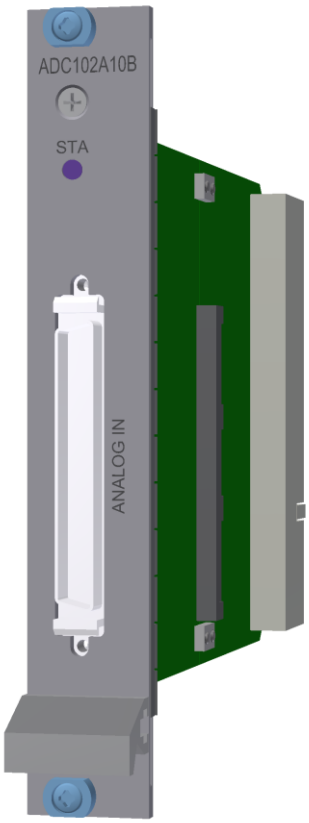
Features

- Multi-channel analog interface SyABus12
  MDR68 front connector for reliable repetitive plugging
  12 symmetrical inputs for high disturbance immunity
    2x ±10V input-voltage range biased at 0V
    Low noise (typically 24$\mu V_{20Hz\text{-}20kHz}$ input-referred)
  5V, 6V and switchable 12V for sensor supply
  Pull-down activated bidirectional control-signal
  Decoupled serial interface for intelligent sensors
- Simultaneous 24bit A/D-conversion at 48/96/192kS/s
  auto calibrating DC- and accurate AC-mode available
- Advanced Record-Trigger capability
  Adjustable between start and end of recording
  Activated by software, hardware or input-voltage
- 32bit recording makes gain-setting obsolete
- 1.5GB cPCI-independent onboard real time memory
  16MS / input for up to 349s recording time (48kS/s)
- Concurrent cPCI-streaming up to the limits of the harddisk (96/192kS/s down-sampled to 48kS/s)
- Nonvolatile calibration and configuration memory
- Onboard voltage and temperature monitoring
- Full Color RGB status LED (marked STA)
- Low power consumption (9W typically)



Description

The ADC102A10B is a low noise 3U 4HP cPCI slot-in card with automatic offset-calibration, offering 12 symmetrical ±20V inputs for many kinds of voltage-output sensors. All its channels have a 100% pure differential signal path from the input connector to the advanced multi-bit delta-sigma analog-to-digital-converters ensuring extraordinary immunity against disturbances being coupled into the cables. 12 contacts of the MDR68 front connector are for sensor supply. Furthermore 0V, 5V, 12V and a switchable 0V contact support various power-supply eventualities. /DETECT checks for plugged sensors and an optically decoupled serial interface is used to communicate with self describing sensors. Concurrent capabilities allow for high-channel recording with many cards (1.5GB onboard RAM) and longtime streaming. Results of the factory-calibration are stored in a nonvolatile memory and used for compensation while measuring.

MDR68 front connector scheme

	68	34	IN12-
	67	33	IN12+
	66	32	IN11-
	65	31	IN11+
SENSOR_0V	64	30	SENSOR_6V
	63	29	IN10-
	62	28	IN10+
	61	27	IN09-
	60	26	IN09+
SENSOR_0V	59	25	SENSOR_6V
	58	24	IN08-
	57	23	IN08+
	56	22	IN07-
	55	21	IN07+
SENSOR_0V	54	20	SENSOR_6V
	53	19	IN06-
	52	18	IN06+
	51	17	IN05-
	50	16	IN05+
SENSOR_0V	49	15	SENSOR_6V
	48	14	IN04-
	47	13	IN04+
	46	12	IN03-
	45	11	IN03+
SENSOR_0V	44	10	SENSOR_6V
	43	9	IN02-
	42	8	IN02+
	41	7	IN01-
	40	6	IN01+
SENSOR_0V	39	5	SENSOR_6V
SWITCH_0V	38	4	12V
IS_SERIAL_IN	37	3	IS_SERIAL_OUT
0V	36	2	5V
/DETECT	35	1	/SHUTTER

