BRODERSEN

INTRODUCTION

The RTU8 unit is a compact outstation with data logging facilities designed for use in the industrial environment.

The unit is designed in a very compact 108/162 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 RTU8 can be delivered with a built-in mains power supply and a charger (with a battery monitor) for an external lead acid battery, enabling the RTU to operate regardless of interruptions in the mains supply.

The RTU8 has a number of integral inputs and outputs and further I/O´s can be added via an expansion bus. The RTU8 is compatible with the Brodersen Series 2000/4000 product range and thus a wide variety of expansion modules can be easily connected to the unit by standard cables.

The unit can be programmed to perform simple control sequences using an IEC 1131-3 (PLC) programming language. The RTU8 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.
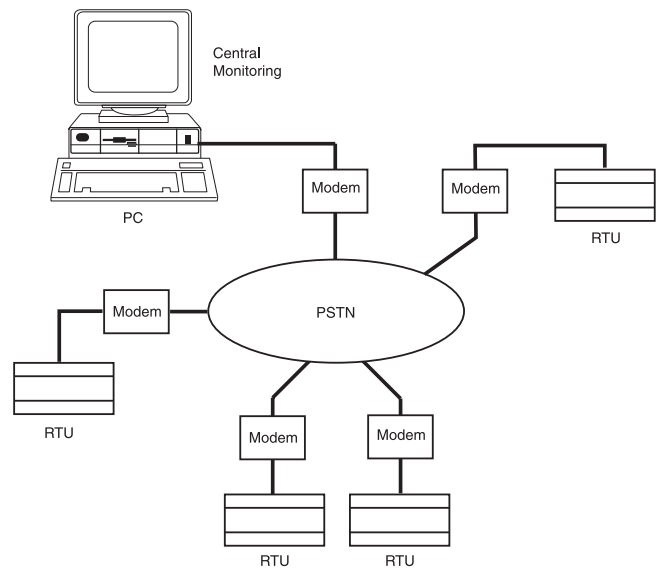
When connected to a GSM modem the RTU offer a simple SMS message alarm option.

The Modbus RTU protocol is used for data transfer from the RTU8 to a PC either directly or via Hayes compatible dial-up modem, GSM, or radio modems.

RTU8
VERSIONS/ORDERING CODES

162mm
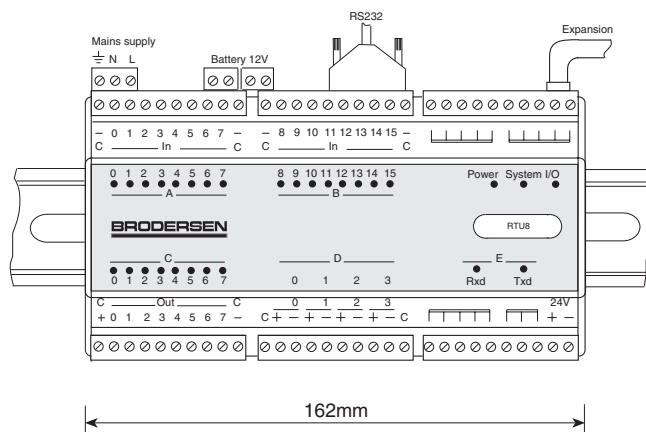
Typical RTU8 application

UCR-28IO/RTU 21.D1

Type	
UCR	UCR

Input/output	
8 digital input/8 digital output	8DIO
16 digital input/16 digital output	16DIO
32 digital input (10-30V DC)	32DI
8 digital input/4 analog input	12I
16 dig. in./8 dig.out./4 analog in.	28IO
24 digietal input/12 relay output	36IO

Options	
RTC and data logging	/RTU

Power supply	
12V DC PS (not isolated)	0
Built-in mains PS 110-240V	1
Built-in PS and battery charger 110-240V	2
Built-in PS 24-48VDC	3

Loop supply	
No loop supply	0
24VDC/200mA*	1
12VDC/400mA*	2
*)UCR-28IO only	

Analogue input range	
0-10V/0-20mA	D1
4-20mA	D2
0-5V	D3
0-20mA	D6
0-2V	D7

Digital input range (digital types only)	
10-30VDC uni-polar	P1
30-60VDC uni-polar	P2
30-60VDC bi-polar	P3
40-72VDC uni-polar	P4
40-72VDC bi-polar	P5
10-30VDC bi-polar	P6
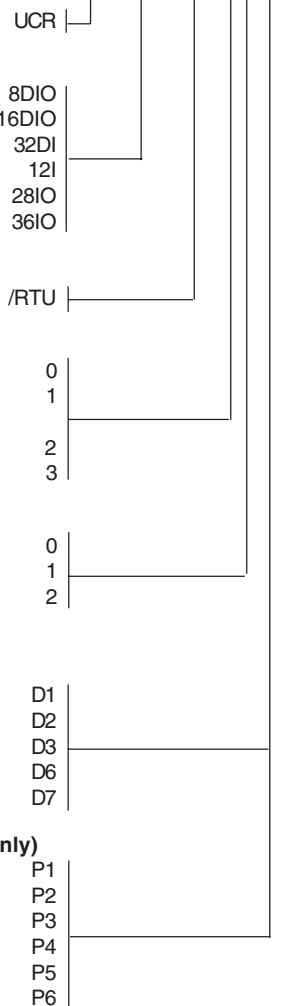
DI on modules with AI is always 10-30VDC uni-polar unless other is specified.

Compact outstation with data logging and local control
RTU8

CONTENT

BRODERSEN

TECHNICAL DESCRIPTION

Input/output

The RTU8 basic I/O fit can include up to 32 input/output terminals. Serial I/O options are available:

Version UCR-	8DIO	16DIO	32DI	12I	28IO	36IO
Digital inputs (10-30V DC)	8	16	32	8	16	24
Digital outputs (PNP o. c.)	8	16	0	0	8	
Analogue inputs (0-10V/4-20mA)	0	0	0	4	4	
Relay outputs (NO)						12

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.

