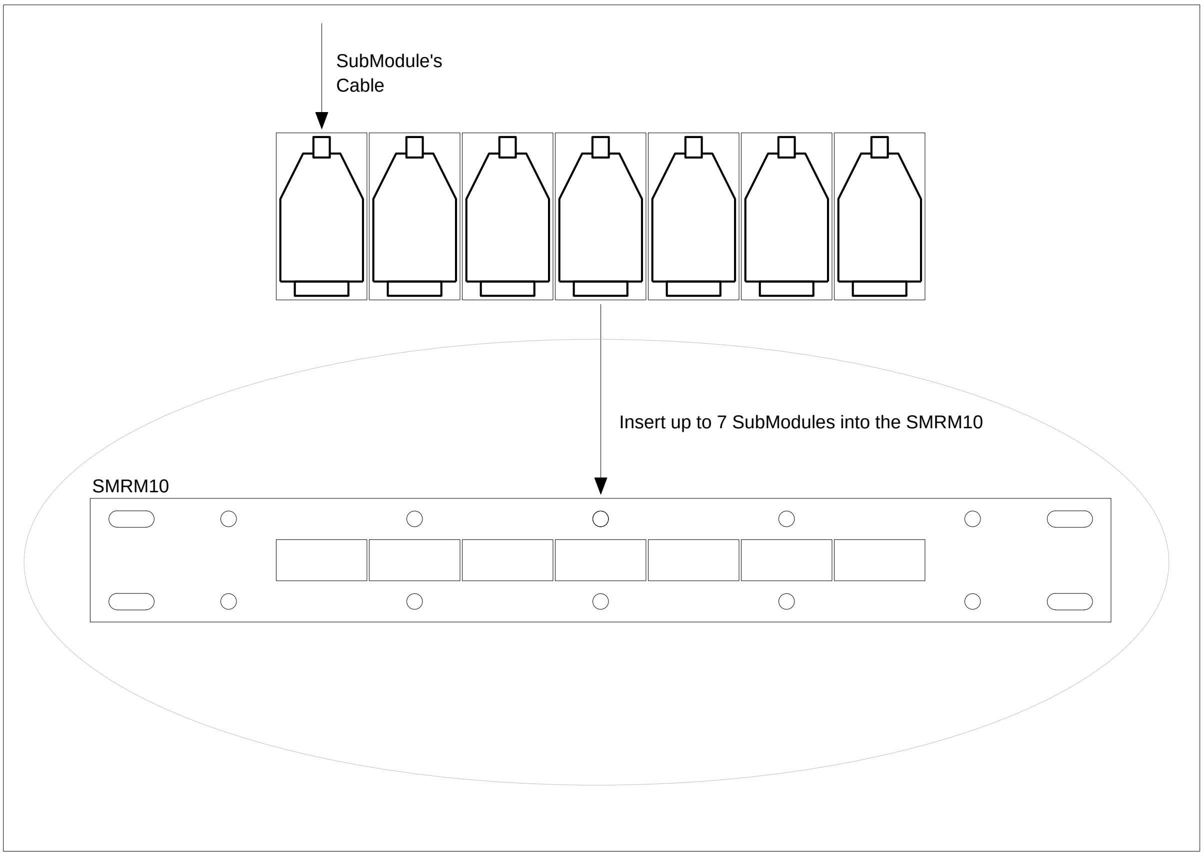


Figure 207. Implementing the SMRM10 into a 19” rack

PSDP10

The PSDP10 is a multiport power distribution panel for powering multiple PAK MKII Mainframes. The panel (which is designed to be mounted in a 19 inch rack) is supplied power through a 5-pin high power D-subminiature port and provides power to 12 recipient PAK MKII Mainframes through 4-pin Lemo connectors.

Where used:

- Supplies the power for up to 12 PAK MKII Mainframes
- Designed according to a 1.5 U form factor for rack-mounting in 19" racks
- Accepts power through a 5-pin high power D-subminiature port
- Provides twelve 4-pin Lemo connectors

Connection diagram per channel

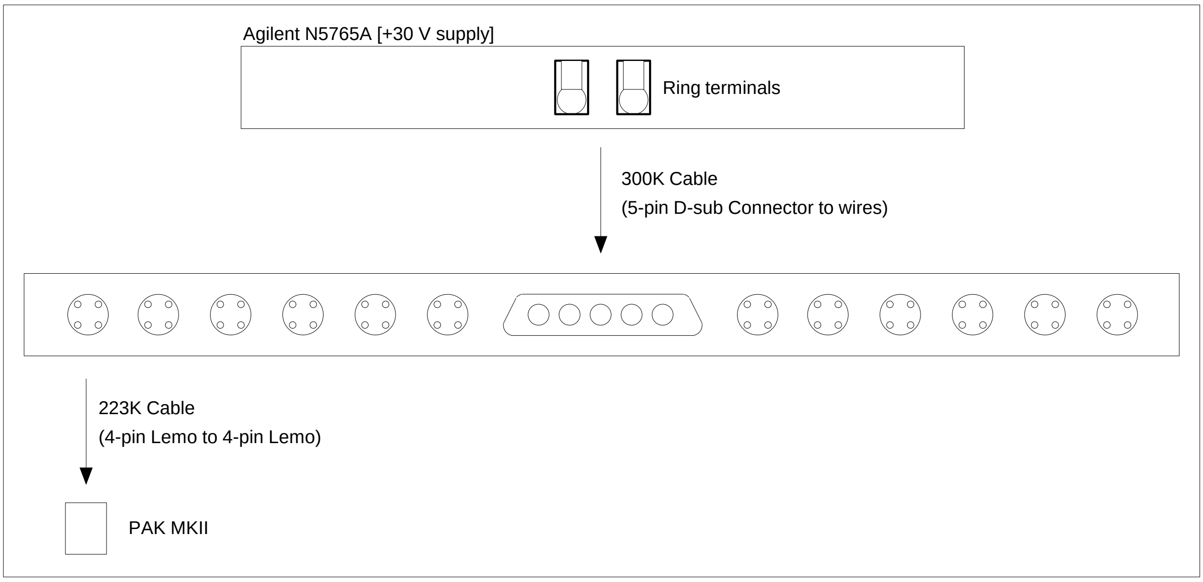


Figure 208. Implementing the PSDP10

Connector Information and Pin Definitions

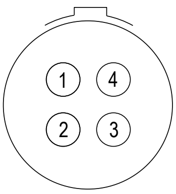


Figure 209. Pinout of the 4-pin Lemo

- Pin 1: +ve
- Pin 2: -ve
- Pin 3: -ve
- Pin 4: +ve

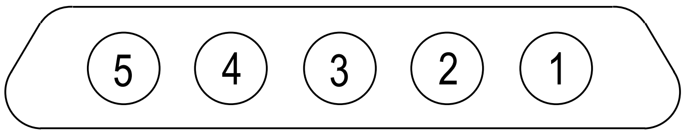


Figure 210. Pinout of the 5-pin D-sub power connector

- Pin 1: +ve
- Pin 2: +ve
- Pin 3: Not connected
- Pin 4: -ve
- Pin 5: -ve

PSDP20

Similarly, the PSDP20 is a multiport power distribution panel for powering multiple BBOX10 or ALOP10s. The panel is supplied power through an 8-pin high power D-subminiature port and provides power to the recipient cards through 5-pin Lemo connectors.

