INTRODUCTION

The RTU-COM unit is a compact outstation / RTU with built-in COM device as PSTN dial-up or GSM dual band modem. The unit has data logging facilities and is designed for use in the industrial environment.

The unit is designed in a very compact 162 mm wide module for DIN-rail mounting (35 mm symmetrical). Dimensions conform to DIN 43880 (used for circuit breakers) thus insuring easy installation in standard installation panels and boxes widely available in the electrical industry.

The RTU-COM can be delivered with a range of different power supply versions including a battery/solar panel option.

Different power save options is available in the RTU-COM. When closing down modem and analogue circuits and enter into sleep mode the power consumption can be reduced to a minimum. All sleep mode facilities are controlled from the application program.

The RTU-COM has up to 16 integral I/O, covering digital inputs and outputs, and analogue inputs as process signal or temperature sensor inputs. 2 S0 counter inputs for flow meters etc. on all versions.

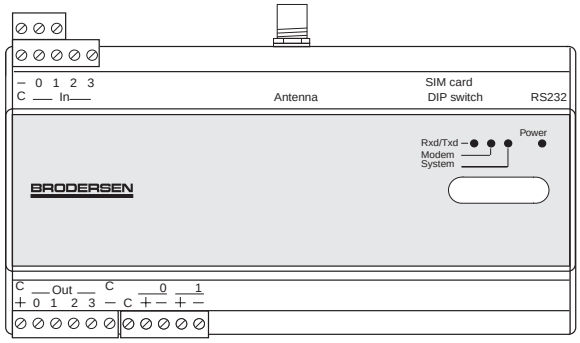
The unit can be programmed to perform simple control sequences using an IEC 1131-3 (PLC) programming language. The RTU-COM includes facilities for local data logging, the process values to be logged are defined as part of the IEC 1131-3 application program. Programming, setup and data transfer is achieved by using the IOTOOL32.

In addition the RTU-COM can be programmed with the Straton for B-CON tool providing support for the IEC1131 programming languages Function Block and Ladder.

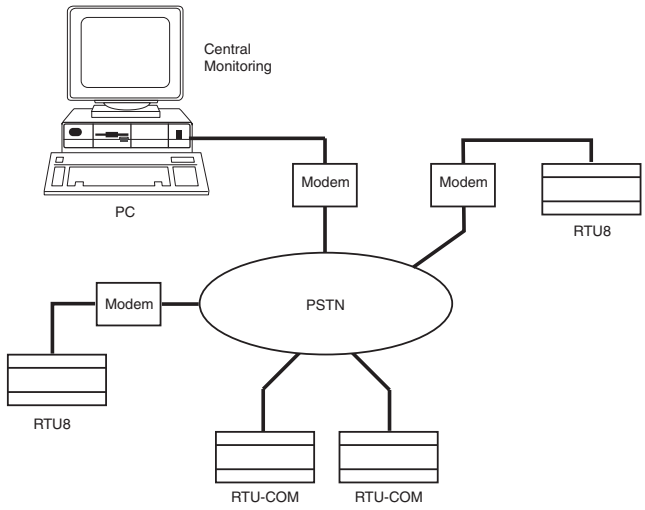
In the RTU-COM version with integrated GSM dual band modem the RTU offer a simple SMS message alarm and control functions.

The Modbus RTU protocol is used for data transfer over the communication link i.e. dial-up modem or GSM.

RTU-COM



Typical RTU-COM application



VERSIONS/ORDERING CODES

UCR-10IO/RC1 10.D1

Type
UCR — UCR

Input/output

4 digital input	4DI...P1
4 digital input/4 digital output	4DIO...P1
4 dig. in./4 dig.out./2 analog in.	10IO
4DI/4DO/1AI/1 Pt100 in.	10IOA
8dig. in/4dig.out/4 relay out.	8DIO..P1

Options

RTU-COM (built-in modem)	/RC

COMs

GSM Dual band modem	1
PSTN V32 dial-up modem	2
RS232 interface	3

Power supply

12V DC PS (not isolated)	00
Mains PS 110-240V	10
PS 24-48VDC/external PS 12V DC	30
Battery/Solar panel PS 12V DC	40
PS 24-60VDC/external PS 24V DC	50

Analogue input range (10IO type)

0-10V/0-20mA	D1
4-20mA	D2
0-5V	D3
0-20mA	D6

Analogue input range (10IOA type)

0-10V/Pt100 -50-100°C	D11
4-20mA/Pt100 -50-100°C	D21
0-20mA/Pt100 -50-100°C	D61

CONTENT

TECHNICAL DESCRIPTION

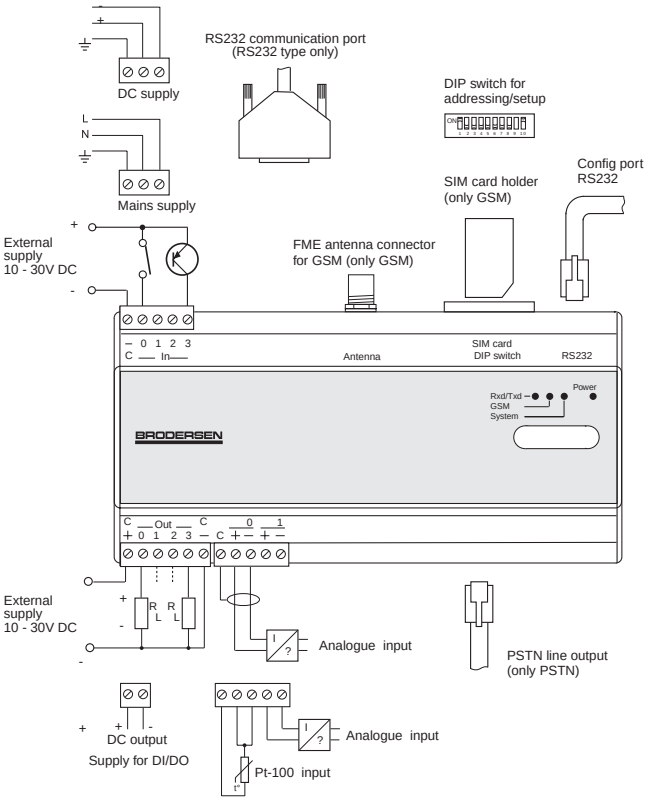
Input/output

The RTU-COM basic I/O fit can include up to 10 input/output terminals. Serial I/O options are available:

Version UCR-	4DI	4DIO	10IO..Dx	10IOA..Dxx	8DIO
Digital inputs (10-30V DC)	4	4	4	4	8
Digital outputs (PNP o. c.)	0	4	4	4	4
Analogue inputs (0-10V/4-20mA)	0	0	2	1	0
Pt100 inputs	0	0	0	1	0
Relay outputs	0	0	0	0	4

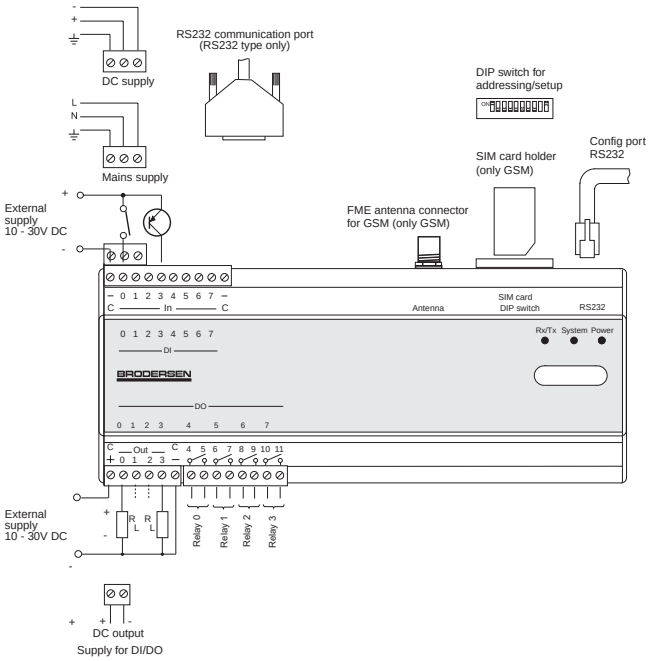
All digital I/O´s are equipped with opto-couplers. The analogue inputs have galvanic isolation between the individual channels. Solid state relays are used for multiplexing the analogue inputs. Pt100 input is not isolated.

Wiring diagram

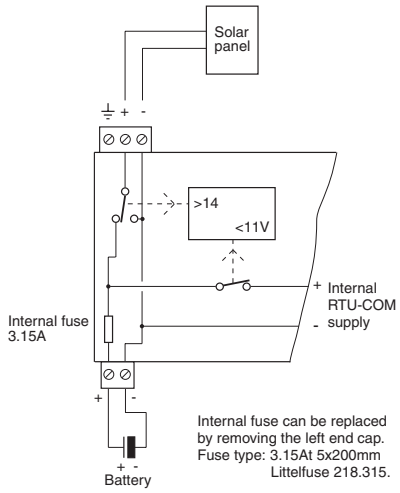


See the installation manual enclosed with the module, for more wiring details.

Wiring diagram
UCR-8DIO



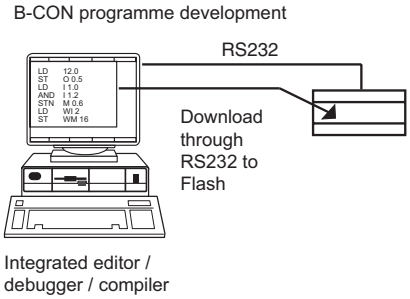
Wiring for type 40 battery and solar panel



CPU capacity/performance

The RTU-COM is equipped with an 8 bit micro-controller. The time related performance versus capacity of the RTU-COM is dependent upon the actual load on the micro controller, which directly relates to the application and therefore the technical data herewith cannot be considered in isolation.

Local control
The RTU-COM compact outstation includes an IEC 1131-3 (B-CON) programming facility; it can be programmed using Instruction list programming language.
Local processing and data handling are configured using a PC with the programming tool installed. The B-CON (IEC 1131-3) programming tools include an integrated editor, compiler, debugger, and down-load facility, for developing application programmes and to down-load them via the programmer port to the RTU-COM or modem.



Examples of instructions used in the IEC 1131 language:

LD	load (read) value e.g.: input or internal register
ST	store (write) value e.g.: output or internal register
AND	logical and e.g.: 2 inputs
ADD	add 2 values
MUL	multiply 2 values
R	reset e.g.: an output
GT	greater than, compare 2 values

The compiled instructions are down-loaded into Flash memory in the RTU-COM. The application programme can be up to 23k bytes. A simple load (LD) or store (ST) instruction require only about 10 bytes of memory.
The RTU has in total 2048 internal registers called BM registers. The first 30-40 BM registers are reserved for use by the specific RTU-COM function like system reports, dial-up, realtime clock, log, SMS functions etc.. The rest is used in the B-CONW application program for handling data. Registers from BM512 and up is battery backed - i.e. keep values stored if RTU is powered off.
From the factory the RTU-COM is default loaded with a small B-CONW program defining the actual I/O, making them readable from IOExplorer.