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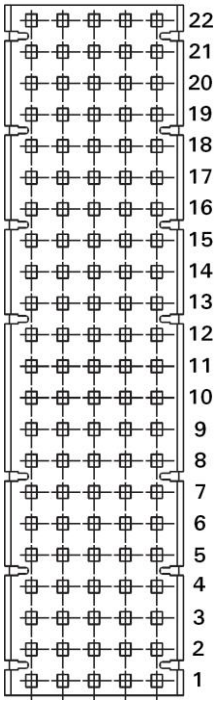
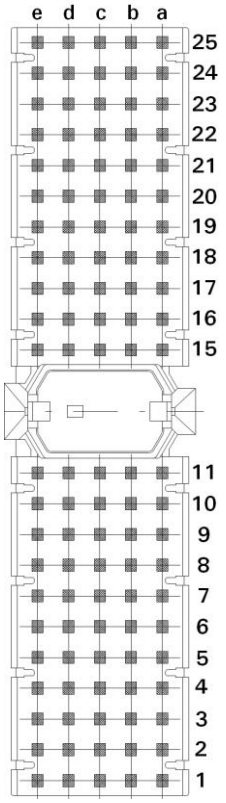
cPCI J2 connector scheme (not standardized)



e	d	c	b	a
AGND	RC_ENA	AGND	PGA0	PGA1
AGND	GND	AGND	PGA2	PGA3
AGND	PGA4	AGND		
+6V5	GND	AGND		
+6V5	RS2_TX	+6V5	GND	/RS2_TX
+6V5	GND	+6V5	/RS2_RX	
+6V5	RS2_RX	+6V5	GND	
	GND		/ENA_RECTRIG	
	RS1_RX_TTL	VIO	GND	
RS2_TX_TTL	GND		/ENABLE	
	RS1_TX_TTL	VIO	GND	
RS2_RX_TTL	GND		/SHUTTER	
	/RECTRIGGER	VIO	GND	
	GND	AUXIOP3	/STOPSTREAM	
		VIO	GND	
	GND	AUXIOP2	/SYNCHRONIZE	FPGA_TDO
FPGA_TCK		VIO	GND	FPGA_TDI
FPGA_TMS	GND	AUXIOP1		VIO
/FPGA_CE	FPGA_CONF_DONE	+3V3	GND	
/FPGA_CS	/FPGA_CONFIG	FPGA_DCLK	24576KHZ	
FPGA_ASD	FPGA_DATA	+3V3	GND	

cPCI J1 connector scheme (standardized)

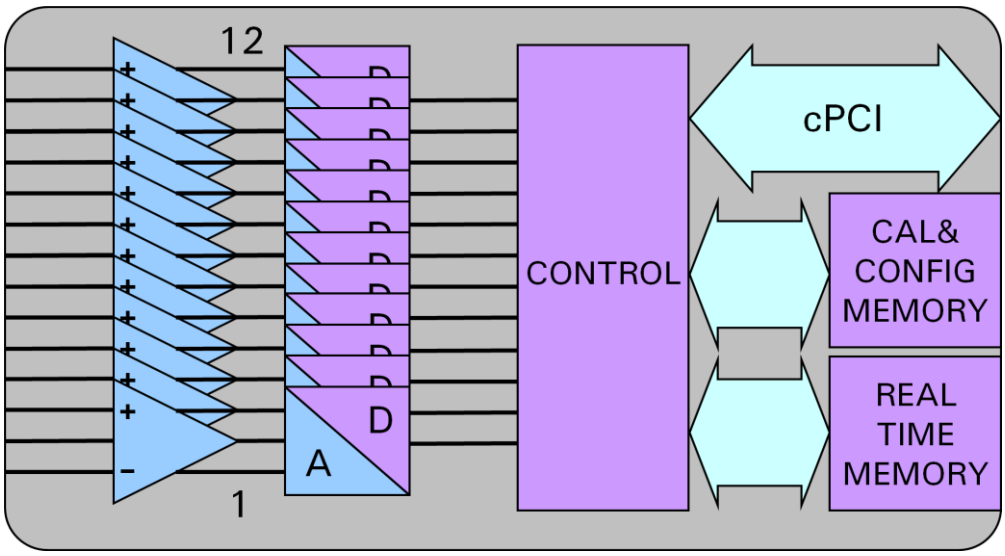


e	d	c	b	a
+5V	+3V3			+5V
	AD0	VIO	+5V	AD1
AD2	+5V	AD3	AD4	+3V3
AD5	AD6	+3V3	GND	AD7
C/BE0	M66EN	AD8	AD9	+3V3
AD10	AD11	VIO	GND	AD12
AD13	GND	AD14	AD15	+3V3
C/BE1	PAR	+3V3	GND	/SERR
/PERR	GND			+3V3
/LOCK	/STOP	VIO	GND	/DEVSEL
/TRDY		/IRDY	/FRAME	+3V3