Where used:

- Supplies the power for up to 12 BBOX10 and/or ALOP10
- Designed according to a 1.5 U form factor for rack-mounting in 19” racks
- Accepts power through an 8-pin high power D-subminiature port
- Provides twelve 5-pin Lemo connectors

Connection diagram per channel

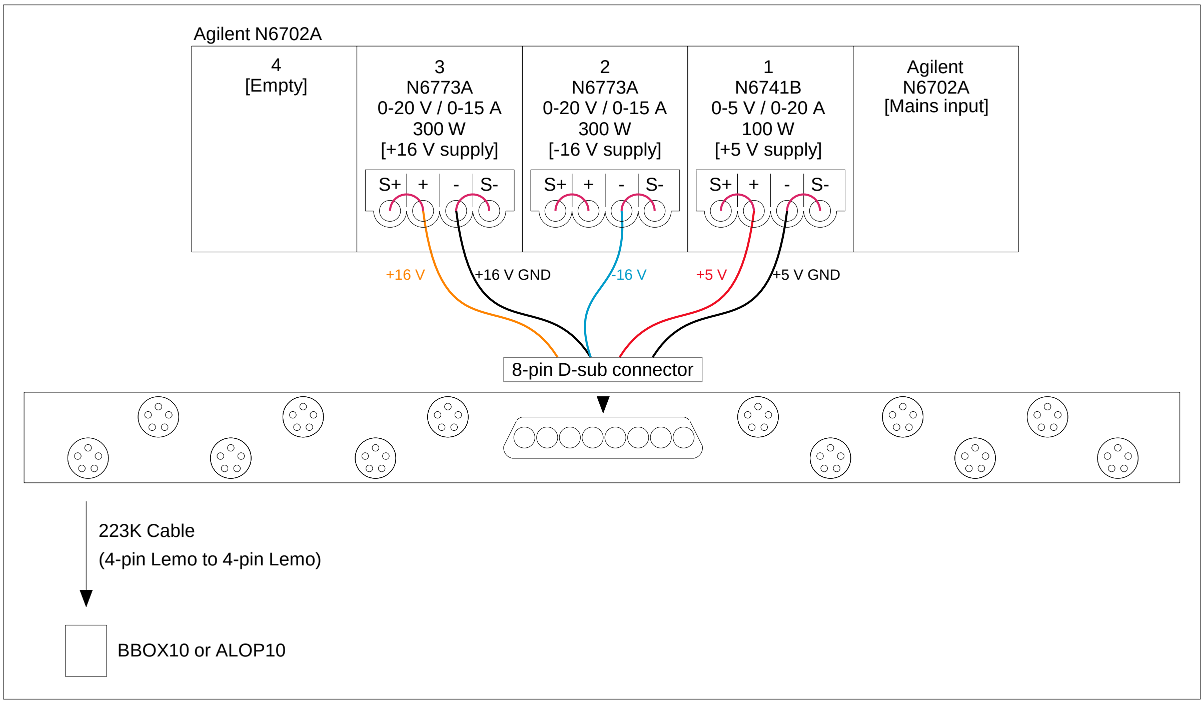


Figure 211. Implementing the PSDP20

Connector Information and Pin Definitions

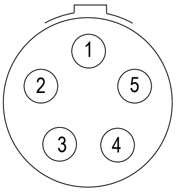


Figure 212. Pinout of the 5-pin Lemo

- Pin 1: +16 V
- Pin 2: +5 V
- Pin 3: +5 V GND
- Pin 4: -16 V
- Pin 5: ±16 V GND

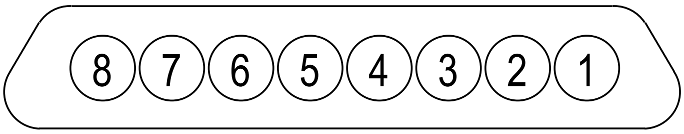


Figure 213. Pinout of the 8-pin D-sub power connector

- Pin 1: +5 V
- Pin 2: +5 V GND
- Pin 3: No connect
- Pin 4: No connect
- Pin 5: No connect
- Pin 6: -16 V
- Pin 7: ±16 V GND
- Pin 8: +16 V

THMx10

Seven thermocouple based SubModules exist, each containing dedicated thermocouple connectors. Each SubModule contains a pair of miniature thermocouple connectors, of the appropriate alloy and color, according to either IEC or ANSI standards. Cold-junction-compensation is facilitated through the use of a 0.5 °C accurate temperature sensor in thermal contact with the connectors' contacts. The SubModule type is identified through a TEDS interface.

Each SubModule connects to the THM42 or THM42 G2 Module through a 300 mm fly-lead ending with a 7-way Lemo FGG 0B connector.