Wiring diagram
UCR-8DIO/RTU00.P1
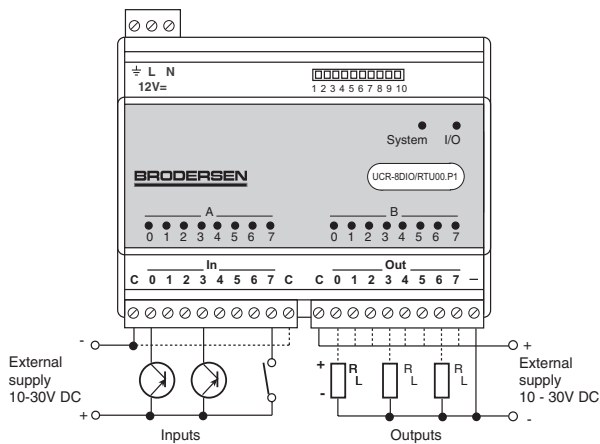
UCR-12I/RTU00.Dx
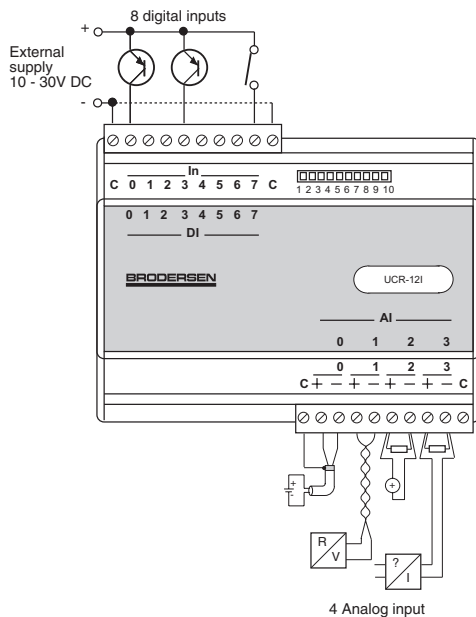
UCR-16DIO
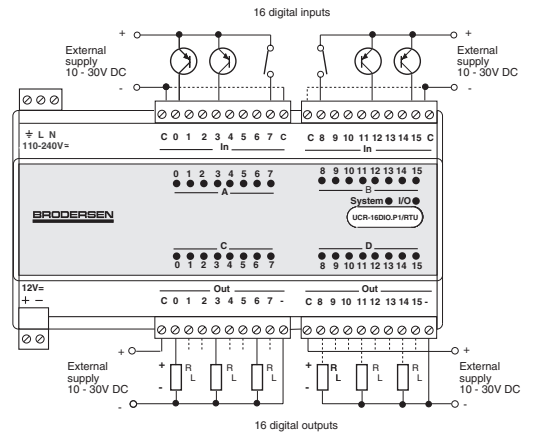
UCR-32DI
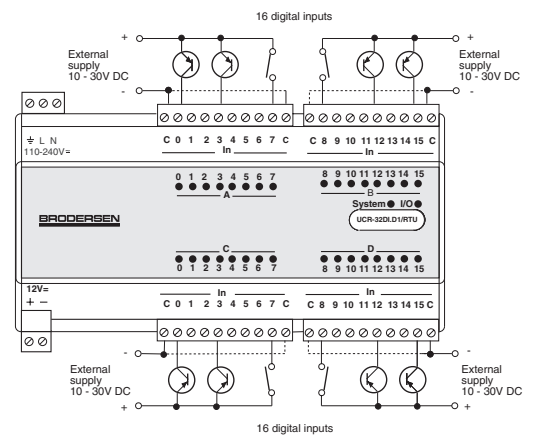
UCR-28IO
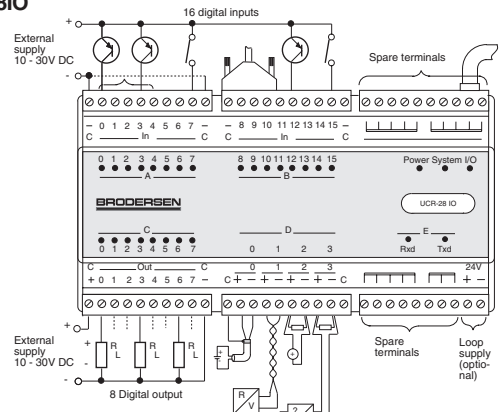
UCR-36IO
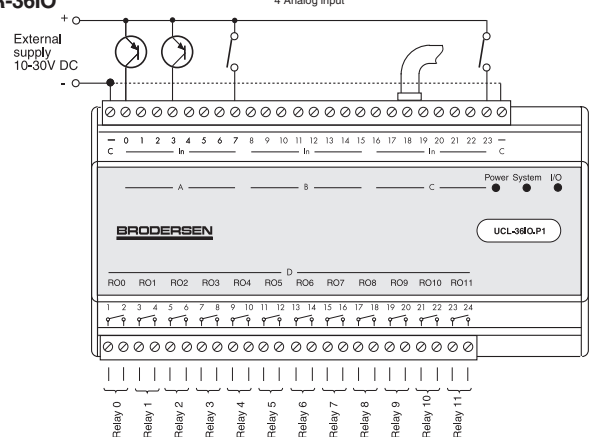
Compact outstation with data logging and local control
RTU8

I/O expansion
The basic I/O fit of the RTU8 can be expanded by attaching System expansion modules.

RTU8 with expansion modules
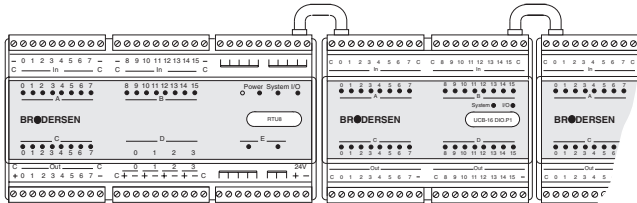
Expansion modules are available with the following I/O configuration:

      8-32 10-30V inputs
      8-32 10-30 V PNP (or NPN) open collector outputs
      8 230V inputs / 8 230V outputs (potential free relay)
      4-8 analogue inputs (0-10V, 4-20mA, etc.)
      8 Thermo coupled inputs (J, K, R, S, T type)
      8 Pt-100, Pt-500 or Pt-1000 RTD inputs
      4 analogue outputs (0-10V, 4-20mA, etc.)

A maximum of 30 expansion modules can be connected to an RTU8. The total number of I/O´s is limited to 104 analogue or 496 digital I/O´s (maximum 104 words or 31 I/O sections). A word equals one analogue channel or 16 digital channels. Please note that modules with more than 16 I/O´s should be considered as 2 or 3 I/O sections.

In the event that the current consumption of the expansion modules exceeds the capability of the power supply, an additional power supply must be inserted.

Indicators

Indicator	8DIO	12IO	16DIO	32DI	28IO
I/O	On: : I/O including expansion OK ⎍⎍⎍⎍ : I/O configuration error Off: : General fault or no power				
System	On: OK ⎍⎍⎍⎍ : Controller error ⊓⊓⊓⊓⊓ : Mains OK, Battery low* ⎍⎍⎍⎍⎍ : Mains off* Off: General fault or no power			On: OK ⎍⎍⎍⎍ :Controller error Off: General fault or no power	
Power	(not applicable)				On: OK ⊓⊓⊓⊓⊓ : Mains OK, Battery low* ⎍⎍⎍⎍ : Mains off* Off: No power

* With Power Supply option 20 (UPS) only.

CPU capacity/performance
The RTU8 is equipped with an 8 bit micro-controller. The time related performance versus capacity of the RTU8 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. It must be noted that an application with a maximum number of I/O´s, running a large application programme, is not able to scan the I/O´s with the minimum time interval and simultaneously log all the process values.

Where doubt exists we recommend making a test, to evaluate the actual performance.

Local control
The RTU8 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) or A-WARE programming tools include an integrated editor, compiler, debugger, and down-load facility, for developing application programmes and to download them via the RS232 line to the RTU8 or modem.

