



**Data + clock and BiPhase modules**

**DCM40**

1 channel module for signal input and output  
Supported dataformats: DATaRec 3, IRIG 106 chapter 10

**Input**

|                              |  |
|------------------------------|--|
| Input signal                 | data + clock:<br>data + clock mode (DCM)<br>data only:<br>asynchronous sampling mode (ASM)<br>BiPhase:<br>BiPhase mode (BPM)   |
| Signal rate DCM and ASM mode | NECL or PECL input:<br>10 kbit/s – 100 Mbit/s<br>RS644 (LVDS) input:<br>10 kbit/s – 70 Mbit/s<br>RS422, RS485 or analogue input:<br>10 kbit/s – 40 Mbit/s<br>TTL input:<br>10 kbit/s – 20 Mbit/s |
| BPM mode                     | all input levels:<br>10 kbit/s – 12 Mbit/s   |
| Clock rate                   | DCM and BPM mode:<br>any specified fixed clock rate is possible<br>ASM mode:<br>internal clock rate all signal levels:<br>10 kbit/s – 100 Mbit/s   |
| Clock source                 | external or internal depending on selected mode  |
| Clock format                 |  |
| DCM mode                     | synchronous to the data  |
| ASM mode                     | the internal receiver clock samples the data asynchronously  |
| BPM mode                     | the internal receiver synchronizes automatically to the incoming BiPhase coded signal  |
| Clock edge                   | rising or falling edge selectable  |

**Single ended input signals**

Signal level TTL or high speed single ended analogue

**High speed single ended analogue input**

Coupling AC or DC coupled  
Input range ± 10 Vp single ended

Input threshold - 5 V to 5 V (selectable in 100 mV steps)  
Input hysteresis 30 mV, 100 mV or 300 mV selectable

**Differential input signals**

Signal level RS422, RS485, RS644 (LVDC), NECL, PECL differential standards or high speed differential analogue

**High speed differential analogue**

Coupling DC coupled only  
Input range ± 10 V differential  
Input threshold 30 mV, 100 mV or 300 mV selectable  
Max. common mode ± 4 V  
Input impedance  
NECL or PECL 100 Ω differential  
RS422 or RS485 51 Ω, 100 Ω or 12 kΩ selectable  
RS644 51 Ω, 100 Ω or 4 kΩ selectable  
TTL 800 Ω, bus hold circuit  
High speed analogue differential single ended 75 Ω or 22 kΩ selectable  
common 50 kΩ

Input data randomizer off, forward P11/P15/P17, reverse P11/P15/P17 selectable

Connector 37-pin D-Sub

**Output**

Output signal  
DCM mode data + clock  
BPM mode BiPhase-L, BiPhase-M or BiPhase-S  
Signal rate  
NECL or PECL 10 kbit/s – 100 Mbit/s  
RS644 10 kbit/s – 70 Mbit/s  
RS422, RS485 10 kbit/s – 40 Mbit/s  
Clock rate the recorded data rate is automatically reconstructed  
Clock format DCM mode:  
NRZ-L, NRZ-M or NRZ-S output coding selectable rising or falling edge selectable  
Signal level NECL, PECL, RS422, RS485, RS644 differential standards selectable  
Pseudorandom generator off/P07/P15/P23 pattern selectable

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Connector 37-pin D-Sub, same as the input

## PCM40

1 channel PCM data recording and playback module  
Supported dataformats: DATaRec 3, IRIG 106 chapter 10

### Input

Input format

Data only mode (ASM)

any specified fixed clock rate is possible  
the defined receiver internal clock samples asynchronously the incoming data (Asynchronous Sampling Mode, ASM)

Data + clock mode (DCM)

any specified fixed clock rate is possible  
the external input clock must be synchronous to the input data, rising or falling clock edge data sampling is selectable (data + clock mode, DCM). NRZ-L, NRZ-M, NRZ-S input coding selectable

BiPhase mode (BPM)

any specified fixed data rate is possible  
the receiver synchronises automatically to the incoming BiPhase coded signal. (BiPhase mode, BPM) BiPhase-L, BiPhase-M, BiPhase-S input coding selectable

Input signal rate

ASM mode

all input signal levels:  
10 kbit/s to 100 Mbit/s

DCM mode

NECL or PECL inputs: 10 kbit/s to 80 Mbit/s  
RS644 (LVDS) input: 10 kbit/s to 80 Mbit/s  
RS422/RS485, analogue input: 10 kbit/s to 30 Mbit/s

TTL input: 10 kbit/s to 20 Mbit/s

BPM mode

all input signal levels: 10 kbit/s to 12 Mbit/s

### Single ended input signals

Signal level TTL or high speed single ended analogue

### High speed single ended analogue input

Coupling

AC or DC coupled

Input range

max. +/-10 Vp single ended

Input threshold

-4 V to 4 V in 100 mV steps

Input hysteresis

30 mV, 100 mV, 300 mV selectable

### Differential input signals

Signal level

RS422, RS485, RS644 (LVDS), NECL, PECL standards or high speed analogue

### High speed differential analogue input

Coupling

DC coupled, only input signal range  
max. +/-10 Vp differential  
differential input threshold 30 mV, 100 mV, 300 mV selectable

Input impedance

NECL or PECL

100 Ω differential

RS422/485/644

51 Ω, 100 Ω or 4 kΩ selectable

TTL

800 Ω, bus hold circuit

High speed

analogue

differential / single ended 75 Ω or 22 kΩ  
selectable, common 50 kΩ

Input

derandomiser

off / forward P11 / P15 / P17 / reverse P11 / P15 / P17 selectable

Input clock

sampling edge

rising / falling selectable

Input data

inversion

off / on selectable

Input data word

time stamping

resolution

100 ns

PCM frame

synchronisation

IRIG 106 standard PCM format  
standard or user defined frame synchronisation  
word (1-48 bits)  
minor frame size: max 8 kByte

Connector

37-pin D-Sub female

### PCM mode recording

Recording modes

throughput, packed and unpacked

Minor frame synch

word length

1 - 48 bits

Minor frame synch

word mask

a bit mask can be defined for each bit of the  
minor frame synchronisation  
the zero bits in the mask means don't care bits  
for the frame synchronisation

Maximum minor

frame size

unpacked mode: 4096 x up to 16-data words  
including the synch word  
packed mode: 65536 data bits including the  
synch word

Minor frame synch

lock criteria

programmable number of found synch patterns

Minor frame synch

lost criteria

programmable number of lost frames

Maximum major

frame size

not limited, however major frames exceeding  
16384 bytes will be splitted into more than one  
data packet

Unpacked mode

padding

LSB or MSB padding selectable

Unpacked mode

word shifting

MSB first or LSB first mode selectable on every  
word

### Packed and throughput

Mode word shifting

MSB first or LSB first mode selectable for the  
whole packet

Watch word check

one up to 16-bit data word can be defined at  
any position in a bit-mask as watch word, and if  
it is defined its absence is continuously checked  
and indicated as error status.