Indicators
The RTU-COM is equipped with 4 status LEDs.

Indicator	Status
Rxd/Txd	Indicate serial communication to the built-in modem
System	On: OK : Controller error Off: General fault or no power
Power	On: OK Off: No power
Modem	GSM On: Searching for network : Connected to provided network : Connected to network and on-line Off: Modem off PSTN On: DCD (Data Carrier Detect) on Off: DCD (Data Carrier Detect) off

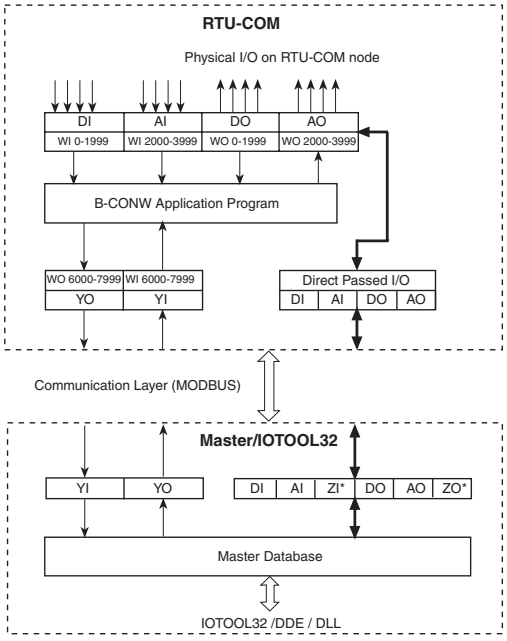
I/O addressing (B-CONW)
The address of the I/O in the RTU-COM has the same structure as other Series 2000/4000 products. The I/O´s are separated into 4 data types;

Digital I/O (DI/DO)
Reflect the physical digital input and output on the node. If you want to have them in our IOTOOL32 database, they need to be defined in the B-CONW application program.

Analogue (AI)
Reflect the physical analogue input on the node. If you want to have them in our IOTOOL32 database, they need to be defined in the B-CONW application program .

Auxiliary type 1 (YI/YO)
The YI/YO is used for handling derived data from module database to PC database. As it is defined in figure xx. Eg. any output information from the master PC has in B-CONW to be read in a YI register (wi6000-7999).

The RTU-COM handles bits (Boleans) and Integers (8/16 bit). Analogue values have to be handled as integers; floating point operation (Reals) is not supported.
The PC software tools use words (16 bits) as a reference for addressing the I/O, but as the RTU-COM is equipped with an 8 bit controller, the addressing uses bytes (8 bits) as a reference.
The inputs and outputs are numbered in the order they appear physically (left to right). Please note that input/output and analogue/digital are numbered separately.



*ZI/ZO is gateway I/O - not used in standard RTU8.
The ZI/ZOs are used for handling data through specific drivers for 3rd party equipment.

In the B-CON programming language the following address and syntax are used for the I/O:

Digital input (DI):

Bit input: **i0.0, i0.1…..i0.3.**
i0.0 loads the first digital input (input 0).
i0.3 loads digital input number 4 (last input).

Byte input: **bi0.**
bi0 loads the digital input byte (input 0-3).

Word input **wi0.**
wi0 loads the digital input word (input 0-3).

Digital Output (DO):

Bit output: **o0.0, o0.1…..o0.3.**
o0.0 sets the first digital output (output 0).
o0.3 sets output number 4 (output 3).

Byte output: **bo0.**
bo0 sets the integer of the 4 outputs (0-15).

Word output: **wo0.**
wo0 sets the integer of the outputs (0-15).

Analogue input (AI):

Input (word): **wi2000 and wi2002.**
wi2000 loads the integer (0-4095) of the first analogue input (channel 0).
wi2002 loads the integer (0-4095) of the analogue input channel 1.

Aux. input (YI), e.g. setpoint transfered via the Modbus from a central station:

Bit input: **i6000.0, i6000.1....i6000.7, i6001.0, i6002.0..**
i6000.0 is the first input in the first byte/word.
i6001.0 is the first input in byte 1.

Byte input: **bi6000, bi6001, bi6002, b600i3…..**
bi6000 loads the first 8 digital inputs (input 0-7).

Word input: **wi6000, wi6002, wi6004, wi6006……**
wi6000 loads the first 16 digital inputs (input 0-15).

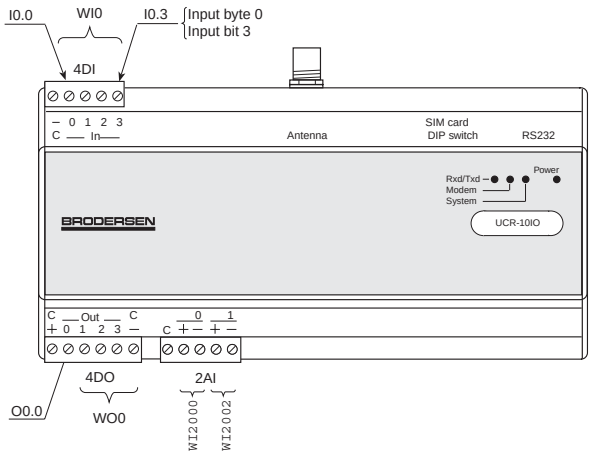
Aux. output (YO), e.g. result to be transfered via the Modbus to a monitoring station

Bit output: **o6000.0,o6000.1..o6000.7,o6001.0..o6001.7,o6002.0..**
o6000.0 sets the first output (output 0).
o6001.0 sets output number 8 (first output in byte 1)

Byte output: **bo6000, bo6001, bo6002, bo6003…..**
bo6000 sets the integer of the first 8 outputs (0-255).

Word output: **wo6000, wo6002, wo6004, wo6006……**
wo6000 sets the integer of the first 16 outputs (0-65535).

B-CONW Addressing



Data logging
The up-loading of data from the RTU-COM can be:

- Cyclic upload controlled by a central PC (for example 24 hours)
- Event driven (such as an alarm).
- Upload on request from the RTU-COM.

The RTU-COM can log events and process values for later analysis. The data logging process can be divided into 3 sections:

- Defining the events and the selection of values to be logged.
- Storage of data, with time stamp, in the log buffer (max. 480k bytes).
- Upload of the data from the module via Programmer port/ RS232 or modem to a PC for analysis.

The actual process values to be logged are selected using the IEC 1131-3 programming facilities in the RTU-COM. Data logging is performed by a dedicated element of the programming language. The log element has the following input parameters:

- Trigger.
- Log identifier.
- Address of the value(s) to be logged (digital wi0..., analogue wi2000..., internal wm20....).
- Number of values to be logged (0-120 words).

The trigger is a Boolean (0/1) which can be linked to an event, e.g. activation of a digital input, or it can be linked to the time base in order to automatically log the defined values cyclically with a given time internal.

For further information regarding the time base and real time clock see below.

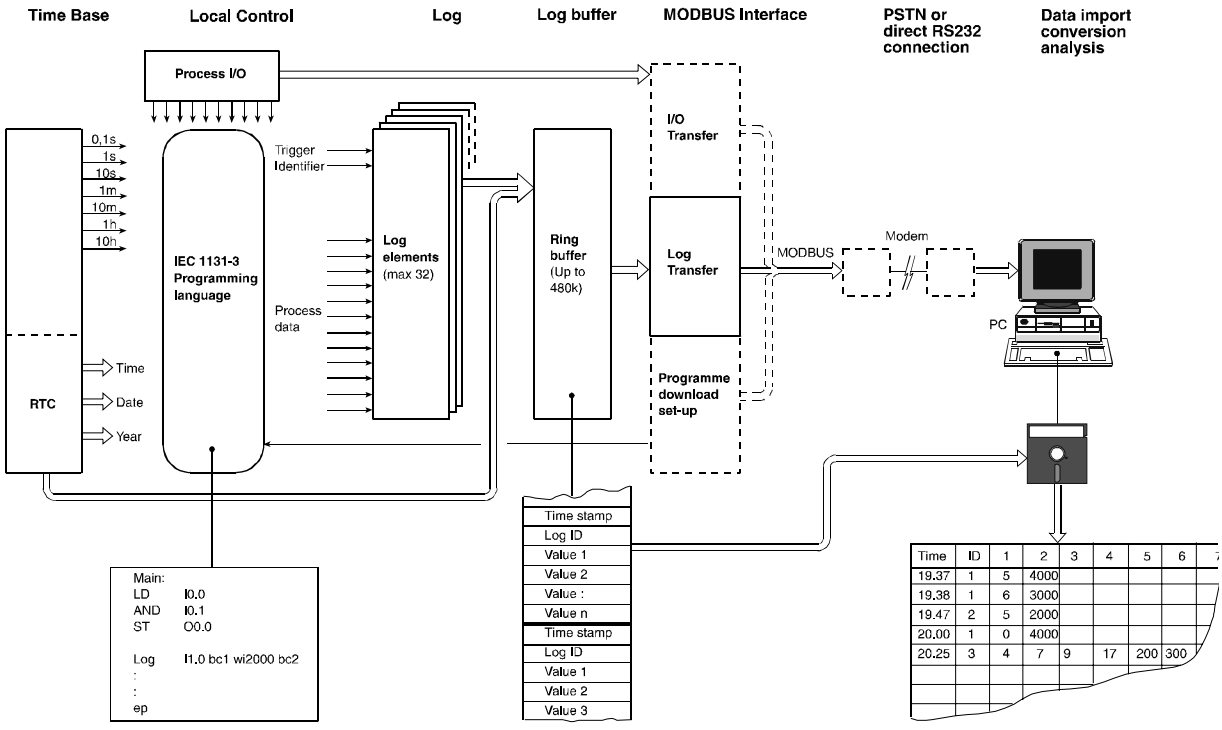
When the trigger input is activated the values specified will be transferred to the log buffer, once every scan of the application program. The process values will be marked with the LOGID and a time stamp derived from the built-in real time clock. The resolution of the time stamp is 0.1 second.
It is possible to define more than one log element in the RTU-COM. The logID is normally a constant (bc) used to identify the actual values after having uploaded the log buffer for analysis. Up to 32 log elements can be specified each having its own identifier and trigger.
The data to be logged uses the general rules for addresses and variables used in IEC-1131 Instruction List (B-CONW) programme; refer to separate manual for further information. It is possible to select any I/O or internal register (word) and the number of inputs/registers to be logged (in consecutive increasing order).