Connection diagram per channel

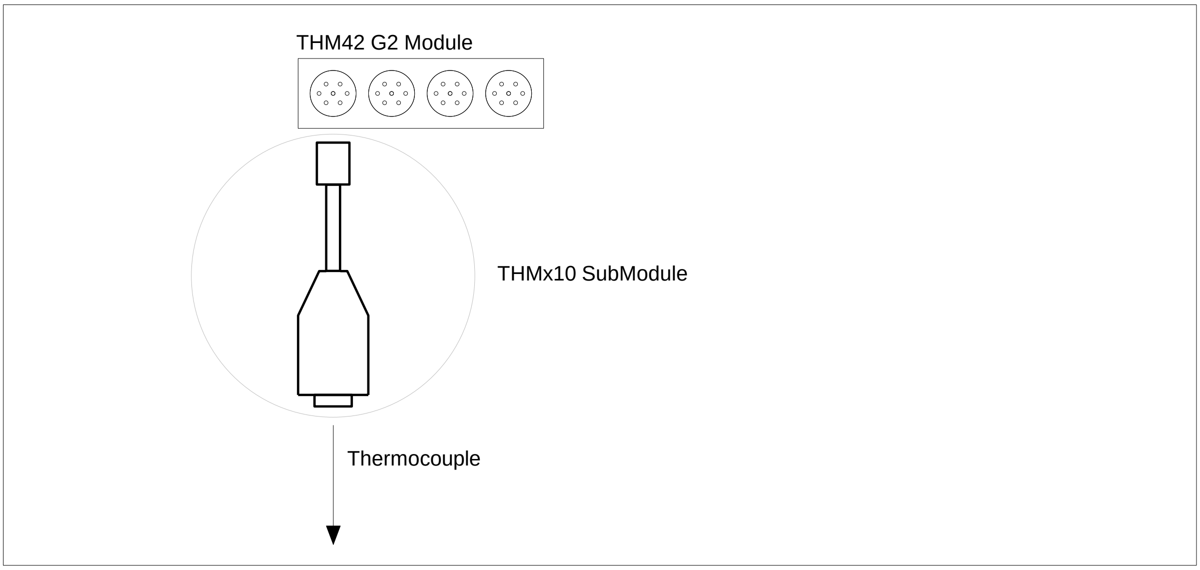


Figure 214. Implementing the THMx10

Connector Information and Pin Definitions

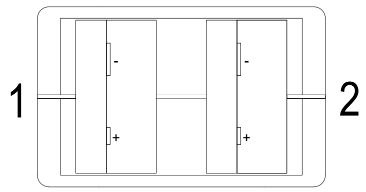


Figure 215. Pinout for the THMx10 SubModules

Miniature thermocouple connector 1 (and similarly thermocouple connector 2):

- Pin +: Thermocouple +
- Pin -: Thermocouple -

These 7 SubModules can be listed as follows:	
	The THME10 SubModule contains Chromel/Constantan (NiCr/CuNi) alloys and has lilac connectors (IEC 584-3 and ANSI MC 96.1)
	The THMJ10 SubModule contains Iron/ Constantan (Fe/CuNi) alloys and has black connectors (both IEC 584-3 and ANSI MC 96.1)
	The THMK10 SubModule contains Chromel/Alumel (NiCr/NiAl) alloys and has green connectors (IEC 584-3)
	The THMK10 SubModule contains Chromel/Alumel (NiCr/NiAl) alloys and has yellow connectors (ANSI MC 96.1)
	The THMT10 SubModule contains Copper/Constantan (Cu/CuNi) alloys and has blue connectors (ANSI MC 96.1)
	The THMT10 SubModule contains Copper/Constantan (Cu/CuNi) alloys and has brown connectors (IEC 584-3)
	The THMU10 SubModule contains Copper/Copper (Cu/Cu) alloys and has white connectors

Table 67. Seven thermocouple based SubModules

THMP10

The THMP10 SubModule is used in conjunction with a THM42 G2 Module to provide 2 sets of 4-way Lemo EGG 0B connectors for use with 2 Pt100 sensors. These connectors provide current to a Pt100 sensor and sense the voltage across it. The SubModule type is identified through a TEDS interface. The THMP10 SubModule connects to the THM42 G2 Module through a 300 mm fly-lead ending with a 7-way Lemo FGG 0B connector.

Where used:

- Supports one channel on a THM42 G2 Module by linking the channel to two sensors
- Designed as a SubModule used to expand the capacity of the THM42 G2 Module
- Accepts one 7-pin Lemo FGG 0B connector
- Provides two sets of 4-pin Lemo EGG 0B connectors for use with Pt100 sensors

Connection diagram per channel

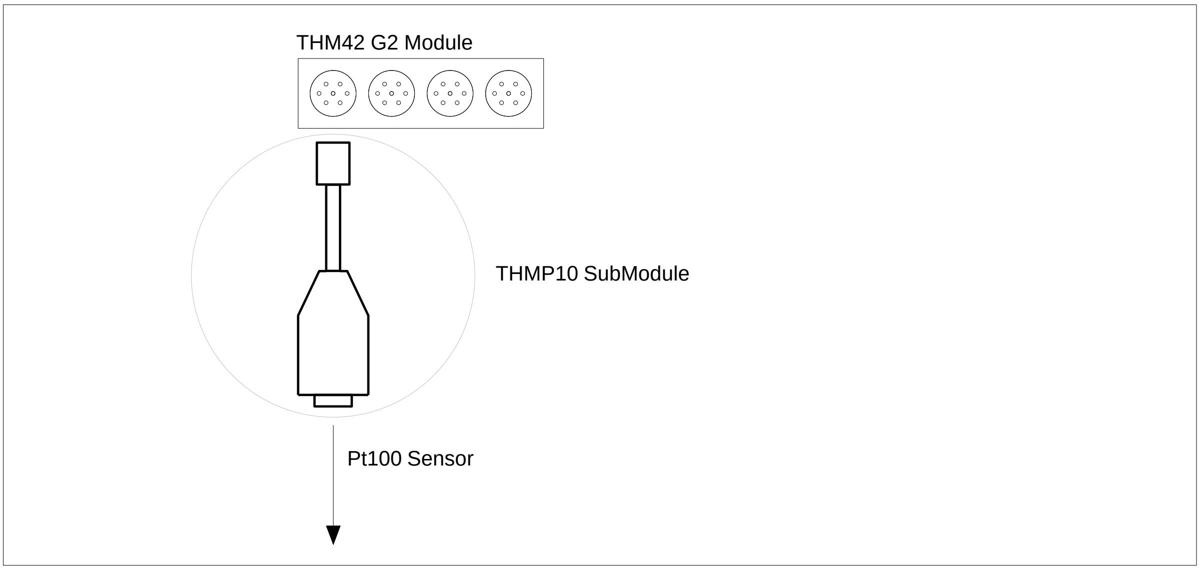


Figure 216. Implementing the THMP10

Connector Information and Pin Definitions

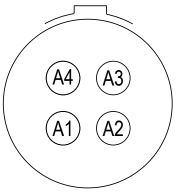


Figure 217. Pinouts for the first 4-pin Lemo

- Pin A1: Positive current lead of first Pt100
- Pin A2: Positive signal lead of first Pt100
- Pin A3: Negative signal lead of first Pt100
- Pin A4: Negative current lead of first Pt100

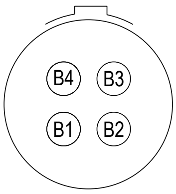


Figure 218. Pinouts for the second 4-pin Lemo

- Pin B1: Positive current lead of second Pt100
- Pin B2: Positive signal lead of second Pt100
- Pin B3: Negative signal lead of second Pt100
- Pin B4: Negative current lead of second Pt100

THMS10

The THMS10 SubModule is used in conjunction with a THM42 G2 Module to provide 2 sets of 4-way general purpose screw terminals to connect to a pair of E, J, K or T thermocouples or a pair of Pt100 sensors. Cold-junction-compensation is facilitated through the use of a 0.5 °C accurate temperature sensor in thermal contact with the connectors' contacts. Constant current is provided for Pt100 use. The SubModule type is identified through a TEDS interface. The THMS10 SubModule connects to the or THM42 G2 Module through a 300 mm fly-lead ending with a 7-way Lemo FGG 0B connector.

