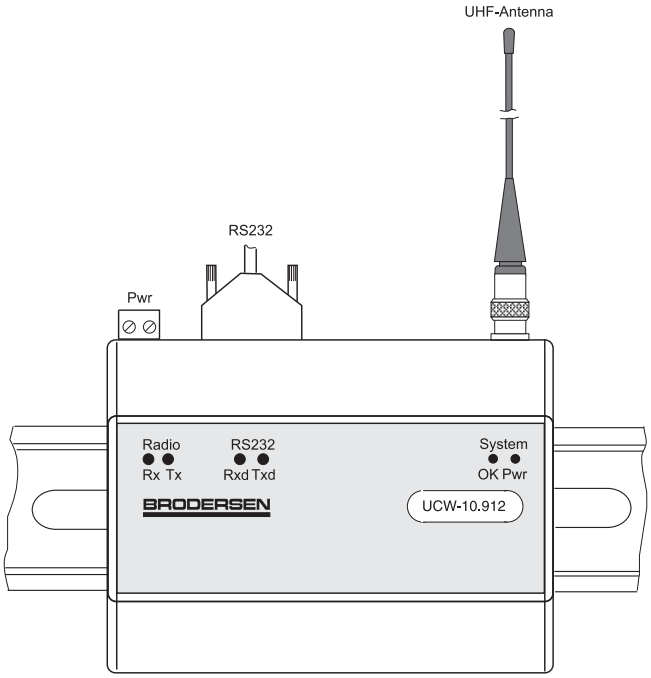
DESCRIPTION

The UCW-10.912 is designed as radio modem for the ISM band in accordance with LPD and CEPT-LPD ETS-300 220. It fulfils all national and EU regulations with regard to radio-technical approval as well as with regard to EU conformity (CE Mark).

The electronics are installed in a housing designed for DIN rail mounting. The supply voltage is 12V DC. 6 LED's provide information on the status of the equipment.

A RS-232/V24 interface is available as interface that works with 9600 baud (8N1). 1200 Bits/s and 2400 Bits/s (standard setting) are available as "radio data transmission rate". The switching frequency for 1200 Bits/s is at 1200/1800 Hz and for 2400 Bits/s at 1200/2400 Hz.

UCW-10.912



VERSIONS/ORDERING CODES

UCW- 10. 912

Type
Radio Modem — UCW

Output
10mW transmission power — 10

Power supply
12V DC±10% — 912
24V DC±10% — 924

TECHNICAL DESCRIPTION

Processor
A C68HC705C8A processor controls the UCW-10.912. It runs with a quartz of 4.00 MHz from where all internal timing signals are derived.

The data which are downloaded via the serial interface are embedded in a radio data frame and transformed into the LF drive voltage for the S/E subassembly via a FFSK modulator.

The gate pulsing of the sender, generation of the preamble, block synchronisation and check sum are also carried out by the processor.

Modulator/Demodulator
The digital data of the control computer are transformed into in 1200/1800/2400 Hz FFSK subcarrier frequencies in the FFSK modulator/demodulator, which means the HF subassembly is modulated.

Watchdog Switching
The UCW-10.912 is equipped with a watchdog switching for the monitoring of the processor. In the case of undervoltage or a computer malfunction, a processor reset is generated and the radio modem is returned to the base state.

Serial Data Interface
A standard 9-pin D-sub connector is used for the serial interface connection. The connector pin assignments for RS-232 interface, are given below.

Data Transfer (9-pole DSub)

Pin	Function	I/O
1	NC	Not used
2	TxD	Transmit data UCW-10.912 → Periphery
3	RxD	Receive data UCW-10.912← Periphery
4	NC	Not used
5	GND	Ground
6	NC	Not used
7	RTS	Handshake UCW-10.912 ← Periphery (not in use)
8	CTS	Handshake UCW-10.912 → Periphery
9	NC	Not used

Supply Voltage (2-pole)

Pin:	Function	
"+"	VCC	Supply Voltage V DC
"-"	GND	0 Volt

LED Displays
The front panel of the UCW-10.912 is equipped with 6 LED's that display information on the status of the UCW-10.912. The meaning of the individual LED's is as follows:

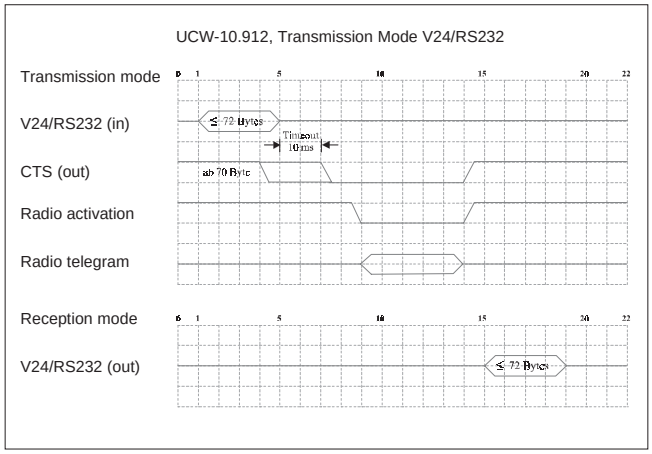
LED	**Function**
Radio Rx	Radio receiving
Radio Tx	Radio transmitting
RS232 RxD	Radio modem recives RS232 data
RS232 TxD	Radio modem sends RS232 data
System	UCW-10.912 is operational
Pwr	Supply voltage

Communication Protocol

The data which are downloaded via the serial interface of the UCW-10.912 is stored temporarily in a data buffer of no more than 72 bytes. In this context, the individual data bytes must be transmitted in one block without any gaps. If a gap of more that ≥10 ms is detected (corresponds to approx. 10 bytes), this is interpreted as the end of the data set.

The downloaded data bytes are then embedded in a radio data frame and transmitted with 1200 / 2400 bit/s modulated to FFSK.

While the radio modem transmits the data via the radio path, the CTS line of the UCW-10.912 is active. This line can also be used as a control signal during the transmission of data blocks > 72 bytes. In this case, CTS is activated with the 65th data byte.



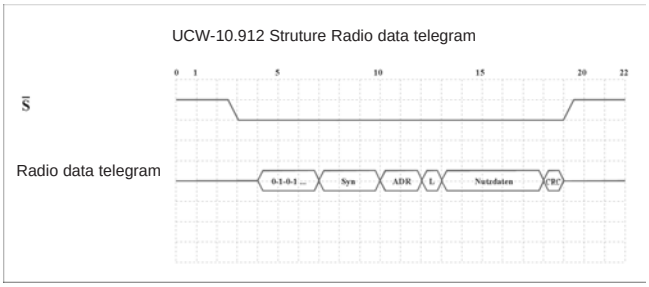
If the UCW-10.912 receives data via radio, these are sent out at the serial interface if the CRC and the address parameters have been checked.
As no control characters are used for interface protocols, the complete binary character set 00 Hex to FF Hex is available as effective characters.
Hereby, the UCW-10.912 acts like a V24/RS232 line with delay time.
If this delay time is taken into account, any chosen protocols can be run (ACK/NAK, Polling-Selecting, Modbus, Siemens SPS etc.).

Physical Structure of the Radio Data Sets

The radio data telegram consists of an unmodulated carrier gate pulsing with a subsequent 0-1-0-1 telegram in advance of the run.
This 0-1 sequence is used for the synchronisation of the demodulator PLL ‘S.
Afterwards, a 14 Bit block synchronisation is carried out by which the start of the telegram is detected.
Then a maximum of 72 bytes effective data follow and at the end the CRC checksum. It is calculated from a cyclical generator polynomial.

Logical Structure of the Radio Telegrams

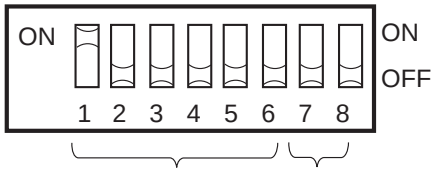
In order to realise customer-specific modules, each user receives his own 16 bit address that is transferred in each radio data telegram and prevents the data from being accessed by other users. This address is followed by an 8 bit block length counter and then by the data to be transmitted.



Modem Configuration

The basic parameters of the modem are set via an externally accessible 8-pole DIP switch. It is used to select the radio channel, in a grid of 25kHz.

DIP Switch 1 (Frequency)



Not used

Frequency selection

1 2 3 4 5 6	Frequency
0 0 0 0 0 0	433.100 MHz
0 0 0 0 0 1	433.125 MHz
0 0 0 0 1 0	433.150 MHz
0 0 0 0 1 1	433.175 MHz
0 0 0 1 0 0	433.200 MHz
: : : : : :	:
1 0 0 0 0 0	433.925 MHz
1 1 1 1 1 1	434.675 MHz
1 1 1 1 1 1	434.700 MHz

TECHNICAL DATA

Operating mode:	Semiduplex.
Frequency range:	433.100 - 434.700 MHz.
HF channels:	64.
Transmission power:	Pout = 10mW.
Reception sensitivity:	- 4dB µV (12dB / SINAD).
Channel bandwidth:	25 kHz.
Modulation type:	FFSK.
Data rate transmission:	2400 (1200) bits/s.
RS-232 Interface Level:	+ / - 3 to 12 V.
Inputs:	RxD, RTS.
Outputs:	TxD, CTS.
Data rate:	9600 Bits/s.
Data format:	8/N/1.
Voltage supply:	12V DC ±10%. 24V DC±10%
Current input:	
With 12V + OK-LED:	
Receive:	< 55 mA.
Transmit:	< 90 mA.
Operating temperature range:	- 20 °C to + 70 °C.
Housing:	Anodized aluminium with plastic ends. According to DIN 43880.
Dimensions:	HxWxD: 80(+connectors)x90x62mm.
Weight:	Approx. 290 g.

DESCRIPTION

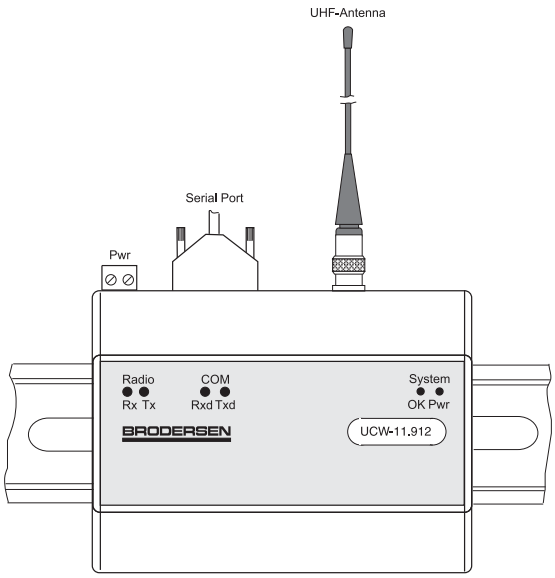
The UCW-11 is designed as radio modem for the ISM band in accordance with LPD and CEPT-LPD ETS-300 220. It fulfils all national and EU regulations with regard to radio-technical approval as well as with regard to EU conformity (CE Mark).

The electronics are installed in a housing designed for DIN rail mounting. The supply voltage is 12V or 24V DC. 6 LED's provide information on the status of the equipment.

The serial data interface is RS-232 / V24 (standard), or RS-485 (optional). Serial data communication parameters are user-adjustable on the UCW-11; data rate 1200 to 38400 bps, selectable parity.

The radio data rate is 2400 bps. The modem has a data buffer memory.

UCW-11.912



VERSIONS/ORDERING CODES

UCW- 11. 912 / 232

Type	
Radio Modem	UCW
Output	
10mW transmission power	11
Power supply	
12V DC±20%	912
24V DC±20%	924
Serial interface	
RS232	232
RS485	485

Brodersen Controls A/S * Betonvej 10 * DK-4000 Roskilde * Denmark * Tel (+45) 4674 0000 * Fax (+45) 4675 7336

TECHNICAL DESCRIPTION

Serial Data Interface

A standard 9-pin D-sub connector is used for the serial interface connection. The connector pin assignments for RS-232 and RS-485 interfaces, respectively, are given below.

RS232 Interface (9-pole DSub)

Pin	Function	I/O
1	NC	Not used
2	TxD	Transmit data (UCW-11.../232 ← periphery)
3	RxD	Receive data (UCW-11.../232 ← periphery)
4	DTR	Connected to pin 6
5	GND	Ground
6	DSR	Connected to pin 4
7	RTS	Handshake (UCW-11.../232 ← periphery) (not used)
8	CTS	Handshake (UCW-11.../232 ← periphery)
9	NC	Not used

RS-485 Interface

Pin	Assignment	
3	B	RS-485 interface
5	GND	Ground / shield
8	A	RS-485 interface

Supply Voltage

The modem requires a supply voltage 12 or 24V DC. This is connected via a 2-pin screw-terminal connector.

Pin	Assignment	
"+"	VCC	Supply voltage VDC
"-"	GND	0 VDC

LED Displays

The front panel of the UCW-11 has 6 LED lamps which provide information about the status of the modem, as follows:

LED	Function
Pwr	Supply voltage on
OK	Modem in operating condition
COM TxD	Serial data transmitting
COM RxD	Serial data receiving
Radio TX	Radio transmitting
Radio RX	Radio receiving

Communication Protocol
Data, which is read via the serial interface of the UCW-11, is temporarily stored in a data buffer. The data must be transmitted in a continuous block, without interruption. If a gap of 10 characters (approximately 10 mSec at 9600 bps) or more is detected, this gets interpreted as the end of the data block.

The data bytes which are thus read are then inserted in a message frame, FFSK modulated, and transmitted at 2400 bps.