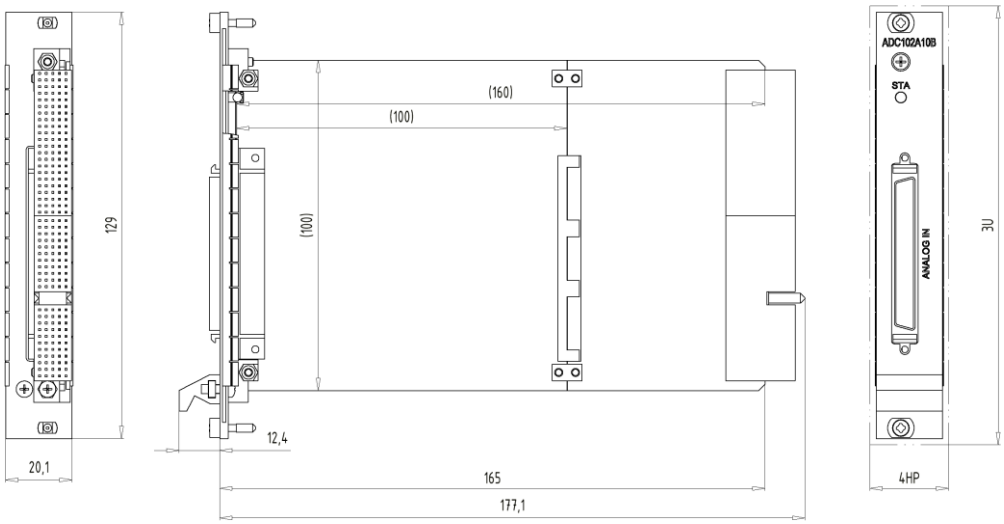
blanks are not connected on the card

C/BE2	GND	AD16	AD17	AD18
AD19	AD20	+3V3	GND	AD21
AD22	GND	AD23	IDSEL	C/BE3
AD24	AD25	VIO	GND	AD26
AD27	GND	AD28	AD29	AD30
AD31	CLK	+3V3	GND	/REQ
/GNT	GND	/RST		
		VIO		
	+5V			/INTA
TDI	TDO		+5V	
+5V	+12V		-12V	+5V

Block diagram



Mechanical data



Weight 163g

Absolute maximum ratings

Parameter		Min	Max	Unit	Remarks
Power	+12V to GND	-0.3	14	V	Stresses above these may cause permanent damage. This is a stress rating only; functional operation at these or any other conditions above is not implied. Exposure to absolute maximum rating conditions for extended periods may affect reliability. Only one absolute maximum rating may be applied at any one time.
	+6V5 to AGND	-0.3	8	V	
	+5V to GND	-0.3	6	V	
	+3V3 to GND	-0.3	4	V	
	VIO to GND	-0.3	4	V	
Analog inputs to AGND		-25	30	V	
Digital inputs to GND		-0.3	4	V	
Storage temperature		-50	125	°C	

Conformity

Electrical safety	complies with DIN EN 61010-1
Electromagnetic compatibility (EMC)	complies with DIN EN 61326

