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Engineering office for electronic designs
Instruments for Particle Physics and Space

User Manual

64 Channel Current-to-Digital-Converter
CDC064
with Chassis CDC-B9

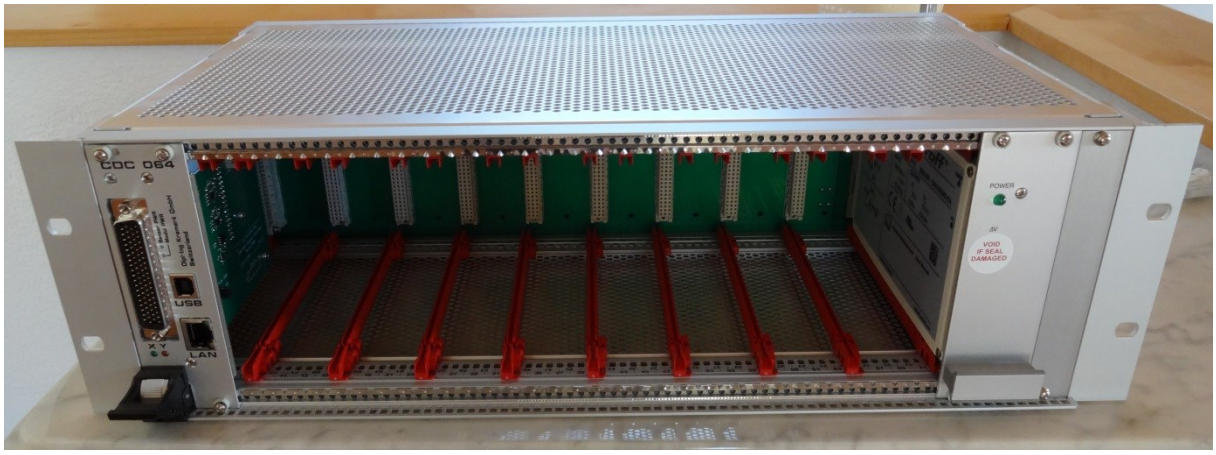


Image 1: CDC064 Module with 19“ Chassis CDC-B9

Index

Features

• Adjustable Full-Scale Range
• Adjustable Speed
    -Data Rate up to 6kSPS
    -Integration Times as low as 166.5us
• USB interface with 1Mbps
• LAN interface 10-100 Mbps
• 2 x 32 galvanic isolated input channels split to X and Y
• Remote Module-Diagnostics : Temperature, Humidity, Supply-Voltage, Supply-Current, Power-ON/OFF, Reset
• Power-Consumption per module 3W
• ARM-Cortex M3 integrated Microprocessor System with active watch-dog reset of 30 sec

• Power-Supply Module MAX2512: 5V-9A, 12V-4A ; Schroff Part No : 13100112 @ RS-Online

Applications

• Photodiode Sensors
• X-Ray Detection Systems

Description

The CDC064 module uses two independent 32-channel current-input analog-to-digital (A/D)converters for X and Y readout.
It combines both current-to-voltage and A/D conversion so that 32 separate low-level current output devices, such as photodiodes, can be directly connected to its inputs and digitized.
For each of the 32 X and 32 Y inputs, an integrated circuit (DDC) provides a dual-switched integrator front-end. This configuration allows for continuous current integration: while one integrator is being digitized by the onboard A/D converter, the other is integrating the input current. Adjustable integration times range from 166 µs to 1s, allowing currents from fAs to uAs to be continuously measured with high precision.