Status indicators

Lock indication

no clock, no data status, measured bit rate  
minor frame locked, major frame locked, watch  
word checking

### Output

Output format

Data + clock mode

(DCM)

NRZ-L, NRZ-M, NRZ-S data + clock mode  
output selectable  
the output clock is synchronous to the data  
the rising or falling clock edge synchronisation  
is selectable

BiPhase mode

(BPM)

BiPhase-L, BiPhase-M, BiPhase-S coded  
output data on separated output selectable.

Output signal level

NECL, PECL, RS422, RS485, RS644  
differential standard selectable

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|                                 |  |
|---------------------------------|--|
| Clock rate                      | the recorded data rate is automatically reconstructed              |
| Signal rate                     |  |
| NECL or PECL                    | 10 kbit/s to 80 Mbit/s   |
| RS644                           | 10 kbit/s to 80 Mbit/s   |
| RS422, RS485                    | 10 kbit/s to 40 Mbit/s   |
| TTL                             | 10 kbit/s – 20 Mbit/s  |
| Data reconstruction             |  |
| time accuracy                   | 1 $\mu$ s  |
| PCM frame reconstruction        | IRIG 106 standard PCM format                                       |
| Output data derandomiser        | off / forward P11 / P15 / P17 / reverse P11 / P15 / P17 selectable |
| Built in pseudorandom generator | off / P07 / P15 / P23 selectable                                   |
| Connector                       | 37-pin D-Sub female (same as the input)                            |

## PCM merger modules

### MRB12

4 channel PCM merger module for signal input and output with burst option  
Supported dataformats: DATaRec 3

All specification valid as specified for MRG12 module with the following extensions:

|                               |                                       |
|-------------------------------|---------------------------------------|
| Burst option                  | channel 1 to 4 (selectable)           |
| Minimum burst size            | 32 bits                               |
| Gap between bursts            | >3 ms                                 |
| BiPhase input                 | channel 1 and 3 (selectable)          |
| Data rate range               |                                       |
| BiPhase mode                  | 7 kbit/s – 4 Mbit/s                   |
| BiPhase signal level          | RS422 differential, single ended, TTL |
| Selectable asynchronous burst | channel 2 and channel 4               |
| Oversampling rate             | 1 Mbit/s – 5 Mbit/s                   |
| Burst switch-off time         | 3 ms                                  |

### MRG12

4 channel PCM merger module for signal input and output  
Supported dataformats: DATaRec 3

#### Input

|                 |  |
|-----------------|--|
| Input signal    | NRZ or BiPhase PCM code  |
| Signal rate     | data + clock: 1 kbit/s – 5 Mbit/s<br>data only mode: 1 kbit/s – 2 Mbit/s<br>maximum 12 Mbit/s for the whole module |
| Clock rate      | any fixed clock rate is possible, the receiver synchronizes automatically to the incoming bit rate                 |
| Clock source    | external or internal   |
| Clock format    | data + clock mode: synchronous to the data, rising or falling edge selectable                                      |
| Signal level    | RS422 differential or single ended, TTL  |
| Input impedance | 100 $\Omega$ , 150 $\Omega$ or 20 k $\Omega$ selectable for RS422, 220 $\Omega$ for TTL                            |
| Connector       | 37-pin D-Sub   |

#### Output

|               |  |
|---------------|--|
| Output signal | up to 4 independent PCM output streams short circuit protected         |
| Output format | NRZ code   |
| Signal rate   | data + clock 1 kbit/s – 5 Mbit/s<br>data only mode 1 kbit/s – 2 Mbit/s |
| Clock rate    | the recorded data rate is automatically reconstructed                  |
| Clock format  | synchronous to the data, rising or falling edge selectable             |
| Signal level  | RS422 differential or single ended TTL                                 |
| Connector     | 37-pin D-Sub, the same as the input                                    |

### MRG40

8 channel PCM merger module for signal input and output  
Supported dataformats: DATaRec 3, IRIG 106 chapter 10

#### Input

|                 |  |
|-----------------|--|
| Input signal    | up to 8 independent PCM input streams  |
| Input format    | NRZ or BiPhase PCM code  |
| Signal rate     | data + clock: 1 kbit/s – 20 Mbit/s per channel<br>BiPhase-L: 10 kbit/s to 10 Mbit/s per channel    |
| Total bitrate   | 160 Mbit/s for the module  |
| Clock rate      | any fixed clock rate is possible, the receiver synchronizes automatically to the incoming bit rate |
| Clock source    | external or internal   |
| Clock edge      | rising or falling edge selectable  |
| Signal level    | symmetrical or asymmetrical per channel configurable<br>RS422, TTL, PECL, NECL configurable        |
| Input impedance | 100 $\Omega$ or 22 k $\Omega$ selectable   |
| Time stamping   | 100 ns   |

#### Output

|               |   |
|---------------|---|
| Output signal | 1 output for selectable monitoring<br>8 independent PCM output streams for replay |
| Output format | NRZ or BiPhase code   |
| Signal rate   | data + clock: 10 kbit/s – 20 Mbit/s   |
| Clock rate    | the recorded data rate is automatically reconstructed                             |
| Clock format  | synchronous to the data, rising or falling edge selectable                        |
| Signal level  | RS422 differential  |
| Connector     | 50-pin D-Sub  |

### MRG41

8 channel PCM merger module for signal input and output  
Supported dataformats: DATaRec 3, IRIG 106 chapter 10

#### Input

|                |   |
|----------------|---|
| Input signal   | up to 8 independent PCM input streams<br>4-channel mode is supported with e-to-e mode loopback      |
| Input format   | NRZ or BiPhase PCM code   |
| Signal rate    | NRZ-L,-M,-S: 10 kbit/s - 20 Mbit/s<br>BiPhase-L,-M,-S: 10 kbit/s – 8 Mbit/s                         |
| Total bit rate | 160 Mbit/s for the module   |
| Clock rate     | any fixed clock rate is possible, the receiver synchronizes automatically to the incoming bit rate  |
| Clock source   | external or internal (internal clock is asynchronous to data in the range of 10 kbit/s - 20 Mbit/s) |
| Clock edge     | rising or falling edge selectable   |