Syntax: log [trigger], [logid], [address], [no. of words]

Programme example (B-CONW):

```
main:

/Event log
      log      i0.0, bc0, wi2000, bc1
      /Logs the first analogue input with log identification 0
      /every time the first digital input is activated.

/Cyclic log
      log      m17.4, bc1, wi2000, bc2

      / Logs the 2 analogue inputs with log identification 1
      /every 10 minutes.

      ep
```

RTU-COM control and datalogging



Log buffer
The log buffer is a ring buffer (FIFO), in which the data is stored in the order they appear (up to 480 k bytes). If the buffer is not emptied, (uploaded via the RS232) the oldest data will be over written by new data, when the buffer is full.
Each record in the log buffer is separated with DLE/STX characters. If DLE (hex code 10) appears in the data area, DLE stuffing is automatically inserted. The PC utility automatically removes the DLE stuffing during upload. One log record can contain up to 120 words of actual log data, but using 4 words for the 2 analogue values and 2 digital words physical on the RTU-COM will in general be the maximum used numbers in a log record. Up to 16 bytes are reserved for the header, the identification and the time stamp. The actual size of the data in the record is specified in the application programme.

Layout of the log buffer:

DLE
STX
LogID
Timestamp
Data
- - - -
- - - -
- - - -
DLE
STX
LogID
Timestamp
Data
- - - -
- - - -
- - - -
- - - -

DLE = Data link escape (0x10)
STX = Start of text (0x02)
LogID = Log identifier ((0-31) + Timestamp indication)
Timestamp = 1, 2 or 7 bytes
Data = 0-120 word

- Full Timestamp/7 byte (00):
  YY MM DD HH MM SS TS
  e.g. 96 09 20 11 24 33 9
- 1 byte Timestamp (01):
  255 sec/10 = 25.5 sec
- 2 byte Timestamp (10):
  65535 sec/10 = 1 hour, 49 min, 13 sec and 5.5 sec

The time stamp is compressed in order to maximise use of the memory. The time stamp will dynamically change in size, from 1 to 7 bytes per event, depending on the interval between the events being logged.

There will be a full time stamp first time the log is activated and after a full hour (xx:00). The full time stamp will be used as a reference for the following time stamps. If the time interval between two logs is negative (set clock or 23:59 to 00:00) there will also be a full time stamp. The PC upload utility automatically decompresses the time stamp whilst up-loading.

Apart from the application related logging, a number of system oriented events will be logged with a time stamp and a specific log ID (> 127). All system logs will have a full timestamp.

Event	Log ID
Power ON and/or microprocessor reset	130
Programme down-load or change of set-up	131
Battery low	132
Battery high/OK	133
Errors detected by the controller. (Status error/communication error, etc.)	150
The log memory has been up-loaded (the PC will request this log to take place).	170
Log buffer overflow	171
LogID in application out of range	172
RTU clock is changed by user (old time noted)	180

In normal use the log memory will never be erased, even though data has been uploaded. When the log memory is full the oldest data is over-written.
The log function includes registration of the log record last uploaded. Using this registration the upload utility can at the next access, start with the first log record which has not yet been uploaded. The PC utility will normally upload the data that has been logged since last upload, by fetching the oldest data first (forwards).
If data is not uploaded in time, the first overflow will occur and a special log will be entered in the log buffer, with time stamp and a specific ID (refer to list above). This enables the user to identify the actual time of the first overflow.

The level of data in the log buffer, which has not yet been uploaded, can be monitored in an internal data register in the application programme (BM18). This register can be used by the RTU application programme to decide wheather the RTU requires an upload of data in order not to loose the information logged (e.g. when log buffer is 50 or 75% full). In such cases the application programme could initialise a dial-up to a central PC requesting an upload.

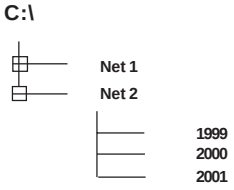
Log buffer size
The log buffer size in use, is changeable by the user. The PC utility is used to configure the percentage of the total log buffer size, which are in use. If the size is set to e.g. 10 %, the log buffer size is approx. 50 k bytes (at 480 k byte total).
This reduce upload time in applications where only the last logged data is needed.
Note ! When the log buffer size is changed, the buffer is reset and all currently logged data are lost.

Uploading data
The logged process values can be transferred to a PC for analysis, either by a direct RS232 connection or via a modem. The upload procedure is fully controlled by the PC, however the RTU-COM can make a request if the buffer is full.

A PC utility is available and can be installed on a standard PC. The PC utility can be used to upload data from an RTU-COM either by connecting the PC directly to the Programmer port interface or by dialling and transferring the data using a Hayes compatible modem. The upload utility utilises the standard Series 2000/4000 tool-kit for WIN2000/NT/XP (IOTOOL32), which includes facilities for operating the modem and the dial-up. The tool-kit enables the user to monitor the actual state of the RTU-COM, including all inputs and outputs and to upload the log buffer. It is also possible to programme and configure the unit via the tool-kit.
The upload utility insures reliable transfer of the data from the log buffer in the RTU-COM to the PC. When the PC uploads the data from the RTU-COM ,it will register which data has been transferred and a make a special log, with a time stamp, to identify the time and date of the upload. When the PC connects to the RTU-COM the next time, it will utilise this registration and normally transfer only the data which has been logged since the last transfer.

The PC upload utility converts the collected data and stores it in a comma delimited file (*.CSV) on a disk. The file name will be: MMDDNNNN.CSV, e.g.: 09200001.CSV
MM: month (1-12)
DD: date (1-31)
NNNN: log file number increasing every upload (0-9999)

The utility automatically uses a directory structure for the files which relates to a given station no. (network no.) and the year.



The comma delimited file can be imported into a database or a spreadsheet for further analysis e.g. Microsoft Access, Microsoft Excel and many other Windows programs.

Example of a comma separated file generated by the utility:

```
Station number: 56,,,,,
Up-load start: 21/08/1996 21:07:04:05,,,,,

21/08/1996 19:37:20:5,1,8,32,64,
21/08/1996 20:37:21:0,3,12,2,,
21/08/1996 20:38:22:0,5,4095,4095,3005,3005
21/08/1996 20:38:23:0,3,127,16,,
21/08/1996 20:40:21:1,7,4,4,,
21/08/1996 20:42:21:1,5,6,32,127,
21/08/1996 20:40:27:2,3,8,,,
21/08/1996 20:40:57:2,23,1356,1356,1356,1356
21/08/1996 20:40:59:9,31,1257,1257,1257,1257
21/08/1996 20:42:21:2,4,11,5,,
21/08/1996 20:44:26:2,5,8,0,0,0
21/08/1996 20:47:21:2,9,8,,,
21/08/1996 20:55:29:2,12,8,,,

Station number: 56
Up-load end: 21/08/1996 21:08:04:05
```

The same example when imported into an EXCEL spreadsheet. Please note that the data separators and time format used, relate to the national settings selected when installing Windows.

Station number: 56					
Up-load start: 21/08/1996 21:07:04:05					
21/08/1996 19:37:20:5	1	8	32	64	
21/08/1996 20:37:21:0	3	12	2		
21/08/1996 20:38:22:0	5	4095	4095	3005	3005
21/08/1996 20:38:23:0	3	127	16		
21/08/1996 20:40:21:1	7	4	4		
21/08/1996 20:42:21:1	5	6	32	127	
21/08/1996 20:40:27:2	3	8			
21/08/1996 20:40:57:2	23	1356	1356	1356	1356
21/08/1996 20:40:59:9	31	1257	1257	1257	1257
21/08/1996 20:42:21:2	4	11	5		
21/08/1996 20:44:26:2	5	8	0	0	0
21/08/1996 20:47:21:2	9	8			
21/08/1996 20:55:29:2	12	8			
Station number: 56					
Up-load end: 21/08/1996 21:08:04:05					

The header and footer are inserted by the utility, the remaining part is data derived directly from the log buffer in the RTU-COM.
The first column displays the time of the log. The second column displays the ID of the data being logged (the ID number defined in the log element of the application program). The following columns display the actual process values (digital or analogue) which have been logged. The number of data-words are defined as a parameter for the log element, in the application program.

If a data-word is used for individual bits (0-15), a conversion must be made in the spreadsheet if it is required to view the individual bits.

For importing the log direct into another PC programme the IOTOOL32 include a DLL interface to the upload facilities. Are used to import the log data into e.g. SCADA, databases with the purpose of offering extended historical data handling (trends, graphical views etc.).

Real time clock / time base
The RTU-COM includes a real time clock and time base, which are used for both local control and data logging. The real time clock includes battery backup (lithium battery).
The real time clock is automatically entered into a log buffer every time the trigger of a log element is activated. The real time clock is also available for use in the IEC 1131-3 application programme making real time control possible, e.g. to start or stop or do any other time function related to the control or the monitoring of the application.
The real time clock can be adjusted via the programmer line directly or via modem. The PC utility collecting the data from the RTU-COM, allows adjustment of the real time clock.
When ever the clock is adjusted, an event with id 180 will be placed in the log. The log will be with a time stamp of the new time, and the old time value will be reported: YY.MM.DD HH.MM.SS$^{100}/_{S}$WD (WD= week day no.).

Programmer port / serial interface RJ11
The RTU-COM programming interface includes a driver which is able to handle both the Modbus protocol (RTU slave) and Brodersen RAC commands. The standard Modbus protocol is used for I/O transfer and for configuration and up/down-load of programmes, a special command set is used. The module has Modbus Slave address 1 as fixed address.

The RS232 port (6 pole modular jack RJ11) is equipped with hardware handshake signals. See section Internal serial interface how to configure the handshake signals.

RS232 programmer port (6 pole RJ11)

Pin no	Signal	Description/Remarks
1	SG	Signal ground
2	RTS	Ready to send
3	RX	Receive data (in)
4	TX	Transmit data (out)
5	CTS	Clear to send
6	GND	Ground (Earth)

Internal serial interface to COM device
The RTU-COM internal serial interface includes a driver which is able to handle also both the Modbus protocol (RTU slave) and Brodersen RAC commands. Hayes compatible modem control is implemented in the RTU-COM to serve the built-in line or GSM modem. When the RTU-COM is delivered with leased line modem or similar on-line communicating device, hardware handshake setup for RTS and CTS is instead enabled.

The use of RTS, CTS handshake, leading and trailing delays are user configurable via the PC utility menu. The settings are only active in non modem mode. In modem mode (Dial-up) the settings are don't care. The handshake functions are as follows.

Handshake RTS Off
RTS is kept inactive (low) at all time. RTS Leading and Trailing values are don't care.

Handshake RTS On
RTS is kept active (high) at all time. RTS Leading and Trailing values are don't care.