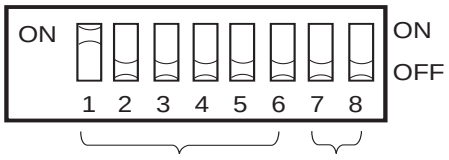
The CTS line of the UCW-11 is active while the modem is transmitting data via the radio path. This line can also be used as a control signal during the transmission of data blocks longer than 270 bytes. The CTS is then activated with the 265th data byte.

Data that is received by the UCW-11 over the radio path is transferred to the modem's serial interface after the CRC and the address parameters have been checked.
Since no control characters are used in the communication protocols, the entire binary character set 00 Hex to FF Hex can be used. The UCW-11 therefore functions as a V24/RS-232 line with dead-time. Because of this, the modem can be operated with any type of protocol: ACK/NAK, poll-select, MODBUS, Siemens SPS, etc.

Radio Message Frame Structure
The radio message frame is transmitted by carrier-keying in a 0-1-0-1 sequence. The keying of the carrier starts when the first character is received via the serial data interface. This saves communication time, since the time used to transfer the characters to the serial data interface can also be used for keying the transmitter.
This 0-1 sequence is used for synchronizing the demodulator PLLs, and is followed by a 14-bit synchronization block which signals the start of a message frame. Next is the user data block of maximum 270 bytes length, and finally the CRC checksum. The checksum is calculated through a cyclical generator polynomial.

Modem Configuration
The basic parameters of the modem are set via two externally accessible 8-pole DIP switches. One of these is used to select the radio channel, the other to set the serial data interface parameters.

DIP Switch 1 (Frequency)

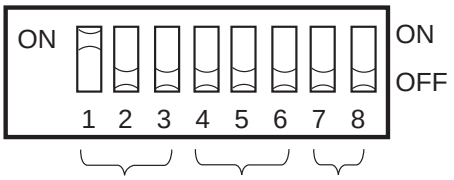


Not used (switch 7 and 8)

Frequency selection

1 2 3 4 5 6	Frequency
0 0 0 0 0 0	433.100 MHz
0 0 0 0 0 1	433.125 MHz
0 0 0 0 1 0	433.150 MHz
0 0 0 0 1 1	433.175 MHz
0 0 0 1 0 0	433.200 MHz
: : : : : :	:
1 0 0 0 0 0	433.900 MHz
1 1 1 1 1 0	433.650 MHz
1 1 1 1 1 1	434.675 MHz

DIP Switch 2 (Serial Communication Parameters)
Switch Assignment : DIP Switch 2



Not used (switch 7 and 8)

Serial Communication Parameters

4 5 6	Settings
0 x x	8 databit, no parity
1 0 0	7 databit, even parity
1 1 0	7 databit, odd parity
1 0 1	8 databit, even parity
1 1 1	8 databit, odd parity

1 2 3	Settings
0 0 0	1200 Baud
1 0 0	2400 Baud
0 1 0	4800 Baud
1 1 0	9600 Baud
0 0 1	14400 Baud
1 0 1	19200 Baud
0 1 1	38400 Baud

NOTE:
If no parity has been set, 8 data bits and one stop bit will be transmitted. If parity is selected, 7 data bits, parity, and 1 stop bit will be transmitted.

TECHNICAL DATA

Operating mode:	Semi-duplex
Frequency range:	433.100 MHz – 434.700 MHz.
HF channels:	64 : selectable via a DIP switch.
Transmitter output power:	P_{out} = 10mW with 50 ohm antenna load.
Receiver sensitivity:	-4dB mV (12dB / SINAD).
Channel bandwidth:	25 kHz.
Modulation type:	FFSK.
Data rate transmission:	2400 bps.
Serial data interface:	
Physical:	RS-232 or RS-485.
Serial data rate:	1200 to 38400 bps.
Data format:	7 or 8 data bits, selectable parity.
Power supply:	
	24VDC ±20% 12VDC ±20%
Load current (@ 24 VDC):	(With “Power” and “OK” LEDs on).
Receiving:	Approx. 40 mA.
Transmitting:	Approx. 65 mA.
Operating temperature:	-20 ^{O}C to +70 ^{O}C (ambient).
Housing:	Anodized aluminium with plastic ends. According to DIN 43880.
Dimensions:	HxWxD: 80(+connectors)x108x62mm.
Weight:	Approx. 340 g.

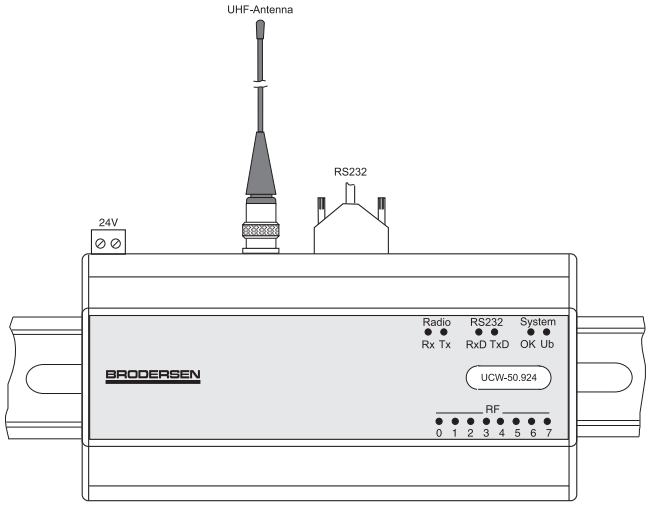
DESCRIPTION

The UCW-50.924 is designed as a SRD (Short Range Device) radio modem in accordance with EN300 220. It fulfils all national and EU regulations with regard to radio-technical approval as well as with regard to EU conformity (CE Marking).

The electronics are installed in a housing designed for DIN rail mounting. The supply voltage is 24-48V DC. 6 LED's provide information on the status of the equipment.

A RS-232/V24 interface is available as interface that works with 9600 baud (8N1). 1200 Bits/s and 2400 Bits/s (standard setting) are available as "data transmission rate". The switching frequency for 1200 Bits/s is at 1200/1800 Hz and for 2400 Bits/s at 1200/2400 Hz.

UCW-50.924



VERSIONS/ORDERING CODES

UCW- 50. 924 / xx

Type
Radio Modem — UCW

Output
500mW transmission power — 50

Power Supply
24-48V DC — 924

Specific Setup Parameters
xx — xx

Brodersen Controls A/S * Betonvej 10 * DK-4000 Roskilde * Denmark * Tel (+45) 4674 0000 * Fax (+45) 4675 7336

TECHNICAL DESCRIPTION

Processor
A HC68HC705C8A processor controls the UCW-50.924. It runs with a quartz of 4.00 MHz from where all internal timing signals are derived.

The data which are downloaded via the serial interface are embedded in a radio data frame and transformed into the LF drive voltage for the S/E subassembly via a FFSK modulator.

The gate pulsing of the sender, generation of the preamble, block synchronisation and check sum are also carried out by the processor.

Modulator/Demodulator
The digital data of the control computer are transformed into in 1200/1800/2400 Hz FFSK subcarrier frequencies in the FFSK modulator/demodulator, which means the HF subassembly is modulated.

Watchdog Switching
The UCW-50.924 is equipped with a watchdog switching for the monitoring of the processor. In the case of undervoltage or a computer malfunction, a processor reset is generated and the radio modem is returned to the base state.

LED Displays
The front panel of the UCW-50.924 is equipped with 6 LED's that display information on the status of the UCW-50.924. The meaning of the individual LED's is as follows:

Radio Rx:
Display of a HF carrier on the set radio channel.

Radio Tx:
This LED illuminates when the HF sender is brightened.

RS-232 RxD:
Control of the RS-232 reception line.

RS-232 TxD:
Control of the RS-232 transmission line.

System:
Illuminates when the UCW-50.924 is operational.

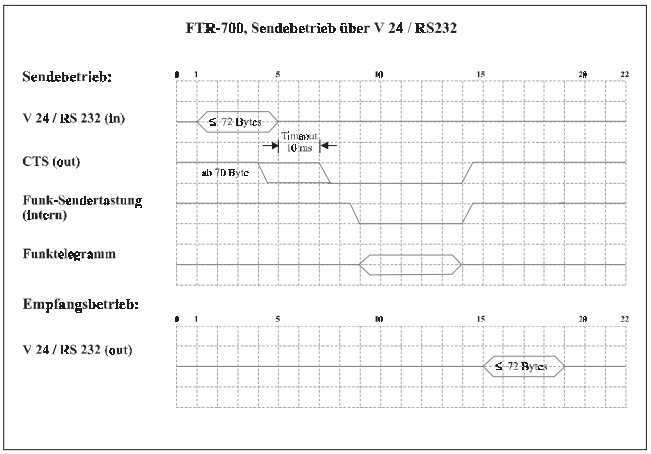
24V:
Control of the operating voltage.

RF:
Field strength indicator.

V24/RS-232 Interface Protocol
The data which are downloaded via the serial interface of the UCW-50.924 is stored temporarily in a data buffer of no more than 72 bytes. In this context, the individual data bytes must be transmitted in one block without any gaps. If a gap of more that ≥10 ms is detected (corresponds to approx. 10 bytes), this is interpreted as the end of the data set.

The downloaded data bytes are then embedded in a radio data frame and transmitted with 1200 / 2400 bit/s modulated to FFSK.

While the radio modem transmits the data via the radio path, the CTS line of the UCW-50.924 is active. This line can also be used as a control signal during the transmission of data blocks > 72 bytes. In this case, CTS is activated with the 65th data byte.



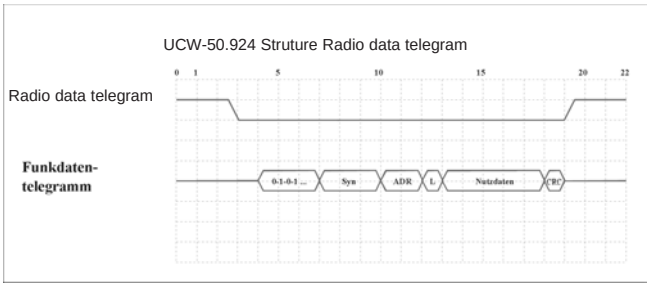
If the UCW-50.924 receives data via radio, these are sent out of the serial interface if the CRC and the address parameters have been checked.
As no control characters are used for interface protocols, the complete binary character set 00 Hex to FF Hex is available as effective characters.
Hereby, the UCW-50.924 acts like a V24/RS232 line with delay time.
If this delay time is taken into account, any chosen protocols can be run (ACK/NAK, Polling-Selecting, Modbus, Siemens SPS etc.).

Physical Structure of the Radio Data Stream
The radio data telegram consists of an unmodulated carrier gate pulsing with a subsequent 0-1-0-1 telegram in advance of the run.

This 0-1 sequence is used for the synchronisation of the demodulator PLL ‘S.
Afterwards, a 14 Bit block synchronisation is carried out by which the start of the telegram is detected.

Then a maximum of 72 bytes effective data follow and at the end the CRC checksum. It is calculated from a cyclical generator polynomial.

Logical Structure of the Radio Telegrams
In order to realise customer-specific modules, each user receives his own 16 bit address that is transferred in each radio data telegram and prevents the data from being accessed by other users. This address is followed by an 8 bit block length counter and then by the data to be transmitted.



Pin Assignment of the UCW-50.924

Supply Voltage (2-pole)

Pin:	Function:	
"+"	VCC	Supply Voltage 24-48V DC
"-"	GND	0 Volt

Data Transfer (9-pole DSub)

Pin	Function	I/O
1	NC	Not used
2	TxD	Transfer data UCW-50.924 → Periphery
3	RxD	Reception data UCW-50.924← Periphery
4	NC	Not used
5	GND	Ground
6	NC	Not used
7	RTS	Handshake UCW-50.924 ← Periphery (not in use)
8	CTS	Handshake UCW-50.924 → Periphery
9	NC	Not used

Frequency settings
Frequencies for use in the applicable countries are selected via dip switch. The setting define the actual radio transceiving frequency and must be equal on all the radio modems in a point to point/network application.
Please note the specific frequencies for use in your country.

Frequency table

Frequency [MHz]	Country	Dip-Switch
456,2500	D	0000
456,4100	D	0001
456,4300	D	0010
456,1700	D	0011
456,2100	D	0100
456,2900	D	0101
458,5000	GB	0110
458,5250	GB	0111
458,5500	GB	1000
458,5750	GB	1001
445,1250	DK	1010
445,1500	DK	1011
445,1750	DK	1100
445,2000	DK	1101
450,9300	NL	1110
468,2000	FI	1111

TECHNICAL DATA

Operating mode:	Semiduplex.
Frequency range:	430-470 MHz.
HF channels:	Up to 64.
Transmission power:	Pout = 500mW .
Channel bandwidth:	12,5 kHz, 20kHz, 25kHz.
Modulation type:	FFSK.
Data rate transmission:	2400 (1200) bits/s.
RS-232 Interface Level:	V24 (+ / - 3 to 12 V).
Inputs:	RxD, RTS.
Outputs:	TxD, CTS.
Data rate:	9600 Bits/s.
Data format:	8/N/1.
Voltage supply:	24-48V DC (20-60V DC).
Current input:	
Reception:	<50mA. (24V DC)
Send:	<1000mA. (24V DC)
Operating temperature range:	- 20 °C to + 70 °C.
Housing:	Anodized aluminium with plastic ends. According to DIN 43880.
Dimensions:	HxWxD: 80(+connectors)x162x62mm.