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|                    |  |
|--------------------|--|
| Signal level       | symmetrical or asymmetrical per channel configurable   |
| Input derandomizer | Off, RND11, RND15 or RND17. selectable from MRG41 Rev. 1   |
| Symmetrical        | signal level limits from -5.1 V to 5.0 V (RS422, LVDS, LVPECL, NECL, ...)<br>absolute maximum signal level limits from -10 V to 10 V |
| Asymmetrical       | threshold level from 0 V to 5 V selectable in 0.1 V steps (TTL, CMOS, ...)<br>absolute maximum signal level limit: 10 V              |
| Input impedance    | 75 Ω or 22 kΩ selectable   |
| Time stamping      | 100 ns   |
| Connector          | 50 pin D-Sub   |

## Output

|                       |  |
|-----------------------|--|
| Output signals        | 8 independent PCM output streams for replay<br>1 separate output for selectable channel monitoring<br>in 4-channel mode channels 5-8 are replay and loop back<br>(the loop back- and monitoring-channels have a jitter of 25% when the input signal uses BiPhase code) |
| Output format         | NRZ or BiPhase code  |
| Output derandomizer   | off, RND11, RND15 or RND17. selectable from MRG41 Rev. 1   |
| Signal rate           | data + clock: 10 kbit/s - 20 Mbit/s  |
| Clock rate            | the recorded data rate is automatically reconstructed  |
| Clock format          | synchronous to the data, rising or falling edge selectable   |
| Signal level          | RS422 differential   |
| Timing reconstruction | 1 μs   |

## PCM mode recording

|                                 |  |
|---------------------------------|--|
| Recording modes                 | throughput, packed and unpacked  |
| Minor frame synch word length   | 7 - 33 bits  |
| Minor frame synch word mask     | a bit mask can be defined for each bit of the minor frame synch<br>the zero bits in the mask means don't care bits for the frame synchronisation |
| Maximum minor frame size        | unpackaged mode: 4096 x up to 16-data words including the synch word<br>packed mode: 65536 data bits including the synch word                    |
| Minor frame synch lock criteria | programmable number of found synch patterns  |
| Minor frame synch lost criteria | programmable number of lost frames   |
| Major frame size                | not limited, however major frames exceeding 16384 bytes will be splitted into more than one data packet  |
| Unpacked mode word Shifting     | MSB first or LSB first mode selectable on every word   |

|  |   |
|--|---|
| Packed and throughput Mode word shifting | MSB first or LSB first mode selectable for the whole packet   |
| Watch word check                         | one up to 16-bit data word can be defined at any position in a bit-mask as watch word, and if it is defined its absence is continuously checked and indicated as error status |
| Status indicators                        | no clock, no data status, measured bitrate  |
| Lock indication                          | minor frame locked, major frame locked, watch word checking   |

## STANAG 3910 module

### STG40

2 channel fibre optic STANAG 3910 record / replay interface  
Supported dataformats: DATaRec 3

|                                 |   |
|---------------------------------|---|
| Input signal                    | STANAG 3910 high speed fibre optic direct digital link  |
| Number of channels              | 1 dual-redundant STANAG 3910 bus or 2 independent STANAG 3910 busses  |
| Operating input signal level    | -35.5 dBm to -12 dBm<br>(operating range 23.5 dB)   |
| Intertransmission dynamic range | 21 dB   |
| Max. input signal level         | max. +7 dBm (with max. 100 μs recovery time)  |
| Output signal level             | -4 dBm to 3 dBm (0.4 mW to 2 mW)  |
| Wavelength                      | 770 nm to 850 nm  |
| Spectral bandwidth              | <60 nm  |
| Operation mode                  | bus monitor and replay  |
| Total bus recording             | yes   |
| Protocol                        | EFABUS and EFABUS Express (EFEx)  |
| Bus load identification         | bus load computed and displayed   |
| Errors                          | glitch, manchester error, SD or ED missing, not full word, too many words in frame if traffic on both lines |
| Warning                         |   |
| Time stamping                   | absolute time stamps for all frames in DATaRec 3 mode   |
| Time resolution                 | 100 ns  |
| Connector                       | JN1055 (HA) style receptacle keyway type N  |

## MIL-STD-1553 bus modules

### MBP12

2 channel output module for dual redundant MIL-STD-1553 busses or 4 single MIL-STD-1553 busses  
supported dataformats: DATaRec 3

|               |   |
|---------------|---|
| Output        |   |
| Output signal | 2 dual redundant MIL-STD-1553 B bus or 4 single MIL-STD-1553 B busses, direct or transformer coupled selectable   |
| Signal level  | direct coupled:<br>6 V <sub>pp</sub> - 9 V <sub>pp</sub> on 35 Ω ± 2% load<br>transformer coupled:<br>18 V <sub>pp</sub> 27 V <sub>pp</sub> on 70 Ω ± 2% load |

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|                             |                                 |
|-----------------------------|---------------------------------|
| Total bus replay            | yes                             |
| Selected bus reconstruction | no                              |
| Bus load identification     | bus load computed and displayed |
| Timing accuracy             | 200 ns                          |
| Connector                   | 4 x 2-pin LEMO for 1553 busses  |

## **MBR12**

2 channel input module for dual redundant MIL-STD-1553 B busses or 4 single MIL-STD-1553 B busses  
Supported dataformats: DATaRec 3

### **Input**

|                         |   |
|-------------------------|---|
| Input signal            | 2 dual-redundant MIL-STD-1553 B bus or 4 single MIL-STD-1553 B busses, direct or transformer coupled selectable |
| Signal level            | Direct coupled: $1.2 V_{pp} - 30 V_{pp}$<br>transformer coupled: $0.86 V_{pp} - 30 V_{pp}$                      |
| Operation mode          | bus monitor only  |
| Total bus recording     | yes   |
| Selected bus recording  | no  |
| Bus load identification | bus load computed and displayed   |
| Time stamping           | absolute time stamps for all messages   |
| Time resolution         | 100 ns  |
| Connector               | 4 x 2-pin LEMO for 1553 busses  |