Where used:

- Supports two channels on a THM42 G2 Module by linking the channel to two sensors
- Designed as a SubModule used to expand the capacity of the THM42 G2 Module
- Accepts one 7-pin Lemo FGG 0B connector
- Provides two sets of 4-pin general purpose screw terminals to connect to Pt100 or Thermocouple sensors

Connection diagram per channel

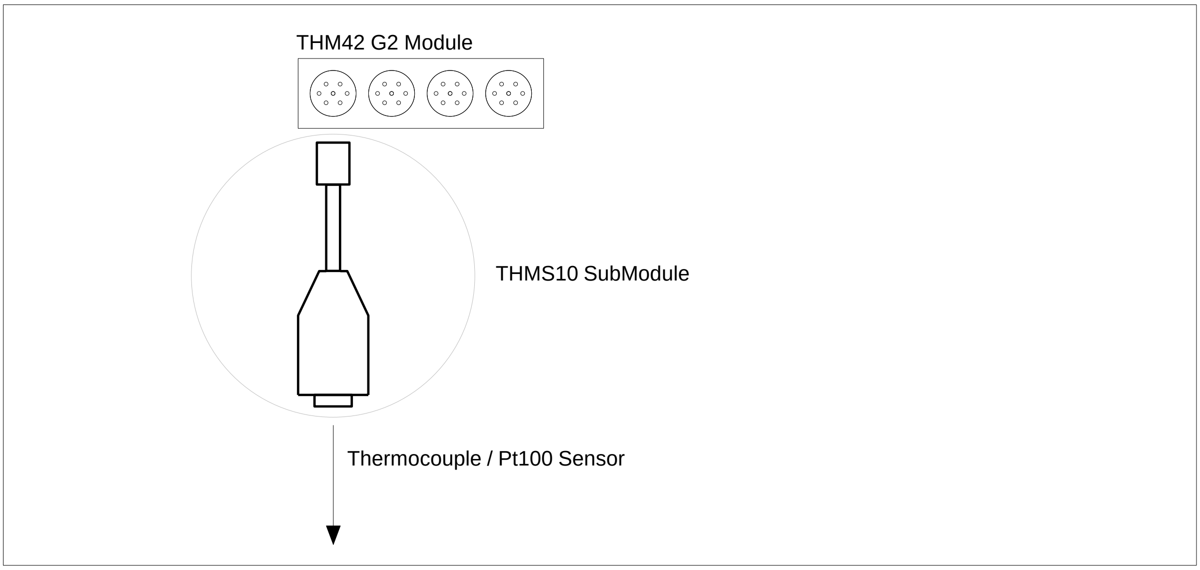


Figure 219. Implementing the THMS10

Connector Information and Pin Definitions

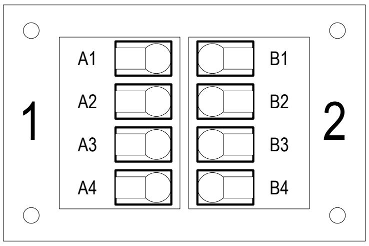


Figure 220. THMS10 front panel and screw terminal input connectors

NOTE: The use of 2-wire and 3-wire Pt100 sensors is not recommended due to an increase in measurement errors brought about by the lead resistance.

The table below provides a summary of the connection procedures for thermocouples and Pt100 sensors when 2 sensors are being connected to the THMS10.

Pin Number	Function	Sensor Type			
		Thermocouple	**Pt100 (4-wire)**	**Pt100 (3-wire)**	**Pt100 (2-wire)**
A1	Excitation0+	NC [1]	Positive current lead of first Pt100	Positive current lead	Jumper between pins A1 and A2 [2]
A2	Signal0+	Positive lead of first thermocouple	Positive signal lead of first Pt100	Positive signal lead of first Pt100	Positive signal lead of first Pt100
A3	Signal0-	Negative lead of first thermocouple	Negative signal lead of first Pt100	Negative signal lead of first Pt100	Negative signal lead
A4	Excitation0-	NC	Negative current lead	Jumper between pins A3 and A4	Jumper between pins A3 and A4
B1	Excitation1+	NC	Positive current lead of second Pt100	Positive current lead	Jumper between pins B1 and B2
B2	Signal1+	Positive lead of second thermocouple	Positive signal lead of second Pt100	Positive signal lead of second Pt100	Positive signal lead of second Pt100
B3	Signal1-	Negative lead of second	Negative signal lead of second Pt100	Negative signal lead of second Pt100	Negative signal lead
B4	Excitation1-	NC	Negative current lead	Jumper between pins B3 and B4	Jumper between pins B3 and B4

Table 68. Connections between 2 Thermocouple/Pt100 Sensors and a THMS10

[1] Not connected
[2] The jumper connection is not made by the THMS10 internally and must therefore be made by the User externally

The table below provides a summary of the connection procedures for thermocouples and Pt100 sensors, when 1 sensor is being connected to channel 1 of the THMS10.

Pin Number	Function	Sensor Type			
		Thermocouple	**Pt100 (4-wire)**	**Pt100 (3-wire)**	**Pt100 (2-wire)**
A1	Excitation0+	NC [1]	Positive current lead of Pt100	Positive current lead of Pt100	Jumper between pins A1 and A2 [2]
A2	Signal0+	Positive lead of thermocouple	Positive signal lead of Pt100	Positive signal lead of Pt100	Positive signal lead of Pt100
A3	Signal0-	Negative lead of thermocouple	Negative signal lead of Pt100	Negative signal lead of Pt100	Negative signal lead of Pt100
A4	Excitation0-	NC	NC	NC	NC
B1	Excitation1+	NC	NC	NC	NC
B2	Signal1+	NC	NC	NC	NC
B3	Signal1-	NC	NC	NC	NC
B4	Excitation1-	NC	Negative current lead of Pt100	Jumper between pins A3 and B4	Jumper between pins A3 and B4

Table 69. Connections between 1 Thermocouple/Pt100 Sensor and channel 1 of the THMS10

[1] Not connected
[2] The jumper connection is not made by the THMS10 internally and must therefore be made by the User externally

The table below provides a summary of the connection procedures for thermocouples and Pt100 sensors, when 1 sensor is being connected to channel 2 of the THMS10.

