MODBUS-RTU

applied to

DIXELL devices

General Index

1. GENERAL INFORMATION

1.1 SERIAL CONFIGURATION FOR DIXELL DEVICES

Physical layer	**=**	**RS485 (RS232 for XJ500 system)**
Baud Rate	**=**	**9600 bps (19200 bps for XJ500 system)**
Data Length	**=**	**8 bit**
Parity	**=**	**None**
Stop Bit	**=**	**1**
START/STOP	**=**	**silent interval of 3 characters**
MIN TIME BETWEEN TWO RETRY	**=**	**500 msec**

XJ500 system: when linking by means of RS232 port and ModBUS protocol, RTS and DTR signals have to be kept at logical level LOW.

1.1.1 SLAVE ADDRESSES:

This field range is 1-247. Address 0 is used for the broadcast address. In this case all the slaves execute the command (only Write Holding Register command) but do not return any answer.

1.1.2 EXCEPTIONS CODE

Dixell's devices answers with exception codes when they are not able to execute the last command received. The exception configuration is:

Not implemented function (0x01)

In this case is requested a function that device is not able to support. Es: every time master sends a function different from '**0x03**' or '**0x10**'

Not implemented area (0x02)

In this case is requested a resource absent in the device. Es: every time is requested a Logic Area absent.

Area index not valid (0x03)

In this case the value of the selected resource is out of range. Example:

- Every time is requested an Element of a Logic Area absent.
- More than 5 Elements requested.
- Writing a parameter out of range
- Writing in a Logic Area just reading.

Read/Write error (0x04)

The device didn't succeeded in reading or writing requested operation. Es: every time reading or writing operation (Ram, E2, RTC and etc) is not ending correctly.

Busy state for slave active (0x06)

The device can't execute requested operation because busy in another analogue operation. Master has to repeat the same request in another time.

The exception answer has the following format:

Slave address	Function code OR hex(80)	Exception code	CRC (LSByte)	CRC (MSByte)

2. COMMANDS DESCRIPTION

2.1 READ HOLDING REGISTERS (0X03)

The command has the following format:

Slave Address	Function Code	Register Address (MSByte)	Register Address (LSByte)	Number of Registers (MSByte)	Number of Registers (LSByte)	CRC (LSByte)	CRC (MSByte)

Slave Address: Defined the address of the device to read from.

Function Code: code of the desired function = 0x03

Register address: is the address of the first register to be red

Number of Registers: Defines the number of Elements (Register) that the device has to return (es. 3 = 3 Registers). **No more than 5 Elements allowed**.

CRC : Defined the CRC calculated for the frame data received and has to be used to verify the integrity of the data itself. It is calculated automatically (see page 7)

The answer message has the following format:

Slave address	Function code	NumByte	Byte Data 1		Byte Data n	CRC (LSByte)	CRC (MSByte)

NumByte: Defined the number of bytes followed without CRC.
ByteData: byte data buffer.

2.2 WRITE SINGLE REGISTERS (0X06)

This command is not available for all instruments.

The command has the following format:

Slave Address	Function Code	Register Address (MSByte)	Register Address (LSByte)	DATA (MSByte)	DATA (LSByte)	CRC (LSByte)	CRC (MSByte)

Slave Address: Defined the address of the device to write to.

Function Code: code of the desired function = 0x06

Register address: is the address of the register to write to

Data: is the data to write

CRC : Defined the CRC calculated for the frame data received and has to be used to verify the integrity of the data itself. It is calculated automatically (see page 7)

The answer message is an Eco of the sent command (so it has the same format)

2.3 WRITE HOLDING REGISTER (0X10)

The command has the following format:

Slave address	Function Code	Register Address (MSByte)	Register Address (LSByte)	Number of Registers (MSByte)	Number of Registers (LSByte)	NumByte	DATA	CRC (LSByte)	CRC (MSByte)

Slave Address: Defined the address of the device to write to.

Function Code: code of the desired function = 0x10

Register address: is the address of the first register to write to

Number of Registers. : Defines the number of registers to write to. **No more than 5 Elements allowed**.

NumByte: Defined the number of bytes followed without CRC. The number of bytes has to be double respect the number of addressed Elements (NumByte = 2*Nreg).

CRC:
Defined the CRC calculated for the frame data received and has to be used to verify the integrity of the data itself. It is calculated automatically (see page 7).

