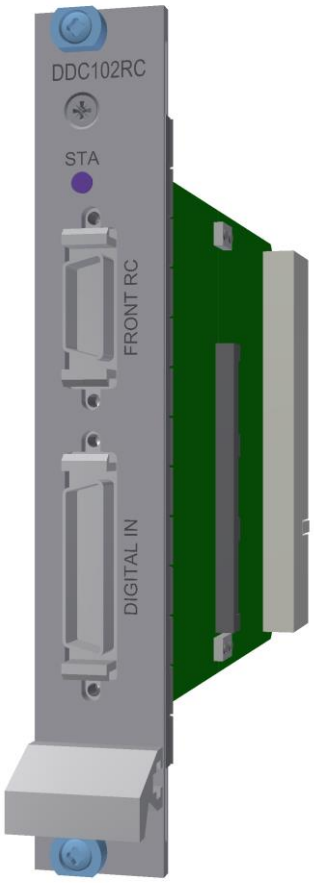
Features

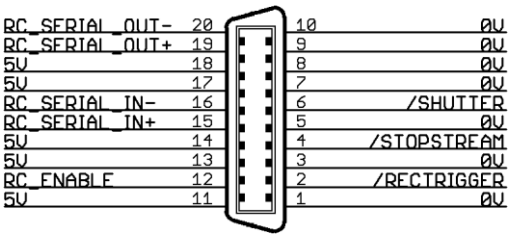
- Multi-channel digital interface SyDBus12
  MDR36 front connector for reliable repetitive plugging
  12 isolated inputs for high disturbance immunity
  Differential or single ended with1.4V threshold
  500V AC isolation (input to case)
  5V and isolated 5V for sensor supply
  1 pull-down activated bidirectional control-signal
  Decoupled serial interface for intelligent sensors
- Simultaneous sampling from 48kS/s up to 6.144MS/s
- Advanced Record-Trigger capability
  Adjustable between start and end of recording
  Activated by software, hardware or input-dependent
- 1.5GB cPCI-independent onboard real time memory
  512MS / input for up to 3.1h recording time (48kS/s)
- Concurrent cPCI-streaming up to the limits of the harddisk (3072/6144kS/s reduced to 1536kS/s)
- Remote-control interface with RS-485
  MDR20 front connector for reliable repetitive plugging
  3 pull-down activated bidirectional control-signals
- Nonvolatile calibration and configuration memory
- Onboard voltage and temperature monitoring
- Full Color RGB status LED (marked STA)
- Low power consumption (6.5W typically)

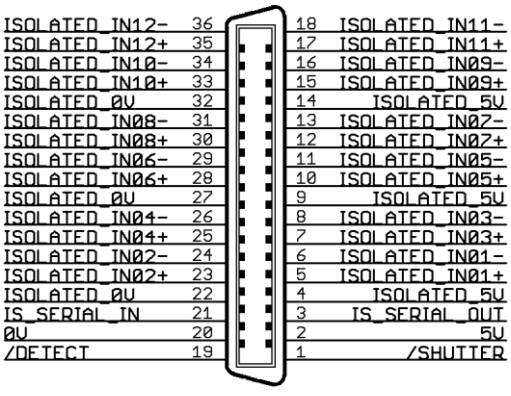


Description

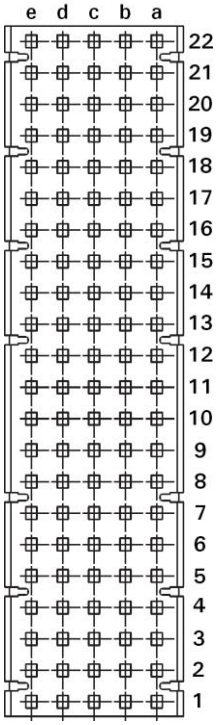
The DDC102RC is a low power high-speed 3U 4HP digital measurement cPCI slot-in card for the mcdRec data-recorder. Its 12 channels can be connected to single-ended as well as the preferred differential signals ensuring extraordinary immunity against disturbances being coupled into the cables. 6 contacts of the MDR36 front connector are for sensor supply. Furthermore 0V and 5V contacts are also available. /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. Configuration-data is stored in a nonvolatile memory. The upper front connector carries an RS-485 interface and a set of triggers. It can be used for remote-control and synchronization between two or more systems.