Pin Number	Function	Sensor Type			
		Thermocouple	**Pt100 (4-wire)**	**Pt100 (3-wire)**	**Pt100 (2-wire)**
A1	Excitation0+	NC [1]	Positive current lead of Pt100	Positive current lead of Pt100	Jumper between pins A1 and B2 [2]
A2	Signal0+	NC	NC	NC	NC
A3	Signal0-	NC	NC	NC	NC
A4	Excitation0-	NC	NC	NC	NC
B1	Excitation1+	NC	NC	NC	NC
B2	Signal1+	Positive lead of thermocouple	Positive signal lead of Pt100	Positive signal lead of Pt100	Positive signal lead of Pt100
B3	Signal1-	Negative lead of thermocouple	Negative signal lead of Pt100	Negative signal lead of Pt100	Negative signal lead of Pt100
B4	Excitation1-	NC	Negative current lead of Pt100	Jumper between pins B3 and B4	Jumper between pins B3 and B4

Table 70. Connections between 1 Thermocouple/Pt100 Sensor and channel 2 of the THMS10

[1] Not connected
[2] The jumper connection is not made by the THMS10 internally and must therefore be made by the User externally

THMS10/250

The THMS10/250 SubModule is used in conjunction with a THM42 G2 Module to provide 2 sets of 4-way general purpose screw terminals to connect to two constant current signals from sensors between 4 mA and 20 mA. Two precision 250 Ω resistors convert the constant current signals to voltage signals between 1 V and 5 V. The SubModule is identified through a TEDS interface. The THMS10/250 SubModule connects to the THM42 G2 through a 300 mm fly-lead ending with a 7-way Lemo FGG 0B connector.

Where used:

- Supports two channels on a THM42 G2 Module by linking the channel to two sensors
- Designed as a SubModule used to expand the capacity of the THM42 G2 Module
- Accepts one 7-pin Lemo EHG 0B connector
- Provides two sets of 4-pin general purpose screw terminals to connect to sensors with a 4 mA to 20 mA current output

Connection diagram per channel

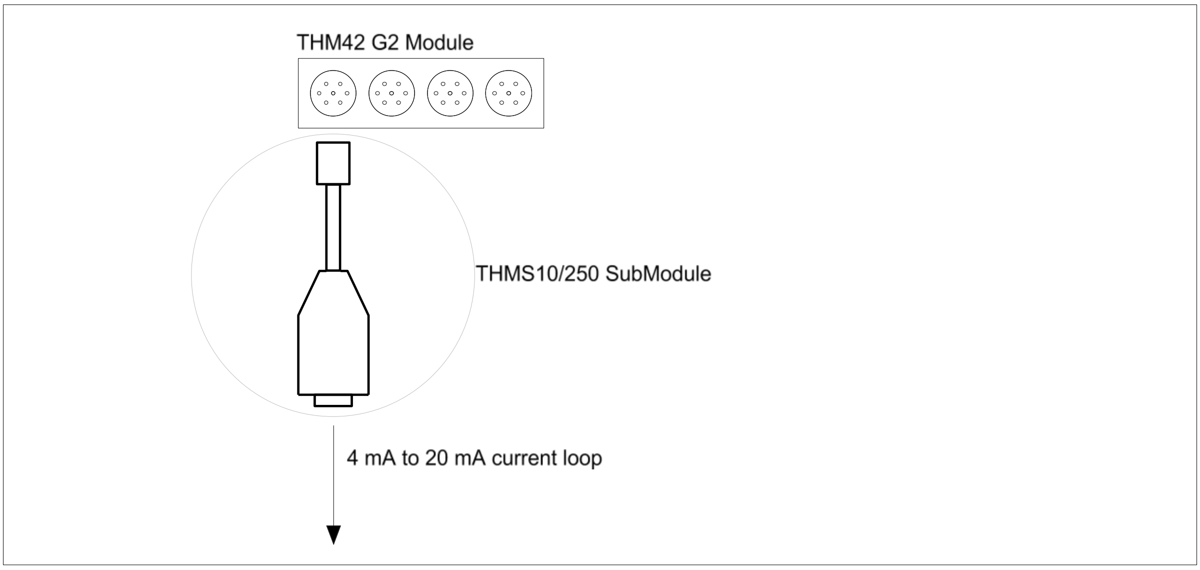


Figure 221. Implementing the THMS10/250

Connector Information and Pin Definitions

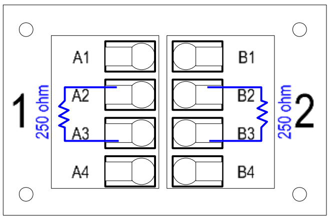


Figure 222. THMS10/250 front panel and screw terminal input connectors

NOTE: The 250 Ω resistors is internal in the THMS10/250 and the user should not add the resistor to the pins.

The table below provides a summary of the connection procedures for sensors with a 4 mA to 20 mA current output that are being connected to the THMS10/250.

Pin Number	Function	Sensor with 4 mA to 20 mA current output
A1	Excitation0+	NC [1]
A2	Signal0+	Positive lead of first sensor
A3	Signal0-	Negative lead of first sensor
A4	Excitation0-	NC
B1	Excitation1+	NC
B2	Signal1+	Positive lead of second sensor
B3	Signal1-	Negative lead of second sensor
B4	Excitation1-	NC

Table 71. Connections between two 4mA to 20 mA output current sensors and a THMS10/250

[1] Not connected

QBNC11

The Quad BNC (QBNC) is a SubModule that is used to split signals from a 7-pin Lemo connector to 4 BNC connectors. A sticker on top indicates with which Modules the QBNC is compatible, and how the signals are mapped.