The answer has the following format:

Slave Address	Function code	Register Address (MSByte)	Register Address (LSByte)	Number of Registers (MSByte)	Number of Registers (LSByte)	CRC (LSByte)	CRC (MSByte)

2.4 THE CRC

The CRC value is calculated (on the entire message) by the transmitting device, which appends the CRC to the message. The receiving device recalculates a CRC during receipt of the message and compares the calculated value to the one received in the CRC field. If the two values are not equal, an error results.
Here there is the code (in C format) to generate CRC.

```
#define MODBUS_GENERATOR 0xA001
Unsigned int CRC;
void ModbusCalcCRC(unsigned char* Frame,unsigned char LenFrame)
{
        unsigned char CntByte;
        unsigned char j;
        unsigned char bitVal;
        CRC = 0xFFFF;

        For(CntByte=0;CntByte<LenFrame;CntByte++)
                {
                CRC ^= Frame[CntByte];
                for(j=0;j<8;j++)
                {
                bitVal = CRC & 0x0001;
                        CRC = CRC >> 1;
                if(bitVal == 1)
                CRC ^= MODBUS_GENERATOR;
                }
                }
}
```

NOTE:
To uniform interpretation mode of data, all data areas will have the following format:

WORD (single data register)															
MSByte								LSByte							
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0

3. REGISTRY ADDRESSES

3.1 DIRECT READING

In this section are listed the registry addresses to consider when acting directly with the controllers using a PC (or other device) able to communicate directly using RS485 connection.

3.1.1 GENERAL INFORMATION

Device's address represent the "Slave address" to be set in the command structure while the "number of registers" is always 1 (the size of the register is always 1).

3.1.2 DEVICE IDENTIFICATION (READ ONLY)

REGISTER	DESCRIPTION	SIZE	NOTE
0	• Family code • Release firmware	1	MSByte: family code LSByte: release firmware
1	• Device Code (MSWORD)	1	See below
2	• Device Code (LSWORD)	1	See below
3	•		
4	•		
5	• release firmware date	1	Day = bit15 / bit11 Month = bit10 / bit7 Year = bit6 / bit0
6	• EEPROM configuration	1	
7	• Probe presence	1	if bit0=1, the probe 1 is present if bit1=1, the probe 2 is present

DEVICE CODE EXAMPLE: 'X R120C' ….
Device Code (MSWord - MSByte) ASCII code char "**R**"
Device Code (MSWord - LSByte) ASCII code char " " (blank)
Device Code (LSWord) :

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Integer value "**120**" – [range (0-999) (1000 is null value)]										(ASCII code char "**C**") -hex(20)					

3.1.3 ANALOGUE INPUTS (READ ONLY)

REGISTER	DESCRIPTION	SIZE	NOTES
256	• Probe 1 (I°)	1	Probe value 1
257	• Probe 1 (II°)	1	Information about probe 1 (**see table 1**)
258	• Probe 2 (I°)	1	Probe value 2
259	• Probe 2 (II°)	1	Information about probe 2 (**see table 1**)
260	• Probe 3 (I°)	1	Probe value 3
261	• Probe 3 (II°)	1	Information about probe 3 (**see table 1**)

Table 1: Probe status

Byte	Description	
Byte (H) Bit0-1-2-3	Measuring unit: **0**=NC,**1**=°C,**2**=°F,**3**=RH%,**4**=PSI,**5**=BAR,**6**=Rpm,**7**=mA,**8**=A,**9**=mV,**10**=V 11,12,13,14,15=not assigned.	
Byte (H) bit 4	Probe resolution (1) decimal (0) integer	
Byte (H) bit 5-6-7		
Byte (L) bit 0	Low alarm active (1)	Probe error (1-1)
Byte (L) bit 1	High alarm active (1)	
Byte (L) bit 2-3-4-5-6-7		

3.1.4 USER PARAMETERS (READ/WRITE)

REGISTER	DESCRIPTION	SIZE	NOTES
768	• first parameter value	1	For meaning, limits and range see the device specifications
769	• second parameter value	1	For meaning, limits and range see the device specifications
770	• third parameter value	1	For meaning, limits and range see the device specifications
N	• nth parameter value	1	For meaning, limits and range see the device specifications

NOTE: The list of parameter of all the DIXELL controllers starts at registry 768. Description of the parameter (and its function) depends on the parameter list of the instrument used.

3.1.5 DEVICE STATUS AND FUNCTIONS (READ-WRITE)

The status of the controller can be modified trough the RS485, for instance is possible to start a defrost cycle, or to lock/unlock the keyboard or to turn the device On or OFF.
To enable/disable a function or a status you have to set the relevant bit of the MSByte to 1 (enable) or to 0 (disable).