Handshake RTS On/Off
RTS is inactive when receiving data, and become active when transmitting data.
The RTS Leading setting defines the delay from activating the RTS to the first character is transmitted.

The RTS Trailing setting defines the delay from the last character is transmitted to RTS is deactivated.

Handshake RTS/CTS
RTS is inactive when receiving data, and is activated when the RTU wants to transmit data. After activating the RTS, the RTU will wait for the CTS to become active, before start transmitting. The RTS Leading delay is still valid in this mode, and an adjustable delay from CTS is activated to first character is then possible. However by setting the Leading time to zero, there is no unnecessary delay from CTS to first character (like normal RTS / CTS function). After activating RTS the RTU wait up to 10 sec for the CTS signal. If timeout occur ,transmission is discarded, and the RTU wait for a new request.

RTS Leading
The RTS Leading define the delay time from activating RTS to transmitting the first character.
The RTS Leading value is configurable in the range 0..500 of 10ms units. Ie. up to 5000 ms.

RTS Trailing
The RTS Trailing define the delay time from the last character is transmitted to RTS is deactivated.
The RTS Trailing value is configurable in the range 0..50 of 10 ms units. Ie. up to 500 ms.

Note!
When setting the Leading value to a long time (e.g. 5 sec) it could be difficult to changes configuration and download Bcon programs due timeouts in the driver. It is advisable not to use longer delay than necessary, and configure RTS Leading delay as the last part when using long delays. If the RTU is inaccessible due long delays, the module setting could be reset to default by setting all code switches ON.

Protocol on serial interfaces
The standard Modbus protocol is used for I/O transfer and for configuration and up/down-load of programmes a special command set is used. The concept and the facilities are compatible with other Series 2000/4000 products, enabling the user to combine products within the product range.
The Series 2000/4000 Modbus driver with DLL and DDE interface can be used directly to link the RTU through the telephone network to a central PC for monitoring, data upload and analysis.

Modbus holding registers (40000...) are used for the I/O transfer. The actual I/O´s are automatically mapped into the holding registers according to the actual I/O configuration.
For programme down-load, setup and log data, a transfer special protocol is used (still using the Modbus frame).

The RTU has a selectable address. For modem operation, a logical address (station no., 0-65535) is used for identification of each RTU-COM. Using the Series 2000/4000 tool-kit each station will have its own net, thus the station number and net number are the same.
In non dial-up modem mode Modbus address 1-31 is used (e.g. leased line multi drop systems).

Modem control (Dial-up)
Both the RTU-COM and the central monitoring station can initiate a dial-up to each other. The central monitoring station may dial the RTU-COM at time intervals, if the RTU-COM detects a situation, which is pre-defined to be a call situation, it can immediately dial-up the central monitoring station and report the actual condition.

The application related modem control (related to the process values) and conditions for making dial-up etc., are handled by the B-CONW application programme in the RTU-COM. Modem control is performed through 4 internal registers (BM2 to BM5).
The calls are made to pre-stored numbers. By specifying alternative numbers if a connection is not made to the primary number, then the secondary numbers will be called in turn, until a successful connection has been made. The number of retries is limited to one cycle, i.e. after the pre-stored numbers and the number of retries per number have been called without success, the RTU-COM will suspend the dial-up. The maximum allowed number of dial-up attempts will be the number of "pre-stored numbers to try" multiplied by "Retry count". If the RTU-COM is unable to make a connection, an error indication is given to the application, (m4.7 is set). The error flag is reset when the RTU-COM receives an incoming call (carrier detected) or when the value in the dial register (bm2) is activated (changed from 0 to1) in order to force a new dial-up.

Low level modem control is performed by the firmware which includes a modem initialisation routine, which is executed at power-up and every time a dial-up is initiated.

The following Hayes commands are used to control the internal modem:

+++	Enter command mode
ATZ	Reset modem
ATE0	Echo off
ATD	Dial up
ATH	Hang up
V0	Displays digital format

The string **ATZ ATE0 V0** is used for modem initialisation by the RTU-COM. The second part of the initialisation string can be re-configured to fit the actual application using the IOExplorer.

Default string: **AT E0 V0 &C1 S0=1**

&C1	Track presence of data carrier (DCD).
S0=1	Auto answer.

Experience shows that modem initialisation can variate in special applications, but it is however highly recommended to keep the default setting and investigate elsewhere in case of communication problems before changing the default settings.

Modbus protocol / I/O database
Serial communication according to Modbus (RTU mode) standard is used. The layout of the protocol and data base is very similar to the one being used in other Series 2000/4000 modules (first module = first register). The holding register addressing (Multiple read/preset command type 03/16) is used for transfer. The RTU-COM also provide support for Modbus Broadcast command. Mainly used for real time clock synchronisation in RTU networks. The Modbus slave protocol is designed as tolerant to odd charcters added to a Modbus frame e.g. generated when passing through radio link or leased line multi drop connections. See special data sheet specifing ModbusRTU in Brodersen RTU products.

The RTU-COM is supported by low level PC drivers for MS WIN2000/NT/XP plus a number of dedicated drivers for standard SCADA packages. The RTU-COM can be operated by the IOTOOL32 telemetry driver, which includes all nessesary dial-up and modem facilities.

DLL or DDE interfaces
The driver interfaces directly to most Windows programmes through DLL or DDE interfaces.
The data structure when using the Series 2000/4000 driver is common for all Series 2000/4000 products. The DLL includes a database which is a mirror of the process values related to a given RTU-COM. The values are separated into 4 data types, digital (DI/DO), analogue (AI/AO), and an auxiliary type (YI/YO).
The user does not need to consider the actual Modbus registers used for the I/O in the RTU-COM. For each RTU, the number of I/O´s is

specified by type and number. The Modbus driver automatically imports the data received, via the Modbus, into the correct position in the data base.
The driver can be configured to perform an automatic connection to each RTU at a given time interval and the driver will also accept calls initiated by an RTU.
The I/O data, collected by the driver, is easily accessed by the application programme specifying a unique address consisting of:

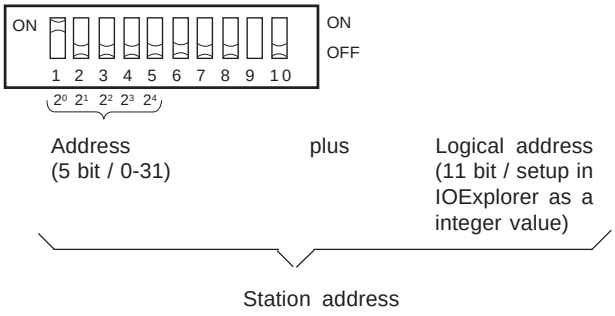
<datatype><Network/station><node/island><module/group<[>I/Oterminal>]

For further information regarding addressing and facilities refer to the separate description of the drivers and the Series 2000/4000 tool-kits. DLL facilities also available for log upload as earlier described.

Station address (dial-up mode)
When using dial-up modems connected to the Public Switched Telephone Network, a number of Remote units will normally enter a central monitoring station through the same physical connection. In order to be able to identify the Remote units, the station number is transferred in the first input holding register.

The station no. (0-65535) is the sum of the binary value selected using code switches 1-5 and the binary value of the logical address configured in the RTU-COM using IOExplorer (default = 0).
The central monitoring station must use the station address to direct the received data to the correct location.

Station address defined as:

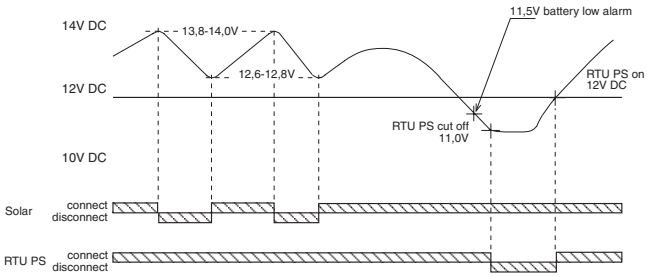


The Modbus address (physical address) is set to address 1 (independent of the switch) when modem control is enabled.
Please note that the PC Modbus driver only supports station numbers 0-1999.

Modbus address (non dial-up modem mode - Option)
When the non dial-up mode is enabled in the RTU-COM, it uses the Modbus address to identify itself. In this mode the 5 address DIP switches defined the Modbus address, and the logical addess is ignored.
Note that the modem should be disabled in the config table if not present.

Charger controller for battery and solar panel
In Power supply version 40 the RTU-COM is equipped with a battery charger controller for use with solar panel. 12V battery and solar panel are connected direct to the RTU-COM. The controller ensure that battery is not over charged. When the battery voltage level reach 13,8-14,0V the solar panel is disconnected. When the voltage level falls to 12,6-12,8V the solar panel is re-connected to charge the battery. To prevent the battery to be deep discharged, the charger controller will cut the supply to the RTU-COM at 11V but already at 11,5 V DC the status bit BM9.6 for battery low alarm will be set to 1. And when the solar panel have charged the battery and the voltage level reach 12V, the controller connect the power to the RTU-COM again.

Typical tinkle charge and low discharge cycle



RTU-COM Power save
RTU-COM is designed for providing power saving features. The RTU-COM has implemented the following power saving options in the hardware:

- Modem power on and of.
- Power the analogue inputs circuits on and off.
- Heart beat for trigging the CPU in reduced power mode.
- Configurable interrupts for waking up the CPU when activating digital inputs.
- Wake up facility when receiving calls via interrupt connected to Ring Indicator.
- Wake up facility when connecting to the programmer port and start sending data.

The applications program B-CON control and define when and how the options are used.

In the firmware some important measures are taken to control and manage the household in relation to the basic low power option.

Below are listed these basic parameters:
- Update of input, outputs, BM registers, and other process param eters are finished, before entering sleep mode.
- After wake up by an incoming call (RI interrupt activated) or connecting to the Programmer port (RxD activated), the module is kept in normal mode until communication has ended or there is no more activity on the programmer port. An in-activity timer function on the Rxd/Txd programmer port with 15s is implemented.
- When power up modem the firmware holds dial command until proper initialised.
- When power on the analogue circuit, a delay for the analogue value to stabilise before release is implemented.

The total power consumption is dependable of application requirement, and is totally controlled by B-CON application programme. E.g. the module could sleep and just wake up every hour for a few seconds, log an analogue value, and enter sleep again. Modem and/or analogue circuits could be on or off during normal or sleep mode. Any combination is possible. Turn off modem and analogue circuits and enter sleep mode to obtain max power reduction.

The RTU-COM will basically have two modes;
Normal mode
The CPU is running constantly, and B-CON application is executed at regular intervals like a normal RTU module. However modem and/or analogue circuits could be turned off to save power, if not used/needed.