Where used:

- Splits the signals coming from an ALO42S or ICM42S Module
- Designed as a SubModule used to expand the capacity of an ALOP42S or ICM42S Module
- Accepts one 7-pin Lemo FGG 0B connector
- Provides 4 BNC connectors to split the signals as follows:
    - For the ALO42S Module, the QBNC11 provides Analog Signal Output, Module Status Output, Device Under Control Input and 5/12 V output
    - For the ICM42S Module, the QBNC11 provides Monitoring Output

Connection diagram per channel

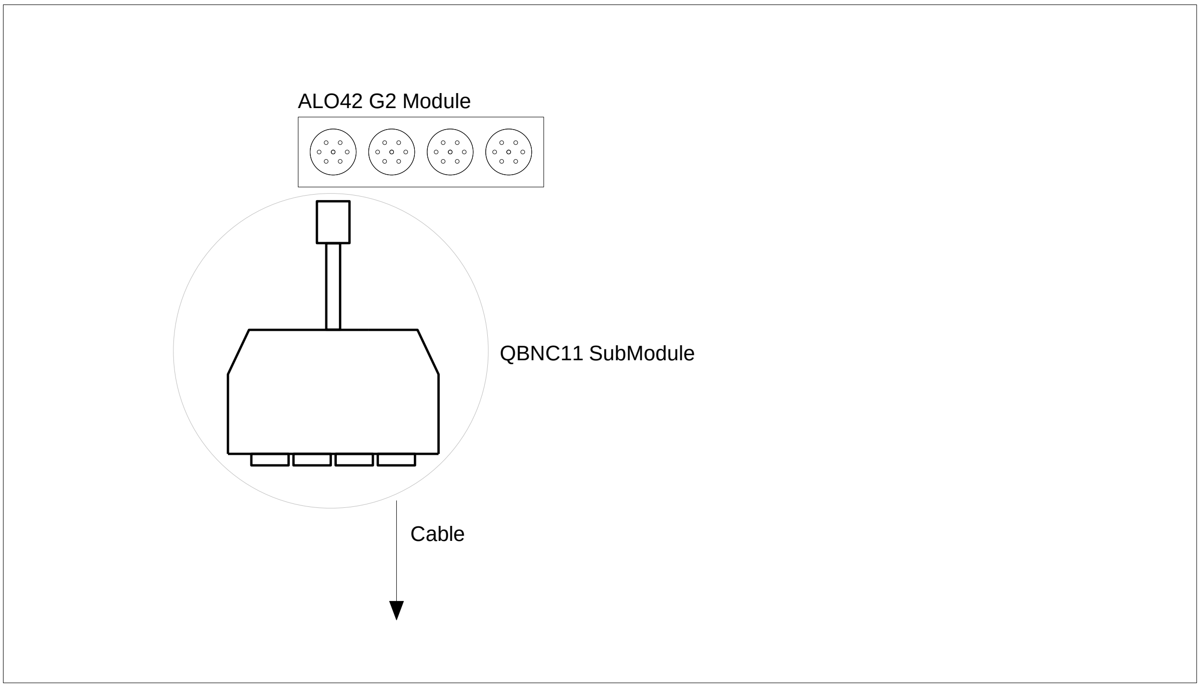


Figure 223. Implementing the QBNC11

Connector Information and Pin Definitions

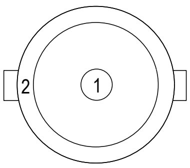


Figure 224. BNC1

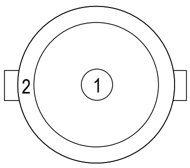


Figure 225. BNC2

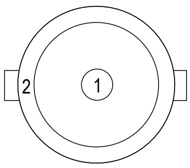


Figure 226. BNC3

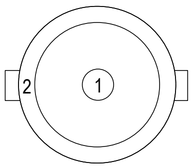


Figure 227. BNC4

Pin 1: Analog Signal Output + Pin 2: Analog Signal Output -	Pin 1: Module Status Output + Pin 2: Module Status Output -	Pin 1: DUC Status Input + Pin 2: DUC Status Input -	Pin 1: 5 V / 12 V Output + Pin 2: 5 V / 12 V Output -

Table 72. QBNC11 Pinouts when connected to an ALO42S G2 Module

Pin 1: CH1 Monitor + Pin 2: CH1 Monitor -	Pin 1: CH2 Monitor + Pin 2: CH2 Monitor -	Pin 1: CH3 Monitor + Pin 2: CH3 Monitor -	Pin 1: CH4 Monitor + Pin 2: CH4 Monitor -

Table 73. QBNC11 Pinouts when connected to an ICM42S G2 Module

VICP10

The VICP10 is an interface board used to provide an excitation voltage to ICP® sensors. It is used in combination with an ICP42 G2 Module to allow for an increased range in voltage excitation. The excitation voltage required by the User is input into the VICP10 through the 2-pin Lemo connector marked ‘PWR’.

Where used:

- Supports one ICP42 G2 Module
- Designed as an interface board to provide voltage excitation to ICP® sensors
- Accepts four 3-pin Lemo FGG 0B connectors for connecting to four ICP® sensors
- Provides four 4-pin Lemo FGG 0B connectors for connecting to an ICP42 or ICP42 G2 Module

Connection diagram per channel

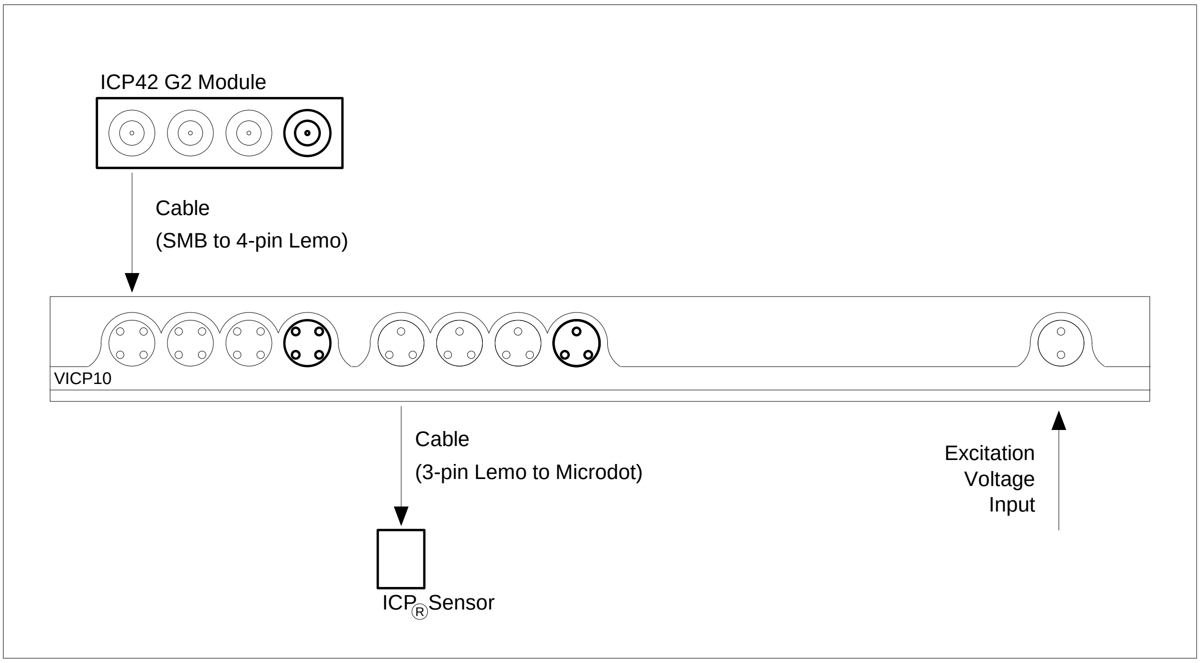


Figure 228. Implementing the VICP10

Connector Information and Pin Definitions

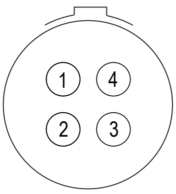


Figure 229. Pinout of the 4-pin Lemo connector to be connected to the ICP42 G2 Module