B-CON programme development
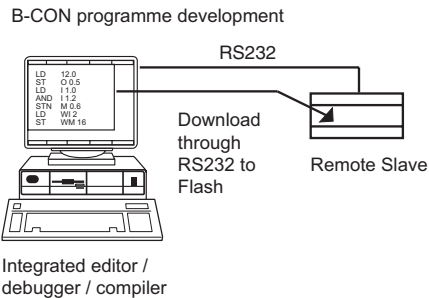
Examples of instructions used in the IEC 1131 language:

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 RTU8. 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 RTU8 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 RTU8 is powered off.

From the factory the RTU8 is default loaded with a small B-CONW program defining the actual I/O, making them readable from IOExplorer.

A-WARE
A-WARE is a user friendly programming interface for the Windows 95/98/NT/2000 environment. A-WARE is object oriented and uses pull-down windows for setting up/configurating the programme.

I/O addressing (B-CONW)
The address of the I/O in the RTU8 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 (module inclusive any I/O expansion). If you want to have them in our IOTOOL32 database, they need to be defined in the B-CONW application program.

Analogue (AI/AO)
Reflect the physical analogue input and output on the node (module inclusive any I/O expansion). 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-CON to be read in a YI register (wi6000-7999).
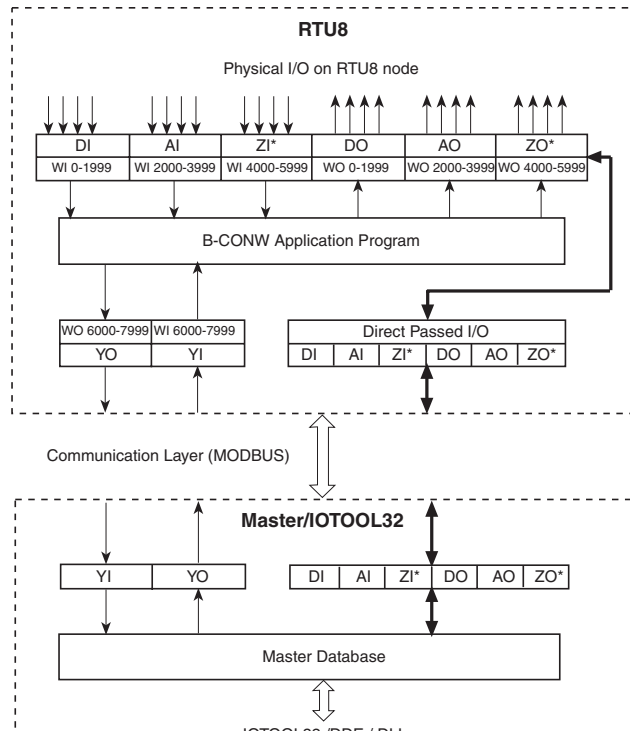
Gateway I/O (ZI/ZO).
The ZI/ZO is not used in the standard RTU8. The ZI/ZO are used in handling data through specific drivers for 3rd party equipment. The ZI/ZO will in this case directly mirror the I/Os on the connected equipment. A referance list of the ZI/ZO to the equipment I/O will be defined.

The RTU8 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 RTU8 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.

Communication Layer (MODBUS)

*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…..i0.7, i1.0…i1.7, i2.0……**
                      i0.0 loads the first digital input (input 0).
                      i1.0 loads digital input number 8 (first input in byte 1).

  Byte input: **bi0, bi1, bi2, bi3…..**
                      bi0 loads the first 8 digital inputs (input 0-7).
  Word input   **wi0, wi2, wi4, wi6………**
                      wi0 loads the first 16 digital inputs (input 0-15).

Digital Output (DO):
  Bit output: **o0.0, o0.1…..o0.7, o1.0…o1.7, o2.0……**
                      o0.0 sets the first digital output (output 0).
                      o1.0 sets output number 8 (first output in byte 1).
  Byte output: **bo0, bo1, bo2, bo3…..**
                      bo0 sets the integer of the first 8 outputs (0-255).
  Word output: **wo0, wo2, wo4, wo6………**
                      wo0 sets the integer of the first 16 outputs (0-65535).

Analogue input (AI):
  Input (word):   **wi2000, wi2002……., wi2014, wi2016………**
                      wi2000 loads the integer (0-4095) of the first analogue input (channel 0).
                      wi2014 loads the integer (0-4095) of the analogue input channel 7.

Analogue output (AO):
  Output (word): **wo2000, wo2002……., wo2014, wo2016………**
                      wo2000 sets the first analogue output (channel 0).
                      wo2014 sets the analogue output channel 3 at the second AO module.

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).

Compact outstation with data logging and local control
RTU8

Example of an island
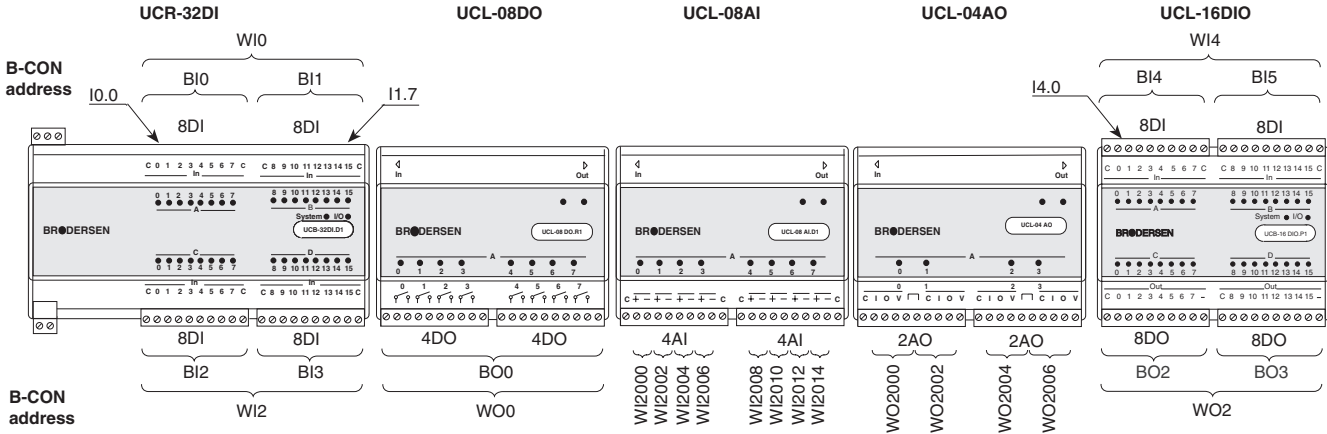
Data logging

The up-loading of data from the RTU8 can be:

- Cyclic upload controlled by a central PC (for example 24 hours)
- Event driven (such as an alarm).
- Upload on request from the RTU8.