Operating conditions

Parameter		Min	Typ	Max	Unit	Remarks
Power supply	(+12V)	11.4	12.0	12.6	V	voltages at the cPCI connectors J1+J2 must be guaranteed to be within these limits
	(+6V5)	6.3	6.5	6.7	V	
	(+5V)	4.7	5.0	5.3	V	
	(+3V3)	3.0	3.3	3.6	V	
	(VIO)	3.0	3.3	3.6	V	
Output current (front)	5V	0		55	mA	all outputs are short-circuit-proof 5V and 12V shall return at 0V or SWITCH_0V the six SENSOR_6V shall return at the six SENSOR_0V
	12V	0		220	mA	
	SWITCH_0V	-220		0	mA	
	SENSOR_6V	0		660	mA	
Analog inputs	IN+ to IN–	±18.8	±20.0	±21.2	V	for digital maximum output analog inputs are DC-biased at 0V connect single ended or differential inputs between IN+ and IN–
	IN+ to SENSOR_0V	-22	0	28	V	
	IN– to SENSOR_0V	-22	0	28	V	
/DETECT input	low	0		0.7	V	10kΩ pull-up-resistor to +3V3 is on the card
	high	1.7		3.3	V	
IS_SERIAL_IN	low	0		0.4	V	330Ω resistor to optocoupler-cathode, anode to+3V3 (on card)
	high	2.2		4	V	
IS_SERIAL_OUT	low	0.5		2.4	V	applicable when connected to optocoupler-cathode and optocoupler-anode is connected to+5V (at sensor)
	high	3.6		5	V	
/SHUTTER and /RECTRIGGER	low	0		1	V	both these and also /STOPSTREAM must be pulled-up with 220Ω resistors to VIO on the backplane
	high	2		3.3	V	
Temperature		0		70	°C	the air surrounding the card must be within these limits
Relative humidity		10		80	%	not to be operated until condensation is evaporated

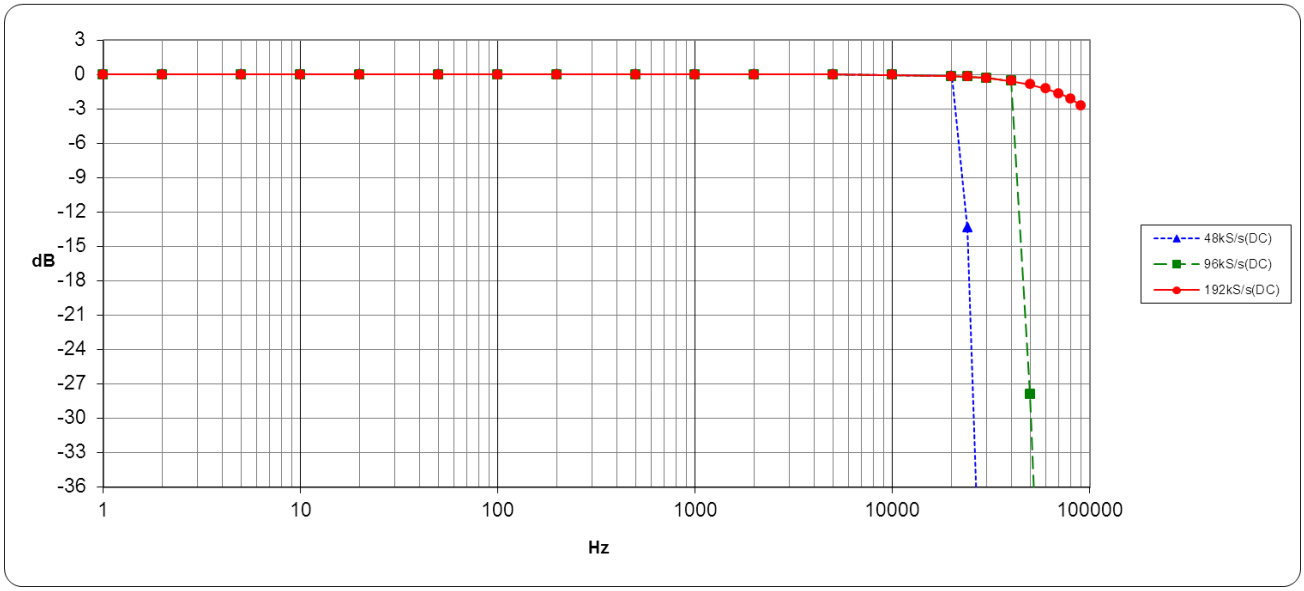
All other inputs and outputs are of the LVTTL-type (max-low=0.7V, min-high=1.7V).
/ENA_RECTRIG, /ENABLE and /SYNCHRONIZE must be pulled-up with 1kΩ resistors to VIO on the backplane.
24576kHz is an input and shall be connected to a stable and accurate clock-source.
SENSOR_0V is connected to AGND, 0V is connected to GND, AGND and GND are not connected on the card.
AGND and GND shall be connected only once in the mainframe.