CDC064 Connectors and LED Functions

Sensor Input :
78-pol D-Sub HD, Male, Type SPC15370, Order-No 1564259
Distributor Farnell.com

USB :
921600 baud, no parity, 8 data bits, 1 stop bit
USB-B, 4-pol, Type 0670688110, Order-No WM12786-ND
Distributor Digikey.com

LAN:
RJ-45, Ethernet (MDIX)
10 Half Duplex
10 Full Duplex
100 Half Duplex
100 Full Duplex
AutoSensing

Backplane :
Eurocard DIN 41612, Type 09031647921, Order-No 1096903
Distributor Farnell.com

Image 2

Frontpanel LED Function

LED	Control
X	DDC-X RunEn-Register Bit[0]
Y	DDC-Y RunEn-Register Bit[0]
Sensor-PWR	Power_Reg (0x1C) Bit[0]
Module PWR	Front-panel handle Up/Down

Table 1

64-Channel Current Input Signals Connector P1

P1 Connector							
Signal	Pin	Signal	Pin	Signal	Pin	Signal	Pin
ISO-GND	60	ISO-GND	21	ISO-GND	40	ISO-GND	1
X_DDC4	61	X_DDC3	22	X_DDC2	41	X_DDC1	2
X_DDC8	62	X_DDC7	23	X_DDC6	42	X_DDC5	3
X_DDC12	63	X_DDC11	24	X_DDC10	43	X_DDC9	4
X_DDC16	64	X_DDC15	25	X_DDC14	44	X_DDC13	5
X_DDC20	65	X_DDC19	26	X_DDC18	45	X_DDC17	6
X_DDC24	66	X_DDC23	27	X_DDC22	46	X_DDC21	7
X_DDC28	67	X_DDC27	28	X_DDC26	47	X_DDC25	8
X_DDC32	68	X_DDC31	29	X_DDC30	48	X_DDC29	9
ISO-GND	69	ISO-GND	30	ISO-GND	49	ISO-GND	10
Y-DDC2	70	Y-DDC1	31	ISO-GND	50	ISO-GND	11
Y-DDC6	71	Y-DDC5	32	Y-DDC4	51	Y-DDC3	12
Y-DDC10	72	Y-DDC9	33	Y-DDC8	52	Y-DDC7	13
Y-DDC14	73	Y-DDC13	34	Y-DDC12	53	Y-DDC11	14
Y-DDC18	74	Y-DDC17	35	Y-DDC16	54	Y-DDC15	15
Y-DDC22	75	Y-DDC21	36	Y-DDC20	55	Y-DDC19	16
Y-DDC26	76	Y-DDC25	37	Y-DDC24	56	Y-DDC23	17
Y-DDC30	77	Y-DDC29	38	Y-DDC28	57	Y-DDC27	18
ISO-GND	78	ISO-GND	39	Y-DDC32	58	Y-DDC31	19
				ISO-GND	59	ISO-GND	20

Table 2

Image 3

ISO-GND is isolated from Chassis-Ground and from all other modules in the chassis.
It is the return path for all 64 current input signal currents.

Module Dimension

The CDC064 module is a CompactPCI Plug-in Unit with one Bottom-Handle and uses two slots (8hp) of a 3U, 84hp Rack Mount Chassis. PCB size is 100mm x 160mm.

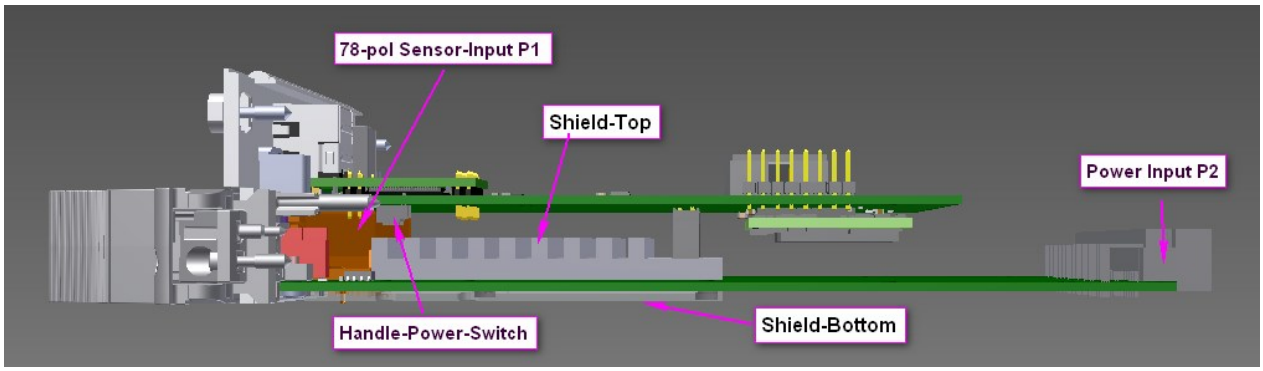


Image 4: CDC064 Module bottom side view. The analog circuits are fully shielded on both sides.