NOTE: The writing of the status bit is allowed only when the relative bit of the LSByte is set to 1.

REGISTER	DESCRIPTION	SIZE	NOTE
1280	• slave status (I°)	1	**MSByte states the operating status of the device (see Table 2)**
1281	• slave status (II°)	1	**MSByte states the operating status of the device (see Table 2)**
1282	• slave status (III°)	1	**MSByte states the operating status of the device (see Table 2)**

Table 2: Device status / function

Register 1280	**Device status**		
MSByte	**STATUS**	**LSByte**	**ENABLE MODIFY**
Bit0	Device ON (1) OFF (0)	*bit0*	
Bit1	Defrost active (1).	*bit1*	
Bit2	Fast freezing active (1).	*bit2*	
Bit3	Keyboard lock (1).	*bit3*	
Bit4	Reset alarms (1)	*bit4*	
Bit5		*bit5*	
Bit6	Energy Saving active (1)	*bit6*	
Bit7	Digital input status active (1)	*bit7*	

Register 1281	**Device functions**		
MSByte	**STATUS**	**LSByte**	**ENABLE MODIFY**
Bit0	On (1) / Off (0) acquisition (XJ500 only)	*bit0*	
Bit1	On (1) / Off (0) recording (XJ500 only)	*bit1*	
Bit2	Transparent mode ModBUS (1) (XJ500only)	*bit2*	
Bit3		*Bit3*	
Bit4	main menu (1) (XJ500 only)	*bit4*	
Bit5	“Holiday” Function (1)	*Bit5*	
Bit6	AUX Function (1)	*Bit6*	
Bit7	LIGHT Function (1)	*Bit7*	

Register 1282	**Device functions**		
MSByte	**STATUS**	**LSByte**	**ENABLE MODIFY**
Bit0	Device reset (1)	*bit0*	
Bit1		*bit1*	
Bit2		*bit2*	
bit3		*bit3*	
bit4		*bit4*	
bit5		*bit5*	
bit6		*bit6*	
bit7		*bit7*	

3.1.6 RELAY OUTPUTS STATUS (READ ONLY)

REGISTER	DESCRIPTION	SIZE	NOTE
2048	• relay outputs status (I°)	1	**MSByte states the operating status of the device. (See table 3)**
2049	• relay outputs status (II°)	1	**As above but the meaning of High byte is different…**
2051	• relay outputs status (III°)	1	**As above but the meaning of High byte is different…**

Table 3 : relay outputs

Register 2048	**DEVICE OUTPUT RELAY I°**		
MSByte	**RELAY STATUS**	**LSByte**	**ENABLE MODIFY**
bit0	On/Off relay	*bit0*	
bit1	Defrost 1 relay	*bit1*	
bit2	Defrost 2 relay	*bit2*	
bit3	Alarm relay	*bit3*	
bit4	Light relay	*bit4*	
bit5	Fan relay	*bit5*	
bit6	AUX1 relay	*bit6*	
bit7	AUX2 relay	*bit7*	

Register 2049	**DEVICE OUTPUT RELAY II°**		
MSByte	**RELAY STATUS**	**LSByte**	**ENABLE MODIFY**
Bit0	Load relay 1	*bit0*	
Bit1	Load relay 2	*bit1*	
Bit2	Load relay 3	*bit2*	
Bit3	Load relay 4	*bit3*	
Bit4	Load relay 5	*bit4*	
Bit5	Load relay 6	*bit5*	
Bit6	Relay out 1 (Generic)	*bit6*	
Bit7	Relay out 2 (Generic)	*bit7*	

Register 2051	**DEVICE OUTPUT RELAY III°**		
MSByte	**RELAY STATUS**	**LSByte**	**ENABLE MODIFY**
bit0	Load relay 7	*bit0*	
bit1	Load relay 8	*bit1*	
bit2	Load relay 9	*bit2*	
bit3	Load relay 10	*bit3*	
bit4	Load relay 11	*bit4*	
bit5		*bit5*	
bit6		*bit6*	
bit7		*bit7*	

XF series: Bit 6, register 2048, is the steam generator
XF series: Bit 7, register 2048, is the steam injector
XF series: Bit 6, register 2049, is the steam extractor

3.1.7 REAL TIME CLOCK (READ-WRITE)

REGISTER	DESCRIPTION	SIZE	NOTE
2816	• Seconds / Minutes	1	MSByte = seconds LSByte = minutes
2817	• Hours / Day of week	1	MSByte = hours LSByte = day of week (1-sun 7-sat)
2818	• Day / Month	1	MSByte = day LSByte = month
2819	• Year	1	Year