INTRODUCTION

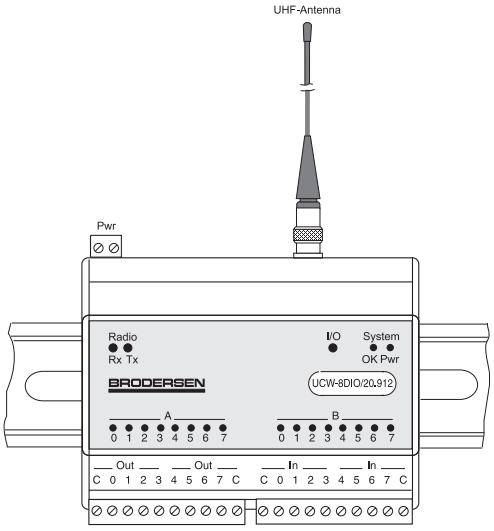
The UCW-8DIO/20 Radio Terminal Unit combines the functions of a radio modem for the ISM band and on-off input/output interface unit. It is designed in accordance with Low Power Directive and CEPT-LPD ETS 300 220. It meets all national and EC requirements relating to radio equipment and its usage, and conforms to CE specifications.

The unit is housed in a DIN rail mounting enclosure. It is available in a 12-24V DC supply voltage version. 21 LED provide information about the status of the Unit at any given time:

LED	Function
Pwr	Supply voltage
OK	Modem in operating condition, flashing in a master unit, if a slave is off-line
I/O	Lights up if external I/O Expansion Modules are connected and active
Radio Tx	Radio transmitting
Radio Rx	Radio receiving
A0…A7	Digital outputs status (8)
B0…B7	Digital inputs status (8)

The standard Unit has 8 opto-isolated digital inputs (positive or negative polarity signals) and 8 digital relay outputs. The radio channel (frequency) and (for some operating modes) address can be set via 2 DIP switches.

UCW-8DIO/20.912



VERSIONS/ORDERING CODES

UCW- 8DIO/20.912

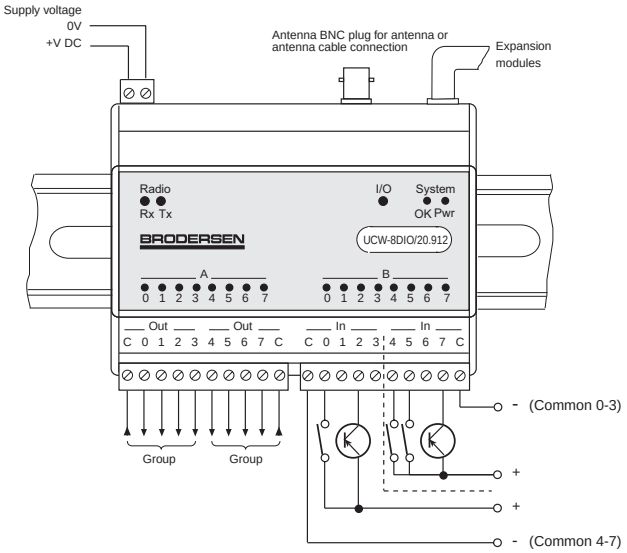
Type
Radio Modem — UCW

Input/Output
8 digital input / 8 relay output — 8DIO

Output
10mW transmission power — 20

Power supply
12-24V DC ±10% — 912

WIRING DIAGRAM



TECHNICAL DESCRIPTION

Connections
All connections to the unit are plug-in screw-terminal connectors, which makes installation easy and allows quick replacement of Units, should the need arise.

Supply Voltage
The Unit requires a supply voltage of 12-24V DC. This is connected via a 2-pin screw-terminal connector.

Digital Inputs
The 8 digital inputs are divided into two groups of 4 inputs each, with a common reference terminal for each group. The inputs of one group can be any polarity, in a voltage range of 10-30V DC. If the “C” (Common) terminal of an inputs group is, for example, connected to GND, the individual on-off inputs of that group can be +24V DC signals. Conversely, if the “C” terminal is connected to +24V DC, the individual on-off terminals can be 0V DC signals.

When an input is activated, its corresponding green LED lights up.

Relay Outputs
The 8 relay outputs are contacts, in two groups of 4 relays each, with a common reference terminal (“C”) for each group.

If radio communication is interrupted, the outputs remain in the existing state for 5 seconds, after which time all outputs are reset to the off position. For a detailed description see “ Time-out Monitoring” section.

Expansion Port
If the UCW-8DIO/20 is used as a MODBUS node in a radio network (see “Operating Modes”), the number of inputs/outputs can be increased, or analogue inputs/outputs added, by connecting Expansion Modules. These Expansion Modules are simply connected to the expansion port of an UCW-8DIO/20 with a short cable.

Operating Modes
The UCW-8DIO/20 can be used in any one of 4 different modes, which can be selected by DIP switches.

In master-slave configurations self-sufficient point-to-point or point-to-multiple-point radio links can be created. UCW-8DIO/20 which is set up as the master interrogates the radio network for the presence of each slave. If a slave does not reply, the master tries to reach the slave a second time. If it is still not successful, it sets its local outputs corresponding to this slave to the off state, and simultaneously tags the slave as being off-line. Slaves which are off-line are addressed only once per cycle: there are no repetitions, so that the cycle time is saved. If even one of the slaves is off-line, the master signals this by flashing its “OK” LED

Point-To-Point Configuration
In this configuration, two UCW-8DIO/20s function as transmission paths for 8+8 primary digital channels (and for the inputs/outputs of any connected Expansion Modules). The inputs to one Unit are transferred as the outputs of the other Unit. By using different Unit (node) addresses and radio frequencies between pairs of units, several pairs of them can operate in point-to-point mode in close proximity, without interfering with each other.

If one Unit is configured as the master, the other operates as a MODBUS slave. The slave must have an address which is greater than the master’s own address by 1. For example, a master which address is set to 5 can address an UCW-8DIO/20 Unit which is set up as a MODBUS slave with the address 6.

In a point-to-point configuration, the 8 primary digital channels of a the UCW-8DIO/20 can be extended by simply connecting Expansion Modules with analogue or digital channels. If a mix of both analogue or digital channels are to be configured, care should be taken that the number of digital inputs of Unit equals the digital outputs of the other. For example, if one Unit has 24 digital inputs, the opposite Unit should have 24 digital outputs.

If only digital or only analogue Expansion Modules are connected, this condition does not apply.

For using of Expansion Modules see section “Using I/O Expansion Modules”.

Examples:
Unit A: 1 x 16 digital inputs, 1 x 8 analogue inputs
Unit B: 2 x 8 relay outputs, 1 x 4 analogue outputs
This configuration is acceptable. The number of digital inputs at one end corresponds one with the digital outputs at the other. The number of analogue channels need not correspond.

Unit A: 1 x 32 digital inputs
Unit B : 3 x 8 relay outputs
This configuration will also work. The number of digital channels on both sides do not correspond, but no analogue channels have been used: in a purely digital configuration the inputs and outputs need not correspond to one another.

Unit A: 1 x 16 digital inputs, 1 x 4 analogue outputs
Unit B : 1 x 8 relay outputs, 1 x 8 analogue inputs
This is also acceptable. The digital channels do not match, but the analogue input data is transmitted in the other direction: no analogue input data is transmitted in the same direction as the digital channels.

Unit A: 1 x 16 digital inputs, 1 x 8 analogue inputs
Unit B: 1 x 8 relay outputs, 2 x 4 analogue outputs
This will not work! The number of digital outputs does not correspond to the number of digital inputs on the other side, and analogue input data is also being transmitted in the same direction. Data will still be transmitted but not given out to the correct module.

Point-To-2-Points Configuration
The point-to-2-points configuration work in the same way as a the point-to-point operation, except that 2 MODBUS slaves are addressed here. The slaves must have addresses greater by 1 and 2, respectively, than the master’s own address. If the master has the address “5”, the slaves must have addresses ”6" and “7”. The master transmit the states of its 8 digital inputs to both slaves: both slaves therefore receive the data relating to all 8 digital inputs of the master. The first group of 4 digital inputs (0-3) of the first slave are given out by the master as its digital outputs 0-3, and the second group of 4 digital inputs (4-7) of the second slave are given out by the master as its digital outputs 4-7.

In a point-to-2-point configuration only primary digital channels are transmitted. The use of Expansion Modules is not possible in such a configuration.

Point-To-4-Points Configuration
In this configuration, four MODBUS slaves are radio linked to one master. The slaves must have addresses greater by 1, 2, 3, and 4, respectively, than the master's own address. If the master has the address "5", the slaves must have addresses "6", "7", "8", and "9". The master transmit the states of its 8 digital inputs to the four slaves: all slaves therefore receive the data relating to all 8 digital inputs of the master.
The first 2 digital inputs (0,1) of the first slave are given out by the master as its digital outputs 0 and 1; the second group of 2 digital inputs (2,3) of the second slave are given out by the master as its digital outputs 2 and 3; and so on.
In a point-to-4-points configuration only primary digital channels are transmitted. The use of Expansion Modules is not possible in such a configuration.

MODBUS Slave Configuration
In a MODBUS slave configuration, an UCW-8DIO/20 Unit can be addressed via radio using the MODBUS protocol. In such configuration, an UCW-10 or UCW-11 is used as a "master gateway" to the radio network. Each UCW-8DIO/20 Unit can be set up with a distinct MODBUS address, which allows up to 255 UCW-8DIO/20 Units to be linked in a single radio network. The outputs of the UCW-8DIO/20 Units can be set and the condition of the inputs can be read from a central location, using the MODBUS protocol.

In a MODBUS network configuration, the I/O capacity of an UCW-8DIO/20 Unit can be extended simply by connecting Expansion Modules (e.g., 32 digital inputs, 8 analogue outputs, 16 digital outputs etc.). The extension inputs and outputs of a UCW-8DIO/20 Unit can also be accessed by the MODBUS master.

Using I/O Expansion Modules
Up to eight Expansion Modules can be connected to a single UCW-8DIO/20Unit. The following Expansion Modules are available:

UCL-16DI.D1:	16 digital inputs
UCL-32DI.D1:	32 digital inputs
UCL-08AI.D1:	8 analogue inputs
UCL-08DO.R1:	8 digital outputs (relays)
UCL-16DO.P1:	16 open collector outputs
UCL-04AO.D1:	4 analogue outputs

The I/O Expansion Modules should always be connected to a UCW-8DIO/20Unit only when the power supply is switched off (or disconnected). About 2 seconds after the UCW-8DIO/20 Unit has been switched on, its «OK» and «I/O» LEDs light up. The «SYSTEM» and «I/O» LEDs on the connected Expansion Module should be permanently lit.

If the "I/O" LED on the UCW-8DIO/20 Unit does not light up or if the I/O LEDs of the Expansion Module start to flash, it indicate a fault in one of the connected Expansion Modules. The same happens if an Expansion Module is disconnected or added on while the power supply is on.

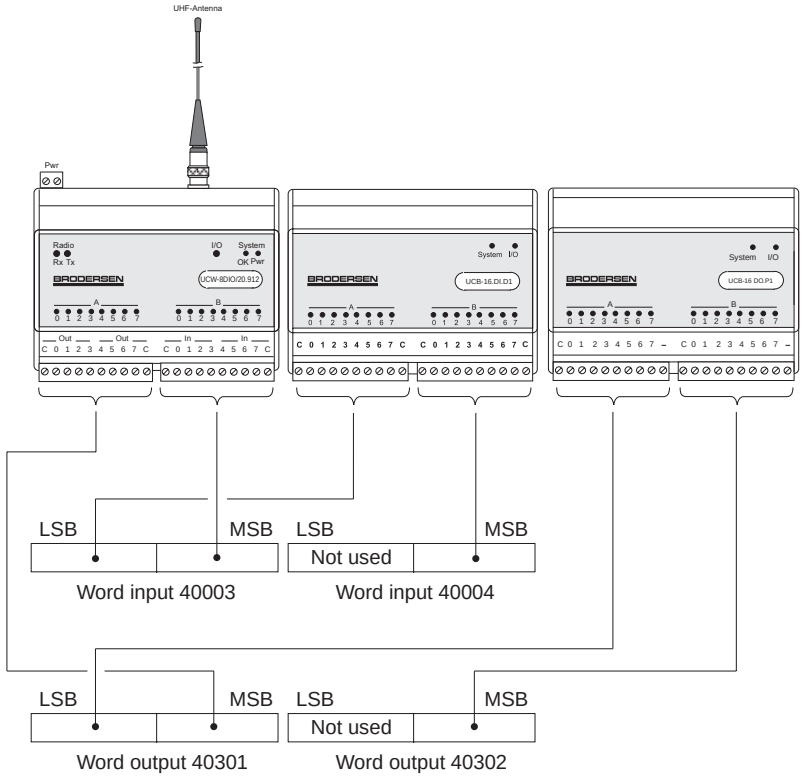
If a brief disconnection of the power supply to the UCW-8DIO/20 Unit does not change anything in the error display, one of the Expansion Modules is clearly defective. Disconnecting Expansion Modules one by one can help identify which one is defective.

There is no fixed order in which Expansion Modules are to be connected to a UCW-8DIO/20 Unit.

MODBUS Registers
The following registers are used in accessing the UCW-8DIO/20:

Register	Function	Explanation
40001	Slave address	MODBUS Slave address, set via DIP switches
40002	Status	Status byte
40003…40070	Inputs	Inputs in the order: Digital inputs Analogue inputs
40301…40370	Outputs	Outputs in the order: Digital outputs Analogue outputs
40901	Radio address	Address of the radio layer. Only instruments with the same radio address can communicate with one another.
40902	t-Timeout	Radio timeout in seconds
40903	x-Timeout	Data timeout (x-timeout) in number of message frames
40907	Instrument ID	Sends the ID of the instrument
40908	Firmware version	Returns the firmware version code (e.g., 0115_{Hex} corresponds to Version 01.15)

Example MODBUS Register



IMPORTANT NOTE!
The MODBUS I/O addressing system used in the radios do **NOT** comply with the general MODBUS I/O addressing system used in the series 2000/4000 modules and IOTOOL32.