Electrical characteristics

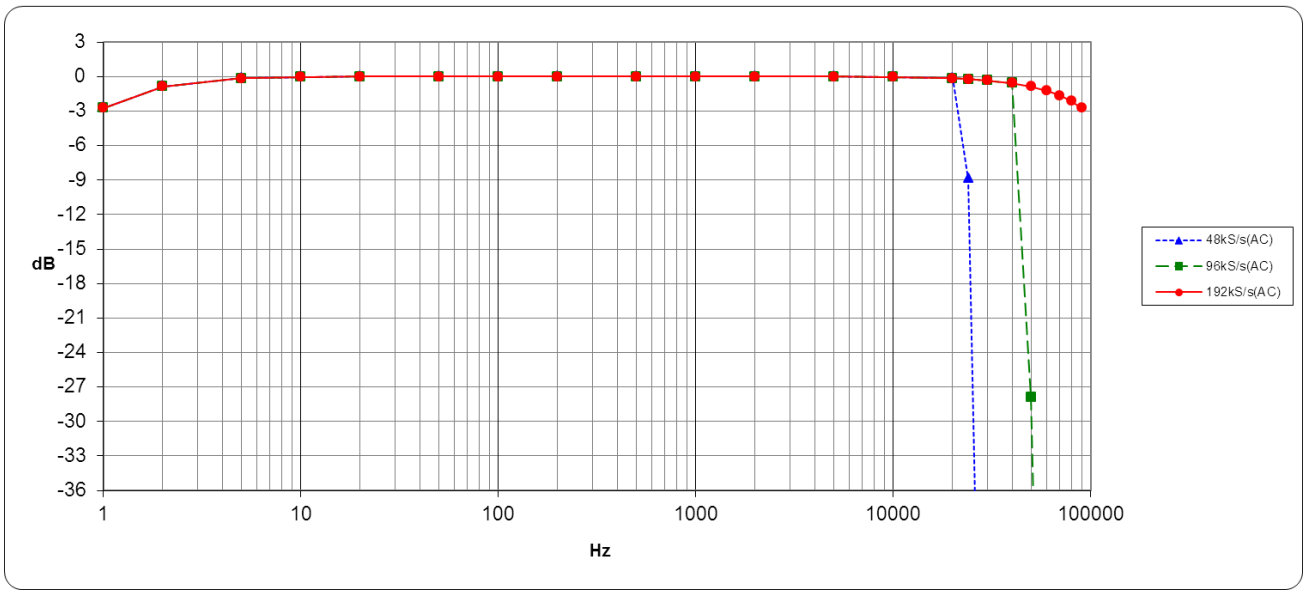
Parameter	Min	Typ	Max	Unit	Condition
Differential full-scale input-voltage	13	14	15	V_{eff}	
Differential input-resistance	14648	14678	14708	Ω	between +inputs and - inputs
Input referred noise @ 48kS/s		21		μV_{eff}	inputs shorted, 20Hz...20kHz-weighted
@ 96kS/s		24		μV_{eff}	
@ 192kS/s		38		μV_{eff}	
Dynamic performance					
Dynamic range @ 48kS/s (A-weighted)	111	119		dB(A)	
(20Hz...20kHz-weighted)	108	116		dB	
Dynamic range @ 96kS/s (A-weighted)	111	118		dB(A)	full-scale input
(20Hz...20kHz-weighted)	108	115		dB	related to worst channel noise,
(20Hz...40kHz-weighted)	105	112		dB	inputs shorted
Dynamic range @ 192kS/s (A-weighted)	111	114		dB(A)	
(20Hz...20kHz-weighted)	108	111		dB	
(20Hz...40kHz-weighted)	105	108		dB	
(20Hz...80kHz-weighted)	102	105		dB	
Total harmonic distortion + noise @ 48kHz		-90	-83	dB	most distorted channel
@ 96kHz		-89	-83	dB	@ input 1kHz, -3dB,
@ 192kHz		-89	-80	dB	20Hz...20kHz-weighted
Accuracy					
DC-offset-error		847	2000	LSB	worst channel
Input referred DC-offset-error		2008	4741	μV	@ 192kS/s,
AC-offset-error		2	10	LSB	inputs shorted
Input referred AC-offset-error		5	24	μV	
Channel separation					most disturbed channel related to driven channel
Crosstalk @ 1kHz (800Hz...1250Hz-weighted)		-77	-75	dB	@ input -3dB, 192kS/s
Crosstalk @ 10kHz (8kHz...12.5kHz-weighted)		-57	-55	dB	
Disturbance immunity					
Common mode rejection ratio @ 100Hz, $5V_{eff}$	46	50		dB	differential gain related to common
Common mode rejection ratio @ 10kHz, $5V_{eff}$	45	52		dB	gain of most disturbed channel
Common mode rejection ratio @ 50kHz, $5V_{eff}$	44	53		dB	@ 192kS/s, all inputs connected
Maximum common mode input voltage (100Hz...100kHz)	10	14		V_{eff}	
Power supply current (+12V)		0	10	mA	
(+6V5)		1262	1500	mA	measured with 100mΩ shunt-
(+5V)		19	25	mA	resistors
(+3V3)		239	300	mA	@ 192kS/s, open inputs
(VIO)		5	20	mA	
Power consumption (+12V)		0.00	0.13	W	
(+6V5)		7.63	9.90	W	
(+5V)		0.10	0.13	W	supply currents from above, voltages measured between shunt-resistors and card
(+3V3)		0.78	1.04	W	
(VIO)		0.02	0.07	W	
(total)		8.53	11.27	W	