MDR front connector schemes



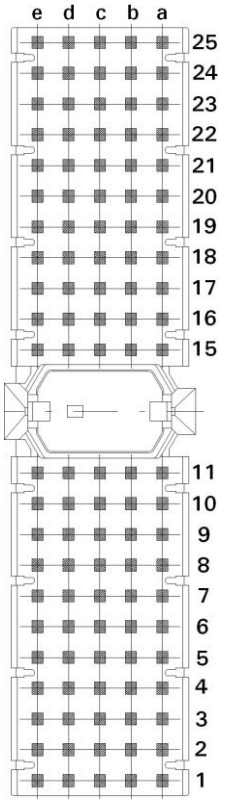


cPCI J2 connector scheme (not standardized)



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)

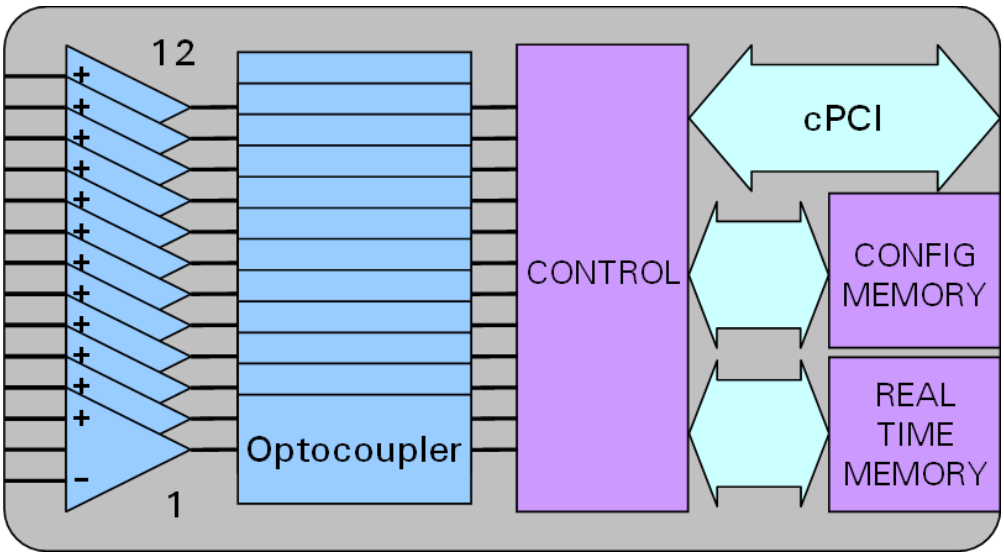


e	d	c	b	a
+5V	+3V3			+5V
	AD0	VIO	+5V	AD1
AD2	+5V	AD3	AD4	+3V3
AD5	AD6	+3V3	GND	AD7
C/BE0	M66EN	AD8	AD9	+3V3
AD10	AD11	VIO	GND	AD12
AD13	GND	AD14	AD15	+3V3
C/BE1	PAR	+3V3	GND	/SERR
/PERR	GND			+3V3
/LOCK	/STOP	VIO	GND	/DEVSEL
/TRDY		/IRDY	/FRAME	+3V3