Slave Address
The Unit's address set via the DIP switches are reproduced in this register. The address can be in the range 0 - 255.

Status
The following status displays are available:

Value	Meaning
0	Status OK
2050	Error in the Expansion Module/s (local bus)

Inputs
The input registers are used as follows: the digital input registers come first, followed by the registers of the analogue inputs.

Since the MODBUS registers are 16 bits wide, 8 digital input states occupy half a MODBUS register. If analogue inputs are also used, these begin with the next whole MODBUS register. Each analogue input occupies an entire MODBUS register. Analogue values are 12 bits wide, but the higher 4 bits are not used.

Example:
An Expansion Module with 16 digital inputs as well as an Expansion Module with 8 analogue inputs is connected to a UCW-8DIO/20 Unit. For this configuration, the input registers are occupied as follows:

The high part of the register 40003 reproduces the primary 8 digital inputs. The low part of the register 40004 produces the first port (A) of the Digital Inputs Expansion Module. The high part of the register 40004 is occupied by the second port (B) of the Digital Inputs Expansion Module.

The 8 analogue inputs of the Analogue Inputs Expansion Module begin at register 40005.

Outputs
The output registers are used as follows: Here too, the digital output registers are first, followed by the analogue output registers.

Since the MODBUS register is 16 bits wide, 8 digital outputs occupy half a MODBUS register. If analogue inputs are also present, these begin with the next complete MODBUS register. Each analogue output occupies an entire MODBUS register. Analogue values are 12 bits wide, but the higher 4 bits are not used.

Example:
Two Expansion Modules each with 8 digital outputs and an Expansion Module with 4 analogue outputs are connected to an UCW-8DIO/20 Unit. For this configuration, the output registers are occupied as follows:

The high part of the register 40301 represents the primary 8 digital outputs. The low part of the register 40301 corresponds to the 8 digital outputs of the first Expansion Module with 8 digital outputs. The high part of the register 40302 is occupied by the second expansion module with 8 digital outputs.

The registers 40303-40306 represent the 4 analogue outputs of the other Expansion Module.

Configuration Register
The Unit's parameters can be set via the 8 configuration registers beginning with MODBUS address 40900. In principle all these registers can only be read. The first 6 registers can be written to only by means of a special hardware, while the last 2 registers cannot be changed at all.

Time-out Monitoring
Between two data transfers the outputs (the primary outputs as well as the outputs of the connected Expansion Modules) are maintained in their existing condition. Two different types of time-out monitoring are used: time based and message frame based. This ensures that the outputs do not remain in an active condition for an indefinite length of time in case of a radio disturbance.

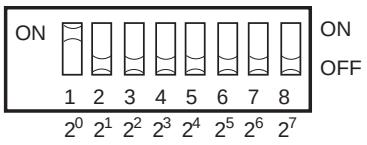
Time-based time-out monitoring is possible only for an UCW-8DIO/20 Unit configured as a MODBUS slave. Time-out monitoring is not available in a Unit configured as a master, whose corresponding outputs (as described earlier) are reset to the off state and the slave switched to "off-line" status if that slave does not respond.

Time-Based Timeout Monitoring (T-Timeout)
A slave UCW-8DIO/20 Unit continually looks for MODBUS message frames which are sent by radio on its frequency. If it does not receive any message frames for 5 seconds, it resets all its outputs to the off state. The time of 5 seconds can be changed, or the timeout function can be disabled entirely.

Message Frame Based Timeout Monitoring (X-Timeout)
Whenever a MODBUS message frame is received by a slave Unit, but not addressed to it, message frame based timeout monitoring comes into effect. The time-based timeout delay is continually reset so that further MODBUS message frames can be received. If however, the instrument is not explicitly addressed even once even after 512 message frames, it sets all its outputs to the off state. The preset value of 512 messages frames can be changed, or the timeout function can be disabled entirely.

Configuring the UCW-8DIO/20
The basic parameters of the Unit can be set via 2 sets of DIP switches which are externally accessible. One set of DIP switches is used for setting the radio channel and mode of operation; the second determines the MODBUS address of the Unit.

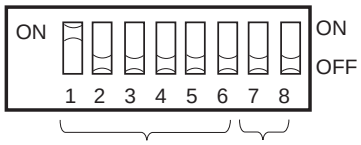
DIP Switch 1 (MODBUS Address)



Address Settings

8 7 6 5 4 3 2 1	Address
0 0 0 0 0 0 0 0	0
0 0 0 0 0 0 0 1	1
0 0 0 0 0 0 1 0	2
0 0 0 0 0 0 1 1	3
0 0 0 0 0 1 0 0	4
: : : : : : : :	:
1 0 0 0 0 0 0 0	128
1 1 1 1 1 1 1 0	254
1 1 1 1 1 1 1 1	255

DIP Switch 2 (Frequency, Mode Of Operation)



Operation mode.

7 8	Mode
0 0	MODBUS slave mode
0 1	Master: point-to-point configuration
1 0	Master: point-to-2-point configuration
1 1	Master: point-to-4-point configuration

Frequency selection

1 2 3 4 5 6	Frequency
0 0 0 0 0 0	433.100 MHz
0 0 0 0 0 1	433.125 MHz
0 0 0 0 1 0	433.150 MHz
0 0 0 0 1 1	433.175 MHz
0 0 0 1 0 0	433.200 MHz
: : : : : :	:
1 0 0 0 0 0	433.900 MHz
1 1 1 1 1 0	434.650 MHz
1 1 1 1 1 1	434.675 MHz

TECHNICAL DATA

General description:	Radio modem with 8 potential-free on-off inputs and 8 potential free relay contact outputs.
Addressing and error control:	16 bit user defined node address 8 bit CRC with Hamming length d = 4.
Frequency and address selection:	DIP switches.
Antenna connection:	BNC connector.
Type of radio communication:	Semi-duplex.
Frequency range:	433.100 MHz – 434.675 MHz.
HF channels:	64.
Transmitter output power:	P_{out} = 10mW with 50 ohm antenna load.
Receiver sensitivity:	-4dB mV (12dB / SINAD).
Channel spacing:	25 kHz.
Type of modulation:	FFSK.
Radio data rate:	2400 bit/s.
Inputs:	8 potential-free, opto-isolated; with reversible polarity.
Input voltage activated:	9,6-28,8V DC
Input voltage deactivated:	Max. 3V DC
Input current: 12V DC:	Typical 3mA.
24V DC:	Typical 6mA.
Outputs:	8 relay contacts; normally open.
Relay type:	Omron G5V
Load:	Max. 60V AC/DC, 1A
Lifetime:	Electrical: $1x10^5$ at 24V DC 1A. Mechanical: $5x10^6$ at 1800 cycles/h
Isolation:	
Input to electronics:	Minimum 500V
Output relay contact to electronics:	Minimum 1000V
Power supply input to electronics:	No isolation
I/O Expansion:	The number of I/O expansion to connect is primary limited by 2 things: 1. max. load = 500mA 2. max. 30 I/O sections/65 I/O words. 3. max. 8 modules (32 input-module count as 2 modules)
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:	12-24V DC ±10%

Load current:	(With “Power” and “OK” LEDs on).
Receiving:	Typical 75 mA
Transmitting:	Typical 120 mA
Maximum:	Typical 250 mA (all relays energized).
Operating temperature:	-20 °C to +70 °C (ambient).
Housing:	Anodized aluminium with plastic ends. According to DIN 43880.
Dimensions:	HxWxD: 80(+connectors)x108x62mm.
Weight:	Approx. 340 g.

INTRODUCTION

Overview
This document contains information about installation, settings, and operation of the Model UCW-24/28IO/50 Wireless I/O Module.

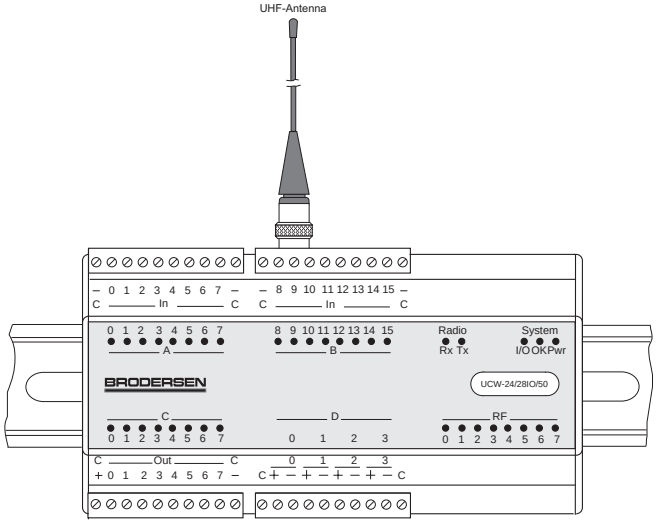
Safety Precautions
This equipment transmits radio waves in the frequency range 400 to 470 MHz. Under certain circumstances, these radio waves could be harmful to any living being or electronic equipment near it. Care should be taken to ensure that the radio and antenna systems are set up by trained persons.
This radio equipment should not be used in life support systems nor in safety / protection systems without our prior written permission.

Disclaimer
We have carefully checked the contents of this document and the hardware and software described in it for compatibility. We cannot however exclude possibilities of deviations and cannot guarantee complete conformity of the document with the equipment it describes. If any corrections or improvements are to be made, they will be taken into consideration in the next edition of this document.
Important instructions are marked by the expression "**Caution!".** These should be carefully observed.

Software Version
The firmware version and document edition valid for the specific product supplied with this document are:

Firmware Version:	Document:	Comments / Changes:
1.1	01/2001	First delivered version
1.40	01/2002	An expansion selection of 16 expansion units are now available, with addition of the following modules: UCL-16DO.N1 UCL-16DO.P1 UCL-32DO.P1 UCL-32.DO.N1 (Power supply needs special consideration when expansion units are installed). Parameter setting can be done through an internal configuration interface.

UCW-24/28IO/50



TECHNICAL DESCRIPTION

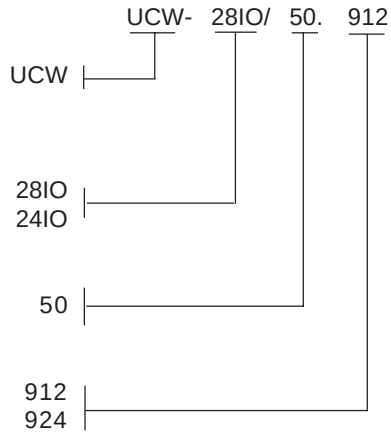
Functions and Features
The UCW-24/28IO/50 is a general-purpose wireless remote I/O module, widely used in industrial monitoring and control, water and effluent treatment plants, pipeline monitoring, and other applications where long distances or other obstacles make it difficult or uneconomical to use wire communication.
The Basic Module has 16 digital inputs, 8 digital outputs, and optionally 4 analog inputs. The I/O capacity of a Basic Module can be expanded by adding one or more Expansion Modules connected through a Local Bus. Its DIN rail mounting enclosure and plug-in screw terminal blocks make it easy to install and replace.

Counter/timers are available for each of the 16 digital inputs of the Basic Module. Therefore each input can be individually configured for timing or counting functions.

Input and outputs are isolated and protected against voltage spikes, using reliable suppression techniques.

The UCW-24/28IO/50 is compatible with MODBUS RTU and MoP (MODBUS over Piciorgros) communication protocols.

VERSIONS/ORDERING CODES



Certification and Approvals
The model UCW-24/28IO/50 is certified in accordance with R&TTE standards, with the following reference numbers:

ISM Band: 433.100 – 434.750 MHz:

Product Designation:	FTR-700
Output Power:	10 mW
Product Description:	SRD
Registration Number:	E811319M-EO
Marking:	CE 0682 (!)

Frequency Range: 430.000 – 470.000 MHz:

Product designation:	HFT-700
Output Power:	500 mW
Product Description:	SRD
Registration Number:	E811062M-EO
Marking:	CE 0682 (!)

Frequency Range: 440.000 – 470.000 MHz:

Product designation:	HFT-700
Output Power:	0.1 –4 W
Product Description:	Land Mobile Service
Registration Number:	E811063M-EO
Marking:	CE 0682 (!)

Caution!
Products that are marked with the symbol (!) did not have uniform European certification at the time of preparation of this document. They should therefore be used according to prevailing local regulations with regard to frequency, transmitting power, operating limitations, etc.

Mechanical Details, Connections, and Wiring

Mechanical Details

The external dimensions of the UCW-24/28IO/50 conform to DIN 43880, making it suitable for standard DIN rail installation. Power supply and input / output signal connections are all through plug-in screw terminal blocks.

Dimensions

The dimensions for the UCW-24/28IO/50 conform to DIN standards for rail mounted electrical apparatus. It can be installed on a standard 35 mm rail in accordance with DIN EN 50022. All variants have a width of 9 units (9T).

Mounting

The DIN rail mounting adaptor is at the base of the UCW-24/28IO/50. The lower spring-loaded lip is engaged with rail first. The body is then pressed upwards and the upper lip clamped onto the DIN rail.

Dismounting

A Unit is removed in the reverse sequence. The upper side of the Unit is forced downward to disengage the upper lip, and then the lower lip is disengaged to free the body of the Unit from the DIN rail.

Wiring

External wiring of these Units must conform to local laws and guidelines relating to electrical equipment. Detailed information can be obtained from local authorities.