Frequency response

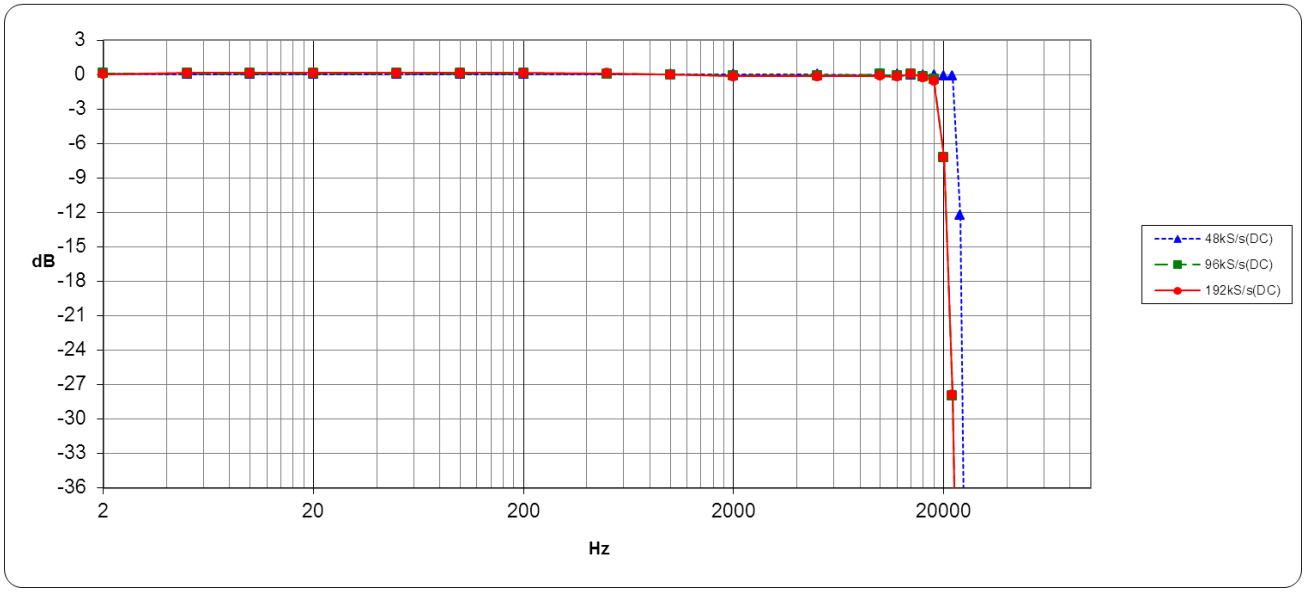
DC-mode



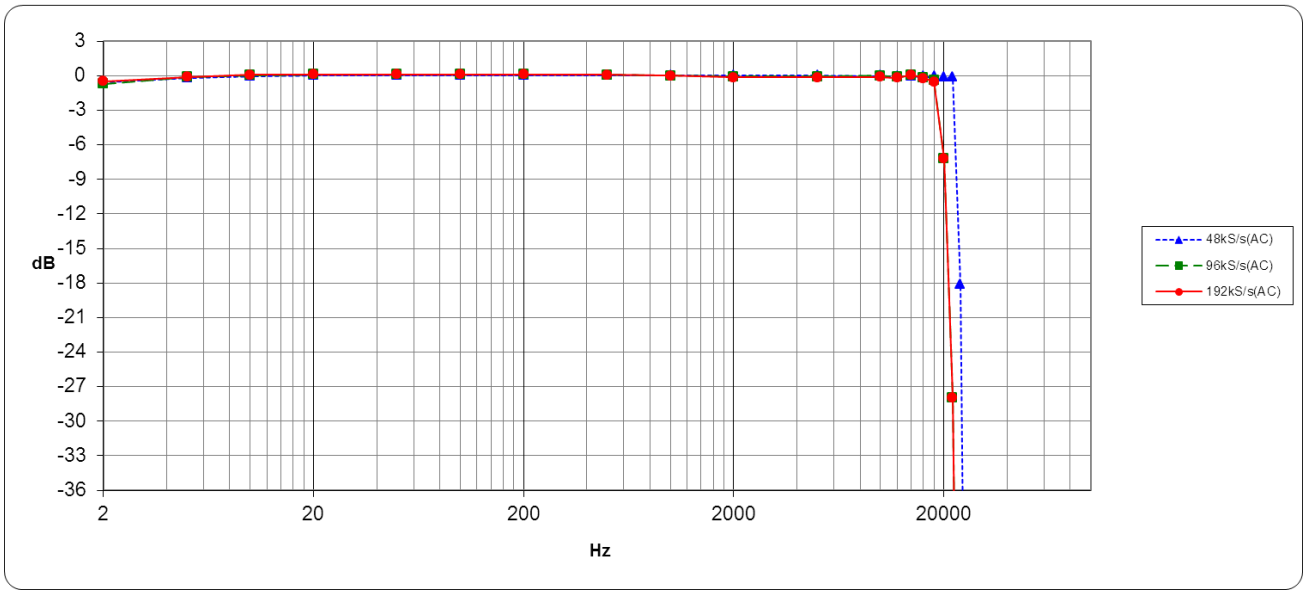
AC-mode



Streaming DC-mode



Streaming AC-mode



Theory of operation

Real world measurement sites are full of disturbances. Shielding is common practice and helps to decrease the problems thereof. Another approach is to use symmetrical/differential transmission techniques where two signals are used. A positive and a negative signal of the same amplitude are subtracted from each other and since 1 – (-1) = 2 the result is useful. When both symmetrical wires are close together or are a twisted pair any disturbance couples into them with the same amplitude and direction; both are positive or both are negative – that is called common-mode-disturbance. The subtraction eliminates that disturbance because 1 – 1 = 0 and also (-1) – (-1) = 0.

Compared to the **TWICE AS MUCH SINGLE ENDED AS DIFFERENTIAL INPUTS** concept (figure 1) where the common-mode-disturbance can only be removed after the input-amplifiers this **AS MUCH SINGLE ENDED AS DIFFERENTIAL INPUTS** design (figure 2) uses a 100% pure differential signal path which removes any common-mode-disturbance when it enters the input-stage. The advantage is that the common-mode-disturbance does not reduce the differential input-voltage-range.