## **UAP40**

4 channel output module for dual redundant MIL-STD-1553 B busses  
Supported dataformats: DATaRec 3, IRIG 106 chapter 10

### **Output**

|               |  |
|---------------|--|
| Output signal | 4 dual redundant MIL-STD-1553 B bus or 8 single MIL-STD-1553 B busses, direct or transformer coupled selectable                                    |
| Signal level  | direct coupled:<br>$7.6 V_{pp} \pm 10\%$ on $35 \Omega \pm 2\%$ load<br>transformer coupled:<br>$21.6 V_{pp} \pm 10\%$ on $70 \Omega \pm 2\%$ load |
| Time accuracy | 200 ns   |
| Connector     | 25-pin D-Sub   |

## **UAR40**

4 channel input module for dual redundant MIL-STD-1553 B busses  
Supported dataformats: DATaRec 3, IRIG 106 chapter 10

### **Input**

|                          |   |
|--------------------------|---|
| Input signal             | 4 dual-redundant MIL-STD-1553 B bus or 8 single MIL-STD-1553 B busses (DATaRec 3 modus), direct or transformer coupled selectable |
| Signal level             | direct coupled: $1.2 V_{pp} - 20 V_{pp}$<br>transformer coupled: $0.86 V_{pp} - 14 V_{pp}$  |
| Operation mode           | bus monitor only  |
| Total bus recording      | yes   |
| Selected bus recording   | no  |
| Select message recording | no  |

|                         |   |
|-------------------------|---|
| Bus load identification | bus load computed and displayed   |
| Error detection         | command continuity, data continuity, Manchester coding, parity, command length errors |
| Time stamping           | time stamps for all messages, exact response time recording                           |
| Time resolution         | 100 ns  |
| Connector               | 25-pin D-Sub  |

## **UAR80**

8 channel dual redundant MIL-STD-1553 record interface  
Supported dataformats: DATaRec 3, IRIG 106 chapter 10

### **Input**

|                            |  |
|----------------------------|--|
| Input signal               | MIL-STD-1553B  |
| Number of channels         | 8 dual-redundant MIL-STD-1553B busses  |
| Signal level               | direct coupled: $1.2 V_{pp} - 20 V_{pp}$<br>transformer coupled: $0.86 V_{pp} - 14 V_{pp}$ |
| Operation mode             | bus monitor only   |
| Total bus recording        | yes  |
| Selected message recording | no   |
| Bus load identification    | bus load computed and displayed  |
| Time stamping              | absolute time stamps for all messages  |
| Time resolution            | 100 ns   |
| Connector                  | 50 pin D-Sub   |

## **ARINC 429 bus modules**

### **ARP12**

8 channel output module for ARINC 429 high speed or low speed busses  
Supported dataformats: DATaRec 3

### **Output**

|                         |                                       |
|-------------------------|---------------------------------------|
| Output signal           | ARINC 429 high speed or low speed bus |
| Signal level            | ARINC 429 standard                    |
| Total bus replay        | yes                                   |
| Bus load identification | bus load computed and displayed       |
| Timing accuracy         | 200 ns                                |
| Connector               | 25-pin D-Sub                          |

### **ARR12**

8 channel input module for ARINC 429 high speed or low speed busses  
Supported dataformats: DATaRec 3

### **Input**

|                          |                                       |
|--------------------------|---------------------------------------|
| Input signal             | ARINC 429 high speed or low speed bus |
| Signal level             | ARINC 429 standard                    |
| Operation mode           | bus monitor only                      |
| Total bus Recording      | yes                                   |
| Bus speed identification | automatic                             |
| Bus load identification  | bus load computed and displayed       |
| Time stamping            | absolute time stamps for all messages |
| Time resolution          | 100 ns                                |
| Connector                | 25-pin D-Sub                          |

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## **ARR40**

24 channel input module for ARINC 429 high speed or low speed busses

Supported dataformats: DATaRec 3, IRIG 106 chapter 10

### **Input**

|                          |   |
|--------------------------|---|
| Input signal             | ARINC 429 high speed or low speed bus                       |
| Signal level             | ARINC 429 standard  |
| Operation mode           | bus monitor only  |
| Total bus recording      | yes   |
| Selected bus recording   | yes   |
| Bus speed identification | automatic   |
| Bus load identification  | bus load computed   |
| Time stamping            | time stamps for all messages, exact response time recording |
| Time resolution          | 100 ns  |
| Connector                | 62-pin D-Sub  |

## **Analogue signal modules**

### **ANH40**

1 channel, high frequency analogue input/output module

Supported dataformats: DATaRec 3, IRIG 106 chapter 10

### **Input**

|                              |  |
|------------------------------|--|
| Input signal                 | differential analogue voltage            |
| Signal level                 | 1 V <sub>rms</sub>                       |
| Signal coupling              | AC or DC                                 |
| DC Accuracy                  | 0.5% in 12/16-bit mode, 1% in 8-bit mode |
| Common-mode voltage          | max. +/- 3.2 V <sub>DC</sub>             |
| Differential input impedance | 75 Ω or 100 kΩ selectable                |
| Time stamping                | 100 ns resolution absolute time          |
| Connector                    | 3-pin LEMO                               |

### **High bandwidth mode operation**

|                    |   |
|--------------------|---|
| Resolution         | 12 bit (8 bit or 16 bit recorded)   |
| Oversampling       | 4x, 8x or 16x   |
| Analogue bandwidth | selectable from DC – 1.28 MHz to DC – 10.24 MHz, 8 bit<br>selectable from DC – 1.28 MHz to DC - 5.12 MHz, 16 (12) bit |
| Dynamic range      | >48 dB (8 bit), >60 dB (16 bit)   |
| Sampling rate      | variable, 2.5 x bandwidth, 3.2 MHz – 25.6 MHz   |

### **Low bandwidth mode operation**

|                    |  |
|--------------------|--|
| Resolution         | 16 bit (8 bit or 16 bit recorded)            |
| Oversampling       | 8x, 16x or 32x                               |
| Analogue bandwidth | DC-128 kHz to DC – 1.28 MHz (selectable)     |
| Dynamic range      | >48 dB (8 bit), >80 dB (16 bit)              |
| Sampling rate      | variable, 2.5 x bandwidth, 400 kHz – 3.2 MHz |