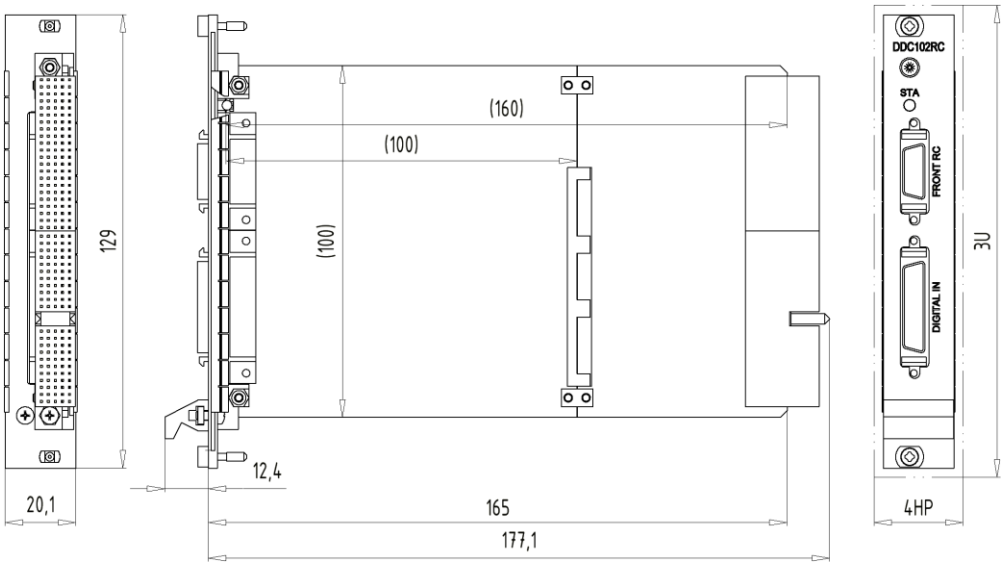
blanks are not connected on the card

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 168g

Absolute maximum ratings

Parameter	Min	Max	Unit	Remarks
Power +5V to GND	-0.3	6	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.
+3V3 to GND	-0.3	4	V	
VIO to GND	-0.3	4	V	
RC_SERIAL_IN± to 0V	-8	13	V	
Isolated inputs to ISOLATED_0V	-25	25	V	
Isolated inputs to CASE	0	500	V_{eff}	
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	Max	Unit	Remarks
Power supply (+5V)	4.7	5.3	V	voltages at the cPCI connectors J1+J2 must be guaranteed to be within these limits
(+3V3)	3.0	3.6	V	
(VIO)	3.0	3.6	V	
Output current (front) 5V	0	55	mA	all outputs are short-circuit-proof, 5V shall return at 0V
ISOLATED 5V	0	500	mA	the three ISOLATED_5V shall return at the three ISOLATED_0V
Output current (front RC) 5V	0	150	mA	short-circuit-proof, the five 5V shall return at the seven 0V
Isolated inputs IN+ to IN–	-17	17	V	maximum differential threshold is 0.2V (50mV typically)
IN+ to ISOLATED_0V	-7	10	V	single ended threshold is between 0.9V and 1.9V (1.4V typically)
IN– to ISOLATED_0V	-7	10	V	connect single ended signals between IN+ and ISOLATED_0V
/DETECT input to 0V low	0	0.7	V	10kΩ pull-up-resistor to +3V3 is on the card
high	1.7	3.3	V	
IS_SERIAL_IN to 0V low	0	0.4	V	330Ω resistor to optocoupler-cathode, anode to+3V3 (on card)
high	2.2	4	V	
IS_SERIAL_OUT to 0V 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	
RC_SERIAL_IN± to 0V	-7	12	V	maximum differential threshold is 0.2V (125mV typically)
RC_SERIAL_OUT± to 0V	0	3.3	V	minimum differential output is 2V when loaded with 100Ω
RC_ENABLE to 0V low	0	0.8	V	when loaded with 1kΩ or more
high	2.1	3.3	V	
/SHUTTER, /RECTRIGGER low	0	1	V	must be pulled-up with 220Ω resistors to VIO on the backplane
and /STOPSTREAM 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.
0V is connected to GND but ISOLATED_0V is isolated from GND (a varistor between ISOLATED_0V and CASE protects the inputs)
CASE and GND shall be connected only once in the mainframe.

Electrical characteristics

Parameter	Min	Typ	Max	Unit	Condition
Single ended input-resistance	21	24	26	kΩ	ISOLATED_IN+ to ISOLATED_0V
Differential input-resistance	45	48	52	kΩ	ISOLATED_IN+ to ISOLATED_IN–
Supported sampling rates	48	2^Nx48	6144	kS/s	max. recording time @ 6144kS/s is 87s
Single ended performance					
frequency response @ 0.8V / 2V	0		1	MHz	@ 6144kS/s*, all inputs connected
frequency response @ 0V / 5V	0		1	MHz	
frequency response @ 0V / 10V	0		1	MHz	
frequency response @ -5V / 5V	0		2	MHz	
frequency response @ -7V / 10V	0		2	MHz	
skew between channels @ 0.8V / 2V	0		326	ns	
skew between channels @ 0V / 5V	0		163	ns	
skew between channels @ -7V / 10V	0		163	ns	
Differential performance					
frequency response @ ±0.2V	0		2	MHz	@ 6144kS/s*, all inputs connected
frequency response @ ±0.4V	0		2	MHz	
frequency response @ ±2V	0		2	MHz	
frequency response @ ±10V	0		2	MHz	
frequency response @ ±17V	0		2	MHz	
skew between channels @ ±0.2V	0		163	ns	
skew between channels @ ±2V	0		163	ns	
skew between channels @ ±17V	0		163	ns	
Channel separation					@ 6144kS/s, tested with square-waves @ 1kHz and 1MHz at each one of 12 inputs, other inputs unconnected
single ended range where unconnected inputs stay LOW	-7		10	V	
differential range where unconnected inputs stay LOW	-17		17	V	
Disturbance immunity					
maximum common mode @ ±0.2V differential input	5	7		V_{PP}	@ 6144kS/s, all inputs connected, square-waves from 50Hz to 1MHz
maximum common mode @ ±2V differential input	40	40		V_{PP}	
maximum common mode @ ±17V differential input	26	26		V_{PP}	
Power supply current					measured with 100mΩ shunt-resistors @ 6144kS/s, open inputs, 0.5A output current at ISOLATED_5V
(+5V)		1070	1200	mA	
(+3V3)		364	400	mA	
(VIO)		3	20	mA	
Power consumption					supply currents from above, real voltages measured between shunt-resistors and card
(+5V)		5.309	6.36	W	
(+3V3)		1.175	1.39	W	
(VIO)		0.010	0.07	W	
(total)		6.494	7.82	W	

* at lower sampling rates f_{max} of frequency response is always less than half the sampling rate and t_{max} of skew is worse.