- Pin 1: Signal-
- Pin 2: Excitation+
- Pin 3: Excitation-
- Pin 4: Signal+

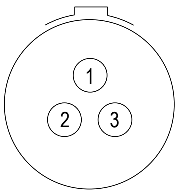


Figure 230. Pinout of the 3-pin Lemo connector to be connected to ICP® Sensor

- Pin 1: AGNDM
- Pin 2: Signal+
- Pin 3: Signal-

MiniTerminal

The MiniTerminal is a remote, interactive User interface that allows additional interaction between the User and PAK software. The MiniTerminal connects to the VME Controller via a serial cable supplied with the MiniTerminal. This is useful in scenarios where it is difficult or unsafe for the User to physically reach the PAK MKII User interface.

The MiniTerminal has:

- A large display size
- 7 buttons
- 3 Status LEDs
- 2 to 5 m cable length
- 5 or 12 V input

MiniTerminal front panel

Figure 231. The front panel of the MiniTerminal

Connecting the MiniTerminal to the PAK MKII

To connect the MiniTerminal to the PAK MKII, use the supplied serial cable and insert one end into any one of the two connectors of the MiniTerminal, and the other end into the PAK MKII “STP” port (7-pin Lemo for a PQ11 G2, PQ12 G2, PQ20 G2, or PQ30 G2).

MiniTerminal detection by the PAK MKII

The MiniTerminal receives its power through the serial cable. Connect the MiniTerminal to the PAK MKII either when the PAK MKII is powered-down or after the PAK MKII has booted (`Idle…` or `Idle` appears on the PAK MKII display). Note that since the MiniTerminal is auto detected by the PAK MKII, the MiniTerminal may be connected at any time after the PAK MKII has booted.

The MiniTerminal detection procedure consists of the following:

- Step 1: When the MiniTerminal receives power, it will first boot up and when complete, clear the LEDs and write its firmware version to the display. Note that if an error occurred while upgrading the MiniTerminal, the display and LEDs will remain off when the MiniTerminal is connected to the PAK MKII. When this error state is detected by the PAK MKII, it will attempt to perform the upgrade procedure to repair the MiniTerminal. The upgrade procedure will be discussed in the steps below
- Step 2: As soon as the PAK MKII has booted, it will begin to periodically test whether a MiniTerminal is connected
- Step 3: When a MiniTerminal is detected, the PAK MKII will clear the display and set LED 2 (amber). Please note that previous versions of the PAK MKII firmware would at this point request from the User to select the MiniTerminal mode. In such a case, the User should just select “PAK”. As long as the same PAK MKII Controller card is used, the request will not appear on subsequent occasions when the MiniTerminal is detected by the PAK MKII
- Step 4: The PAK MKII will now determine if the MiniTerminal supports upgrading of its firmware and, if true, determine whether the current firmware executing on the MiniTerminal is the same as that stored on the PAK MKII. If the MiniTerminal firmware version is different, the PAK MKII will perform the upgrade procedure to upgrade the firmware stored on the MiniTerminal. If the firmware is the same or the MiniTerminal does not support upgrading, continue at step 8
- Step 5: When the upgrade procedure starts, the MiniTerminal display and LEDs will be off (it will appear as if the MiniTerminal was powered-down). The message `Wait:UMT` or `:UMT` will appear on the PAK MKII display. The upgrade process may take up to 20 seconds

- Step 6: If `Reboot` or `Boot` appears on the PAK MKII display, it means that the upgrade procedure was successful and that power to the MiniTerminal must be recycled for the new firmware to execute. Continue once again at step 1 of the detection procedure
- Step 7: If `UMTError` or `Err` appears on the PAK MKII display, it means an error occurred during the upgrade procedure. If step 1 is performed again, the MiniTerminal display and LEDs will remain off. To recover the MiniTerminal from this error state, firstly disconnect the MiniTerminal and only reconnect it to the PAK MKII after the PAK MKII has booted. If the PAK MKII detects the MiniTerminal in its error state, the PAK MKII will perform the upgrade procedure again. Continue at step 5
- Step 8: LED 2 (amber) will be cleared and LED 3 (green) set when the PAK MKII has completed the detection procedure and is ready for normal operation. The display will also be off

After the MiniTerminal is detected by the PAK MKII, the upgrade procedure will be repeated if PAK software upgrades the PAK MKII with new MiniTerminal firmware. As mentioned previously, during the upgrade procedure, the MiniTerminal display and LEDs will be off and the message `Wait:UMT` or `:UMT` will appear on the PAK MKII display.

Connector information and pin definitions

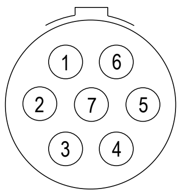


Figure 232. Pinout for the 7-pin Lemo connector on the MiniTerminal
(when looking into the front panel's connector or at the rear of the cable's connector)

Following are the Lemo connector pin definitions for each input of the G2 Combined System Controller and Power Supply boards:

- Pin 1: Rx
- Pin 2: Tx
- Pin 3: 5 V STDBY
- Pin 4: GND
- Pin 5: 12 V
- Pin 6: SyncLink Signal Input
- Pin 7: PSU Wake Up

Transportation

SeatFrame

The SeatFrame allows PAK MKII front ends to be mounted together with a notebook onto a car seat. The SeatFrame can only be used together with the MF02, MF03, MF04 and MF06 Mainframes.