Low Voltage Power Input at Connector P2:

- +5V_DG / 0.4A max
- +12V_DC / 0.2A max, galvanic isolated analog supply

Supply Voltage Tolerance: ±10%

Power-Input P2	
C1	+5V_DG
A1	+5V_DG Return (GND)
A32	+12V_DC
A31	+12V_DC Return (AGND)

Table 3

Note: Both module supplies are switched ON/OFF by the frontpanel-handle switch.

Mains AC Power Input CDC-B9 Chassis

Mains Power Input: 230V AC
Two fuses: Phase and Neutral with 2Ampere, Slow characteristic

Image 5: Remove power-cord to get access to the extraction slits to change fuses.

Max Power Consumption with nine CDC064 Modules installed: 50 Watt

High voltage is inside the chassis. Do not open. Do not remove screws.

Module-Setup

• Com-Port Selection

Select	JP3	JP4	Default
USB	2-3	2-3	
LAN	1-2	1-2	X

Table 4

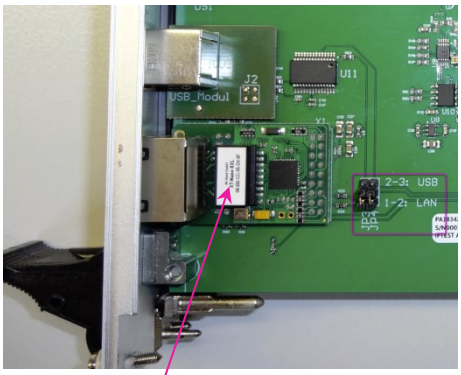


Image 6

USB port is selectable with jumper JP3, JP4 at upper position 2-3.

UART Settings :
Baud-Rate : 921600 fixed
Parity : No
Data-Bits : 8
Stop-Bit : 1

LAN port is selected with jumper JP3, JP4 at lower position 1-2.

The LAN connection is done with the XT-Nano-SXL LAN to UART interface via local port 1002 (table 4).

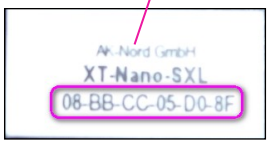


Image 7

Each module has its individual MAC address, labeled at the PCB.
AK-Nord provides an Administrator tool for programming the interface parameters as well as permanent IP.

XT-NANO SXL settings

	Serial Config Menu	
1	Baudrate	921600 (1.041.666)
2	Databits	8
3	Parity	N
4	Stoppbits	1
5	Flow Control	N
6	RTS Protocol	0
7	DCD Protocol	0
8	DTR Protocol	0
9	DSR Protocol	0
a	Emulation	TCPSERVER
b	EmuCode	0
c	BUS	RS232
d	InputTimeOut*10ms	0
e	Local Port	1002
f	With SSL/TLS	N

	TCP Menu	
1	Port Timeout	30 (sec)
2	TCP-KeepAlive (Y/N)	Y
3	Naglemode (Y/N)	Y
4	Num of TXPackets	0 (auto)