The RTU8 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 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 RTU8. 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 RTU8. 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-CON) 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**]

Progamme example (B-CON):

```
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,  bc8

        / Logs the first 8 analogue inputs with log identification 1
        /every 10 minutes.

        ep
```
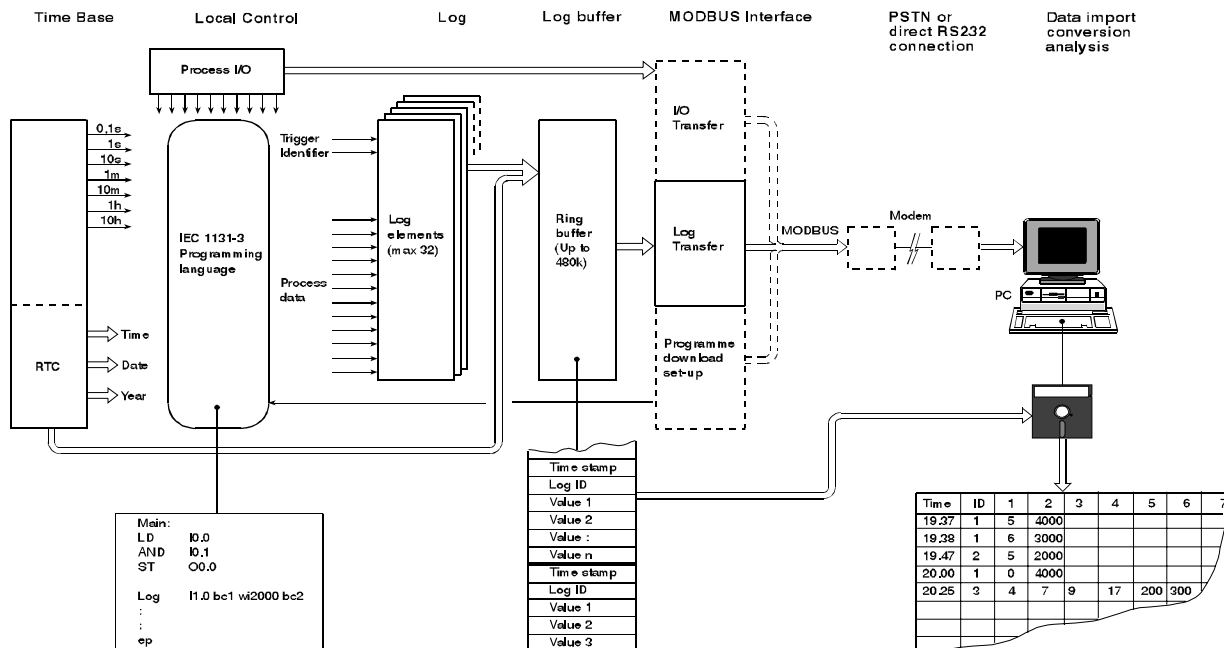
RTU8 control and datalogging

RTU8 CONTROL AND DATALOGGING

Compact outstation with data logging and local control
RTU8

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, e.g. up to 120 analogue values or 1920 digital (120 words total). 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	DLE	=	Data link escape (0x10)
STX	STX	=	Start of text (0x02)
LogID	LogID	=	Log identifier ((0-31) +
Timestamp			Timestamp indication)
Data	Timestamp	=	1, 2 or 7 bytes
- - - -	Data	=	0-120 word
- - - -			
- - - -	● Full Timestamp/7 byte (00):		
DLE	YY MM DD HH MM SS TS		
STX	e.g. 96 09 20 11 24 33 9		
LogID			
Timestamp	● 1 byte Timestamp (01):		
Data	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 and/or power off (in case battery back-up is installed)	132
Battery high and/or power on (in case battery back-up is installed)	133
Mains power off (in case battery back-up is installed)	134
Mains power on (in case battery back-up is installed)	135
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 RTU8 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 RTU8 either by connecting the PC directly to the RS232 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 Windows 95 and NT (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 RTU8, 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 RTU8 to the PC. When the PC uploads the data from the RTU8 ,it will register which data has been transferred and make a special log, with a time stamp, to identify the time and date of the upload. When the PC connects to the RTU8 next, 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.

C:\

    ⊞─── Net 1
    ⊞─── Net 2

                ─── 1996
                ─── 1997
                ─── 1998
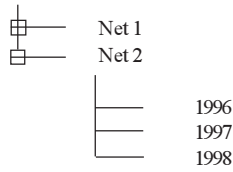
The comma delimited file can be imported into a database or a spreadsheet for further analysis e.g. Microsoft Access, Microsoft Excel and many other Windows programs.

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 RTU8.
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 RTU8 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 RS232 line either directly or via modem. The PC utility collecting the data from the RTU8, 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.).

Primary Serial interface COM1
The RTU COM1 interface includes a driver which is able to handle both the Modbus protocol (RTU slave) and Brodersen RAC commands. Hayes compatible modem control is implemented in the RTU8. 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. 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 (number and type of expansion modules).
For programme down-load, setup and log data, a transfer special protocol is used (still using the Modbus frame).
The RTU has a selectable Modbus address (low level address, 1-31) used in radio or multi drop systems. For modem operation, a logical address (station no., 0-65535) is used for identification of each RTU8. Using the Series 2000/4000 tool-kit each station will have its own net, thus the station number and net number are the same.
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.
The primary communication interface can be delivered with RS232 or RS485 interface.

COM1 as RS485
The RS485 port (9 pole sub-D) is equipped with Data and RTS signals (data +/- and RTS +/-). The RS485 interface is isolated with opto-couplers to avoid noise and ground level differences when using long communication lines.

NOTE: When using RS485 the Modem mode of the RTU8 cannot be used. That means also the dial out from the RTU8 is **NOT** possible.
RS485 port

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Pin no	Signal	Description
1	Data -	Data minus
2	Data +	Data plus
3	NC	Not connected
4	NC	Not connected
5	DGND	Signal ground
6	RTS -	Request to send minus
7	RTS +	Request to send plus
8	NC	Not connected
9	NC	Not connected

If RTU8 is the last node in a multidrop line, a termination resistor must be mounted.

COM1 as RS232
The RS232 port (9 pole sub-D) is equipped with all hardware handshake signals (DCD, DTR, DSR, RTS, CTS, RI).

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.

RS232 port (9 pole sub-D)

Pin no	Signal	Description/Remarks
1	DCD	Data carrier detect (in)
2	RX	Receive data (in)
3	TX	Transmit data (out)
4	DTR	Data terminal ready (out)
5	SG	Signal ground
6	DSR	Data set ready (in)
7	RTS	Request to send (out)
8	CTS	Clear to send (in)
9	RI	Ringing indicator (in)

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 (number and type of expansion modules).
For programme down-load, setup and log data, a transfer special protocol is used (still using the Modbus frame).
The RTU has a selectable Modbus address (low level address, 1-31) used in radio or multi drop systems. For modem operation, a logical address (station no., 0-65535) is used for identification of each RTU8. Using the Series 2000/4000 tool-kit each station will have its own net, thus the station number and net number are the same.