### **Output**

|               |  |
|---------------|--|
| Resolution    | 16 bit                                     |
| Output type   | single ended                               |
| Signal level  | 1 V <sub>rms</sub>                         |
| Impedance     | 75 Ω                                       |
| Dynamic range | replay mode >70 dB<br>loopback mode >60 dB |

Connector 2-pin LEMO

### **ANP20**

8 channel output module for single ended analogue voltage  
Supported dataformats: DATaRec 3

|                               |  |
|-------------------------------|--|
| Output signal                 | single ended analogue voltage                          |
| Signal level                  | ±1 V, ±2 V, ±5 V, ±10 V full scale output without load |
| Output impedance              | 75 Ω   |
| External load                 | >1 kΩ (short circuit protected, but not recommended)   |
| Analogue bandwidth            | defined by recorded data, but maximum 45 kHz           |
| Digital to analogue converter | 24 bit Sigma-Delta, 16 bits used                       |
| Dynamic range                 | >80 dB   |
| Crosstalk                     | <-80 dB  |
| Distortion                    | <-80 dB (1 V, 2 V, 5 V range)<br><-75 dB (10 V range)  |
| Calibration                   | built-in automatic calibration                         |
| Connector                     | 37-pin D-Sub   |

### **ANP41**

8 channel output module for single ended analogue voltage  
Supported dataformats: DATaRec 3, IRIG 106 chapter 10

### **Input**

|                               |  |
|-------------------------------|--|
| Output signal                 | single ended analogue voltage                          |
| Signal level                  | ±1 V, ±2 V, ±5 V, ±10 V full scale output without load |
| Output impedance              | 75 Ω   |
| External load                 | >1 kΩ (short circuit protected, but not recommended)   |
| Digital to analogue converter | 24 bit, 16 bit used                                    |
| Dynamic range                 | >80 dB   |
| Crosstalk                     | better than the dynamic range                          |
| Distortion                    | <-80 dB (1 V, 2 V, 5 V range)<br><-75 dB (10 V range)  |
| Bandwidths                    | defined by recorded data, but max. 80 kHz              |
| Calibration                   | built-in automatic calibration                         |
| Connector                     | 37-pin D-Sub   |

### **ANR20**

8 channel input module for differential analogue voltages with ICP sensor power  
Supported dataformats: DATaRec 3

### **Input**

|                                |                                     |
|--------------------------------|-------------------------------------|
| Input signal                   | differential analogue voltage       |
| Signal level                   | ±1 V, ±2 V, ±5 V, ±10 V             |
| Signal coupling                | AC, DC or ICP                       |
| ICP power                      | 4 mA constant current, up to 30 V   |
| Differential input impedance   | 100 kΩ                              |
| Common input impedance         | 500 kΩ                              |
| Analogue to digital conversion | 24 bit Sigma-Delta, 16 bit recorded |
| Dynamic range                  | >80 dB                              |
| Distortion                     | <-80 dB                             |
| Crosstalk                      | <-80 dB                             |

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|                  |                                |
|------------------|--------------------------------|
| Phase error      | max 0.2°                       |
| AC & DC accuracy | +/- 0.4%                       |
| Main bandwidth   | DC-500 Hz to DC-45 kHz         |
| Calibration      | built-in automatic calibration |
| Connector        | 37-pin D-Sub                   |

## **ANR41**

8 channel input analogue voltages module for differential input with ICP sensor power up to 80 kHz  
Supported dataformats: DATaRec 3, IRIG 106 chapter 10

### **Input**

|                                |   |
|--------------------------------|---|
| Input signal                   | differential analogue voltage                         |
| Signal level                   | ±1 V, ±2 V, ±5 V, ±10 V                               |
| Signal coupling                | AC, DC or ICP   |
| ICP power                      | 4 mA constant current, up to 30 V                     |
| Differential input impedance   | 100 kΩ  |
| Common input impedance         | 25 KΩ   |
| Analogue to digital conversion | 24 bit Sigma-Delta, 16 bit recorded                   |
| Dynamic range                  | >80 dB  |
| Distortion                     | <-80 dB   |
| Crosstalk                      | Better than the dynamic range                         |
| Phase error                    | max 0.2°  |
| Input filters                  | digital FIR-filters with linear phase                 |
| AC & DC accuracy               | +/- 0.4%  |
| Analogue bandwidth             | DC – 500 Hz to DC – 80 kHz, selectable (no mirroring) |
| Sampling rate / bandwidth      | 2.5   |
| Calibration                    | built-in automatic calibration                        |
| Connector                      | 37-pin D-Sub  |

## **ANR80**

16 channel analogue record module with ICP sensor power up to 20 kHz  
Supported dataformats: DATaRec 3, IRIG 106 chapter 10

|                               |  |
|-------------------------------|--|
| Input data                    | differential or single ended analogue voltage  |
| Number of channels            | up to 16 channels  |
| Signal level                  | ±250 mV <sub>p</sub> , ±500 mV <sub>p</sub> , ±1 V <sub>p</sub> , ±2 V <sub>p</sub> , ±5 V <sub>p</sub> and ±10 V <sub>p</sub> |
| Differential input impedance  | 1 MΩ   |
| Single ended input impedance  | 1 MΩ   |
| Coupling                      | DC, AC or ICP (-3 dB@0.1 Hz)   |
| Analogue bandwidth            | DC to 0.5 kHz – DC to 20 kHz, selectable in groups of 8 channels (no mirroring)  |
| Sampling rate / bandwidth     | 2.5  |
| Analogue to digital converter | 24 bit / 16 bits recorded  |
| Input filter                  | digital FIR-filter with linear phase   |
| Phase error                   | max. 0.2°  |
| AC and DC accuracy            | +/- 0.4%   |
| Dynamic range (SFDR)          | >95 dB   |
| Crosstalk                     | better than the dynamic range  |

|                  |                                |
|------------------|--------------------------------|
| Distortion (THD) | <-90 dB                        |
| Calibration      | built-in automatic calibration |
| Connector        | 50 pin D-Sub                   |

## **Voice and serial module**

### **VSM12**

2 channel voice input, 2 channel voice output and 1 channel serial input / output  
Supported dataformats: DATaRec 3, IRIG 106 chapter 10