Power Supply Connections

The UCW-24/28IO/50 is designed for a supply voltage of 12 VDC or optionally 24 VDC. With the 12 VDC version, the Basic Module supplies power directly to connected Expansion Modules. With the 24 VDC version, an additional Power Adaptor Unit (UCS 53 924) has to be connected between the Basic Module and the Expansion Module. Model numbers for the various versions are as follows:

Model:	Voltage:	Expansion Module Power Supply:
UCW-28IO/50.12	12 Volt DC	Supplied directly
UCW-28IO/50.24	24 Volt DC	Requires Power Adaptor Unit
UCW-24IO/50.12	12 Volt DC	Supplied directly
UCW-24IO/50.24	24 Volt DC	Requires Power Adaptor Unit

The supply voltage is connected via a 3-pole plug-in screw terminal block. The polarity is as follows (front panel of instrument viewed head-on, with the screw terminal block above):

Outside (left):	Housing
Centre:	+12 VDC or +24 VDC
Right:	GND

Caution!
Expansion Modules must be connected via the Local Bus connector, before switching on the power supply to the Basic Module. With 24 VDC versions, an additional Power Adaptor Unit must be used with the Extension Unit.

Input / Output Connections
Digital Inputs
The 16 potential-free digital inputs of the UCW-24/28IO/50 are divided over ports A and B into groups of 4 inputs each, each with a common return terminal "C". The inputs may be in any polarity, with a voltage range of 12 to 24 VDC. If the "C" terminal of a group is connected to GND, the separate digital input signals in that group of 4 would be at +12 to +24 VDC, and vice versa for reverse polarity.

When an input is activated, the corresponding LED lights up.

Assignment of inputs to the bits in Register 2:

	Port A								
C	0	1	2	3	4	5	6	7	C
Common1-4	Input 1	Input 2	Input 3	Input 4	Input 5	Input 6	Input 7	Input 8	Common5-8
Register 2	Bit 0	Bit 1	Bit 2	Bit 3	Bit 4	Bit 5	Bit 6	Bit 7	

	Port B								
C	8	9	10	11	12	13	14	15	C
Common9-12	Input 9	Input 10	Input 11	Input 12	Input 13	Input 14	Input 15	Input 16	Common13-16
Register 2	Bit 8	Bit 9	Bit 10	Bit 11	Bit 12	Bit 13	Bit 14	Bit 15	

Digital Outputs
The eight digital outputs C0....C7 (Port C) are switched by PNP transistors, with floating emitter-collector terminals. Power for digital outputs must therefore be supplied from an external source. Each output can switch a load of 500 mA, maximum. When an output is switched on, its corresponding LED lights up.

The + and – lines of the power supply for energizing the digital outputs (9 to 30 VDC) must be connected, respectively, to the + and – terminals of the digital output terminals group. The individual digital outputs lines are of +ve polarity (when switched on).

Assignment of outputs to the bits of Register 300:

	Port C								
C	0	1	2	3	4	5	6	7	C
+ 9-36V	Output 1	Output 2	Output 3	Output 4	Output 5	Output 6	Output 7	Output 8	-
Register 300	Bit 0	Bit 1	Bit 2	Bit 3	Bit 4	Bit 5	Bit 6	Bit 7	

Analog Inputs (Model UCW-28IO/50)
The four isolated analog inputs of Model UCW-28IO/50, grouped in Port D, accept current loop signals in the range 0-20 mA. Each input has 2 connecting terminals (+ and -). Use only shielded twisted-pair cables for analog input signals. Analog signal cables should be kept as short as possible, and should not be routed near power cables.

	Port D								
C	1+	1-	2+	2-	3+	3-	4+	4-	C
Shielding	Input 1	Input 1	Input 2	Input 2	Input 3	Input 3	Input 4	Input 4	Shielding

Caution!
Only twisted cables should be used for carrying analog input signals, and these should be kept as short as possible!

Using Expansion Modules
The total number of inputs and outputs of an UCW-24/28IO/50 node depends on the Expansion Modules used in addition to the Basic Module. Up to 8 Expansion Modules can be connected to one Basic Module, through the Local Bus connectors (RJ-45 type). The following Expansion Modules are available:

- UCL-16DI.D1: 16 digital inputs
- UCL-32DI.D1: 32 digital inputs
- UCL-08AI.D1: 8 analog inputs
- UCL-08DO.R1: 8 digital relay outputs
- UCL-16DO.P1: 16 digital solid-state switch (open-collector) outputs
- UCL-04.AO.D1: 4 analog outputs

When adding Expansion Modules, they should be connected to only when the power is switched off. About 2 seconds after the Basic Module has been switched on, the “System OK” and the “System I/O” LEDs light up, indicating that the instrument is ready for operation and that one or more Expansion Modules are connected.

The “System OK” and “System I/O” LEDs on the connected Expansion Modules should be continuously lit. A fault in an Expansion Module will cause the “System I/O” LED to switch off, and the “I/O” LED of the Expansion Module to start blinking. This also occurs when an Expansion Module is disconnected, or if an Expansion Module is added without first switching off the Basic Module.

If any of these conditions occur, switch off the power to the Basic Module, and switch it on again. If the same error indications occur, one of the expansion modules is clearly defective. Disconnecting Expansion Modules one by one can help identify which one is defective.

There is no fixed order in which Expansion Modules are to be connected to a Basic Module.

Caution!
When connecting Expansion Modules to a Basic Module which uses 24VDC supply voltage, an external 12V Power Supply Adaptor for the additional module is required.

Expansion Units: Power Supply Voltage And Loads
Expansion Units require 12 VDC supply. The 12 VDC input supply version of the UCW-24/28IO/50 (i.e., the Model UCW-28IO/50.12) can supply power, without the use of an Auxiliary Power Pack, to Expansion Units connected to it, up to a maximum load of 1 A. With Expansion Units connected, the input power consumption of an RTU-700 increases proportionally.

If the total load of Expansion Units exceeds 1A, then an auxiliary power pack (Model UCS-53.924) has to be added. All subsequent Expansion Units (after the first of these which add up to a load of 1A) are supplied by the auxiliary power pack. The power pack can operate with a supply voltage of 12 to 48 VDC, with an output of 12 VDC, up to 1.3 A.

The power input load of each Expansion Unit type is given in section 3.7 of this document.

The 24 VDC version of the UCW-24/28IO/50 Basic Unit (i.e., the model UCW-28IO/50.24) cannot supply power to Expansion Units. When this version of the Basic Unit is installed, the output of the Auxiliary Power Pack is connected to the power input of the first Expansion Unit, next to the Basic Unit.

LED Functions

LED	Function
System Pwr	Power supply on
System OK	Operating mode and error indication (*)
System I/O	Lights up if one or more expansion modules are connected and in operation
Radio Tx	Lights up while data is being transmitted over the radio channel
Radio Rx	Lights up while data is being received over the radio channel
A0...A7	Indicate status of digital inputs 1-8
B0...B7	Indicate status of digital inputs 9-16
C0...C7	Indicate status of digital outputs 1-8
RF	Indicates field strength of received radio signal

(*) Under normal operating conditions the “System OK” LED is permanently lit. Errors are indicated by coded blinking patterns, described below:

Blinking Codes: OK LED	Condition
LED off	Basic Module fault; or not ready
LED continuously on	In operating condition; no faults
LED blinks with equal on and off periods	The Unit is a master in a point-to-point or point-to-multiple-point network, and one or more of the slave nodes is not responding
2 short blinks followed by a long pause	Invalid address. Slave node addresses must be in the range 1-239. A master node address must be in the range 0-235.
3 short blinks followed by a long pause	One of the Expansion Modules has a fault. Or, an Expansion Module been removed or added, while the node is active (i.e., while the Basic Module is powered on)
4 short blinks followed by a long pause	Radio fault: transmitter/receiver fault, or interrupted radio transmission

Switching On
When a Basic Module is switched on, all the LEDs (except the OK, Radio Rx, and Radio Tx LEDs) light up for about 2 seconds, to confirm that the LEDs are functional. This is followed by the software version number being displayed on the 16 digital input status LEDs, as 4-bit BCD numbers (on = 1; off =0).

Example:

Port A	Port B	Software version
0000 0001	0010 0100	01.24

These LEDs are then extinguished, and the OK LED lights up.The Unit is now ready for operation. If a fault exists, this is indicated through a coded blinking sequence of the OK LED, as listed above.

Additional Functions

Counter / Timer
Each of the 16 internal digital inputs has a counter and a timer function available: i.e., up to 16 event counters and timers are possible in a single UCW-24/28IO/50 Basic Module. A 16-bit register containing the counter/timer value is assigned to each input. The first counter/timer register is assigned to Input 0 (Port A) and the last counter/timer register to Input 15 (Port B).

Counter
If an input has been configured as a counter, pulses (each consisting of a logic high plus a logic low transition) at the input are counted. This feature can be used to measure outputs of pulse type sensors such as flowmeters.
Input pulses are continuously counted, from the instant the UCW-24/28IO/50 becomes operational.

The inputs of Port A are configured as counters, at the factory, before dispatch. This configuration can be changed via the control register 918.
The 16-bit counters have a counting range of 0 to 65535 (0000h to FFFFh). After reaching the end of the range, the counter starts again from zero.

A master station would count the number of pulses accumulated in a counter register as the difference between the register values read during successive radio polling cycles. Counter overflow at FFFFh should be taken into account.

When power supply is interrupted, the counters are all reset to 0.
The power interruption event is stored in a status byte, so that this can be taken into consideration when the next radio polling cycle takes place. The maximum input frequency for the counter function is f =10Hz.

Example: flow measurement using the counter function

A flowmeter connected to an digital input generates 10 pulses per litre. The UCW-24/28IO/50 is polled at 09.45 by the remote master station and returns the counter value for that input as 12700. The next polling takes place at 09.48, by which time the count value has increased to 13060. Therefore 360 pulses have been counted in 3 minutes, corresponding to 36 litres in that time, or 12 litres per minute.

Timer
If an input is configured as a timer, the value of the corresponding register is incremented at the rate of 1 count per second, with a timing resolution of 1/10 second.

The inputs of Port B are configured as timers, at the factory, before dispatch. This configuration can be changed via the control register 918.
The 16-bit counters have a counting range of 0 to 65535 (0000h to FFFFh). After reaching the end of the range, the counter starts again from zero.

A master station would count the number of pulses accumulated in a timer register as the difference between the register values read during successive radio polling cycles. Counter overflow at FFFFh should be taken into account.
The power interruption event is stored in a status byte, so that this can be taken into consideration when the next radio polling cycle takes place. The scanning (reading) rate of these inputs is over 10 per second, and therefore the residual error is less than +/- 100mS.

Example: monitoring pump running time in an effluent treatment plant

While Pump 1 is running, the on/off input B0 is activated (Timer 1). While Pump 2 is running, input B1 is active (Timer 2). At 08:00 Timer 1 registers a value 7455, and Timer 2 a value of 65430.

The next polling by the master station takes place at 08:15, at which time the Timer 1 registers a value 7892. The difference between the successive values 437. Therefore, between 08.00 and 08.15, Pump 1 has run for a total time of 437 seconds (7 minutes and 17 seconds).

At time 08.15, Timer 2 registers a value of 462. It has run to its maximum value of 65535 and then reset itself to 0. Therefore the total time that this pump has run, between the successive polling cycles, is the difference between of 65535 and 65430 (=105) plus the difference between 0 and 462 (= 463; the “0” is also counted as a second). In other words, between 08:00 and 08:15 hrs., Pump 2 has run for a total of 568 seconds (= 9 minutes and 28 seconds)

Analog Inputs: High and Low Limit Detection, and Averaging
If analog inputs exist in an UCW-24/28IO/50 node, either in the Basic Module or in one or more Expansion Modules connected to it, the minimum, maximum, and average values are automatically determined for the first 4 analog inputs.

An averaging period of 60 seconds is set in the UCW-24/28IO/50 at the factory, before delivery. The user can change this averaging period, by altering the contents of the control register 919. A value of 0 in effect disables the averaging function.

The 60-second averaging period results in a running time of 2 years, given the Unit's memory capacity. If this period is exceeded, the average value is reset and the calculation begins once again.

There are two identically configured sets of registers for storing these values, respectively for the **current** set of values and the **previous** set of values. When at least one of the group of "current" registers is read, all the registers (min. max. and average) of this set, corresponding to this channel, are copied to the "previous" registers, and the "current" registers are reset. The remote master station can then read the "current" set of values. If a message frame transmitted by an UCW-24/28IO/50 is not received, for any reason, by the remote master station, these values are always available in the "previous" set of registers (after the "current" values have been reset by the reading action). This means that any lost values can be read from the "previous" registers.

Note that 4 registers are assigned to each analog input channel: corresponding to minimum, maximum, and average values, plus the redundancy counter. As soon as even one of these registers is read, and the data transmitted, all the registers corresponding to that analog input channel are reset (minimum and maximum values are reset, and averaging starts again). It is important to read all registers of a channel during transmission so that one can have all the values at a definite point in time. If the corresponding radio message frame is lost, these values can then be read as many times as required from the "previous" registers.

Each set of registers has a redundancy counter. Repeated or missing message frames can be detected with the help of this counter. The "current" counter is increased by 1 every time that set of registers is accessed and read.

If a transmitted radio message frame is lost, it could be for one of two reasons: either the polling message frame from the remote master station was not received, or the response message frame transmitted by the UCW-24/28IO/50 node was not received by the master station

If the polling message frame is lost, the UCW-24/28IO/50 does not receive the command to read out the register. As a consequence, the contents of the "current" registers are not copied to the "previous" registers. If the "previous" registers are read, only old values will be transmitted. Therefore, in this event, the "current" registers must be read out again. If the UCW-24/28IO/50 response message frame is transmitted but lost, the UCW-24/28IO/50 has correctly understood the command to read out the register, so the required values are copied into the "previous" register. In this condition, the valid data is available in the "previous" register.