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 subtractor eliminates that disturbance because 1 – 1 = 0 and also (-1) – (-1) = 0.
Isolation is the third player in the fight against disturbance (figure 2). It avoids the so called ground-loops occurring when there is more than one ground-connection-path between two pieces of equipment. The duplicate ground paths form the equivalent of a loop antenna which very efficiently picks up interference currents (figure 1). Lead resistance transforms these currents into voltage fluctuations. As a consequence of ground-loop induced voltages, the ground reference in the system is no longer a stable potential and the resulting disturbances become part of the signal.

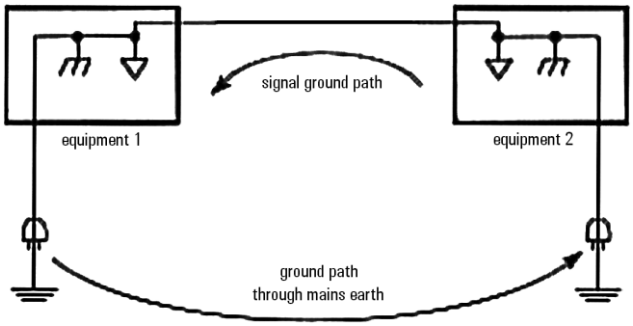


figure 1 ground-loop is closed – interference is induced

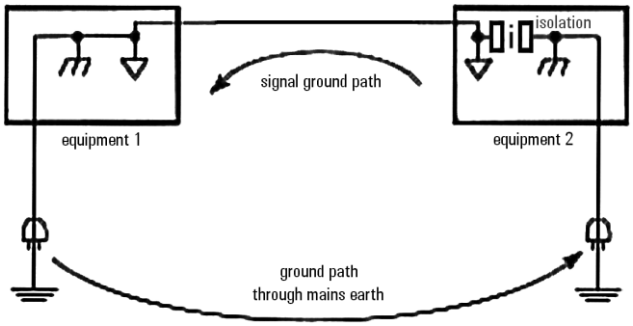


figure 2 ground-loop is open – no interference is induced

Signals entering the card are passing small damping-resistors before reaching integrated ESD-protected RS-485 receivers. Additional 220k-resistors at the negative inputs modify the threshold to around 1.4V expanding for single-ended use. The outputs of these receivers are connected to high-speed-optocoupler inputs. The whole input-circuit is isolated from CASE and GND and powered by an isolated DC-DC-converter. A varistor limits the maximum isolation-voltage to protect the isolation-barriers inside the converter and the couplers. Since the converter delivers 600mA of output-current and the input-circuit contents with 100mA, the remaining 500mA are available for sensor-supply.

While no measurements are made the converter can be turned off by a power-switch that is operated from the control-unit where also the 12 digital signals are collected simultaneously from the optocoupler-outputs and stored in real time memory. Up to 512MS / input can be stored there and when full, oldest data is overwritten by the latest.
Streaming via the cPCI bus is performed simultaneously; 48...1536kS/s are sent directly, 3072kS/s and 6144kS/s are reduced to 1536kS/s.

End-point of recording can be between Record-Trigger and 3.1 hours later. The Record-Trigger can be released by cPCI-command, by pulling down /RECTRIGGER at J2 or the upper front connector, by reaching a cPCI-register definable low-to-high or high-to-low transition of one of the input-channels or when the frequency at one selectable input exceeds or drops below the trigger-frequency derived from a cPCI-register definable value.

A counter counts impulses of a 122.88MHz reference-clock between high-to-low transitions of one selectable input. To handle very low and very high input frequencies the reference-clock and/or the input-clock can be halved up to 15 times. The counter's result is stored into a 32bit-register and available through cPCI. Optionally the result can be recorded instead of input 11 and updated every 32 samples.

/SHUTTER is a pull-down-activated bidirectional control-signal; it is available at J2 and both front connectors and can be sensed and released through cPCI.

A so called Shutter-counter counts high-to-low /SHUTTER-transitions from the beginning of the recording until the Record-Trigger occurs, the result is stored into a register that can be seen from cPCI. Optionally the Shutter can be recorded instead of input 12.

/DETECT is another pull-down-activated signal; it is available at the lower 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 ISOLATED_5V and ISOLATED_0V contacts of the lower front connector can be used for isolated sensor supply and the earthbound 5V and 0V offer further possibilities.

The upper front connector is for remote-control purposes. It features an RS-485 interface, five 5V and seven 0V power supply contacts as well as the pull-down activated bidirectional control-signals /SHUTTER, /RECTRIGGER that have been described above and the /STOPSTREAM that can also be released by cPCI-command or by pulling down the contacts at J2 or the upper front connector.

Temperature-sensor, voltage-check, front-panel-LED and nonvolatile configuration memory are available to cPCI.

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