Sleep mode
Sleep mode is a power saving mode where the CPU crystal (code execution) is stopped, for maximum power save . Each 250 ms a heartbeat interrupt wake the CPU shortly to service watchdog and other firmware housekeeping. The Dallas 80C320 CPU internal ring oscillator provides instantaneous code execution, when waked by

interrupts, which eliminate X-TAL stabilisation time during sleep mode housekeeping. To resume normal mode, different events are possible e.g. sleep time is expired or changes of digital input. This is controlled by a combination of configuration fields and BM register settings.
Switch to sleep mode is controlled by the B-CON application programme. By entering the maximum seconds to sleep in WM44 and set WM40 to 1, the module enters sleep mode. The firmware terminates all processes in an appropriate way, before sleep mode is entered. Note! Sleep is cancelled by firmware if communication is currently active, or has been within the last 15 seconds. The application programme must then try later to enter sleep mode. A sleep response code register (BM42) is provided, to test which event caused normal mode resume or firmware sleep mode cancellation.
All timers, counters, data etc. are frozen during sleep. I.e. B-CON application timers, counters, data etc. continue with the value, just before sleep, when normal mode is resumed.

A wake up occur when the module leave sleep mode, and normal mode is resumed. This is initiated by a hardware interrupt from heartbeat, digital input, modem RI or programming port Rx, and wake up the module as follows.

Timeout:
The maximum sleep time defined in WM44 is expired.

Digital Input:
A digital input changes has occurred. See configuration possibilities later.

Modem ring:
A incoming call (Ring signal) is received by the modem, wake up the module, and communication could be established. This is of course only possible if power is applied to the modem during sleep.

Programming port:
Programming port Rx input signal activity wake up the module, and communication could be established. I.e. when a PC is connected, the module wakes up.

Modem
Modem power is turned on/off by the B-CON application. The modem could then be off most of the time, and just turned on when communication is needed, to reduce power. Power Control register BM46 is used to select modem mode. The modem is default on at power on. Note! It will take a while from B-CON turns it on, to the modem is initialised and ready (especially GSM), and a B-CON dial command is then not executed before the modem is ready. If the modem is powered off, a dial is just ignored by the firmware.

Analogue circuits
The analogue circuit power is turned on/off by the B-CON application. The analogue circuit could then be off most of the time, and just turned on when needed, to reduce power. Power Control register BM46 is used to select mode. The analogue circuit is default on at power on. Note! It will take some time from B-CON turns it on to the AD converter and reference etc. is stabile. Bit 14 of the analogue word (invalid bit) is set to '1' when analogue circuits are off, and during the stabilisation time. This is used by B-CON application to check if analogue values are valid or not. If an external transducer is powered simultaneously, additional time must be expected, due to transducer settling time and analogue input low pass filter time constant. The B-CON application programmer must take care of this. However if power is very critical, the module could sleep during the stabilising period.

Digital input
The 4 digital input is configurable in a number of ways, and could wake up the module. If digital input wake up function is enabled, all DI's will have the wake up function. Note: If wake up function is enabled and the module is sent to sleep, using the counters on DI0 and DI1 will wake up the module at each count.

Wake up can either be on a positive transition change (OFF to ON) or a negative transition change (ON to OFF). They are configured in pairs. DI0 + DI1 and DI2 + DI3. The following options are selected in the configuration menu:

DI0 and DI1

OFF->ON:
A digital input '0' to '1' transition, wake up the module, and normal mode is resumed. The B-CON application program test which event caused the wake up, and take action accordingly.

ON->OFF:
A digital input '1' to '0' transition, wakes up the module, and normal mode is resumed. The B-CON application program test which event caused the wake up, and take action accordingly.

DI2..DI3

OFF->ON:
A digital input '0' to '1' transition, wake up the module, and normal mode is resumed. The B-CON application program test which event caused the wake up, and take action accordingly.

ON->OFF:
A digital input '1' to '0' transition, wake up the module, and normal mode is resumed. The B-CON application program test which event caused the wake up, and take action accordingly.

It is important to note that the digital wake up function actually only wake up the module. It means than a DI change e.g. an alarm on a DI, must be activated for more than 300ms, to make sure that the module wake up and the B-CON program are able to perform a scan to read what DI has changed so the application defined type of action can be performed.

Power consumption
Power consumption is directly related to the actual application, i.e. type of internal modem, number of I/O´s active on the RTU-COM etc. Below are examples for the standard RTU-COM versions. All figures are typical consumption at 12V.

RTU-COM version	UCR-10IO (AI)		UCR-4DI		UCR-4DIO		UCR-10IOA (AI)		UCR-8DIO	
	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.
Controller/electronics/ LEDs/IO (DI)	25 *	70	25 *	70	25 *	70	25 *	70	25	130
Analogue IO	0	10	0	10	0	10	0	15	0	0
GSM modem idle	5	8	5	8	5	8	5	8	5	8
GSM modem on-line	100	200	100	200	100	200	100	200	100	200
PSTN modem idle	50	60	50	60	50	60	50	60	50	60
PSTN modem on-line	60	100	60	100	60	100	60	100	60	100

*) Power consumption in sleep mode.

Note: The figures are estimates and are subject to change. If RTU-COM is used in solar panel application special power calculation sheet will be required to calculate current consumption and to define battery and solar panel requirements.

Counter input
Two 32 bit counters is provided on digital input 0 and 1. The counters values are battery backed, when power is off. Each counter is provided with a reset function. The counter values and reset are located in a number of BM registers. If the counter value overflow, it

wrap around and start from zero again.
By default the counters are disabled, and must be enabled in the PC utility configuration menu before use. When counters are disabled the allocated BM registers are free for other use.
The counters are firmware polled, which limit the count frequency when the CPU is loaded heavily. If the module is loaded with max. I/O, large B-CON program etc. only up to 60 Hz count frequency could be expected.
Note ! When downloading B-CON application program, or changes of the module configuration, the counters are blocked for a short period, and counts could be lost.

SPECIAL REGISTERS RTU-COM

Overview

BM/reg.	Description	Type
BM0	error/overflow	R
BM1	m1.0 system indicator	R
	m1.1 system indicator	R
	m1.6 Disable/enable loop power supply	R/W
BM2	command register 1=dial, 2=hang up, 3=send SMS, 4= send SMS to no. of last received SMS	R/W
BM3	telephone no.	R/W
BM4	m4.0-m4.3 handshake inputs	R
	m4.4-4.5 Com state	R
	m 4.6 Password	R
	m4.7 Dial time out (error)	R
BM5	communication counter	R
BM6	User info (derived from USER field in the IOExplorer	R
BM7	configuration menu)	
BM8	m8.0 switch1	R
	m8.1 switch2	R
	m8.2 switch3	R
	m8.3 switch4	R
	m8.4 switch5	R
	m8.5 switch6	R
	m8.6 switch7	R
	m8.7 switch8	R
BM9	m9.0 switch9	R
	m9.1 switch10	R
	m9,6 Battery status (0=OK)	R
BM10	Seconds 0-59	R
BM11	Minutes 0-59	R
BM12	Hours 0-23	R
BM13	Week day 1-7	R
BM14	Date 1-31	R
BM15	Month 1-12	R
BM16	Year 0-99	R
BM17	m17.0 0.1 second interval Trigger	R
	m17.1 1 second interval	R
	m17.2 10 second interval	R
	m17.3 1 minute interval	R
	m17.4 10 minute interval	R
	m17.5 1 hour interval	R
	m17.6 10 hour interval	R
	m17.7 not used	
BM18	Log buffer 0-255 0: Empty 254: Full	R
BM19	SMS text messages	R/W
BM20	m20.4 SMS transmission OK	R
	m20.7 SMS transmission time out (error)	R
BM21	m21.0-m21.1 counter reset	W
	m21.2-m21.7 not used	
BM22	Counter 0	R
BM23		
BM24		
BM25		

BM/reg.	Description	Type
BM26 BM27 BM28 BM29	Counter 1	R
BM30 BM31	SMS write register	R/W
BM40	m40.0 '0' = Normal mode (default). '1' = Go to sleep mode. m40.1 '0' = Enable DI change wakeup (default). '1' = Disable digital input changes wakeup. m40.2 '0' = Enable modem activity wakeup (default). '1' = Disable modem activity wakeup. m40.3 '0' = Enable programming port activity wakeup (default). '1' = Disable programming port activity wakeup. m40.7 Not used.	R/W R/W R/W R/W
BM41	Not used	NA
BM42	Exit sleep mode response 0 = No event (sleep mode was not entered). 1 = Timeout event wakeup. 2 = Digital input change wakeup. 3 = Modem activity wakeup. 4 = Programming port activity wakeup.	R
BM43	Not used	NA
BM44	Sleep time register 0...65535 sec to stay in sleep mode. 0 is ignored. 65535 no sleep timeout.	R/W
BM46	m46.0 '0' = Enable analogue circuit. '1' = Power off analogue circuit. m46.1 '0' = Enable internal modem circuit. '1' = Power off internal modem circuit. m46.2-m46.7 not used	R/W R/W NA
WMxx	Writeable register from SMS - see SMS message section	R/W

Error/indicator/alert (inputs)
Run time errors and corresponding indicators are monitored/controlled using BM0 and BM1

Register	Description
BM0	Runtime error/overflow
BM1 m1.0	System indicator
m1.1	System indicator

Modem control registers
The modem is controlled from 4 internal registers (M-registers).

Register	Description
BM2	Command register (output) 0=No action, st. by 1=Dial no. selected by bm3 2=Hang up 3=Send SMS message 4=Send SMS to no. of last received SMS
BM3	Telephone (selection) no. (0-29)
BM4 m4.0 m4.1 m4.2 m4.3 m4.4-m4.5 m4.6 m4.7	 CTS, Clear to send (input) DSR, Data set ready (input) RI, ringing indicator (input) DCD, Data carrier detect (input) Communication state (read only) Correct password received Dial request suspended (1"=Error)
BM5	Communication counter

54	State	Remark
00	Idle	No communication (comcounter =0)
01	Active	Communication (comcounter ≥ 1)
10	All updated	Set when all inputs has been read once

The command register (output) is used to initiate and terminate a call. The call is made to the pre-stored number selected in the telephone register, see above.

The telephone number (output) is selected from up to 30 pre-stored telephone numbers to decide which number to dial. The pre-stored telephone numbers are defined in the configuration menu, using the IO Explorer software. The telephone number register (bm3) can be used either to force the use of a given pre-defined number, by writing the number into the register - or it can be used to read the actual number currently being dialled. The automatic dial procedure writes the actual number into the register, allowing the B-CONW application programme to monitor the number being dialled and control it accordingly.

CTS, DSR, RI and DCD (input) are the handshake signals (bit inputs) from the modem, which may be used in the application programme to control the modem.