3.1.8 ALARMS STATUS (READ ONLY)

REGISTER	DESCRIPTION	SIZE	NOTE
3328	• Alarms (I°)	1	Each bit states an alarm **(see table 4)**
3329	• Alarms (II°)	1	Each bit states an alarm **(see table 4)**

Table 4 : alarms

Register 3328	**ALARMS LIST I°**		
MSByte		**LSByte**	
bit0	Load 9 alarm	*bit0*	Load 1 alarm
Bit1	Load 10 alarm	*bit1*	Load 2 alarm
bit2	Load 11 alarm	*bit2*	Load 3 alarm
bit3	Door open or liquid level alarm	*bit3*	Load 4 alarm
bit4	Generic Digital input alarm	*bit4*	Load 5 alarm
bit5	Real Time clock alarm	*bit5*	Load 6 alarm
bit6		*Bit6*	Load 7 alarm
bit7		*Bit7*	Load 8 alarm

Register 3329	**ALARMS LIST II°**		
MSByte		**LSByte**	
Bit0	No link Alarm	*Bit0*	ACQ general alarm (*XJ500*)
bit1	High pressure	*bit1*	ACQ serious alarm (*XJ500*)
Bit2	Low Pressure	*bit2*	REC alarm (*XJ500*)
bit3		*bit3*	REC serious alarm (*XJ500*)
bit4		*bit4*	Printer alarm (XJ500)
bit5		*bit5*	Printer serious alarm (XJ500)
bit6		*bit6*	Fax/Modem alarm (XJ500)
bit7		*bit7*	Fax/Modem serious alarm (XJ500)

3.2 READING CONTROLLERS INFORMATION TROUGH XJ500

Is possible to read information from a net of devices using an XJ500 as RS232-RS485 gateway. The controllers need not to be present in the XJ500 setup.
To act as gateway the XJ500 has to be set in TRANSARENT MODE

3.2.1 GENERAL INFORMATION

- When the XJ500 TRANSPARENT mode is activated, it links the device that is connected to the RS232 serial port to one of the controllers connected to the RS485.
- the transparency of a 232 and a 485 network is complete; each ModBUS command sent to the RS232 serial port of the XJ is repeated to the SLAVE connected on the RS485 output and vice versa for the answer
- baud-rate for the RS232 serial port is 19200bps, while that of the RS485 serial port is 9600bps.
- If the acquisitions/recording are active when the master sends a “transparent start” command, the XJ500 stops RS485 transmission for 10 seconds; when these 10 seconds are over, it exits transparency for time-out. Time-out time is reset at each command, to be forwarded to RS485, is received. Read the XJ500 status to be sure that the transparent mode is activated (register 1281, bit 0 of MSByte).
- if the acquisitions are not active when the master sends a transparency command, the XJ500 will not change its status until it receives a “transparency exit” command or the acquisitions are activated.

3.2.2 TO SET THE XJ500 IN TRANSPARENCY MODE

To the transparent mode function is necessary to set 1 on bit 2 of MSByte of register 1281 of he XJ500.
To exit XJ500 from transparent mode is necessary to set 0 on MSByte of register 1281 of the XJ500.
The address of the XJ500 is given by its “SYSTEM ID” (found in the SETUP\XJ UNIT\IDENTIFICATION menu)

3.3 READING DEVICE INFORMATION INTO XJ500 RUN TIME MEMORY

This section list the registry addresses to use to read information about status and measures of device, that belongs to the XJ500 Setup (so present in its device list), into XJ500 Run time memory.
XJ500 System ID represent the "Slave address" to be set in the command structure. The registry address is 13056 + Adr parameter of the instrument you want to read. The "number of register" to read will give you back information desired following the table below:
EXAMPLE: we want to read *probe 2 value* of a controller (with adr=12) connected to an XJ500 (whose "System ID"=0001). The structure of the reading command will be the following (reefer to page 4 for command general information):

Slave Address	Function Code	Register Address	Number of Registers	CRC
01	**03**	**13068**	**2**	**Automatically calculated**

NOTE: to read the Run time information the XJ500 must be in Acquisition or Recording mode

3.3.1 XJ 500 NETWORK RUN-TIME DEVICE INFORMATION

REGISTER	DESCRIPTION	SIZE	NOTE
1	• Probe 1 value	1	
2	• Probe 2 value	1	
3	• Probe 3 value	1	
4	• Set Point	1	
5	• Probe Status	1	LSBYTE: Probe 1 (*) MSBYTE: Probe 2 (*)
6	• Probe Status	1	LSBYTE: Probe 3 (*) MSBYTE: SET (*)
7	• Alarms (I°)	1	
8	• Alarms (II°)	1	**See table 5**
9	• Status (I°)	1	**See table 5**
10	• Status (II°)	1	**See table 5**