Modem control (Dial-up)
Both the RTU8 and the central monitoring station can initiate a dial-up to each other. The central monitoring station may dial the RTU8 at time intervals, if the RTU8 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-CON application programme in the RTU8. 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 RTU8 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 RTU8 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 RTU8 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 external 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 RTU8. Experience shows that many manufacturer of modems make minor additions or variations from the standard. Therefore reference must be made to the user manual for the actual modem, to be sure that correct initialisation of the modem is made. The second part of the initialisation string can be configured to fit the actual modem using the IOExplorer, which is part of the tool-kit delivered by the RTU8.

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

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

Some modems store the setup in non-volatile memory, in which case the setup can be made directly in the modem and the initialisation string can be omitted. **Please note** that if a modem has data compression capabilities, this facility must be switched off.

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 RTU8 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 Modbus in RTU8.

The RTU8 is supported by low level PC drivers for MS Windows 95/98/ME and Windows NT/2000 plus a number of dedicated drivers for standard SCADA packages. The RTU8 can be operated by the IOTOOL32 telemetry driver, which includes 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 RTU8. The values are separated into 4 data types, digital (DI/DO), analogue (AI/AO), and 2 auxiliary types (ZI/ZO and YI/YO).
The user does not need to consider the actual Modbus registers used for the I/O in the RTU8. For each RTU8, 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 RTU8 at a given time interval and the driver will also accept calls initiated by an RTU8.
The I/O data, collected by the driver, is easily accessed by the application programme specifying a unique address consisting of:

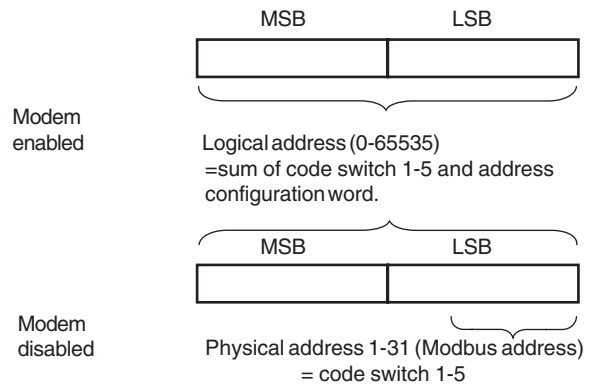<datatype><Network/station><node/island><module/group<[>I/Oterminal>]

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 (net No./Logical address)
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 (Logical Address) 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 EEPROM (default = 0).
The central monitoring station must use the logical address to direct the received data to the correct location.

Modem enabled   Logical address (0-65535)
=sum of code switch 1-5 and address configuration word.

Modem disabled   Physical address 1-31 (Modbus address)
= code switch 1-5

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.

RTU8 Power Supply/battery charger (option UPS only)
The RTU8 can be equipped with an integrated switch mode power supply and a charger circuit, able to charge and monitor an external lead acid battery.
The battery can be a 3 to 12 Ahour battery, depending on the actual load and the required backup time. The actual backup time can be calculated from the average consumption of the modules installed (RTU8 and expansion module(s)) and the capacity of the battery used (see examples below). As the power supply has a current limiter, the recharge time will depend on the size of the battery and the average current used for the electronic circuits.

The following outputs/voltages are derived from the RTU8 power supply:
- Supply for the micro controller and other electronics in the RTU8 module itself (5V).
- 12V (10-13.6V) for expansion modules (local bus), 8/10 pole modular jack.
- 12V (10-13.6V) for digital I/O, and optional Radio/modem max. 2A maximum, 2 pole plug-in screw terminal.
- 24V loop supply, max. 200 mA, optional with 28I/O RTU8 only, plug-in screw terminal.
- Battery, charging current up to 1.1A, 2 pole plug-in screw terminal (UPS option only).

The maximum current supplied from the power supply to the battery and electronic circuits is 1.1 A.

Power supply block diagram
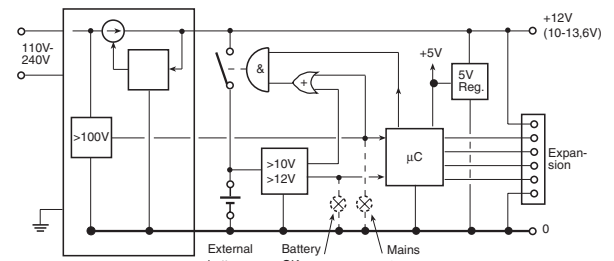
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A mains indicator informs the CPU that mains supply is applied. If the mains supply should fail or go lower than accepted by the power supply, a status flag (m9.7) indicates the fault to the application program, which may issue a warning by making a dial-up or by setting a local output. Battery low voltage warning is also given when the battery is discharged to approximately 20% of its capacity (11.0V). The indicator returns to normal when battery is charged to approximately 80% of its capacity . The indicator (m9.6) allows the CPU and the application programme to issue a warning and close down before loosing operation. The close down procedure may include a controlled shut down sequence of the process and an emergency call (dial-up) to the central monitoring station.

To prevent damaging the battery by deep discharge, the battery will automatically be disconnected and the operation will stop, without any further warning, if the battery voltage goes below 10.4V.

The battery ON/OFF signal enables the CPU to disconnect the battery, for a short period, during operation in order to test the battery.

Due to the fact that the output of the charger has a higher open circuit output voltage than the battery voltage, it is not possible to detect a missing battery without disconnecting the battery from the charger.

When mains is applied the battery is disconnected shortly from the charger at start-up and hereafter every 24 hours (00:00) to check the battery voltage. If low or missing battery is detected the battery will be checked every 10 second until the voltage is back to normal (>12V).

Typical charge / discharge cycle
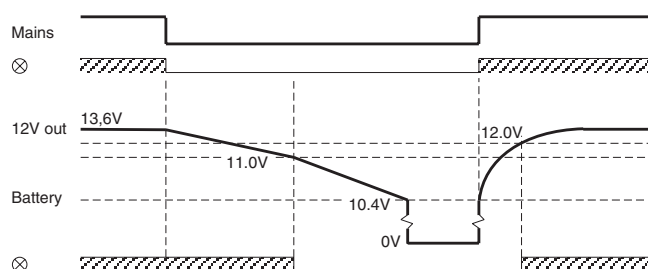
Power consumption

Power consumption is directly related to the number of I/O´s connected to the RTU8.

Below are examples for the standard RTU8 versions as stand alone units. All figures are typical consumption at 12V. The additional current for expansion modules can be found in the relevant data sheets.

RTU8 version	UCR-8DIO		UCR-16DIO		UCR-32DI		UCR-28IO	
	min.	max.	min.	max.	min.	max.	min.	max.
Controller/electronics/LEDs	55	90	55	105	55	90	65	100
Digital inputs (12V)	0	25	0	50	0	100	0	50
Digital outputs (load 40mA/12V)	0	160	0	640			0	320
Analogue inputs (4-20mA/24V loop)							20	250
Total 12V consumption (mA)	55	275	55	795	55	190	85	720

If equipped with battery back-up, the average consumption per time unit, should be added to calculate the actual load and back-up time.