#### **Voice channel input**

|                         |   |
|-------------------------|---|
| Input signal            | microphone or line input / channel  |
| Signal level            | microphone: -40 dBV <sub>rms</sub><br>line: 0 dBV <sub>rms</sub> , -40 dBV <sub>rms</sub><br>(1 V <sub>rms</sub> , 10 mV <sub>rms</sub> ) |
| Input impedance         | microphone: 100 kΩ<br>line: 100 kΩ  |
| Frequency range         | 20 Hz – 20 kHz  |
| Max. sampling frequency | 50 kHz  |
| Coding                  | 8 / 16 bit linear, programmable   |
| Connector               | 6-pin LEMO  |

#### **Voice channel output**

|                       |                                    |
|-----------------------|------------------------------------|
| Output signal         | headphone or line (75 Ω / 600 Ω)   |
| Signal level          | 1 V <sub>rms</sub> without load    |
| Signal to noise ratio | 48 / 80 dB (8 bit / 16 bit source) |
| Output impedance      | 75 Ω                               |
| Frequency range       | 20 Hz to 20 kHz                    |
| Connector             | 4-pin LEMO                         |

#### **Serial interface input**

|              |                              |
|--------------|------------------------------|
| Input signal | serial data stream, 8 bits   |
| Signal level | RS232 or RS422, selectable   |
| Baud rate    | 60 – 200 kBaud, programmable |
| Connector    | 9-pin D-Sub                  |

#### **Serial interface output**

|               |                                |
|---------------|--------------------------------|
| Output signal | serial data stream as recorded |
| Signal level  | RS232 or RS422, selectable     |
| Baud rate     | 60 – 200 kBaud, programmable   |
| Connector     | 9-pin D-Sub                    |

## **Asynchronous serial modules**

### **ASM12**

8 channel input and output module for asynchronous serial line  
Supported dataformats: DATaRec 3

#### **Input**

|              |  |
|--------------|--|
| Input signal | asynchronous serial data                         |
| Signal level | RS232 and RS422, input and output, selectable    |
| Data rate    | max. 230.4 kBaud, standard baud-rates selectable |

#### **Recording method**

|                |   |
|----------------|---|
| Operation mode | Input or output configurable by connector pin |
| Termination    | RS422: 120 Ω or 20 kΩ                         |

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|                            |  |
|----------------------------|--|
| Maximum in / out data rate | 110 to 115.2 kBaud, but all channels of one module must work exclusively with one of the high baudrate group or one of the low baudrate group at the same time<br>high baudrate group: 4800, 7200, 9600, 14.4 k, 19.2 k, 28.8 k, 38.4 k, 57.6 k, 115.2 and 230.4 kBaud |
| Low baudrate group         | 110, 300, 600, 1.2 k, 2.4 k, 4.8 k, 7.2 k, 9.6 k, 19.2 k and 38.4 k  |
| Message timing             | longest allowed gap between characters within one message is selectable from 2 bits to 16 characters   |
| Message star               | time-stamped with 100 ns absolute time   |
| Timing accuracy            | 1 µs   |
| Character format           | 5, 6, 7 or 8 bits input / output recorded always 8 bit   |
| Stop bits                  | 1, 1.5 or 2  |
| Parity                     | no, even, odd, space and mark parity   |
| Connector                  | 37-pin D-Sub   |

## ASM40

The ASM40 is a 16 channel module for RS232 or RS422 / RS485 asynchronous serial data  
The ASM40 is a record or replay module  
Supported dataformats: DATaRec 3, IRIG 106 chapter 10

### Input

|                          |   |
|--------------------------|---|
| Input signal             | asynchronous serial data  |
| Signal level             | RS422 / RS485 or RS232, selectable  |
| Termination              | RS422 / RS485: 110 Ω or 24 kΩ; RS232: 5 kΩ  |
| Maximum in/out data rate | 112.5 Baud – 230.4 kBaud, 112.5, 150, 225, 300, 450, 600, 900, 1200, 1800, 2400, 3600, 4800, 7200, 9600, 14.4 k, 19.2 k, 28.8 k, 38.4 k, 57.6 k, 76.8 k 115.2 k, 230.4 k and `free baud rate mode`<br>- 1Mbaud (total module data rate should not exceed 3 Mbaud) |
| Recording method         | message oriented, characters are stored on 8 bits   |
| Message timing           | longest allowed gap between characters within one message is selectable from 1 to 255 bits message start is time-stamped with 100 ns absolute time.   |
| Timing accuracy          | 1 µs  |
| Character format         | 5, 6, 7 or 8 bits input / output – recorded always on 8 bits  |
| Start bit                | 1   |
| Stop bits                | 1, 1.5 or 2   |
| Parity                   | no, even, odd, space ["0"] and mark ["1"] parity  |
| Input signal level       | RS422 / RS485: differential threshold voltage: -200 mV and +200 mV (max. common mode voltage: -7 V to 12 V); hysteresis: 40 mV<br>RS232: threshold voltage: low / high: 0.8 V / 2.4 V; hysteresis: 0.6 V  |

### Output

|              |   |
|--------------|---|
| Signal level | RS422: differential voltage: 5 V (unloaded) min. 2 V (50 Ω termination)<br>RS485: differential voltage: 5 V (unloaded) min. 1.5 V (27 Ω termination)<br>RS232: voltage swing: ±6.5 V (unloaded) |
| Connector    | 50-pin D-Sub, male, input or output configurable by connector pin   |

## Parallel input / output module

### PAR12

Parallel data (2-16 bit) record / replay module  
Supported dataformats: DATaRec 3

#### Input

|                 |  |
|-----------------|--|
| Number of bits  | 2, 4, 8, 16 bit word mode  |
| Data rate range | 62 bit/s to 20 Mbit/s total bitrate<br>1 ks/s to 1.25 Ms/s (16 bit words)<br>1 ks/s to 2.5 Ms/s (8 bit words)<br>1 ks/s to 5 Ms/s (4 bit words)<br>1 ks/s to 10 Ms/s (2 bit words) |
| Clock rate      | any fixed clock rate is possible, the receiver synchronises automatically for the incoming bit rate. (maximum clock rate with analogue inputs: 200 kHz)                            |
| Clock source    | external or internal   |
| Clock format    | parallel data + clock mode: synchronous to the data, rising or falling edge selectable   |
| Signal level    | RS422 differential or TTL or analogue<br>+5 V <sub>p</sub> , +12 V <sub>p</sub> , +28 V <sub>p</sub> single ended  |
| Input impedance | 100 Ω or 20 kΩ selectable for RS422 inputs, 75 Ω or 330 Ω for TTL inputs, 1 M Ω for the analogue inputs  |
| Time resolution | 100 ns   |
| Connector       | 37-pin D-Sub   |