The communication state (input) can be used to monitor when a transfer of I/O data has successfully taken place. The communication state is controlled by Modbus Holding register 49999. The PC driver (Modbus master) writes to the register when the PC has received all the registers defined.

The communication counter (input) can be used to monitor if the transfer of data is successful. In every read or write cycle on the Modbus, the counter is incremented. The RTU-COM requires at least two messages (Read and Write) to update. For third party equipment/ software several messages might be required to update a remote unit depending on the actual Modbus commands being used. In such cases, data for the actual protocol driver must be consulted or the value must be set to a suitably high figure.

When the line connection is terminated, the communication state and the communication counter are returned to 0-19.

User Registers
BM6 and BM7 (WM6) are directly derived from the "User" field in the configuration menu. By using IOExplorer it is possible to enter parameters into an application programme, e.g. a set-point without having to re-compile.

Register	Description
BM6	User register high byte
BM7	User register low byte

Code Switch (inputs)
The setting of the code switches are copied to internal registers (BM8/ BM9) for monitoring purposes. Please note that the code switches are used by the firmware, therefore they cannot be used independently.

Register	Description	
BM8		
m8.0	Code switch 1	Address
m8.1	Code switch 2	Address
m8.2	Code switch 3	Address
m8.3	Code switch 4	Address
m8.4	Code switch 5	Address
m8.5	Code switch 6	Not used
m8.6	Code switch 7	Not used
m8.7	Code switch 8	Not used
BM9		
m9.0	Code switch 9	Not used
m9.1	Code switch 10	Modem/RTU-COM config

Power Montor (type 40 solar charger controller)
It is possible to monitor the condition of the external lead acid battery and the mains supply in the application programme.

Register	Content
M9.6	Battery status (1=error, 0=OK)

Real Time Clock
The real time clock can be used in the application programme to start /stop or do any other time function related to the control or to the monitoring of the application.
The real time clock and the time base is available in a number of internal registers (BM10 to BM 17).

Register	Content	Range	Remarks
BM10	Seconds	0-59	
BM11	Minutes	0-59	
BM12	Hours	0-23	
BM13	Week day	1-7	1=Monday, 7= Sunday
BM14	Date	1-31	
BM15	Month	1-12	
BM16	Year	0-99	

Time Base
The time base will typically be utilised to trigger the log elements in order to facilitate cyclic logging and they may also be used to trigger other functions related to the actual application.

Register	Time interval
M17.0	0.1 second
M17.1	1 second
M17.2	10 second
M17.3	1 minute
M17.4	10 minute
M17.5	1 hour
M17.6	10 hour
M17.7	not used

The output of the time base is active only for one scan in the application programme (e.g. 100 ms).
All outputs of the time base are active for one scan immediately after the module is turned on (or reset). There after the time based, is synchronised to the real time clock meaning that the 10-minute-output (BM 17.4) is activated exactly at 11:00:00, 11:10:00, 11:20:00, 11:30….

Buffer Level Indicator
BM 18 is used to indicate which part of the log buffer has not yet been uploaded. The value is an integer (0-255).

Register	Log buffer		
BM18	**Value**	**Level %**	
	0	0	Buffer empty
	64	25	
	128	50	
	192	75	
	255	100	Buffer full / overflow

SMS Message / sending
The RTU with GSM modem offers the possibility to send SMS alarm messages, with or without variables.

The pre-stored SMS text messages are defined in the configuration menu, using IOExplorer. Up to 40 characters can be stored in each of the 40 messages. Note: only 7-bit ASCII chars can be used, i.e. no special national characters are supported.

The variables in the SMS messages are defined by the syntax:

%[type]<regID>, where
% defines start of variable
[type] defines type of data. Default are used W for word. Value in is signed integer, range –32768 to +32767 decimal
<regID> defines B-CON data register id – e.g. WM512. Valid range; WM100-WM2046. Note: An integer (word) represent two byte memory registers and the number are defining byte registers, so only even registers should be addressed.

The message format is:
Text text **%Wnnn** more text **%Wnnn text** (max. 40 chars)

SMS Service Center telephone no. can be entered in the configuration menu. Often the number is not required as the GSM provider take care of this automatically.

The SMS option is controlled from the following registers.

Register	Description
BM2	Command register (output) 3=Send SMS message 4=Send SMS to last received SMS no.
BM19	SMS text message selection (0-39)
BM20	m20.4 SMS transmission status (1=OK) m20.7 SMS transmission time out (1=error)

Command register (output) is used to initialise the send SMS message procedure. This is done to the pre-stored number of SMS receiver selected in the telephone no. register BM3.
If BM2 is set to 4, a selected message is send to the phone no of the last received phone no.

Message selection (output). The text message is selected from the pre-stored message with BM19 (0-39).
The SMS sending procedure state (read only) can be used to monitor when a SMS transmission has been successful or have failed. If the transmission is successful the BM20.4 is set to "1" and cleared when initiating a new SMS transmission.
If the transmission fails for some reason (e.g. SMS service no. is busy or wrong), the module retry after 60s. After 3 retries and fails BM20.7 is set to "1" and the session is terminated.
In case of an incoming call the session is set on stand-by, and resumed after the incoming call is terminated.

Example

SMS text string 5 contains text:

"Tank %W512 level: %W514 cm"

The RTU will substitute **%W512** with the value of WM register 512 and **%W514** with WM514 in the SMS string.
Telephone list no 1 contains: +45 2242 3763

To send this text, the B-CON application program must do the following:

Set BM19 = 5 (select SMS text string)
Set BM3 = 1 (select a phone number from the list (0…29))
Set BM2 = 3 (send SMS message command)

If WM512 = 02_H, WM514 = $036B_H$ the following text will be send by the RTU COM and read out on the receivers (phone no +45 2242 3763) display :

"Tank 2 level: 875 cm"

Parameters are formatted with leading zero suppression and '-' (minus sign) as required. A parameter occupies from 1 to 6 characters in the message.

SMS Message / receiving
The RTU with GSM modem is able to receive a message. To enable remote control of the application, the RTU will accept a message with a fixed text and format containing one parameter value. The parameter is stored in a fixed memory location in the B-CON data register area.

The SMS message format is defined by the syntax:

Cmd<value>, Where **<value>** is a decimal number within the range –32768 to +32767

E.g. "Cmd55".

The value 55 is stored in data register WM30.
In the B-CON application program it is possible to use the register value to activate outputs or change setpoints etc.

The RTU will NOT respond to the caller.

Enter telephone number in the Telphone no list via SMS.
Up to five telephone numbers in the telephone list in the configuration table can be entered with a SMS message. This is done by using the SMS format;
Cmdpno "phone no 0" "phone no 1" "phone no 2 " "... etc. - up to 5 numbers.

Example: Cmdpno "+45123456" - will write +45123456 into telephone no 0 in the list.

Existing number in the actual entry will be overwritten. If you do not enter any number but just define " " the entry will be overwritten with blanks.

If you put "Ack" (like **AckCmd55**) in front of your message, one of three possible acknowledge messages will be send to the caller:

If the caller is in the admission list and the message format is valid:
RTUyy response, command accepted
If the received message format is invalid:
RTUyy response, command rejected/error
If the caller is not in the admission list, the RTU will respond with:
RTUyy response, no admittance
- where **yy** equals the RTU address.

SMS Safety / acknowledgement issues
It is possible to enable a safety function, so only 5 predefined mobile phone numbers can change settings. If none is listed, SMS command from any mobile phone is accepted. Is defined in the configuration menu using IOExplorer.

When receiving SMS messages system acknowledgement must be returned. See previous paragraph.

Counter registers
BM 21..29 are used by the counters, if enabled. When the Reset bit is activated, the corresponding counter is cleared, and remain cleared as long as the Reset bit is activated.

Register	Description
BM21 m21.0 m21.1 m21.2..m21.7	 Reset counter 0 Reset counter 1 Not used
BM22	Counter 0 bit 0..7
BM23	Counter 0 bit 8..15
BM24	Counter 0 bit 16..23
BM25	Counter 0 bit 24..31
BM26	Counter 1 bit 0..7
BM27	Counter 1 bit 8..15
BM28	Counter 1 bit 16..23
BM29	Counter 1 bit 24..31

B-CON Power save command and monitor registers
A number of BM registers are used by the B-CON application program, in conjunction with some configuration registers, to control the sleep mode features in the RTU-COM

WM40 Sleep mode command register
Instructs firmware to close processes and enter sleep mode. One or more of the wakeup possibilities could be disabled during sleep to prevent unwanted wakeup. Writing 1 will enter sleep and keep everything enabled.

m40.0 "0" = Normal mode (default).
"1" = Go to sleep mode.
m40.1 "0" = Enable DI change wakeup (default).
"1" = Disable digital input changes wakeup.
m40.2 "0" = Enable modem activity wakeup (default).
"1" = Disable modem activity wakeup.
m40.3 "0" = Enable programming port activity wakeup (default).
"1" = Disable programming port activity wakeup.
m40.4..m41.7 Not used.

BM42 Exit sleep mode response register
A response code indicates which event caused the exit from sleep mode;
0 = No event (sleep mode was not entered).
1 = Timeout event wakeup.
2 = Digital input change wakeup.
3 = Modem activity wakeup.
4 = Programming port activity wakeup.

BM43
Not Used

WM44 Sleep Time Register
Word value range 0..65535. Units of seconds the RTU stay in sleep mode, unless another event occur which resume normal mode operation before timeout (e.g. digital input change). Value 0 is just ignored. Value 65535 (0xFFFF) the timer is disabled and the RTU will be kept in sleep mode until another event occur.

BM46 Power Control Register
Enable, disable power to optional circuits. The circuits are enabled by default at POR and B-CON start

m46.0 "0" = Enable analogue circuit.
"1" = Power off analogue circuit.
m46.1 "0" = Enable internal modem circuit.
"1" = Power off internal modem circuit.

TECHNICAL DATA

INTERFACE

Internal serial interface / modem interface:

Signal level:	RS232C/TTL.
Hardware handshake:	DCD, DTR, DSR, RTS, CTS, RI
Baud Rate:	300, 600, 1200, 2400, 4800, 9600, 19200
Format (default):	8 bit (binary), 1 start bit. No parity, 1 stop bit.
Protocol:	Modbus slave (RTU mode).
Error Check:	CRC (16).
Modem control:	Hayes compatible.
Dial-up (modem):	DTMF or pulse dialling to pre-stored telephone numbers. Up to 30 pre-stored numbers. Each number can be up to 20 digits.

Serial interface / programmer port:

Signal level:	RS232C/v.24.
Hardware handshake:	RTS, CTS
Baud Rate:	300 - 9600
Format (default):	8 bit (binary), 1 start bit. No parity, 1 stop bit.
Protocol:	Modbus slave (RTU mode).
Error Check:	CRC (16).