	WEB-Login	
	User	XT
	Password	XT

	DNS-Menu	
1	DNS Server1	10.0.0.1
2	DNS Server2	0.0.0.0
3	DNS Name	CDC064_xxx

xxx= Serial number 000..999

	DHCP Menu	
1	DHCP (Y/N)	Y

Set DHCP = N for permanent IP

Table 5: Default XT-Nano-SXL Interface Parameters

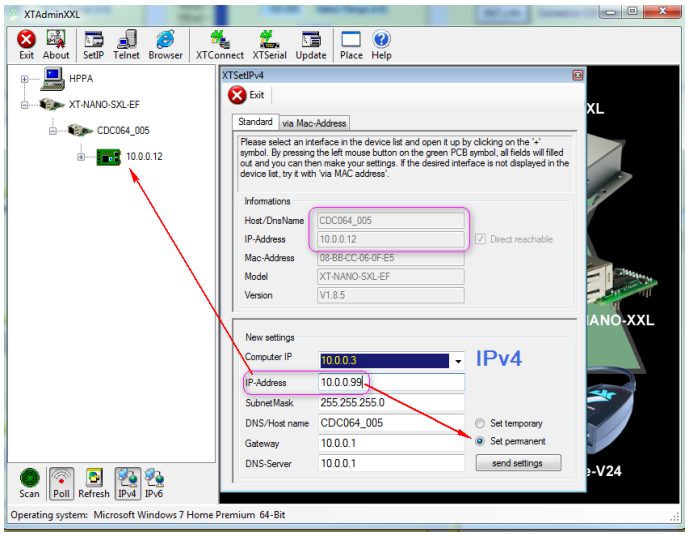


Image 8 : Programming permanent IP-Address with the Admin tool from AK-Nord

Communication

Communication via LAN or USB is done in ASCII-code and hexadecimal numbers with commands described in the « CDC064 Commands and Registers Rev 3.3 » table.

Commands

Display with address increment:
d(addr,nunits) example: d(0x4,0xa)
d() reads nunits of 32 bit data starting from addr, incrementing the addr +4 after each read; nunits range: 0x1..0x20

Write:
w(addr,data) example: w(0x5,0xb)
Command w() is to write data to the specified address.

Display without address increment:
D(addr,nunits) example: D(0x4,0xa)
Command D() is same as d() but without increment of addr.

Display Repeat:
d() : Uses the previously transmitted values of addr and nunits.
This command gets the fastest response time.

Command-examples are in « CDC064 Commands and Registers Rev 3.4 » table page 2.

Note : All commands are terminated with CF+LF.

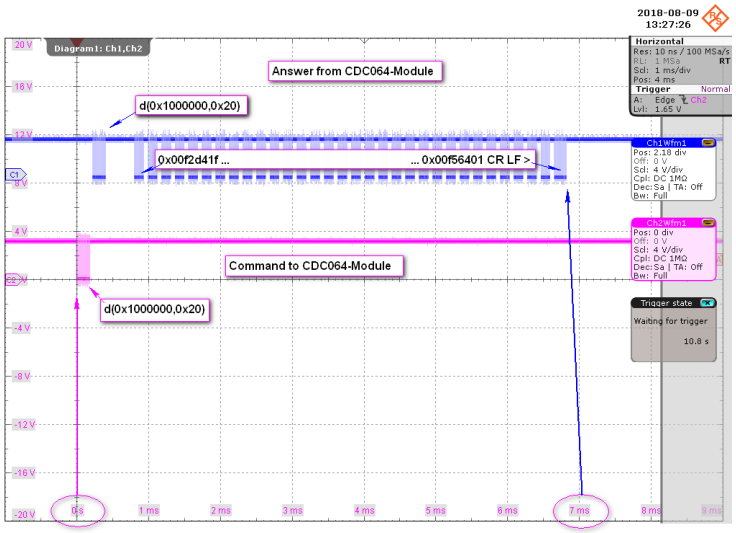


Image 9: ADC-Data transfer via command d(0x1000000,0x20) ;