#### Output

|                 |  |
|-----------------|--|
| Number of bits  | 2, 4, 8, 16 bit word mode  |
| Data rate range | 62 bit/s to 20 Mbit/s total bitrate<br>16 bit words: 1 ks/s to 1.25 Ms/s<br>8 bit words: 1 ks/s to 2.5 Ms/s<br>4 bit words: 1 ks/s to 5 Ms/s<br>2 bit words: 1 ks/s to 10 Ms/s |
| Output format   | NRZ coded parallel data  |
| Clock rate      | the recorded data is automatically reconstructed   |
| Clock format    | synchronous to the data, rising or falling edge selectable   |
| Signal level    | RS422 differential or single ended TTL   |
| Output          | Short circuit protected  |
| Output timing   | 1 µs   |
| Connector       | 37-pin D-Sub (same as input)   |

### DCP40

DCRsi compatible parallel data reconstruct module  
Supported dataformats: DATaRec3

#### Output

|                  |  |
|------------------|--|
| Data format      | 8 bit NRZ-L data   |
| Control format   | 8 bit parallel data + clock or DCRsi compatible replay mode selectable   |
| Data rate        | 8 kbit/s to 256 Mbit/s total bitrate   |
| Clock rate       | 1 kHz to 32 MHz  |
| Clock source     | parallel mode: internal reconstruction of recorded clock frequency<br>DCRsi mode: WrClk replay clock input using the WrDatRdy control signal   |
| Signal level     | data (RdDat07), clock (WrClk), data parity (RdPrty), output data validation (RdDatVal), block synchronization (RdBlkSync), replay readiness (DatTrRdy): differential NECL auxiliary data (RdAuxData), auxiliary clock (RdAuxClk): differential EIA-RS422 |
| Output impedance | 390 Ω pull down to - 5.1 V (NECL)  |

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## Input

|                 |   |
|-----------------|---|
| Signal level    | clock (WrClk), output data enable (WrDatRdy): differential NECL |
| Time resolution | 1 µs  |
| Connector       | 37-pin D-Sub  |

## DCR40

DCRsi compatible parallel data record module  
Supported dataformats: DATaRec 3, IRIG 106 chapter 10

## Input

|                 |   |
|-----------------|---|
| Data format     | 8 bit parallel NRZ-L data   |
| Control format  | 8 bit parallel data + clock or DCRsi compatible mode selectable   |
| Data rate       | 8 kbit/s to 256 Mbit/s total bitrate  |
| Clock rate      | 1 kHz to 32 MHz internal or external  |
| Signal level    | data (WrDat0...7) + clock (WrClk), data parity (WrPrty), Input data validation (WrDatRdy): differential NECL<br>auxiliary data (WrAuxData), user event set (UsrSet): differential EIA-RS422 |
| Input impedance | 120 Ω or 4 kΩ differential selectable   |

## Output

|                           |   |
|---------------------------|---|
| Signal level              | clock (RdClock), block synchronization (RdBkSync), record ready (DatTrRdy): differential NECL |
| Buffer overflow (BuLimit) | differential EIA-RS422  |
| Time resolution           | 100 ns  |
| Connector                 | 37-pin D-Sub  |

## Network interface module

### ETH40

2 channel Ethernet interface module  
Supported dataformats: DATaRec 3, IRIG 106 chapter 10

|                        |  |
|------------------------|--|
| Input format           | 10/100 Mbit/s Ethernet bus communication   |
| Network interface      | Ethernet IEEE 802.3 industry standard<br>10 Mbps baseband CSMA/CD (10BASE-T) and 100 Mbps baseband CSMA/CD (100BASE-TX) standards  |
| Local buffer           | 64 MByte   |
| Max. average data rate | 200 Mbit/s   |
| Recorded information   | destination address, source address, length, data, FCS (checksum)<br>the module also records "runt packets" (collision fragments). |
| IP address             | all messages received on the Ethernet are recorded.  |
| Timing accuracy        | 5 µs   |
| Message generation     | a free message (up to 1.5 kByte long) can be programmed for both channels independently to be transmitted on the Ethernet bus.     |
| Message rate           | 1 ms to 60 s, settable in 1 ms steps   |
| Input connector        | 2 x 9-pin D-Sub (male)   |

## Video modules

### VCP12

2 channel analogue audio / video output module  
Supported dataformats: DATaRec 3, IRIG 106 chapter 10

|                               |   |
|-------------------------------|---|
| Number of channels            | 2 video, 2 x 2 audio channels   |
| Video output signal           | analogue video CVBS or Y/C or RGB with separate synch.  |
| Video output level            | CVBS / Y: 1 V <sub>pp</sub> ; C: 0.3 V <sub>pp</sub> ; RGB: 0.7 V <sub>pp</sub>                   |
| Video input level             | 0.5 to 1.4 V <sub>pp</sub> with AGC (Nom.: 1 V <sub>pp</sub> )                                    |
| Video output impedance        | 7 Ω with 75 Ω termination   |
| Video input resolution filter | D1, <sup>3</sup> / <sub>4</sub> D1, <sup>2</sup> / <sub>3</sub> D1, HD1, SIF (all expanded to D1) |
| Audio output signal           | dual (stereo) or mono analogue audio signal (per channel)   |
| Audio output level            | 1 V <sub>rms</sub>  |
| Audio output impedance        | 100 Ω with 47 kΩ termination  |
| Time annotation               | inserted into the video signal  |
| Output format                 | NTSC, PAL or SECAM as recorded  |
| MPEG2-TS input                | data + clock (RS422 differential or single ended TTL-Level)                                       |
| Connector                     | 37-pin D-Sub  |