CONTROL AND DATA LOGGING

IEC 1131-3 (B-CON)

Program memory (Flash):	23 Kbytes.
Memory usage per instruction line:	6-24 bytes.
Typical maximum program size:	1500 instruction lines.
Scan interval:	50-250 ms (note 1).
Internal registers (BM):	2048 (note 7).

Real time clock

Automatic correction for leap years.		
Accuracy:	25°C:	Better than +/- 1 second per day.
	-20 + 50°C:	Better than +/- 5 seconds per day.
Adjustment accuracy:		±1s.
Back-up battery:		Internal Lithium battery (800 mAh).
Back-up time:		min. 2 years (without external battery or mains supply).

Data logging

Cyclic log interval:	0.1, 1, 10 seconds. 1, 10 minutes. 1, 10 hours.
Log memory:	up to 480 kBytes.
Time stamp:	Time, date, year (compressed format).
Resolution:	0.1 second.
Number of log elements:	max. 32.
Log record:	ID, time stamp, process values (max. 120 words), see note 1.

Back-up battery:	Internal Lithium battery (800 mAh).
Back-up time:	min. 2 years (without external battery or mains supply).
Log upload time:	typically 5 seconds per 1k byte @9600 Baud. See appendix for table with typical log upload time.

Counters:

Minimum pulse / pause width:	6ms
Max. counting frequency:	80Hz

POWER SUPPLY/CHARGER

Supply Versions:

	00	10	30	40	50
Supply voltage nominal	12V DC	110-240V AC/DC	24-48VDC	12VDC batt.	24-60V DC
Supply voltage absolute maximum input range	10-14,8	100-265	20-60V	12-15V	20-72V
Mains frequency	DC only	40-60 Hz	DC only	DC only	DC only
Max Power	6W	18W	14W	24W	14W
Outputs:					
Output current, total 0,9A		1,1 A	0,9 A	2A	
Output external output Max. current	12VDC (= suppl.) 400mA	12V +/- 1,5V 400mA	12V +/- 0,5V 400mA	-	24V +/-1V 300mA
Isolation:					
Input/mains (primary) to electronics	0V	3,75kV		0V	3,75kV

Type 40 figures are subject to change.
Note 8, 9, 10.

MODEMS

GSM Dual band modem

Standards:	GSM 1800/1900 Class1(1W),GSM phase2.
AT command set:	Based on V.25ter and GSM 07.05 & 07.07. No auto-framing available.
SMS:	Mobile Originated (MO) and Mobile Terminated (MT). Mode Text & PDU point to point.
Cell broadcast:	In accordance with GSM 07.05
Data mode:	Asynchronous 2400, 4800, 9600 bits/s. Transparent / Non-Transparent mode. Mode 3.1 KHz (PSTN) and V110 (ISDN)
Antenna:	External antenna via SMA conn.
SIM Card:	Voltages: 3 and 5V supported.
Approvals:	CTR19 and CTR20

PSTN Modem

Connector:	6 pole RJ11 type modular jack
Modem Speeds:	V.32bis, V.32, V22bis, V.22A/B, V.23and V.21, Bell 212A and 103
Error correction:	V.42 LAPM and MNP 2-4
Data compression:	V.42 bis and MNP5 (MNP10 data throughput enhancement)
AT command set:	Hayes compatible.
Linearity:	Better than ± 1LSB.
Temperature stability:	Better than ± 50ppm/°C (typical).
Common mode input voltage:	Max. ±80V DC (note 1).
Common mode rejection ratio:	Min. 60dB (typical 72dB).
Series mode rejection:	Min. 30dB (50-120Hz)
Isolation (input to input):	500V (note 1).
Approvals:	Pan European CTR21 standard.
Isolation line interface:	1500 V.

DIGITAL INPUT/OUTPUT

Inputs:

Input voltage activated:		10-30V DC (note 2,3).
Input voltage deactivated:		Max. 3V DC.
Input current:	12V DC:	Typical 3mA.
	24V DC:	Typical 6mA.
Input delay:		Typical 1ms.

Outputs:

External voltage:	10 - 30V DC (note 2,3).
Output voltage drop:	Max. 1.5V (output activated).
Output current:	Max. 0.5A.
Output peak current:	Max. 5A in 1 second (note 2,3).
Output leakage current (off):	Max. 0.5mA.
Output delay:	Max. 1ms.

Isolation
(input or output to electronics, input to output): 1kV AC.

Indicators:

Digital input:	One for each digital input (red) indicating active input.
Digital output:	One for each digital output (yellow) indicating active output.
System:	Indicating RTU OK (green)
Power:	Indicating power and battery OK (green)
Rxd/Txd	Indicating serial communication on modem.
Modem:	Indicating modem status (green).

RELAY OUTPUT

Outputs:	4 potential free SPST-N/O contacts
Output voltage:	Max. 240V AC/30V DC.
Output current:	Max. 1A AC, 2.5A DC (resistive).
Output delay:	Typical 10ms.
Lifetime (relay):	Min. 100.000 operations at rated load.
Contact material:	Gold overlay silver alloy.

Isolation:

Electronic to contacts:	2kV AC	2,5kV DC
Contact to other contacts:	500V AC/DC	

Indicators: None

ANALOGUE INPUT (DX)

Inputs: 1 or 2 multiplexed analogue channels with solid state multiplexer (note 1, 5).

Input configuration: Differential (+/ -), flying capacitor type.

Input measuring ranges:

Type no. code	Voltage input	Current input
.D1	0-10V	0-20mA
.D2		4-20mA
.D6		0-20mA

Resolution: 12 bit, 0-4095.

Input impedance: Voltage: D1: 100 kOhm.
Current: D1: 500Ohm(note 4).
D2/D6: 100 Ohm.

Absolute maximum ratings: Voltage: ±40V DC.
Current: ±30mA DC.

Sampling interval: Min. 100 ms (note 5).

Measuring accuracy:
25°C: ±0.2%±6LSB (typically 0.05%±3LSB).
-10°-55°C: ±0.3%±8LSB (typically 0.1%±4LSB).

PT100 INPUT (Dxx)

Input: 1 analogue channel for Pt100 temperature sensor.

Input configuration: 3 wires (or 2 wires).

Input measuring ranges: Pt-100
P1: -50 - + 100°C.
Optional Pt1000 and other ranges.

Resolution: 12 bit.

Measuring accuracy: Better than ± 0.5% of FSR.
Linearity: Better than ± 0.1% of FSR (note 16).

Temperature stability: Better than ± 100ppm/°C (typical).

Isolation: No isolation input to electronic.

GENERAL

Current consumption / typical values (12V):

UCR-10IO:	max. 105 mA.
UCR-4DIO:	max. 90 mA.
UCR-4DI:	max. 100 mA.
UCR-xx sleep mode:	max. 25mA.
Modem GSM idle:	max. 10mA.
Modem GSM on-line:	Max. 200mA.
Modem PSTN idle:	Max. 60 mA
Modem PSTN on-line:	Max. 80 mA

Isolation: IEC class II, 3,75 kV.
(mains supply versions)
Safety earth required.

Ambient temperature: -10 - +55°C.

EMC: EN 50081-1/EN50082-2.

Climatic:

Dry heat:	IEC 68-2-2, Test Bd, Temp. +55°C, Duration 8h.
Cold:	IEC 68-2-1, Test Ad, Temp. -10°C, Duration 8h.
Damp heat:	IEC 68-2-3, Test Ca, Temp. 40°C, RH 95%, Duration 8h.

Mechanical:

Vibration:	IEC 68-2-6, Test Fc (sinusoidal), Freq. 10-150Hz, Amp. 4g, 5 sweeps in 3 orthogonal axes.
Shock:	IEC 68-2-27 (half sine), Acc. 15g, Pulse time 11msec., 3 x 6 shocks.

Protection: IP20.

Mounting: 35 mm DIN-rail, EN50022.

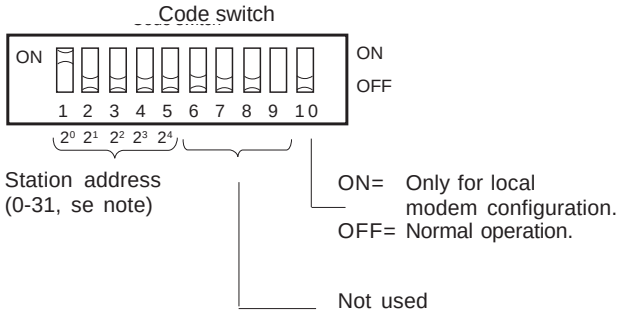
Terminals: Max. 1.5 mm^2 wire.

Housing: Anodized aluminium with plastic ends. According to DIN 43880.

Dimensions: HxWxD: 80(+connectors)x162x62 mm.

CODE SWITCH/ADDRESS SELECTOR

The code switch of the RTU-COM selects the address for the serial interface to modem.



Note:
The station address is defined as the sum of the binary value selected using switch 1-5 and the binary value of the logical address defined in the configuration table (default=0).

TABLE ANALOGUE INPUTS

Integer (binary value) = Input - range MIN.
R

where R is the resolution (LSB).