The mains power supply will, until the battery is fully charged, work as a constant current source limited to 1.1A. The electronic circuits (RTU8 and expansion modules) will draw their required current and the remaining current will be used to charge the battery. If the current consumption exceeds the capacity of the power supply for a short time, such as when a radio enters transmit mode, the excess current will be drawn from the battery.

If the RTU8 consumption alternates between 0.4A and 0.8A, the charging current will alternate between 0.7A and 0.3A until the battery is fully charged. If the two intervals are equal (50% each), the average load will be 0.6A and the corresponding charging current will be 0.5A. If the load current alternates between 0.5A (90% of time) and 2A (10% of time) the average load will be 0.65A and the corresponding average charging current will be 0.45A.

Battery performance

Below are examples for the 3 sizes of batteries and 4 levels of load. All figures are typical. The calculations assume that the battery is fully charged or fully discharged using the RTU8 charger circuit. Also it is assumed that the average load is constant during test (both charge and discharge periods).

Total load (mA / 12V)	150			300			600			900		
Battery (A hours)	3	6	12	3	6	12	3	6	12	3	6	12
Backup time (hours)*	20	40	80	10	20	40	5	10	20	2.5	6.5	13
Recharge time (hours)*	6.5	13	26	7.5	15	30	12	24	48	30	60	120

* The figures above assume nominal values for the battery. In reality the figures could degrade dramatically as the performance of a battery may vary widely with temperature and age. If a high degree of security is required, it is strongly recommended that these figures are viewed very conservatively. At high ambient temperature the recharge time may be prolonged.

Counter input (only UCR-28IO and UCR-12I)

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. When using an island with few physical I/O, few online Modbus registers, and few words to log (e.g. 2DI, 4AI, 2DO, 10YI, 10YO, 10 words to log , 3K byte B-CON program), up to 80 Hz (50% duty cycle) could be counted. 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.

BRODERSEN

SPECIAL REGISTERS RTU8
Overview

BM/reg.	Description	
BM0	error/overflow	
BM1	m1.0	system indicator
	m1.1	system indicator
	m1.6	Disable/enable loop power supply
BM2	command register 1=dial, 2=hang up, 3=send SMS	
BM3	telephone no.	
BM4	m4.0-m4.3	handshake inputs
	m4.4-4.5	Com state
	m 4.6	Password
	m4.7	Dial time out (error)
BM5	communication counter	
BM6	User info (derived from USER field in the IOExplorer	
BM7	configuration menu)	
BM8	m8.0	switch0
	m8.1	switch1
	m8.2	switch2
	m8.3	switch3
	m8.4	switch4
	m8.5	switch5
	m8.6	switch6
	m8.7	switch7
BM9	m9.0	switch8
	m9.1	switch9
	m9.6	Battery status (0=OK)
	m9.7	Mains status (0=OK)
BM10	Seconds	0-59
BM11	Minutes	0-59
BM12	Hours	0-23
BM13	Week day	1-7
BM14	Date	1-31
BM15	Month	1-12
BM16	Year	0-99
BM17	m17.0	0.1 second interval Trigger
	m17.1	1 second interval
	m17.2	10 second interval
	m17.3	1 minute interval
	m17.4	10 minute interval
	m17.5	1 hour interval
	m17.6	10 hour interval
	m17.7	not used
BM18	Log buffer 0-255 0: Empty 254: Full	
BM19	SMS text messages	
BM20	m20.4	SMS transmission OK
	m20.7	SMS transmission time out (error)
BM21	m21.0-m21.1	counter reset
	m21.2-m21.7	not used
BM22	Counter 0	
BM23		
BM24		
BM25		
BM26	Counter 1	
BM27		
BM28		
BM29		

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
	m1.2-m1.5	Not used (0)
	m1.6	Loop power supply
	m1.7	Reserved (acoustic alert)

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
BM3	Telephone (selection) no. (0-29)
BM4	
m4.0	CTS, Clear to send (input)
m4.1	DSR, Data set ready (input)
m4.2	RI, ringing indicator (input)
m4.3	DCD, Data carrier detect (input)
m4.4-m4.5	Communication state (read only)

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

Register	Description
m4.6	Correct password received
m4.7	Dial request suspended (1"=Error)
BM5	Communication counter

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-CON 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.

Compact outstation with data logging and local control
RTU8

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 RTU8 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.

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	Baud rate
m8.6	Code switch 7	Baud rate
m8.7	Code switch 8	Baud rate
BM9		
m9.0	Code switch 9	Modem OFF/ON
m9.1	Code switch 10	

Power monitor (UPS option only)
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)
M9.7	Mains 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 10 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
BM19	SMS text message selection (0-9)
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.

Message selection (output). The text message is selected from the pre-stored message with BM19 (0-9).
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 WM80.
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.

If instead 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 3 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

Compact outstation with data logging and local control
RTU8

TECHNICAL DATA

INTERFACE

Serial interface:

Signal level:	RS232C/v.24.
Connector:	9 pole sub-D, male.
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.

CONTROL AND DATA LOGGING

IEC 1131-3 (B-CON)

Program memory (Flash):	23 Kbytes (note 19).
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 15).

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, note 20
Max. counting frequency:	80Hz, note 20

I/O expansion bus

Capacity:	max. 31 I/O sections (up to 30 expansion modules). max. 104 analogue or 496 digital I/O (104 words total).
Connector:	RJ45 Modular jack, 8/10 pole.
Signal level:	5V (CMOS).
Protocol:	Synchronous data (shift register type).
Local bus cable length:	Max. 1 m between 2 modules. Max. 5 m totally.

POWER SUPPLY/CHARGER

Supply Versions:

	00	10	20	30
Supply voltage nominal	note 21 12VDC	110-240V AC/DC		24-48V DC
Supply voltage absolute maximum input range	10-14,8V	100-265V		20-65V
Mains frequency	DC only	40-60 Hz		DC only
Power consumption	Max 6W	Max 18W	Max 20W	Max 14W
Outputs:				
Output current, total		1.1 A	1.1 A (note 5)	0.9 A
Output 12V expansion (local bus)		12V+/-0.5V (note16&17)	10-13.6V (note 5)	12V+/-0.5V (note 16&17)
Output 12V external output		12V +/- 1.5V max. 400mA (note16, 17&18)	10-13.6V max. 2A (note 5)	12V +/- 0.5V max. 400mA (note 16, 17&18)
Loop supply (optional)		12V±5% / max. 400mA 24V±5% / max. 200mA		
Isolation:				
Input/mains (primary) to electronics (secondary)	0V	3,75 kV AC IEC class 2		1500V AC

(Option: version for 24V UPS)

Battery back-up (option 2x (UPS) only):

Battery:	12V lead acid
Battery capacity:	3-12 Ah (note 3)
Charging current:	0-1 A (note 4)
Charging time:	Battery capacity / (1.1A - average load current) (note 5).
Back-up capacity (battery fully charged):	Average load current x 0.8 x battery capacity.
Cut-off voltage:	10.3V.
Off state battery load:	<0.5 mA.