### VCR12

2 channel analogue audio / video record interface  
Supported dataformats: DATaRec 3

|                                |   |
|--------------------------------|---|
| Video input signal             | analogue video signal CVBS (composite) and Y/C (S-Video)                                  |
| Video input level              | CVBS/Y: 1 V <sub>pp</sub> +3 dB / -6 dB (AGC); C: 0.3 V <sub>pp</sub> +3 dB / -6 dB (AGC) |
| Video input impedance          | 75 Ω  |
| Video input format             | NTSC, up to 720 x 480<br>PAL, SECAM up to 720 x 576                                       |
| Video output resolution filter | D1, <sup>3</sup> / <sub>4</sub> D1, <sup>2</sup> / <sub>3</sub> D1, HD1, SIF, QSIF        |
| Video sampling format          | 4:2:0   |
| Video encoding algorithm       | MPEG-2 (MP@ML) with variable or constant structure  |
| Video GOP-structure            | IIIIIII, IPPPPPPP, IBPBPBPBP or IBBPBBPBB   |
| Video GOP-Size                 | 1 ... 252   |
| Audio input signal             | dual (stereo) or mono analogue audio signal (per channel)                                 |
| Audio input level              | 1 V <sub>rms</sub>  |
| Audio input impedance          | 100 kΩ  |
| Audio sampling frequency       | 48 kHz  |
| Audio bitrate                  | 32 Kbps, 96 Kbps, 192 Kbps, 384 Kbps  |
| Audio encoding algorithm       | MPEG-1 (Layer 2)  |
| Recorded data rate             | 0.5 - 15 Mbit/s per channel   |
| Time stamping resolution       | 33.3 ms (NTSC), 40 ms (PAL, SECAM)  |

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|                 |   |                                |
|-----------------|---|--------------------------------|
| MPEG2-TS output | data + clock (RS422 differential or single ended TTL-Level) | (real time position, raw data) |
| Connector       | 37-pin D-Sub  |                                |

## VCR40

4 channel analogue audio / video record interface  
Supported dataformats: DATaRec 3, IRIG 106 chapter 10

|                                |  |
|--------------------------------|--|
| Number of channels             | 4 video / 4 audio  |
| Video input signal             | analogue video signal CVBS (composite) and Y/C (S-Video)                           |
| Video input level              | CVBS/Y: 1 Vpp +3 dB/-6 dB (AGC); C: 0.3 Vpp +3 dB / -6 dB (AGC)                    |
| Video input impedance          | 75 Ω   |
| Video monitor output level     | as input level (if terminated with 75 Ω)   |
| Video monitor output impedance | 75 Ω (series resistor)   |
| Video input format             | NTSC, up to 720 x 480; PAL, SECAM up to 720 x 576                                  |
| Video sampling format          | 4:2:0  |
| Video output resolution filter | D1, <sup>3</sup> / <sub>4</sub> D1, <sup>2</sup> / <sub>3</sub> D1, HD1, SIF, QSIF |
| Video encoding algorithm       | MPEG-2 (MP@ML) with CBR or VBR   |
| Video GOP-structure            | IIIIIII, IPPPPPPP, IBPBPBPB or IBBPBPBB  |
| Video GOP-size                 | 1 - 252  |
| Audio input signal             | 1 analogue audio signal per video channel  |
| Audio input level              | 1 <sub>V<sub>RMS</sub></sub>   |
| Audio input impedance          | 100 kΩ   |
| Audio monitor output level     | as input level (terminated with 47 kΩ)   |
| Audio monitor output impedance | 100 Ω with 47 kΩ termination   |
| Audio sampling frequency       | 48 kHz   |
| Audio bitrate                  | 32 Kbps, 96 Kbps, 192 Kbps, 384 Kbps   |
| Audio encoding algorithm       | MPEG-1 (Layer 2)   |
| Recorded data rate             | 0.5 - 15 Mbit/s per channel  |
| Time stamping resolution       | 1 video frame: 33.3 ms (NTSC), 40 ms (PAL, SECAM)                                  |
| Time insertion                 | selectable on 4 position on the screen   |
| MPEG2-TS input                 | data + clock (RS422 differential or single ended TTL-Level)                        |
| Connector                      | 50 pin D-Sub   |

## GPS module

### GPS12 / GPS40

GPS receiver module interface with time synchronization of internal clock

|             |   |
|-------------|---|
| Frequency   | single frequency (L1) (GPS12)<br>dual frequency (L1 + L2) (GPS40) |
| Update rate | 1 Hz (GPS12)<br>10 Hz (GPS40)                                     |

|                                  |   |
|----------------------------------|---|
| Max. velocity                    | 514 m/s (GPS12)<br>unlimited (GPS40)  |
| Max. altitude                    | 18.000 m (GPS12)<br>unlimited (GPS40)<br>(for authorized users)   |
| Altitude                         | 1.800 m (GPS12)<br>almost unlimited velocity<br>(for authorized users)                                  |
| Differential GPS (Rover) and RTK | support for RTCM SC104 version 2.1 and 2.2  |
| Acquisition time                 | cold: <60 sec<br>warm: <10 sec<br>hot: <1 sec   |
| Acceleration                     | max. 7 g  |
| 1 PPS accuracy                   | 100 ns  |
| RF antenna                       | active antenna: user selectable antenna<br>power: 3.3 V, 5 V or 12 V<br>passive antenna<br>-95 dBm      |
| Minimum RF input level           |   |
| LNA power supply                 | The TNC-Connector central pin supplies +4.7 V + 0.1 V voltage for LNA with sourced current up to 100 mA |
| <b>Antenna Recommendations</b>   |   |
| Antenna Gain                     | 1565 ~ 1610 Mhz – 5.0 dB typical  |
| Axial Ratio                      | 3.0 dB max.   |
| Output Impedance                 | 50 Ohm  |
| LNA gain                         | 32 ± 2 dB   |
| Noise Figure                     | 1565 ~ 1610 Mhz –1.7 dB typical   |

## Input

|                                      |  |
|--------------------------------------|--|
| 1 PPS / 10 PPS / 100 PPS             |  |
| Recorder (timing signals: TTL level) |  |
| Configuration                        | GPS receiver interface language (RS232 level)  |
| DGPS input                           | differential GPS correction data (RS232 level) |

## Output

|                |  |
|----------------|--|
| Message format | NMEA versions 2.1, 2.2, 2.3, 3.0 (RS232 level)   |
| Timing signals | 1 PPS GPS (synchronized to GPS or UTC)<br>1 PPS recorder<br>10 PPS recorder<br>(all timing signals: TTL-LBURL) |
| Antenna        |  |
| Connector      | TNC female   |
| Connector      | 9-pin D-Sub  |
| Connector      | 4-pin LEMO   |

## Battery backup module

### BBM20

|                       |  |
|-----------------------|--|
| Battery backup module |  |
| Type                  | NiCd   |
| Nominal voltage       | 28.8 V   |
| Capacity              | 500 mAh  |
| Full charge time      | 2.5 h  |
| Supply time           | up to 3 minutes, at least 6 consecutive power losses |
| Rear connector        | eject without power input                            |