The redundancy counter is used to cope with this situation. The current value of the redundancy counter is read and stored by the remote master station, every time it polls a node. If a response message frame transmitted by the node is lost, the "previous" register can be read during the next polling access. If the redundancy counter value here is higher than the value obtained during the previous polling access, then the values of the lost message frame are here. If the latest redundancy counter reading by the remote master station is the same as the previous polling access, the current values are obtained by reading the "current" registers.
The redundancy counter size is 16 bits. After reaching the value 65535 (FFFF Hex) it starts again from 0. This should be considered during the evaluation of the counter.

Whenever the UCW-24/28IO/50 is reset, the first resetting of the minimum, maximum, and average value registers is delayed by 3 seconds. This ensures that the correct values of analog input channel measurements are available.

The structure of the register block for the minimum, maximum and average values of the analog inputs is shown below. An absolute register address cannot be specified here, because the registers can have different addresses after the UCW-24/28IO/50 has been configured. Therefore only the register offset can be indicated as a reference here.

Register Offset	Function	Note
0	Current min. value 1	Current minimum value analog input 1
1	Current max. value 1	Current maximum value analog input 1
2	Current average value 1	Current average value analog input 1
3	Current redundancy 1	Current redundancy value analog input 1
4	Current min. value 2	Current minimum value analog input 2
5	Current max. value 2	Current maximum value analog input 2
6	Current average value 2	Current average value analog input 2
7	Current redundancy 2	Current redundancy value analog input 2
8	Current min. value 3	Current minimum value analog input 3
9	Current max. value 3	Current maximum value analog input 3
10	Current average value 3	Current average value analog input 3
11	Current redundancy 3	Current redundancy value analog input 3
12	Current min. value 4	Current minimum value analog input 4
13	Current max. value 4	Current maximum value analog input 4
14	Current average value 4	Current average value analog input 4
15	Current redundancy 4	Current redundancy value analog input 4
16	Previous minimum value 1	Previous minimum value analog input 1
17	Previous maximum value 1	Previous maximum value analog input 1
18	Previous average value 1	Previous average value analog input 1
19	Previous redundancy value 1	Previous redundancy value analog input 1
20	Previous minimum value 2	Previous minimum value analog input 2
21	Previous maximum value 2	Previous maximum value analog input 2
22	Previous average value 2	Previous average value analog input 2
23	Previous redundancy value 2	Previous redundancy value analog input 2
24	Previous minimum value 3	Previous minimum value analog input 3
25	Previous maximum value 3	Previous maximum value analog input 3
26	Previous average value 3	Previous average value analog input 3
27	Previous redundancy value 3	Previous redundancy value analog input 3
28	Previous minimum value 4	Previous minimum value analog input 4
29	Previous maximum value 4	Previous maximum value analog input 4
30	Previous average value 4	Previous average value analog input 4
31	Previous redundancy value 4	Previous redundancy value analog input 4

Caution!
The register contents of the UCW-24/28IO/50 are deleted when its power supply is interrupted.

Registers Assignment

Registers Structure
The UCW-24/28IO/50 Series use the industry-standard MODBUS RTU communication protocol. This means that all registers have a word width of 16 bits, and are arranged in 3 consecutive groups. A write operation is executed by transmitting the start address, followed by the data words. A read operation is executed by transmitting the start address, followed by a 16-bit number that defines the number of data words that will follow immediately.

In addition to read and write registers, the UCW-24/28IO/50 also contains special registers: read-only “RP registers”, and “E-registers” whose contents are saved to a non-volatile memory area as soon as they are written to, so that these contents are protected against power interruptions.

Types of access:

(R) : read register
(W) : read/write register
(WP) : read register containing operational settings
(E) : EEPROM backed-up register (contents protected against power interruptions)

The register numbers before the brackets in the following table correspond to the actual transmitted addresses in the data message frames that have to be accessed. The logical MODBUS addresses are additionally shown in brackets for clarity.

RTU-700: Read and Write Registers

Register	Function	Remarks
0 (40001)	RTU address	MODBUS address, set on DIP switches, through which communication can be established with an RTU node (R)
1 (40002)	Status	Status byte. If a value is written in this register it resets the status byte (R/W)
2 (40003)	Input register	Input (R). Sequence: on/off inputs, analog inputs, counter/timer (Port A/B), min./max./ average values/redundancy counter (current) min./max / average values /redundancy counter (backup)
300 (40301)	Output register	Outputs (W). Sequence: on/off outputs, analog outputs

SPECIAL REGISTER

Register	Function	Remarks
900 (40901)	Radio address	Address of the radio layer(R/WP/E)
901(40902)	t-timeout	Time based timeout, in seconds (R/W/E)
902(40903)	x-timeout	Message frames based timeout, in number of message frames (R/W/E)
906(40907)	Node (RTU) ID	Sends the ID of the node (RTU) (R)
907(40908)	Firmware	Firmware version (R). e.g., 0115Hex corresponds to version 01.15
910(40911)	Radio channel	Currently used radio channel (R/W)
911(40912)	Default radio channel	Radio channel used when next switched on (R/W/E)
912(40913)	Transmitter power	Transmitter power output setting (0-100) (R/W). At the factory this is set to the maximum value specified in the order.
913(40914)	Default transmitter power	Transmitter power output when next switched on (R/W/E)
914(40915)	Received radio field strength	Received field strength of the last received message frame, in percent (R)
916(40917)	Station address	Logical address of node (R/W/E)
918(40919)	Pin configuration Timer/counter	Each internal input corresponds to a bit (Port A7=MSB, port B8=LSB) If the bit is set (occupied), this input has a counting function If the bit is 0, this has a timer function
919(40920)	Averaging time	Average values of analogue inputs in seconds (R/W/E)
930(40931)	On/off inputs	Number of available digital inputs (R)
931(40932)	Analogue inputs	Number of available analogue inputs (R)
932(40933)	Digital outputs	Number of available digital outputs (R)
933(40934)	Analogue outputs	Number of available analogue outputs (R)
934(40935)	Event counter	Number of available event counter (R)
935(40936)	Time counter	Number of available operating time counter (R)

Description of Register Functions
RTU Addresses
This register contains the addresses set via the DIP switch. The address range is 0-255.
Addresses 0 and 241-255 are reserved for the master station and should not be used for UCW-24/28IO/50 slave stations.

Status
The operating condition of the RTU can be determined from the status register. The following status messages are supported at the present time:

Bit	Meaning
0	Internal fault 1
4	RTU reset of the radio component during operation
5	RTU faulty radio component
6	Fault in one or more Expansion Modules
7	Power interruption/restart: counter and timer are reset

Caution!

Except for bit 6 (Expansion Module fault) all status bits are reset when any of the register bits are re-written. Bit 6 remains in its previous state until the Expansion Module fault is cleared.

Digital and Analog Input Registers
The input registers block is arranged with digital input registers first, followed by the analog input registers, and finally the 16 registers for the counter/timer function for the 16 digital inputs of the Basic Module. The first register after the analog input values is the counter/timer register of input A0; the 16th register after the analog values is the counter/timer register of input B7.

Since the registers are 16 bits wide, eight digital inputs occupy half a register word. Port A occupies the low bits of register 2, Port B the high bits. If analog inputs exist, these begin with the next complete register. Each analog input occupies 12 bits of a full register, with the upper 4 bits unused.

All on/off and analog inputs, as well as the counter/timer functions, can be accessed via the respective status registers.

Assignment of the inputs A0-A7 and B8-B15 of the UCW-24/28IO/50 to the bit positions of Register 2:

Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Inp	B15	B14	B13	B12	B11	B10	B9	B8	A7	A6	A5	A4	A3	A2	A1	A0

Example: on/off and analog input registers assignment

Two Expansion Modules, respectively with 16 digital inputs and 8 analog inputs are connected to an UCW-28IO/50 Basic Module. For this configuration, the input registers are assigned as follows:

- Register 2 has the states of the 16 digital inputs of the Basic Module
- The high bits of Register 3 contain the states of Port A of the Expansion Module with 16 digital input
- The low bits of Register 3 contain the states of Port B of the Expansion Module with digital inputs
- The four registers containing the values of the analog inputs of the UCW-28IO/50 Basic Module begin with Register 4
- The eight registers containing the values of the analog inputs of the Expansion Module begin with Register 8
- The 16 counter/timer registers start with Register 16. The first of these corresponds to Port A0, the last to Port B15
- The “current” registers containing minimum, maximum, and average values of the first four analog inputs start with Register 32.
- The “previous” registers containing minimum, maximum, and average values of the first four analog inputs start with Register 48.

Digital and Analog Output Registers
The output registers block is arranged with digital output registers first, followed by the analog output register bits.

Since the registers are 16 bits wide, eight digital outputs occupy half a register word. Port A occupies the lower part of a register. If analog outputs exist, these begin with the next complete register. Each analog output occupies 12 bits of a full register, with the upper 4 bits unused.

Assignment of the output ports of an RTU Basic Module to the output register bits:

Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Inp	—-	—-	—-	—-	—-	—-	—-	—-	C7	C6	C5	C4	C3	C2	C1	C0

Example: digital and analog output registers assignment

Two Expansion Modules, respectively with 8 digital inputs and 4 analog outputs are connected to an RTU Basic Module. For this configuration, the output registers are assigned as follows:

- The low bits of Register 300 contain the 8 digital output states of the RTU Basic Module.
- The high bits of Register 300 contain the digital output states of the first Expansion Module with 8 digital outputs.
- The low bits of Register 301 contain the digital output states of the second digital output Expansion Module.
- Since no more digital outputs exist in this configuration, the high bits of Register 301 are unused.
- The registers for 4 analog outputs of the analog output Expansion Module start with Register 302.

Caution!
In RTU’s using the Brodersen compatible MODBUS RTU protocol, the assignment of registers differs from the standard version!

RTU Configuration Registers
The configuration and special registers start from address 900, and hold the set-up parameters of an RTU station. The position of the register determines whether it is “read”, or “write” register, or a register that is pre-written only by the manufacturer. Some of the registers are saved in non-volatile memory, secured against power interruptions.

Configuration Register: Radio Address
The address of the radio transmission layer is located here. A radio network is given a unique address. This prevents networks using the same frequency within radio range of each other from interfering with one another.

Timeout Monitoring
All outputs of an RTU Basic Module and connected Expansion Modules are maintained in their current states between successive data transfers. To avoid problems with outputs remaining constant unintentionally due to disturbances in radio transmission, two intervals are monitored: time elapsed since receipt of the last message frame: (“t” Timeout) and number of data blocks received since the last message frame carrying the address of that station (“x” Timeout).

Configuration Register: Time Based (“t”) Timeout Monitoring
The UCW-24/28IO/50 constantly monitors the radio message frames that are transmitted by it. If the RTU does not receive any polling message frame from the master station within a predetermined time interval (“n” seconds), all outputs are reset to off condition. The limiting time interval can be altered by setting an appropriate value in this (“t” timeout) register. Setting this register’s value to zero effectively disables the “t” timeout function.
The t-timeout interval is set to 10 seconds at the factory, before delivery.

Configuration Register: Data Blocks (“x”) Timeout Monitoring
In a radio network that consists of many stations (stations), it is possible that a particular station may not be addressed by the master station for a length of time. The data block (“x”) timeout defines the number of polling message frames within which the RTU station must be addressed at least once. If the station is not addressed in this number of consecutively received data blocks, its outputs are automatically reset to off condition. The factory set value for this is 512 message frames.
This function can be disabled by writing the value “ 0 “ into this register.

Configuration Register: RTU ID
This register enables a master station to identify RTU stations that are active in a radio network, and to verify that the correct RTU model is installed at a slave station. The ID codes of UCW-24/28IO/50 Series versions are:
- 0010 h: UCW-24IO/50
- 0011 h: UCW-28IO/50

Configuration Register: Software Version
The contents of this register identify the software version used in an RTU. A value of 0115h means software level version 1.15. This value is also displayed on the LEDs (as a BCD bit pattern) when the RTU is switched on.

Configuration Register: Radio Channel
This register allows the radio channels to be selected through software. If the value of 00 is set in this register (factory set before delivery), the frequency channel is set via the DIP switches accessible from outside. Any other value in this register selects a different user-programmed frequency. If no DIP-switches are available for frequency-setting, the frequency value set in the configuration register “Specific Radio Channel” is used when the RTU is switched on.

Configuration Register: Specific Radio Channel
If an RTU is configured in such a way that any one of several frequencies in a band can be used, but must not be set via the DIP-switches, the frequency channel must be selected through this register. If the frequency is adjustable via DIP-switches the value “00” must be written into this register.
This is the frequency that will be selected when the RTU is switched on.

Configuration Register: Transmitter Output Power
This register contains the transmitter output power value, in the range 0-100%. This value is not linear! Register value of 100 corresponds to 500 mW in a medium power RTU, and 4 watts in a high power RTU. The transmitter power can be limited by an internal setting depending on statutory restrictions.
If the value of 00 is set in the Specific Transmitter Output Power Configuration Register (factory set before delivery), the frequency channel is set via the corresponding DIP-switches accessible from outside. Any other value in this register selects a different user-programmed output power.

If no DIP-switches are available for setting the output power, the output power value set in the configuration register "Specific Transmitter Output Power" is used when the RTU is switched on.

Configuration Register: Specific Transmitter Output Power
A change in the contents of the Transmitter Output Power Register has an immediate effect on the current transmitter output power. This value is however lost when an RTU is reset or if the power supply is interrupted. The value of the Transmitter Output Power Register is copied from Specific Transmitter Output Power Register whenever an RTU is reset or restarted after a power supply interruption. If the transmitter output power is to be kept at a constant value at all times, both registers must be set accordingly. If the transmitter output power is to be adjusted via the DIP-switches, a value of "00" must be written into the Specific Transmitter Output Power Register.

Configuration Register: Field Strength of Received Signal
The field strength of the received radio signal at the time of receiving the last message frame is recorded in this register as a percentage value (0-100%).
Specific field strength levels, corresponding percentage values, and the coded LED display patterns are listed in the following table.