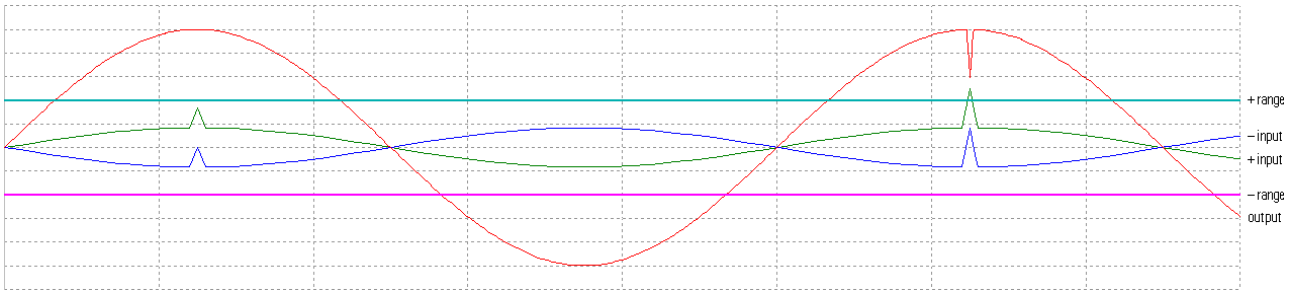


figure 1 common-mode removed after the input-stage: input-signal + disturbance must be within the input-voltage-range

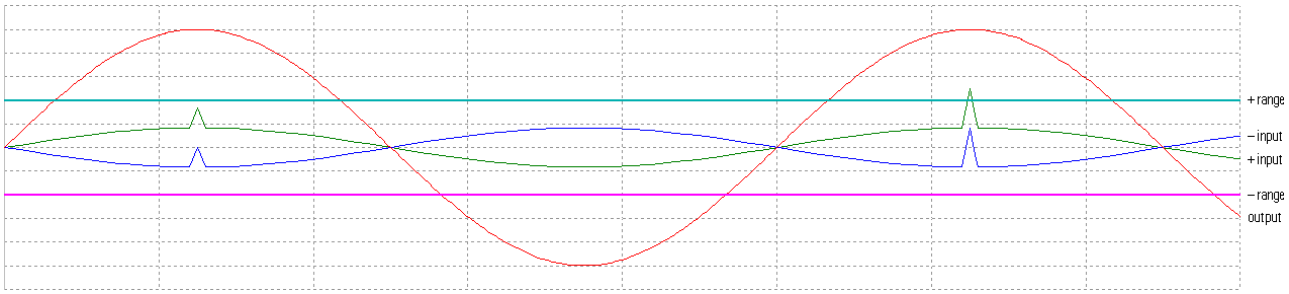


figure 2 common-mode removed at the input-stage: input-signal + disturbance can be above the input-voltage-range

Signals entering the card are passing ESD-protections and well balanced differential LRC-filters where high-frequency-components are removed that the following amplifiers cannot damp sufficiently. These symmetrical-I/O-amplifiers cancel common-mode-disturbances, amplify the differential-signals and add a pole for bandwidth-limitation. Together with the subsequent differential RC-filters a total attenuation of 70dB is achieved at half the oversampling-speed of the simultaneously sampling differential advanced multi-bit delta-sigma analog-to-digital-converters – low aliasing-distortions are the benefit. The converters offer selectable reduction-low-pass-filters for 48, 96 and 192kHz output rate and a high-pass-filter can be switched on to reduce the offset whenever DC is not of interest.

The digital control unit collects the serial 24bit data-streams from the converters, optimizes them to 32bit words and stores up to 16MS / input in real time memory; when full, oldest data is overwritten by the latest.
Streaming via the cPCI bus is performed simultaneously; 48kS/s is sent directly, 96kS/s and 192kS/s are down-sampled to 48kS/s. End-point of recording can be between Record-Trigger and 349 seconds later. The Record-Trigger can be released by cPCI-command, pulling down /RECTRIGGER at J2 or reaching a cPCI-register definable value of one of the first eight input-channels.
/SHUTTER is a pull-down-activated bidirectional control-signal; it is available at J2 and the front connector and can be sensed and released through cPCI. /SHUTTER is recorded in Bit0 of every channel and counted in a cPCI-register.
/DETECT is another pull-down-activated signal; it is available at the front connector and can be sensed through cPCI.
IS_SERIAL_IN is decoupled by an optocoupler and connected to RS2_RX_TTL at J2; IS_SERIAL_OUT is a pull-down output and connected to RS2_TX_TTL at J2; both can be switched on and off by cPCI-commands.
The SENSOR_6V and SENSOR_0V contacts of the front connector are for the main sensor supply and 12V, 5V, 0V as well as SWITCH_0V offer further possibilities.
Temperature-sensor, voltage-check, front-panel-RGB-LED and nonvolatile calibration and configuration memory are available to cPCI. During factory-calibration gains of all channels are measured and stored in this memory.

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