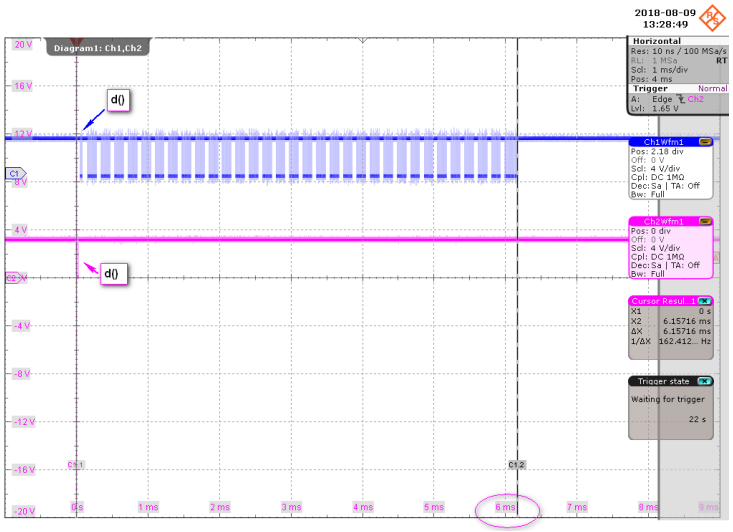
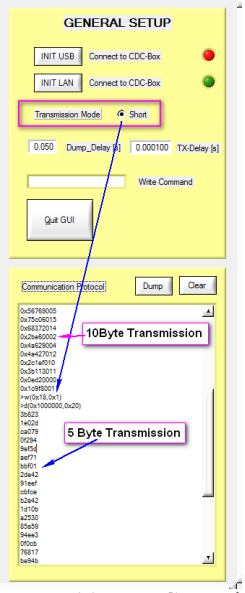


Image 10 : ADC-Data transfer via repeat command d() ;

ADC-Data Transmission Modes



For time critical applications the transmission mode for ADC-datas could be set to 'Short' with the command w(0x18,0x1).
In this mode the transmission of ADC-data is stripped from 10 byte to 5 byte.
This is pure 20bit-ADC-data without any overhead and cuts transmission time to 4.3ms for 32 channels of ADC data.

Image 11: PM-GUI with Transmission-Mode Register set from Default to Short.

CDC-X and CDC-Y converters are seperate units within one CDC064-module and need their individual initialization.

Initialization Command Sequence

1. Select Range
2. Set Conversion Time
3. Enable Configuration
4. Check Configuration flags
5. Enable Run

Example CDC-X:

w(0x0,0xfc0)	// Select 350pC Integration Capacity	(1)
>d(0x0,0x1)	// Read Config Register	
0x00000fc0	// Result of Config Register	
>w(0xc,0x11170)	// Set Conversion Time Register to 3.5ms -> i=q/t = 350pC/3.5ms = 100nA	(2)
>d(0xc,0x1)	// Read Conversion Time Register	
0x00011170	// Result of Config Register	
>w(0x4,0x0)	// Set ConfigEn-Flag -0-1 restarts configuration	
>w(0x4,0x1)	// Set ConfigEn-Flag -0-1 restarts configuration	(3)
>d(0x4,0x1)	// Read ConfigEn Register and flags	(4)
0x0fc0000**f**	// Check Config Parity Flag (configuration programming successful)	
>w(0x8,0x1)	// Set RunEn Register Run- Flag	(5)
>d(0x8,0x1)	// Check RunEn Register Run- Flag set	
0x0000000**1**	// Check RunEn Register Run- Flag set	
>		

Example CDC-Y:

w(0x3000000,0xfc0)	// Select 350pC Integration Capacity	(1)
>d(0x3000000,0x1)	// Read Config Register	
0x00000fc0	// Result of Config Register	
>w(0x300000c,0x11170)	// Set Conversion Time Register to 3.5ms -> i=q/t = 350pC/3.5ms = 100nA	(2)
>d(0x300000c,0x1)	// Read Conversion Time Register	
0x00011170	// Result of Config Register	
>w(0x3000004,0x0)	// Set ConfigEn-Flag -0-1 restarts configuration	
>w(0x3000004,0x1)	// Set ConfigEn-Flag -0-1 restarts configuration	(3)
>d(0x3000004,0x1)	// Read ConfigEn Register and flags	(4)
0x0fc0000**f**	// Check Config Parity Flag (configuration programming successful)	
>w(0x3000008,0x1)	// Set RunEn Register Run- Flag	(5)
>d(0x3000008,0x1)	// Check RunEn Register Run- Flag set	
0x0000000**1**	// Check RunEn Register Run- Flag set	
>		

Read ADC-Data

After the converstion time n ADC-datas are generated and ready to read from the X- or Y-base address.
With conversion time n+1 new ADC-datas are generated and immediately overwrites old ADC-datas one by one.