Monitor outputs:

Mains:	>100V	ON	(note 2)
Battery:	>12.0V	ON	80% capacity
	<11.5V	OFF	20% capacity

DIGITAL INPUT/OUTPUT

Inputs:

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

BRODERSEN

Outputs:

External voltage:	10 - 30V DC (note 10).
Output voltage drop:	Max. 1.5V (output activated).
Output current:	Max. 0.5A.
Output peak current:	Max. 5A in 1 second (note 10).
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)
I/O:	Indicating I/O and local bus OK (green)
Power: (28IO only)	Indicating power and battery OK (green)
Rxd/Txd (28IO only)	Indicating serial communication on RS232 line.

ANALOG INPUT

Inputs:	4 multiplexed analogue channels with solid state multiplexer (note 12).
Input configuration:	Differential (+/ -), flying capacitor type.

Input measuring ranges:

Type no. code	Voltage input	Current input
.D1	0-10V	0-20mA
.D2		4-20mA
.D3	0-5V	
.D6		0-20mA
.D7	0-2V	

Resolution:	12 bit, 0-4095.		
Input impedance:	Voltage:	D1:	100 kOhm.
		D3/D7:	50 kOhm.
	Current:	D1:	500Ohm(note 11).
		D2/D6:	100 Ohm.

Absolute maximum ratings (note 10):

Input voltage:	±40V DC.
Input current:	±30mA DC.

Sampling interval: Min. 100 ms (note 12).

Measuring accuracy:

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

Linearity:	Better than ± 1LSB.
Temperature stability:	Better than ± 50ppm/°C (typical).
Common mode input voltage:	Max. ±80V DC (note 8).
Common mode rejection	

ratio:	Min. 60dB (typical 72dB).
Series mode rejection:	Min. 30dB (50-120Hz)
Isolation (input to input):	500V (note 8).
Loop supply (optional):	24V±5% / max. 200mA 12V±5% max. 400mA (short circuit protected).

RELAY OUTPUTS

Outputs:	12 potential free SPST-N/O contacts.
Output voltage :	Max. 240V AC.
Output current:	Max. 1A AC (resistive).
Output delay:	Typical 10ms.
Lifetime (relay):	Min. 100.000 operations at rated load.
Contact material:	Gold overlay silver alloy.
Isolation (coils-contacts):	2kV AC 50Hz 1 min (IEC255-5). 4kV 1,2/50micro s. / impulse withstand (IEC255-5).

GENERAL

Current consumption (12V) note 14:

UCR-16DIO:	max. 105 mA.
UCR-32DI:	max. 90 mA.
UCR-28IO:	max. 100 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.

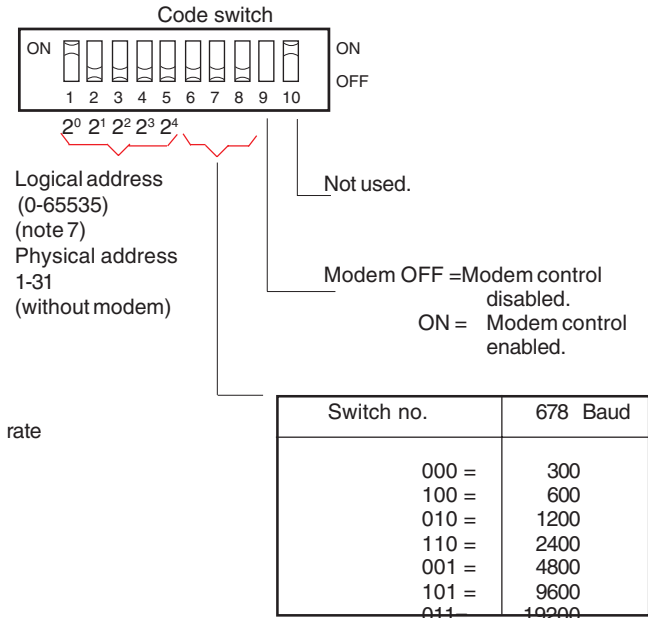|	
Protection:	IP20.
Mounting:	35 mm DIN-rail, EN50022.
Terminals:	Max. 1.5 mm² wire.
Housing:	Anodized aluminium with plastic ends. According to DIN 43880.
Dimensions:	HxWxD: 80(+connectors)x108/162x62 mm.

Compact outstation with data logging and local control
RTU8

CODE SWITCH/ADDRESS SELECTOR

The code switch of the RTU8 selects the address, baud rate, etc.

Code switch

$2^0\ 2^1\ 2^2\ 2^3\ 2^4$

Logical address
(0-65535)
(note 7)
Physical address
1-31
(without modem)

Not used.

Modem OFF = Modem control
disabled.
ON = Modem control
enabled.

rate

Switch no.	678 Baud
000 =	300
100 =	600
010 =	1200
110 =	2400
001 =	4800
101 =	9600
011=	19200

The logical address is defined as the sum of the binary value selected using switch 1-5 and the binary value of the logical address configured in the FLASH (default = 0).

TABLE ANALOGUE INPUTS

Integer (binary value) = $\dfrac{\text{Input - range MIN.}}{R}$
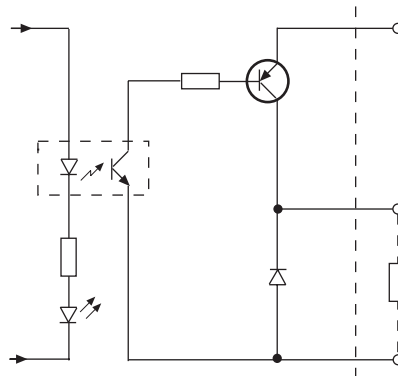
where R is the resolution (LSB).

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

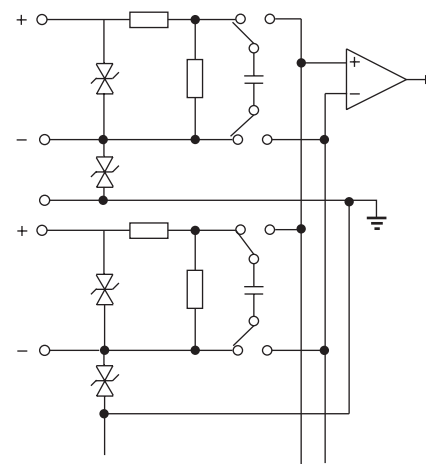## CIRCUIT CONFIGURATION (DIGITAL)

Input
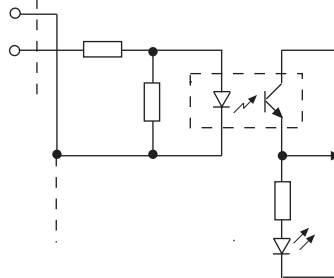
Output (PNP)

CIRCUIT CONFIGURATION (ANALOGUE)

CONFIGURATION

The IOExplorer or SM (System Monitor for DOS) is used to configure the RTU8 and to pre-define telephone numbers. Refer to separate description.