Field Strength	Value in %	LED Display	Comments
0,5µV	17%	3 red	Low signal strength
1µV	28%	Yellow	Good signal
5µV	51%	1 green	Very good signal
10µV	61%	2 green	
30µV	75%	3 green	
150µV	98%	4 green	

Configuration Register: RTU Address
The logical address of the RTU is set in this register. The value of this register also reflected in register 0. If the address can be set via a DIP switch, the DIP switch setting takes precedence.

Configuration Register: Counter/Timer Setting
Each of the 16 on-off inputs of a Basic Module can be have either a counter or a timer function. This register determines these functions for each of the on-off inputs. If register bit is "0", the corresponding input has a timer function. If the bit is "1", the input has a counter function.

Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Inp	A7	A6	A5	A4	A3	A2	A1	A0	B15	B14	B13	B12	B11	B10	B9	B8

Register Contents: UCW-28IO/50 Without Expansion Modules
The table below is an example of the register addresses of UCW-28IO/50. The configuration registers are not listed here.

Register	Function	Comments
0	Slave address	MODBUS address set via DIP switches, through which the RTU can be accessed by the master station.
1	Status	Status byte
2	Digital inputs	16 digital inputs of the Basic Module
3-6	Analog inputs	4 analog inputs of the Basic Module
7-22	Counter/timer	16 counters / timers (inputs ports A, B)
23-38	Min/Max/Avg	Current min-, max-, average and redundancy values of the first 4 analog inputs
39-54	Min/Max/Avg	Previous min-, max-, average and redundancy values of the first 4 analog inputs
300	Digital outputs	8 on/off outputs of the Basic Module (high bits)

Register Contents: UCW-24IO/50 Without Expansion Modules
The table below is an example of the register addresses of an UCW-24IO/50. The configuration registers are not listed here.

Register	Function	Comments
0	Slave Address	MODBUS address set via DIP switches, through which the RTU can be accessed by the master station.
1	Status	Status-Byte
2	Digital inputs	16 digital inputs of the Basic Module
3-18	Counter/timer	16 counters / timers (inputs ports A, B)
300	Digital outputs	8 on/off outputs of the Basic Module (high bits)

Operating Modes
The UCW-24/28IO/50 can be configured for point-to-point (P2P) or point-tomultiplepoint (P2MP) radio networking. Either one of these two modes can be selected by DIP switch settings.

Point-to-Point Radio Link
This mode allows a number of digital and/or analog signals to be transmitted via a wireless channel. The inputs at one end are reproduced as corresponding outputs on the other, and vice versa. If the RTU is used without an Expansion Module, Input Port A of one station corresponds to Output Port C of the opposite station.

Addressing in Point-to-Point Links
To establish a P2P link, one RTU is designated as the master station, by setting the appropriate DIP switch. The second RTU is used in its normal mode as a slave station. Communication between the two is based on the MoP protocol. If more than one P2P radio links are operating simultaneously within radio range of each other, the following addressing rules should be observed:

- Up to 15 different master station addresses in the format nnh can be coded by the DIP switch (e.g.: nnh = 11h, 22h, 33h, ... Eeh).
- The address FFh is reserved and can not be used as a master station.
- A master station with the address nnh communicates with a slave station with the address nnh+1 (Example: a master station with the address 33h will communicate with a slave station having the address 34h).

Explanation of address assignments:
To differentiate between master and slave stations, in each radio message frame the hexadecimal counting block Fnh (n = 1 to n = E) as well as the code 00h are reserved for the central station. If an RTU is set up as a master, the low bits of the address coding DIP switch are used for the master station address.

Example:
DIP switch = 04h -> Central station code = F4h
DIP switch position = 66h -> Central station code = F6h
For slave station addresses, the full 8 bits of the address coding DIP switches are used, with the next consecutive address being interpreted as a slave station address.
Example:
DIP switch = 04h -> Slave station 05h is accessed
DIP switch = 77h -> Slave station 78h is accessed
Up to 14 point-to-point radio links on the same radio frequency can be operated within radio range of each other, by using distinct addresses.
Caution!
By using a distinctive address setting, the master station is prevented from accepting messages from stations that are not part of its network.
This does not however, eliminate the possibilities of interference and disturbances in communication if other radio transmitters within range are operating simultaneously on the same frequency.

Operation
The master station continuously polls the slave station. If it receives a valid response from the slave station, an on-going exchange of data begins between the two stations. The states of all digital inputs and values of all analog inputs at one station are reproduced as corresponding outputs at the other. Only that part of the data that is valid for the hardware configuration at the receiving end is acted upon.
If, for example, an RTU master station has 8 analog inputs, and the opposite slave station has only 4 analog outputs, the measured values of only the first 4 analog inputs of the master RTU are transmitted. Expansion Modules can be connected via the Local Bus to the Basic Module in any arbitrary sequence. In a P2P system, the internally set timeout limits are continuously monitored.
If one of the RTU's does not receive a validly addressed message frame from the other RTU within the predetermined "t" timeout interval, the outputs of the first RTU are automatically reset to the default "off" states. The timeout limit period can be set to a user-determined value, or disabled, by setting a suitable value in the corresponding register.
At the master RTU station, if radio communication with slave RTU station is interrupted, the "System OK" LED starts blinking.

Point-to-Multiple-Points Networks
One master station can operate with up to 4 slave stations in a self-sufficient RTU network, without a supervisory computer or PLC. The digital inputs of the master RTU are transferred in parallel to all slave RTU's on the same network. The number of digital I/O's can be increased by adding 1 to 16 Extension Modules. The 8 digital outputs of the master station Basic Unit are allocated to digital inputs of the slave stations, depending on the number of slave stations on the network, according to user requirements.

Addressing in Point-to-Multiple-Points Networks
In a point-to-multiple-point network, each RTU is individually set up as master or slave through the DIP switch provided for this purpose. Another DIP switch is used to set up the RTU for either standard MODBUS-RTU or MoP communication protocol. Several networks can be operated within radio range of each other, by selecting distinct station addresses, according to the following rules:

- Up to 15 different master station addresses can be DIP switch coded in the format Address = nnh (e.g., 11h, 22h, 33h... EEh).
- The address FFh is reserved: it cannot be used as a master station address.
- A master station with address "nnh" will communicate with slave stations with addresses "nnh+1", "nnh+2",.....(e.g., a master station with the address 33H will communicate with slave stations with addresses 34h, 35h,….)

Explanation of address assignment:
In order to differentiate message frames transmitted by master stations from those transmitted by slave stations, the range of hexadecimal numbers Fnh (n= 1 through E) and the specific code 00h are reserved for master stations. To set up an RTU as a master station, the low bits of the address coding DIP switches are used for its address.

Example:
DIP switch setting = 04h - > Master station identification = F4h
DIP switch setting = 66h - > Master station identification = F6h.
For setting the address of a slave station, all 8 bits of the address coding DIP switches are used, and the succeeding code number is interpreted as a slave station address.

Example:
DIP switch setting = 04h - > Slave station called = 05h
DIP switch setting = 77h - > Slave station called = 78h
Therefore, by using distinctive address coding, up to 14 multi-slave radio networks, each with its own master station, can be operated within radio range of each other, using a single frequency channel.

Caution!
By using a distinctive address setting, the master station is prevented from accepting messages from stations that are not part of its network. This does not however, eliminate the possibilities of interference and disturbances in communication if other radio transmitters within range are operating simultaneously on the same frequency.

Operation
When a master RTU is switched on, it starts polling the slave RTUs. If any of the slave stations fail to acknowledge the polling, the "OK" LED at the master RTU will blink with equal on and off times. As long as acknowledgements from all slave stations are correctly received by the master RTU, its "OK" LED remains continuously on. In a radio network with one master and 2 slaves, the first four inputs of the first slave RTU are reproduced as outputs 0-3 of the master RTU. The first four inputs of the second slave RTU are reproduced as outputs 4-7 of the master RTU. In a radio network with 3 or 4 slave RTUs, only the first 2 inputs of each slave RTU are reproduced as outputs at the master RTU. If a slave station drops out, two attempts are made by the master station to establish contact with that slave station. If the master does not succeed in doing so in these two attempts, the slave is tagged as not reachable, and the "System OK" LED will start blinking. Thereafter, each slave station that is´tagged as not reachable is only briefly monitored in each polling cycle, for its presence/absence on the radio network. This is so that the performance of the entire system is not impaired. The active outputs of the master RTU that are assigned to this slave station are reset to off condition, after the predetermined "t" timeout interval has elapsed. If a dormant slave starts responding again, it is automatically included in the polling roster by the master station.

Message Frame Structure
This chapter describes how the registers of an UCW-24/28IO/50 can be accessed through a remote radio modem (e.g., model TRM-700H/T1X or TRM-700H/M). Using this facility, a network of up to 240 UCW-24/28IO/50 Wireless I/O Modules can be controlled from a PLC, PC, or SCADA system.

The MoP Protocol
The MoP protocol (MODBUS over Piciorgros) is basically similar to the MODBUS-RTU protocol, but MoP has some enhancements that optimize it for radio communications. These enhancements allow complete data exchange (reading and writing of registers) with the slave stations in a single radio transmission cycle (one data block from the master to the slave station, plus one return data block from the same slave station to the master station). By comparison, the standard MODBUS-RTU protocol requires 4 message frames to achieve the same result: 2 message frames for writing to the slave station registers plus 2 message frames for reading the slave station registers.
The MoP message frame consists of a header followed by a data block. The header is consists of a function code (60h) to identify the protocol, the receiver station address, and up to 2 repeater station addresses.
Using radio repeaters is possible only with the MoP protocol. The standard MODBUS protocol is not designed for such functions. Any slave station in a network can simultaneously function as a repeater for other stations. On the basis of the information in the header, the slave stations that are addressed as repeaters immediately re-transmit the data block they have received. The MoP protocol is selected through the operating mode (see description of DIP switches). If no DIP-switches are available for setting the type of operation, the MoP protocol is always activated.

UCW-24/28IO/50 polling data block transmitted by a master station using the MoP protocol:

60	(ZB)	A1	A2	A3	A4	IR_H	IR_L	IR_X

OR_H	OR_L	OR_X	$D1_H$	$D1_L$	....	Dn_H	Dn_L

60: Function code: identifies a polling data block with MoP protocol
ZB: This control byte is automatically generated by a TRM-700H/M master station operating in the “ZZ” mode, and will not be transmitted to it by the control system. With all other operating modes of the master station, this byte will be transferred as the value “FFh”
A1…A4: Radio addresses
IR_H/IR_L: Address of first input register that is to be read
IR_X: Number of input registers which are to be read
OR_H/OR_L: Address of the first output register that is to be written
OR_X: Number of the output registers that are to be written
$D.._H$/$D.._L$: Data for the output register. 2 data bytes must be transmitted for each output register that is to be written.

UCW-24/28IO/50 acknowledgement data block:

E0	(ZB)	A1	A2	A3	A4	IR_H	IR_L	IR_X

$D1_H$	$D1_L$	....	Dn_H	Dn_L

E0: Function code: identifies an acknowledgement data block with MoP protocol
ZB: This control byte will be automatically filtered by the TRM-700H/M master station operating in the “ZZ” mode, and will not be passed on to the control system. With all other operating modes of the master station, this byte must be transferred as the value “FFh”
A1...A4: Radio addresses for acknowledgement data blocks
IR_H / IR_L: Address of the first input register that is to be read, and the status of which is to be transmitted
IR_X: Number of input registers which were read out
$D.._H$ / $D.._L$: Data for the input register. 2 data bytes must be transmitted for each input register that has been read

Accessing UCW-24/28IO/50H Registers Using The MoP Protocol
By accessing the appropriate registers, all inputs, outputs, counters, timers, or controls of an UCW-24/28IO/50 can be determined (separately or together), and at the same time the state of any of any of the outputs can be changed.
Basically, there are 3 different types of registers:

- Input registers
- Output registers
- Control registers

Input registers give out the value of the inputs, counters, timers, etc., and are therefore registers from which values can be read out. They begin with the address 0. Output registers correspond to the on/off and analog outputs of an RTU and can be written with the respective values. They start with the address 300 = 012Ch. Control registers are intended for various control functions such as setting the transmitting power, reading the field strength, etc. They begin with the address 900 = 0384h. Some control registers can be read and written, others can only be read.
All registers have a width of 16 bits. If fewer bits are used for a particular function (analog inputs), only the lower bits are used. The sequence of the inputs and outputs in the registers is always as follows:

- Digital inputs or outputs
- Analog inputs or outputs
- 16 counter/timer registers (sequence: port A0, A1-A7, B0, B1-B7)
- Minimum, maximum, and average values (only for the first 4 analog inputs)

Example 1: Data communication using the MoP Protocol
Data block sent from a master station to a slave station:
- The data block is to be routed via Stations 07 and 08 (functioning as repeater stations) to Station 04.
- The status of all the digital inputs and the measured values of analog inputs 1 – 3 are to be transmitted back (Registers 0002 to 0005 to be read; counter register = 4).
- Digital outputs 1, 2, and 3 of the UCW-24/28IO/50 slave station with address 04 are to switched on (value 07h is to be written to the register 0300 = 012Ch).
- Output 1 of the analog output module is to be set to 10 mA (value 0800h is to be written to the register 0301 = 012Dh).