Example:
Read 32 channel ADC-Data from CDC-X
d(0x1000000,0x20)
0x468941F
0x232540F
0x28AA41B
0x23EB00E
0x30AD00A
0x3DF100B
0x75C201A
0xF08A01E
0x1BAD0009
0x2BAA240D
0x3C790419
0x4A86341D
0x53BD2418
0x5A5A2408
0x5DC34017
0x601CE01C
0x3028007
0x641100C
0x7C9A016
0x4048003
0x1C457406
0x108DE413
0x3A9AD405
0x2B172415
0x51E78414
0x485C0002
0x5D796004
0x598D0012
0x638AF010
0x613B6011
0x6379C000
0x63E40401
>

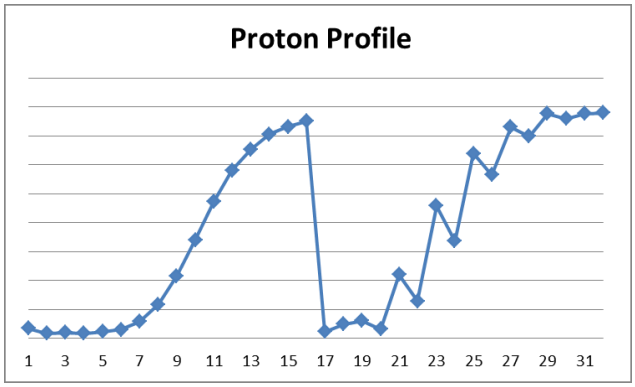


Image 12:
These Sensor channels are not connected in ascending order to the CDC064 Input and need remapping.
The remapping sequence for this Ionisation-Chamber example is in the file „CDC_Mapping_CDC064.cvs“, see attachment.

Extraction of the 20 MSB represents the ADC-datas.
Example Current calculation of e.g. channel 15:
Y(n)=a*x(n)
a = 200nA/2^20
x(15) = 0x5DC34017 => ADC-data = 0x5DC34 = 384‘052
Y(15) = 200nA/2^20 *384‘052 = 73.25 nA

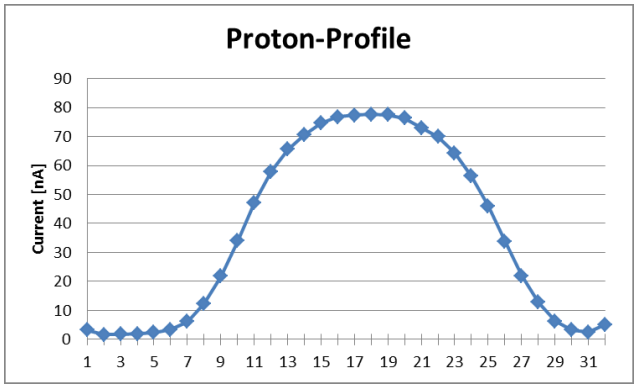


Image 13: Sensor channels with remapped channel order

ADC-RAM-Buffer (ARB)

After each conversion the ADC-data of 32 channels are stored into the ADC-RAM-Buffer ARB.
The ARB is an adjustable ring buffer from 32 x 32 bit (1 Data-Set) up to 992 x 32 bit (31 Data Sets).

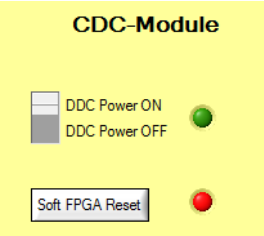
Two ADC-RAM-Buffer store CDC-X data and CDC-Y data.

ARB-Base-	SET1	SET2	SET3	SET4	SET5	...	SET31
Address X	0x1000000	0x1000080	0x10000100	0x1000180	0x10000200		0x10000F00
Address Y	0x4000000	0x4000080	0x40000100	0x4000180	0x40000200		0x40000F00

Table 6

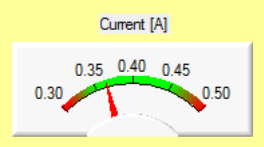
Module-Diagnostics-Registers

Power Register 0x1C:



Two bits controls
• Analog-Supply ON/OFF, reduces module power consumption by 30%
• FPGA-Reset : Resets the module-logic to its default state