(*) if bit 6=1 the probe resolution is decimal

TABLE 5 : ALARMS FOR XJ500 DEVICE NETWORK

Register 7	**ALARMS**		
MSByte		**LSByte**	
bit0	Load 9 alarm	*Bit0*	Load 1 alarm
bit1	Load 10 alarm	*Bit1*	Load 2 alarm
Bit2	Load 11 alarm	*Bit2*	Load 3 alarm
bit3		*Bit3*	Load 4 alarm
bit4		*bit4*	Load 5 alarm
bit5		*bit5*	Load 6 alarm
bit6		*bit6*	Load 7 alarm
bit7		*bit7*	Load 8 alarm

Register 8	**ALARMS**		
MSByte		**LSByte**	
bit0		*bit0*	**Probe 1**: **01**-Low alarm **10**-High alarm
Bit1		*bit1*	11-Probe failure
bit2	Digital Input alarm	*bit2*	**Probe 2**: **01**-Low alarm **10**-High alarm
bit3	Digital Input alarm	*bit3*	11-Probe failure
bit4	Real Time clock alarm	*bit4*	**Probe 3**: **01**-Low alarm **10**-High alarm
bit5		*bit5*	11-Probe failure
bit6		*Bit6*	
bit7	No Link alarm	*Bit7*	

Register 9	STATUS		
MSByte		**LSByte**	
bit0		*Bit0*	Load 7 Active
bit1		*Bit1*	Load 8 Active
Bit2		*Bit2*	Load 9 Active
bit3		*Bit3*	Digital input (status) active (XJA controller)
bit4		*Bit4*	
bit5		*Bit5*	
bit6		*Bit6*	
bit7		*Bit7*	

Register 10	STATUS		
MSByte		**LSByte**	
bit0	Defrost 1 output active	*bit0*	Device ON/OFF
Bit1	Defrost 2 output active	*Bit1*	Defrost active
bit2	Load 1 output active	*Bit2*	Fast freezing active
bit3	Load 2 output active	*Bit3*	Energy saving active
bit4	Load 3 output active	*Bit4*	Alarm output active
bit5	Load 4 output active	*bit5*	AUX output 1 active
bit6	Load 5 output active	*Bit6*	AUX output 2 active
bit7	Load 6 output active	*Bit7*	Fan output active

3.4 READING DEVICE CONFIGURATION INFO INTO XJ500 MEMORY

The following section state the registry addresses to use to read information about the settings of a device that belongs to the XJ500 Setup and is present in its device list .
XJ500 System ID represent the "Slave address" to be set in the command structure. The registry address is 12800 + Adr parameter of the instrument you want get info about. The "number of register" to read will give you back information desired following the table below:
EXAMPLE: we want to read the *device label* of a controller (with adr = 5) connected to an XJ500 ("System ID" = 0002). The structure of the "read" command is the following (reefer to page 4 for general information about the command):

Slave Address	Function Code	Register Address	Number of Registers	CRC
02	**03**	**12805**	**3**	**Automatically calculated**

3.4.1 XJ500 NETWORK DEVICE SETUP

REGISTER	DESCRIPTION	SIZE	NOTE
1	• Index	8	LSBYTE – relative MSBYTE – absolute
2	• Code		LSBYTE – family code MSBYTE – mask code
3	• Device label (I°)		
4	• Device label (II°)		
5	• General info		**See table 6**
6	• Real configuration (I°)		
7	• Real configuration (II°)		
8	• Probes presence		LSBYTE: probes present MSBYTE: probes enable to recording

TABLE 6 : SETUP FOR XJ500 DEVICE NETWORK

Register General Info	**SETUP**		
MSByte		**LSByte**	
bit0	Save status	*Bit0-3*	Measurement unit **0**=NC,**1**=°C,**2**=°F,**3**=RH%,**4**=PSI,**5**=BAR,**6**=Rpm,**7**=mA,**8**=A,**9**=mV,**10**=V
Bit1	Save alarm (1=yes, 0=no)		
bit2	Synchronise clock enable (1=yes, 0=no)		
bit3	Device enable (1=yes, 0=no)		
bit4		*bit4*	
bit5		*bit5*	
bit6		*Bit6*	Automatic print enable (1=yes, 0=no)
bit7		*Bit7*	