Polling message frame:

60	(ZB)	07	08	04	00	00	02	04

01	2C	02	00	07	08	00

60	Function code: identifies a polling data block with MoP protocol
ZB:	This control byte is automatically generated by a TRM-700H/M master station operating in the “ZZ” mode, and will not be transmitted to it by the control system. With all other operating modes of the master station, this byte must be transferred as the value “FFh”
07 08 04 00	Routing addresses: repeater station 1, repeater station 2, destination slave station (address 04), master station (address 00)
00 02	Address of the first register that is to be read
04	Number of 16-bit registers that are to be read
01 2C	Address of the digital output registers of the UCW-24/28IO/50 Basic Unit (012C hexadecimal corresponds to 0300 decimal)
02	Number of 16-bit data words to be transmitted
00 07	The first data word, written to address 0300. This is the output register of the RTU Basic Unit, that is used to activate outputs 1, 2, and 3 in this example.
08 00	The second register word, written to the address 0301

Acknowledgement data block from the slave station to the master station

- Acknowledgement message frame from Slave Station 4; digital inputs 4 and 5 are activated (0018h)
- Analog input 1 supplies a value of 0620h, analog input 2 a value of 0A71h, analog input 3 a value of 0147h

Polling message frame:

E0	(ZB)	00	07	08	04	00	02	04

00	18	06	20	0A	71	01	47

E0	MoP protocol identifier for polling response data block
ZB:	This control byte will be automatically filtered by the TRM-700H/M master station operating in the “ZZ” mode, and will not be passed on to the control system. With all other operating modes of the master station, this byte must be transferred as the value “FFh”
00 07 08 04	Destination addresses: repeater station 1, repeater station 2, transmitting (responding slave) station
00 02	Addresses of registers to be written
04	Number of registers to be written
00 18	Digital input register: inputs 4 and 5 are activated
06 20	Measured value: analog input 1
0A 71	Measured value: analog input 2
01 47	Measured value: analog input 3

Explanation:
The sequence of characters in the polling message frame (which includes “FF” in second place) is transmitted by a PLC, SCADA PC, or DCS through a serial data interface, via a locally connected radio modem (more information available at www.piciorgros.com). Therefore this sequence of characters represents only the logical part of the data block. If the communication between the radio modem and PLC / SCADA PC / DCS uses another protocol (e.g., Siemens 3964R), the sequence of characters should be treated as the logical content of that communication protocol.
In this example, the destination RTU which is accessed through repeater stations 07 and 08, responds with an acknowledgement message frame and at the same time sends the required data back to to the master station.

Example 2: Data Communication Using the MoP Protocol

- The RTU ID and the software version number of the station with address 4 are to be read from the control registers
- At the same time, the status has to be reset (writing from 0000h to register 0001h)

The transfer takes place with a TRM-700H/M operating in the “ZZ” mode.
Therefore, this control byte is not included in the transmitted data block.

60	04	00	00	00	03	A4	02	

00	01	01	00	00

- Acknowledgement message frame from Slave Station 4, RTU ID number (1002h), and firmware version 1.00 (0100h) are sent.

E0	00	04	00	00	03	A4	02

10	02	01	00

MODBUS Slave Mode Operation
The MODBUS-RTU Protocol
When operated in the MODBUS-RTU mode, an UCW-24/28IO/50 station can be accessed using MODBUS code 3 (register read) and code 16 (register write).
The register structure of MODBUS-RTU is basically similar to that of the MoP protocol. Register 0 corresponds to the MODBUS register 40001 (however in the MODBUS protocol it is addressed as "0"). The UCW-24/28IO/50 returns a MODBUS acknowledgement after every data block it receives. In contrast to the MoP protocol, the standard MODBUS protocol requires two complete data block transfers in order to read inputs and write outputs. The mode of operation is selected via the appropriate DIP switches (see the section of this Manual that describes DIP switch designations and functions).

The Brodersen Compatible MODBUS-RTU Protocol
In the MODBUS-RTU and MoP protocols, digital inputs and outputs are accessed through the registers. If the number of digital inputs or outputs can be accessed via the control registers, it would then be possible to directly determine the status of the individual I/O channels through these registers.
Example: Two Expansion Modules with 8 relay outputs each are connected to an UCW-24/28IO/50 Basic Module. The Basic Module has 8 digital outputs, in addition to the outputs of the two Expansion Modules relay modules, RO1 and RO2). The status of the outputs in the registers is as follows:

40301		40302		40303	
H	**L**	**H**	**L**	**H**	**L**
RO1 Port A	**INT Port A**	**—**	**RO2 Port A**	**—**	**—-**

Brodersen Automation has implemented a modified version of the protocol, which always allocates a complete register for each Module. If a Module has only 8 on/off outputs, only the low bits of the register are used, and the high bits remain unused. This feature is taken into consideration in the Brodersen Compatible MODBUS RTU mode. In this mode, the position in the registers cannot be determined from the total number of on/off inputs. Therefore, the status it is recommended that this mode be used only with Brodersen systems. In the above example, the allocation of registers in the Brodersen Compatible MODBUS-RTU mode would be as follows:

40301		40302		40303	
H	**L**	**H**	**L**	**H**	**L**
—	**INT Port A**	**—**	**RO1 Port A**	**—**	**RO2 Port A**

RTU DIP Switch Settings: 500mW RF Output

DIP Switches Bank 1								DIP Switches Bank 2							
1	2	3	4	5	6	7	8	1	2	3	4	5	6	7	8
A0	A1	A2	A3	A4	P0	P1	F0	F1	F2	F3	F4	F5	M0	M1	M2

RTU Address					
A0	A1	A2	A3	A4	Address
0	0	0	0	0	0 (Master station only)
1	0	0	0	0	1
0	1	0	0	0	2
1	1	0	0	0	3
0	0	1	0	0	4
:	:	:	:	:	:
1	1	1	1	1	31

Power Output Settings: 500mW Module		
P0	P1	Power Output
0	0	10mW
1	0	100mW
0	1	250mW
1	1	500mW

Radio Channel						
F0	F1	F2	F3	F4	F5	Channel
0	0	0	0	0	0	0
1	0	0	0	0	0	1
0	1	0	0	0	0	2
1	1	0	0	0	0	3
0	0	1	0	0	0	4
1	1	1	1	1	1	63

The assignment of radio frequencies to radio channels depends on theapplication, as well as the frequencies allowed in the respective bands.
Therefore, for some of the bands, fewer frequencies than the programmable maximum of 64 would be available.

Operating Mode			
M0	M1	M2	Operating Mode
0	0	0	Slave station using MoP protocol; or slave station in a point-to-point configuration
0	0	1	Slave station using Brodersen Compatible MODBUS-RTU Protocol
0	1	0	(Not permissible)
0	1	1	Slave station using MODBUS-RTU Protocol
1	0	0	Master station; point-to-point configuration
1	1	0	Master station, master + 2 slaves configuration
1	0	1	Master station, master + 3 slaves configuration
1	1	1	Master station, master + 4 slaves configuration

UCW-24/28IO/50 Specifications

General description: Wirelesss remote I/O module combining the functions of digital and analog inputs / outputs with a built-in radio modem.

I/O (Basic Module): 16 digital inputs, isolated, floating reference potential
8 digital outputs, solidstate, isolated
4 analog inputs (Model UCW-24/28IO/50 only).

Special functions:
- Radio repeater chain: 4 stations: transmitting station, repeater station1, repeater station 2, destination station.
- Counters: Up to 16 counters, 16 bits each.
- Timers: Up to 16 timers, 16 bits each.
- Min./max./average: For the first 4 analog inputs.

HF Frequencies: 433 - 434 MHz , 440 - 470 MHz.

Channel assignments: Continuously variable over full frequency range.

Transmitting power:
- Medium power: 10 mW - 500mW.
- High power: 100mW - 6W (at 3 dB level).

Power supply: 12 or 24 V DC +/- 20%.

Enclosure: Coated aluminum body with plastic ends; per DIN 43880; DIN rail mounting.

Dimensions: Approx. 162 x 80 x 62 mm (excluding BNC connector and terminal blocks).

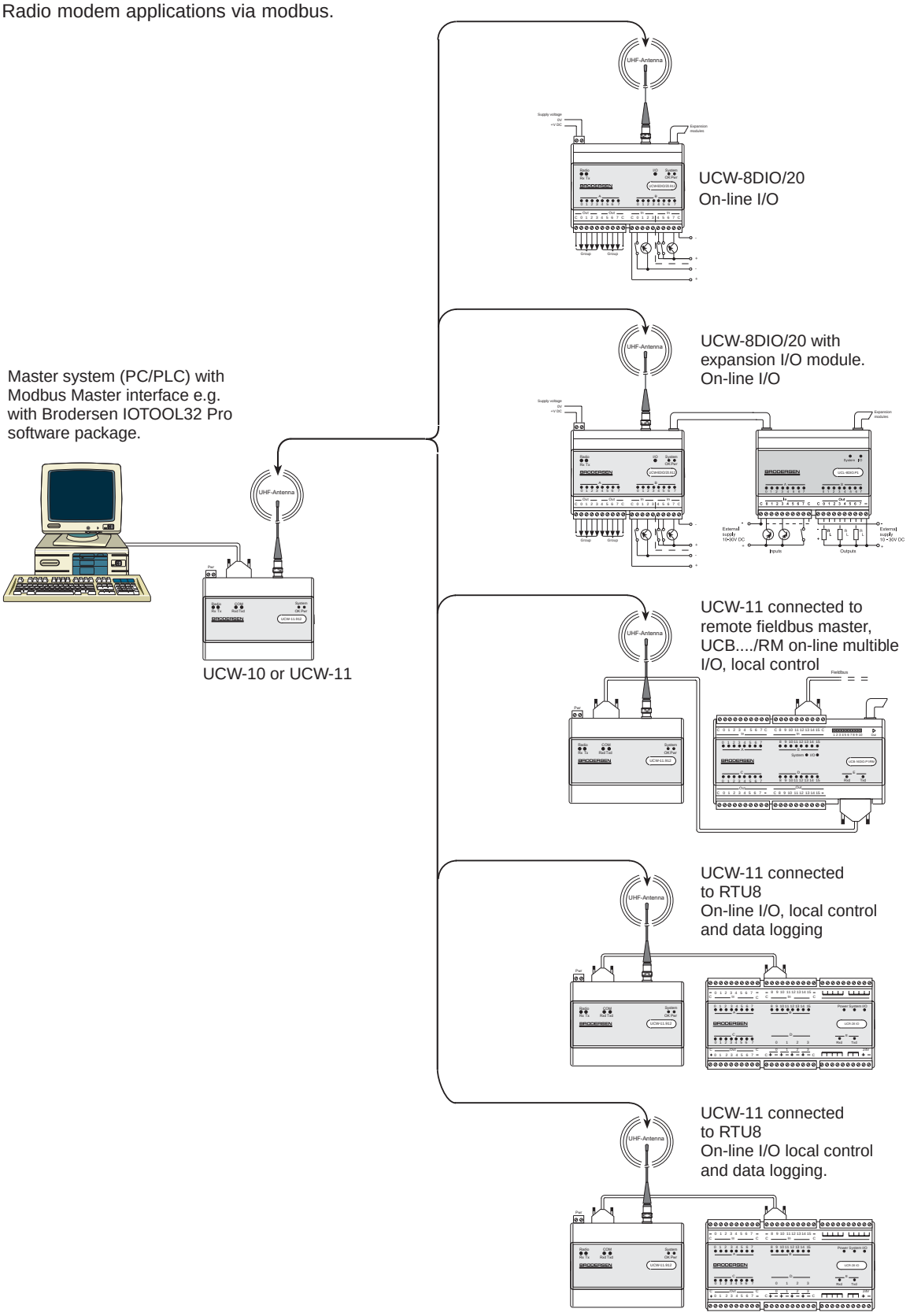
Operating temperature: -20 to +70 °C.

APPLICATIONS

Radio applications examples.
The Brodersen 10mW radio modem series offers different kind of setups and can be used in different kind of application where a master station must control and/or monitor one or more substation. Please find in this document a subset of applications for the Brodersen radio modems and I/O radios.

APPLICATIONS

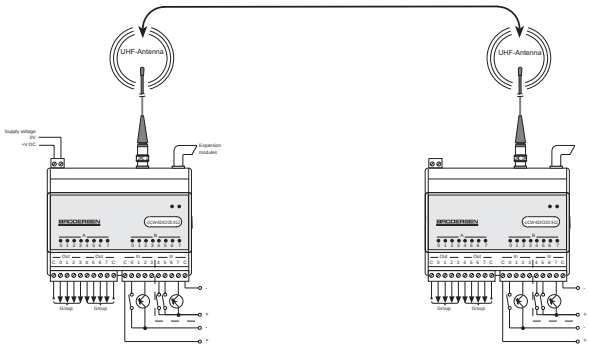
Radio modem applications via modbus.



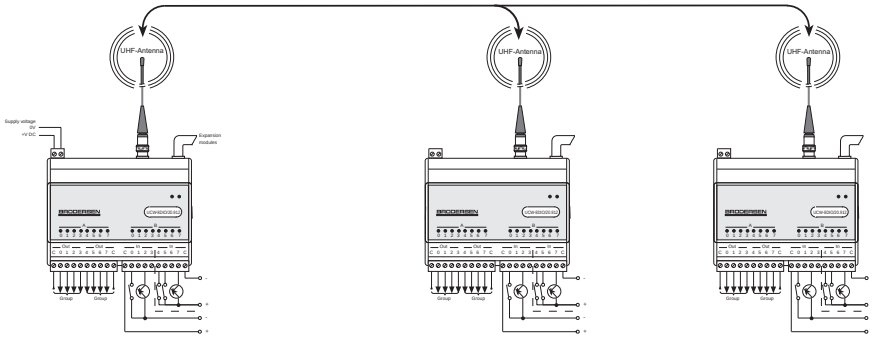
APPLICATIONS

Point-to-point / point-to-multi-point data transfer with UCW-8DIO/20 I/O radio modems.

Point to Point System (Master-Slave)



Point to 2 Points System (Master-2 Slaves)



Point to 4 Points System (Master-4 Slaves)