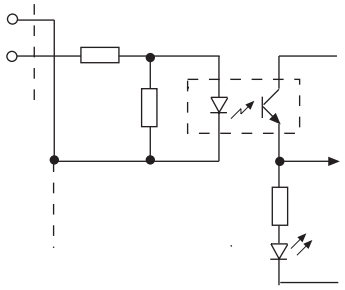
Input range				Integer (Binary-code)
0-10V	0-5V	0-20mA	4-20mA	
Input [V]		Input [mA]		
<0	<0	<0	<4.0	0
0	0	0	4.0	0
1	0.5	2	5.6	410
2	1.0	4	7.2	819
3	1.5	6	8.8	1229
4	2.0	8	10.4	1638
5	2.5	10	12.0	2048
6	3.0	12	13.6	2457
7	3.5	14	15.2	2867
8	4.0	16	16.8	3276
9	4.5	18	18.4	3686
10	5.0	20	20.0	4095
>10	>5.0	>20	>20.0	4095
2.442mV	1.221mV	4.884uA	3.907uA	Resolution

ANALOGUE TABLE (Pt-100)

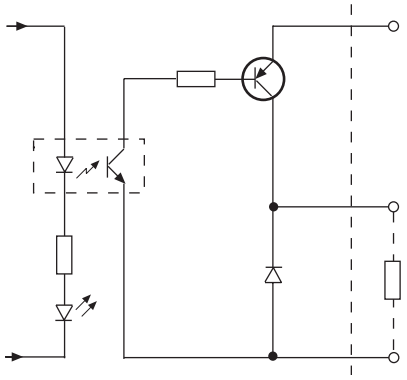
Temperature	Range
	-50 - 100°C
	Integer (binary code)
<-50	0
-50	0
-25	683
0	1365
25	2048
50	2730
75	3413
100	4095
125	4095
150	:
200	:
250	:
300	:
300	:

CIRCUIT CONFIGURATION (DIGITAL)

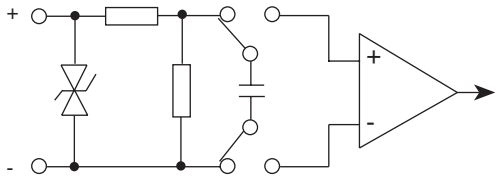
Input



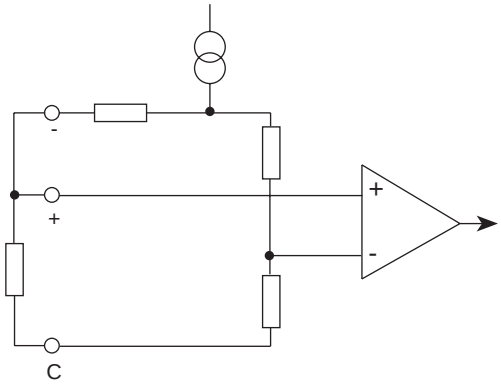
Output (PNP)



CIRCUIT CONFIGURATION (ANALOGUE)



CIRCUIT CONFIGURATION (Pt-100)



CONFIGURATION

The IOExplorer is used to configure the RTU-COM and to pre-define telephone numbers. Refer to separate description.

RTU-COM configuration table
Configuration fields

A number of configuration fields are provided. The field values are changed and downloaded into the RTU-COM flash memory, using the IOTOOL32 configuration menu. The fields are used for values which are programmed once when setting up the module (e.g. protocol parameters and baud rate).
The following fields are provided to control the RTU-COM.

Note! The fields may not appear in the same order in the actual module.

No	Type	Text	min..max		Current value / default settings
1.	S	Port A cfg.	(1..1)	:	1 Modbus
2.	S	HandShake	(1..4)	:	3 RTS On/Off Modbus (RTU-COM non dial-up only)
3.	W	RTS Leading	(0..500	:	1 of 10 msec (RTU-COM non dial-up only)
4.	W	RTS Trailing	(0..50)	:	0 of 10 msec (RTU-COM non dial-up only)
5.	W	PLC TX Dreg	(40001..40300)	:	40001 Holding reg
6.	W	PLC RX Dreg	(40301..40600)	:	40301 Holding reg
7.	W	Logical addr	(0..65503)	:	0
8.	W	Modem	(0-1)	:	Enabled
9.	W	Retry count	(0..10)	:	3
10.	W	Max comm cnt	(1..256)	:	256
11.	W	Subs. to try	(1..10)	:	1
12.	W	Redial delay	(2..120)	:	90 Seconds
13.	T	Tel. no.	(0..29)		
14.	T	Modem init.	(0..0)		
15.	T	PIN code	(0..0)	:	none
16.	W	Modem reset	(0..9999)	:	720 minutes
17.	W	User	(0..65535)	:	0
18.	C	Date/Time	(Y/M/D H:M:S)	:	01/03/19 - 09:30:36
19.	P	Password		:	Disabled
20.	W	Log Buf Size	(5..100)	:	100 Percent
21.	T	SMSC Tel. No	(0..0)		(GSM only)
22.	T	SMS Text	(0..19)		(GSM only)
23.	T	SMS in Poll	(10-100)	:	60 Seconds
23.	T	SMS AC	(0..2)	:	(GSM only)
24.	S	DI counters	(1..2)	:	1 Disabled
25.	S	DI0..DI1		:	OFF->ON
26.	S	DI2..DI3		:	OFF+>ON
27.	S	Port B cfg	(1..1)	:	1 Modbus
28.	S	Baud Rate	(1..6)	:	6 9600
29.	S	Parity	(1..3)	:	1 None
30.	S	Handshake	(1..4)	:	3 RTS On/off
31.	W	RTS Leading	(0..500)	:	1 of 10msec
32.	W	RTS Trailing	(0..50)	:	0 of 10msec

Field	Description
1.	Header - Non configurable
2.	Primary serial port handshake . Select RTS, CTS function.
3.	Defines the delay from the RTU is activating RTS, to transmission of first character.
4.	Defines the delay from the RTU is transmitting last character to deactivating RTS.
5.	TX defines the first Modbus holding register to be used for data, transferred from the RTU-COM to the PC Modbus master.

Field	Description
6.	RX defines the first Modbus holding registers to be used for data transferred from the PC Modbus master to the RTU-COM. Note that broadcast command is supported.
7.	The Logical address or station no. for a given RTU-COM. The address is equal to the sum of the value entered in field 2 (0-65535, default = 0) and the binary value selected at code switches 1-5 (0-31). In the PC the station address will normally equal the net number. The low level address or the physical address of the RTU-COM are the low byte of the logical address.
8.	Modem, can be disabled in hardware versions without modem.
9.	Defines the number of retries which should be made to the same telephone number before giving up or continuing to the next number, if the call is not successful.
10.	Number of successful communication requests before automatically hanging-up. The value 256 will disable auto-hang-up. The internal register BM5 contains the actual communication counter.
11.	Defines whether alternative telephone numbers should be tried. E.g. if 3 is selected the module, in increasing order, tries the first 3 pre-stored numbers. As soon as a proper connection is established following numbers will not be tried.
12.	Defines the delay from an unsuccessful attempt to dial to a new attempt to establish connection.
13.	Up to 30 pre-stored telephone numbers, each number can be up to 20 digits, can be defined. Dial digits 0-9, #, *, A, B, C, D can be entered to select a phone number. A number of control characters can also be entered: T Tone dial P Pulse dial , Delay/pause (2 seconds). W Wait for dial tone (5 seconds). Some special functions may be selected, refer to modem user manual for further information.
14.	Modem initialisation string. The following default string is used: AT E0 V0 &C1 S0=1. The string can be changed by entering appropriate ASCII characters. Any data compression or error correction MUST be switched OFF.
15.	SIM card PIN code for GSM modem. If no number is entered, nothing is sent to the modem. Note that 0000 and 00000 is a valid PIN code.
16.	Modem reset interval. This is a safe function which reset the modem by a power-off/power-on procedure in intervals specified by the user. Range 0-9999 minutes. 0 equals no reset and default is 720.
17.	User defined parameter which can be used for set-points or other programme controls in the B-CON application pro gramme. The value entered in field 10 is copied to registers bm6/bm7 (wm6) in the B-CON programme. The value is entered as an integer (0-65535), however in practice this could be separated into 16 individual bits or 2 bytes, each having a specific function in the application programme.

Field	Description
18.	Real time clock adjustment. The actual time in the RTU-COM can be monitored and adjusted either by entering the time or by copying the PC clock to the RTU-COM.
19.	Enabling/disabling password facility in the RTU-COM.
20.	Log buffer size. Define the size of log buffer in the range of 5 to 100% of 480kB. If changed all data in log is lost.
21.	GSM provider SMS Service Center No. Used if sending SMS text messages via GSM modem.
22.	SMS text messages. Up to 40 fixed text messages with max. 40 characters can be stored in the module. Only 7 bit ASCII are supported.
23.	SMS Poll. Define the frequency of polling the modem for received SMS. Range: 10-100s default set to 60s.
24.	SMS admittance control. Table with list of mobile phone numbers accepted to change values via SMS messages. If no numbers in table no admittance control enabled (default)
25.	Disable/enable the counter function on DI0 and DI1.
26.	Define type of wake-up transition for the 2 first inputs.
27	Define type of wake-up transition for the last 2 digital inputs.
28.	Programming port settings - Header-Non configurable:
29.	Defines the port baud rate. 300, 600, 1200, 2400, 4800, 9600 baud is possible. Default= 9600
30.	Defines port parity. None, Even, Odd is possible. The character length is fixed at 8 data bits. No parity is default
31.	Programmer serial port handshake. Select RTS, CTS functions.
32.	Defines the delay from the RTU is activating RTS to transmission of the first character.
33.	Defines the delay from transmission of the last character to deactivating RTS.

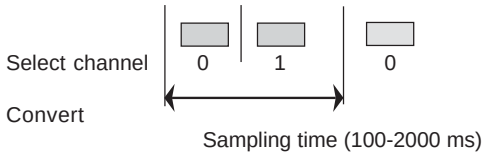
NOTES/REMARKS

1) Section A, B and C are isolated from each other. The individual analogue inputs are isolated from each other. Due to protection devices in the analogue inputs the voltage measured from the common (C) terminals to any other terminals must not exceed ±80V.

2) The polarity at the input must be positive. The common terminal must be connected to the negative.
3) Input signals exceeding the maximum values **MAY CAUSE PERMANENT DAMAGE** to the module.

4) External resistor (500 Ohm) to be mounted for ~0-20mA input. Note that the internal resistance must be calculated as parallel to the 500 ohm.

5) Only one analogue input channel is active at a time, the multiplexing is automatic via the built-in micro-controller.
The actual scan time for the analogues relates to the CPU load and hence the selected interval for the application program. If the application program is executed with a short interval there might not be sufficient time to perform the analogue multiplexing thus resulting in a slow sampling rate (worst case 2 seconds).



The analog input is represented by an integer (binary number) from 0 to 4095 depending on the input signal, see table above.

6) Depending on the noise level versus signal level, shielded cables and/or twisted pairs might be necessary. The shield of the cable should normally be connected to common (C) of the I/O modules.

7) Register BM 0-511 are cleared at start-up. Registers BM 512-2047 are battery backed, the values stored are independent of power and must therefore be cleared manually if required.

8) The 12V external supply is not isolated from the circuit supplying the electronics. It is therefore recommended to use an external source for the I/O if the I/O signals are influenced by electrical noise, e.g. from long cables or inductive load.

9) The external output is short circuit protected and overload protected. The maximum current is limited at high ambient temperature. The maximum load current should be de-rated approximately 1% per °C above 25°C.

10) The RTU00 must only be powered from safe low voltage as there are no isolation provided at the supply input.

Appendix A

TYPICAL LOG UPLOAD TIME

In general the log upload time depend on the actual data speed used. On modem connections - and specially on GSM modem connections, the log upload time can be very different.
Log upload time can be reduced by only uploading data since last upload. Also reducing the log size, can minimize the log upload time.

The typical values given below is just to give an idea of the log upload time.

Application	Speed (baud)	Type	Time
Null Modem/ direct RS232 cable	9600	Full upload	33 minutes.
PC with PSTN/ RTU with GSM	9600	Full upload	62 minutes.