RTU8 configuration table

Field	Type	Description	(Min..Max)	: Current Value	Unit
1.	S	Port A cfg.	(1..1)	:1	Modbus
2.	S	HandShake	(1..4)	:3	RTS On/Off Modbus
3.		Boot delay		:2	Seconds
4.	W	RTS Leading	(0..500):	1	of 10 msec
5.	W	RTS Trailing	(0..50) :	0	of 10 msec
6.	W	PLC TX Dreg	(40001..40300) :	40001	Holding reg
7.	W	PLC RX Dreg	(40301..40600) :	40301	Holding reg
8.	W	Logical addr	(0..65503)	:0	
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 no.	(0..0) :	none	
16.	W	User	(0..65535)	:0	
17.	C	Date/Time	(Y/M/D H:M:S):	01/03/19 - 09:30:36	
18.	T	Table 101	(0..33)		
19.	T	Table 102	(0..33)		
20.	T	Table 103	(0..33)		
21.	P	Password		:Disabled	
22.	W	Log Buf Size	(5..100):	100	Percent
23.	T	SMS Tel. No	(0..0)		
24.	T	SMS Text	(0..9)		
25.	T	SMS AC	(0..2)	:GSM only	
26.	S	DI counters	(1..2)	:1	Disabled

Field 5, 6, 8, 9 and 17-19 should normally not be changed. They relate to special appllictions and usage with third party software or equipment.

Field	Description
1	Header – Non configurable
2	Primary serial port handshake . Select RTS, CTS function.
3	Boot delay at power up. Ensure master and localbus expansion module is up running before system boot and localbus scan start
4	Defines the delay from the RTU is activating RTS, to transmission of first character.
5	Defines the delay from the RTU is transmitting last character to deactivating RTS.
6	TX defines the first Modbus holding register to be used for data, transferred from the RTU8 to the PC Modbus master.
7	RX defines the first Modbus holding registers to be used for data transferred from the PC Modbus master to the RTU8.

8	The Logical address or station no. for a given RTU8. 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 RTU8 are the low byte of the logical address.
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. Experience shows that many manufacturers of modems make minor additions or variations from the standard, therefore reference must be made to the user manual for the actual modem to be sure that correct initialisation of the modem is made. 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	User defined parameter which can be used for set-points or other programme controls in the B-CON application programme. 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.
17	Real time clock adjustment. The actual time in the RTU8 can be monitored and adjusted either by entering the time or by copying the PC clock to the RTU8.
18 19 20	User defined linearization tables for analogue I/O. Default is down loaded tables for standard analogue AI and AO modules.
21	Enabling/disabling password facility in the RTU8.

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22	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.
23	GSM provider SMS Service Center No. Used if sending SMS text messages via GSM modem.
24	SMS text messages. Up to 10 fixed text messages with max. 40 characters can be stored in the module. Only 7 bit ASCII are supported.
25	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)
26	Disable/enable the counter function on DI0 and DI1. Only available in 28IO and 12I version.

NOTES/REMARKS

1) The scan interval can be selected by the user, however it should be noted that the capacity of the micro-controller will limit the minimum scan time. The time related performance versus capacity for the RTU8 is a result of the actual CPU load. The technical data related hereto, must be considered in total. A large application programme with the maximum number of I/O´s, is not able to scan the I/O´s with minimum interval and simultaneously log all process values.

2) The mains indicator is activated when the mains voltage is sufficient to enable the power supply to work.
Due to the fact that the output of the charger has a higher open circuit output voltage than the battery voltage, it is not possible to detect a missing battery without disconnecting the battery from the charger. When mains is applied, the battery is disconnected shortly from the charger at start-up and hereafter every 24 hours (00:00) to check the battery voltage. If low or missing battery is detected the battery will be checked every 10 seconds until the voltage is back to normal (>12V).

3) The capacity of the battery must be selected according to the actual consumption and required backup time. The battery could degrade dramatically due to temperature and age. If a high degree of security is required, it is strongly recommended that such figures are considered very conservatively.

4) The internal power supply and charger will act as a constant current source until the battery is charged. The actual charging current, will be the difference between the capacity of the power supply (1.1A nominal) and the actual consumption of the RTU8, including expansion modules.

5) The 12V output is supplied from the power supply/battery circuit. When the battery is fully charged (operating on mains supply) the voltage will typically be13.6V. When operating at battery supply, the voltage drops slowly while discharging until the cut-off voltage is reached (typically at 10.4V).
If the current exceeds the maximum current of the built-in power supply (1.1A), the excessive current will be drawn from the battery thus discharging the battery. The power supply/charger circuit includes thermal protection. At maximum ambient temperature (55°C) the continuos output current is automatically reduced to approx. 0.8A after a certain time (10-15 minutes). The de-rating is approximately 1% per °C above 25°C.
If the unit has a battery connected to it, it is possible to supply a high output current (maximum 2A specified) for a period of time, as the battery will deliver the remaining current. At high ambient temperature the recharging time may be prolonged.
The battery MUST be equipped with an external fuse, max. 2A.

6) Setup can be configured using the IO Explorer.

7) The station address or net no. in the RTU8 is defined as the sum of the binary value, set using switches 1-5 and the binary value of the logical address configured in the FLASH (default = 0).

8) Section A, B, C and D are isolated from each other. The individual analogue inputs (UCR-28IO) 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.

9) The polarity at the input must be positive. The common terminal must be connected to the negative.

10) Input signals exceeding the maximum values **MAY CAUSE PERMANENT DAMAGE** to the module.

11) 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.

12) 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 4 seconds).

Select channel | 0 | 1 | 2 | 3 | | 0 |

Convert

Sampling time (100-4000 ms)
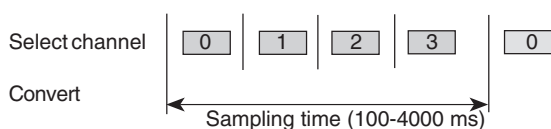
The analog input is represented by an integer (binary number) from 0 to 4095 depending on the input signal, see table above.

13) 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.

14) Figures exclude load on 12 or 24V loop supply. The loop supply's contribution to the consumption is approximately 2.9 times the actual loop currect at 24V and 1.4 times the actual loop current at 12V.
The total current consumption increases when the battery voltage decreases. At minimum voltage the current can increase up to 20%.

15) 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.

16) 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.

17) The sum of current consumed from the 12V rail, i.e. internal consumption, consumption from the external screw terminals and by expansion modules at the local bus, must never exceed the maximum total output current.

18) 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.

19) Firmware version 2.11 (1.11 for 28IO types) and later provide 23 K byte. Earlier versions provide 14 K byte.

20) The counter frequency is reduced when the module is heavily loaded, see counter section.

21) 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.

Note: Measured on PC with IOTOOL32Pro v.2.40 and an UCR-28IO/ RTU10.D1 firmware version 1.15.