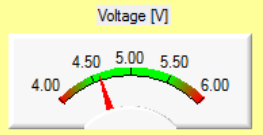
Power 5V-Current 0x20:



Digital Supply

•LSB = 268.6 uA ; Typical I_{5V} = 0.36A

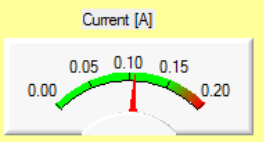
Power 5V-Voltage 0x24:



Digital Supply

•LSB = 14 mV ; Typical U_{5V} = 5V (+/-10%)

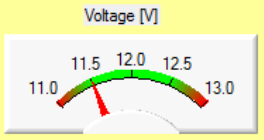
Power 12V-Current 0x28:



Analog Supply

•LSB = 268.6 uA ; Typical I_{12V} = 0.11A

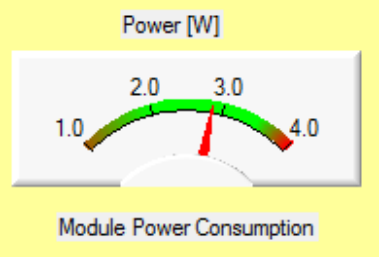
Power 12V-Voltage 0x2C:



Analog Supply

•LSB = 14 mV ; Typical U_{12V} = 12V (+/-10%)

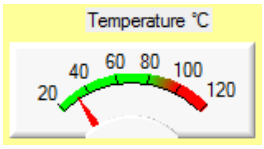
Module Power Consumption:



Power consumption depends on the Analog-Supply ON/OFF status and value of Integration-Time (ConversionTimeReg).

Typical: 2 - 3.5Watt

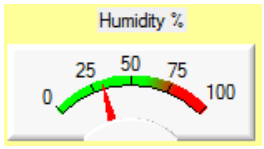
Interface-Board Temperature 0x30:



•Temp[°C]=(Reg-Value)/2^16) * 165 -40

Example: See CDC064 Commands and Registers Table

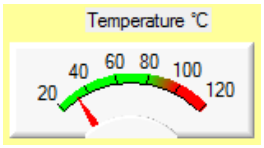
Interface-Board Humidity 0x34:



•Humidity[% RH]= (Reg-Value)^16) * 100

Example: See CDC064 Commands and Registers Table

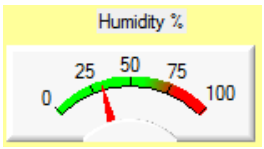
DDC-Base-Board Temperature 0x40:



•Temp[°C]=(Reg-Value)/2^16) * 165 -40

Example: See CDC064 Commands and Registers Table

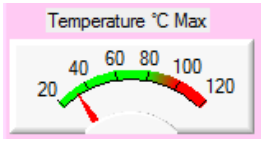
DDC-Base-Board Humidity 0x44:



•Temp[°C]=(Reg-Value)/2^16) * 165 -40

Example: See CDC064 Commands and Registers Table

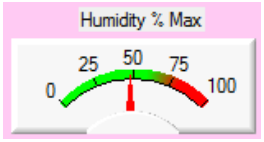
Interface-Board Peak-Temperature 0x38:



•Temp[°C]=(Reg-Value)/2^16) * 165 -40

Example: See CDC064 Commands and Registers Table

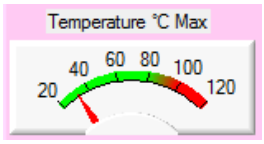
Interface-Board Peak-Humidity 0x3C:



•Humidity[% RH]= (Reg-Value)^16) * 100

Example: See CDC064 Commands and Registers Table

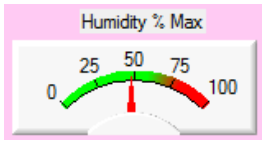
DDC-Base-Board Peak-Temperature 0x48:



•Temp[°C]=(Reg-Value)/2^16) * 165 -40

Example: See CDC064 Commands and Registers Table

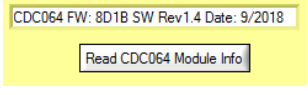
DDC-Base-Board Peak-Humidity 0x4C:



•Temp[°C]=(Reg-Value)/2^16) * 165 -40

Example: See CDC064 Commands and Registers Table

Module Firmware and Software Rev. (MIR) 0x100:



45-Bit ASCII String:
Module Name; Firmware Checksum; Software Revision; Production Date

Revision History

Date	Revision	Update/Revision/Comment
2018-10-15	1.2	Initial issue
2018-10-25	1.3	Index added

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Trouble Shooting:

1. Check Mains Power-Switch at the CDC-B9 chassis rear side switched ON
2. Check Power-Supply module front-panel LED ON
3. Check LAN cable connected, check both LAN-LEDs flashing, ping the gateway to the module
4. Check both module power-LEDs at the CDC064 front-panel ON
5. Check X-Y-LED at the CDC064 front-panel. Should react at RunEn start /stop commands
6. Read and check the ConfigReg, ConfigEn, RunEn, ConversionTime registers for correct values
7. Check CDC064 module power consumption, supply currents and voltages with the Module-Diagnostics registers
8. Check module temperature and humidity with the Module-Diagnostics registers
9. Wait 30 seconds for module-watch-dog reset
10. Power-Cycle the module using the frontpanel-handle switch
11. Change the module slot in the CDC-B9 Chassis
12. Power-Cycle the CDC-B9 chassis
13. Call the Hotline for assistance

Appendix

Mapping Example File: “CDC_Mapping_Neutral.csv”

	A	B
1	GUI Chart	P1 Ch Input
2	CH_1	1
3	CH_2	2
4	CH_3	3
5	CH_4	4
6	CH_5	5
7	CH_6	6
8	CH_7	7
9	CH_8	8
10	CH_9	9
11	CH_10	10

Table 7

Linearity Correction Example File: “Error Table CDC064 SN5 1000nA.csv”

	A	B	C
1	CDC064 SN 005		
2	Calibration Current [nA]: 1000		
3	CH-No	X [%]	Y [%]
4	1	-0.701437	-2.256492
5	2	0.249289	0.142025
6	3	-0.521351	-2.084926
7	4	0.26467	0.194346
8	5	0.2318	0.092536
9	6	0.293259	0.086787
10	7	-0.518602	-2.112749
11	8	-0.590794	-2.17574
12	9	0.233479	0.034655
13	10	0.274416	0.197587
14	11	-0.520574	-2.169843
15	12	-0.523827	-2.196995

Table 8

CDC-Y Data Example File: “CDC_DATA_Y_File_2933.csv”

	A	B	C	D	E	F	G	H
1	Integration Time [ns]: 693050							
2	CDC-Range [pC]: 350.000000							
3	Current at ADC-Max(MSB 20Bits) [nA]: 505.014068							
4	Average Value: 10							
5								
6	Average Pedestal Y: 3700							
7	Averaged Data Pofil Y with channel-mapping, multiplied by range value, Result in nA, Pedestals substracted							
8								
9	Channel 1	498.969367						
10	Channel 2	499.064236						
11	Channel 3	499.219315						
12	Channel 4	499.214201						
13	Channel 5	499.075870						
14	Channel 6	499.209633						
15	Channel 7	499.117706						
16	Channel 8	499.114022						
17	Channel 9	499.083488						
18	Channel 10	498.989368						
19	Channel 11	499.069073						
20	Channel 12	499.029844						
21	Channel 13	498.996461						
22	Channel 14	498.994915						
23	Channel 15	499.057964						
24	Channel 16	499.171374						
25	Channel 17	499.018428						
26	Channel 18	499.117114						
27	Channel 19	498.884305						
28	Channel 20	498.922265						
29	Channel 21	499.155087						
30	Channel 22	498.847068						
31	Channel 23	499.077753						
32	Channel 24	499.096984						
33	Channel 25	498.974613						
34	Channel 26	499.118699						
35	Channel 27	499.020874						
36	Channel 28	499.091582						
37	Channel 29	498.917868						
38	Channel 30	498.900879						
39	Channel 31	499.193386						
40	Channel 32	499.109805						
41								

Table 9