The SeatFrame has the following features:

- Consists of machined aluminium
- Side feet can be adjusted in width to suit the seat
- Can be disassembled and folded for easy transportation
- Equally suited for both left hand and right hand drive vehicles
- Multiple settings and adjustments allows the notebook to be placed in the position that best suits the User

Front view of a SeatFrame

Figure 233. Front view of a SeatFrame

The SeatFrame consists of two parts:

- SeatFrame top: used to attach a notebook to the top of a PAK MKII, and
- SeatFrame bottom: used to attach a PAK MKII to the seat of a car

SeatFrame Top

Figure 234. SF10 Top

SeatFrame Bottom

Figure 235. SF10 Bottom

Fitting a PAK MKII (MF02, MF03 or MF04 without fans) to a SeatFrame

- When mounting a MF02, MF03 or MF04 Mainframe to the SeatFrame, loosen the Mainframe Spacers from its placeholders using a 4 mm Allen key
- Place the spacers in the 4 outer positions
- Place the Mainframe on the Base of the SeatFrame

NOTE: Spacers are required as these mainframes do not have plenum covers.

Figure 236. Fitting a PAK MKII to the SeatFrame Bottom

Fitting a PAK MKII (MF04 or MF06 with fans) to a SeatFrame

- When mounting a MF04 or MF06 Mainframe to the SeatFrame, fasten the Mainframe Spacers in its placeholders using a 4 mm Allen key
- Temporarily remove the 4 M5 screws holding the Plenum Cover at the bottom of the Mainframe
- Place the Mainframe on the Base of the SeatFrame

Securing a Mainframe to the SeatFrame

- Tighten the Mainframe to the Base using the M5 captive screws and an 8 mm Spanner

Figure 237. Securing the PAK MKII to the SeatFrame Bottom

Fastening the Notebook Platform with the Ball Joint Base to the Mainframe

- Place the Notebook Platform with Ball Joint Base on top of the Mainframe
- Fasten the Ball Joint Base to the Mainframe using the M5x16 cap screws provided and a 4 mm Allen key in the 4 positions provided

Figure 238. Fastening the SeatFrame Top to the PAK MKII

Adjusting the Notebook Platform to fit Notebook size

- The Notebook Platform is adjustable in the horizontal and vertical directions
- Loosen the M8 bolts under the 4 Notebook Bases with a 13 mm Spanner
- Move the Notebook Bases to accommodate Notebook length. Loosen the M8 bolts under the Notebook Platform with a 13 mm Spanner
- Move the Floating Adjustment Beam to accommodate Notebook width

Figure 239. Adjusting the SeatFrame Top to accommodate Notebook

Securing the Notebook to the Notebook Base

- Place the Notebook on the Notebook Platform
- Insert the Notebook Locating Post into the Notebook Base
- Tighten the locating pin thumb screw by hand
- Repeat this on all 8 Notebook Posts on each of the 4 Notebook Bases

Securing the Notebook Screen

- Attach the Notebook Screen Brace to the Notebook Platform by using the thumb screw provided
- To support the screen, pivot the Screen Brace Restraint to clamp the screen and fasten it using the Screen Brace Restraint thumb screw

Figure 240. Securing the Notebook screen

Situational Adjustments

- To support the angle of the Seat Back Rest, adjust the rear handle using an 8 mm Allen key to loosen and fasten the M10 cap screw

Figure 241. Adjusting the Seat Back Rest of SeatFrame Bottom

- Adjust side feet back and forth to fit the shape of the car seat comfortably using a 13 mm spanner

Figure 242. Adjusting feet of SeatFrame Bottom

- Move the Ball Joint Leaver to the right and turn the notebook platform to the desired position. Toggle the Ball Joint Leaver again to fix the position

Depending on the Notebook size, the Notebook may interfere with a Safety Belt Hook. Should this occur, screw on the Safety Belt Hook extension using the M6 screws provided and a 5 mm Allen key.

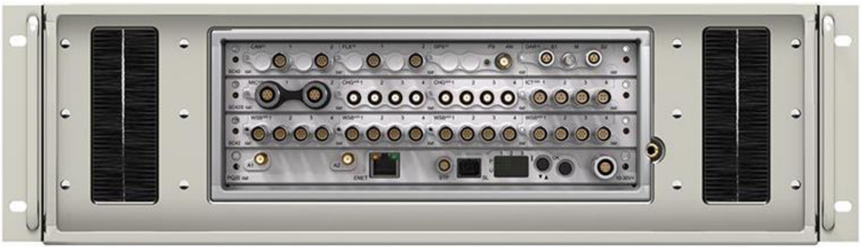
Rack Mounted Systems

The RM04, RM06 and RM10 are compact, machined aluminum Rack Mounting Kits which house 4, 6 and 10-slot PAK MKII Mainframes in 19 inch racks.

Each Rack Mount has specifically been recessed to ensure that all cables are contained behind the rack's front face. These cables can then be routed to the left and right sides of the Mainframe. At the rear, a horizontal brace provides a mounting point for cable connector flanges should this be required. This is particularly useful in those cases where a conversion of connector types is required between that used by the PAK MKII and that used by the testing facility. The sides and rear of the Mounting Kit have been left open to allow air entering from the bottom of the rack to properly cool each Mainframe.

RM04

DIMENSIONS:	
Width:	482.6 mm
Depth:	556.9 mm
Height:	134.2 mm



RM04 houses an MF02, MF03 or MF04 Mainframe

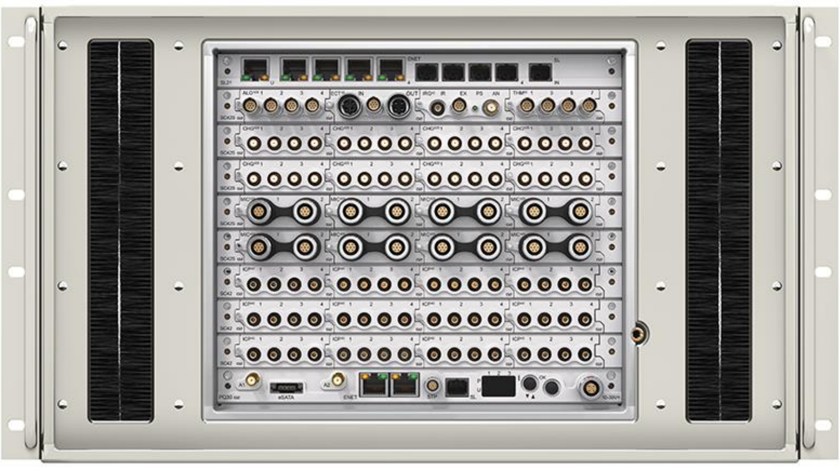
RM06

DIMENSIONS:	
Width:	482.6 mm
Depth:	556.9 mm
Height:	177.2 mm

RM06 houses an MF06 Mainframe

RM10

DIMENSIONS:	
Width:	482.6 mm
Depth:	556.9 mm
Height:	256.2 mm



RM10 houses an MF10 Mainframe

Table of Figures

Table of Tables

Disclaimer