MODBUS-RTU applied to DIXELL devices.

1. COMMANDS DESCRIPTION

1.1 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 device address that received the answer of reading data.

Function Code: code of the desired function = 0x03

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

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 data received. It is calculated

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.

1.2 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 device address that received the answer of reading data.

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 data received. It is calculated

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

1.3 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 device address that received the answer of writing data.

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 data received.

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)

√ Serial configuration for DIXELL controllers

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.

√ Slave addresses:
This field range is 1-247. Address 0 is used for the broadcast address. In this case the slave execute the command (only Write Holding Register command) but doesn't return some response

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

1. 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**'

2. Not implemented area (0x02)
In this case is requested a resource absent in the device. Es: every time is requested a Logic Area absent.

3. 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.

4. 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.

5. 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)

1.4 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 actual value it 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

2. REGISTRY ADDRESSES

In this section are reported the registry addresses to consider when acting directly with the controllers (If the device is connected to an XJ500 this last have to be set in "Transparent Mode", see next page).
Device's address represent the "Slave address" to be set in the command structure while the "number of registers" is always 1 (see command description).

IDENTIFICATION (read only)			
REGISTER	**DESCRIPTION**	**SIZE** (register)	**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)					

ANALOGUE INPUTS (read only)			
Register	**DESCRIPTION**	**SIZE** (register)	**NOTES**
256	• Probe 1 (I°)	1	Probe value 1
257	• Probe 1 (II°)	1	Information about probe 1 (**table 1**)
258	• Probe 2 (I°)	1	Probe value 2
259	• Probe 2 (II°)	1	Information about probe 2 (**table 1**)
260	• Probe 3 (I°)	1	Probe value 3
261	• Probe 3 (II°)	1	Information about probe 3 (**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		

USER PARAMETERS (Read/Write)			
Register	**DESCRIPTION**	**SIZE** (register)	**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: Parameter list meaning depends on the instrument .

In order to enable a function (device ON.OFF, defrost, etc..), you have to set the relevant bit of the MSByte to 1 (enable) or to 0 (disable). The writing of the status bit is allowed only when the relative bit of the LSByte is set to 1.

DEVICE STATUS (read-write)			
Register	**DESCRIPTION**	**SIZE** (Register)	**NOTE**
1280	• slave status (I°)	1	The high bite states the operating status of the device (when reading High byte and Low byte have the same value. When writing low byte states which status elements have to be written). See table 2
1281	• slave status (II°)	1	As above but the meaning of High byte is different…
1282	• slave status (III°)	1	As above but the meaning of High byte is different…

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)	*bit0*	
Bit1	On (1) / Off (0) recording (XJ500)	*bit1*	
Bit2	Transparent mode ModBUS (1)(XJ500)	*bit2*	
Bit3		*Bit3*	
Bit4	main menu (1) (XJ500)	*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*	

XJ500 TRANSPARENT modes:

- 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 (these are not necessarily present in the XJ500 set-up.
- the transparency of a 232-MODBUS and a 485-MODBUS network is complete; rather, each ModBUS command that the master sends to the RS232 serial port of the XJ is repeated to the SLAVE connected to the RS485 output for the reply.
- The transparency of a 232-MODBUS and 485-DIXBUS network is partial; rather, it’s only valid for areas 3-4-5 and for physical commands. Further information can be obtained through areas 50 and 51.
- The baud-rate for the RS232 serial port is 19200bps, while that of the RS485 serial port is 9600bps.
- If the acquisitions 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 updated at each command it receives. Read the XJ500 status to be sure that the transparent mode is activated.
- if the acquisitions are 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.

RELAY OUTPUTS STATUS (read)			
Register	**DESCRIPTION**	**SIZE** (Register)	**NOTE**
2048	• relay outputs status (I°)	1	The high bite 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…
2050	• relay outputs status (III°)	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 2050	**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

EAL TIME CLOCK (read-write)			
Register	**DESCRIPTION**	**SIZE** (Register)	**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

ALARMS STATUS (read)			
Register	**DESCRIPTION**	**SIZE** (Register)	**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)

The following section state the registry addresses to consider when reading information about controllers connected to an XJ500.
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 to read. 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 address 5) connected to an XJ500 (whose “System ID” is 0002). The structure of the reading command will be the following (please reefer to page 2):

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

XJ500 NETWORK SETUP DEVICE (read address 12800+Adr)			
Register	**DESCRIPTION**	**SIZE** (register)	**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 5**
6	• Real configuration (I°)		
7	• Real configuration (II°)		
8	• Probes presence		LSByte: probes present MSByte: probes enable to recording

TABLE 5 : 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		
bit2	Synchronise clock enable		
bit3	Device enable		
bit4		*bit4*	
bit5		*bit5*	
bit6		*Bit6*	Automatic print enable
bit7		*Bit7*	

The following section state the registry addresses to consider when reading information about controllers connected to an XJ500.
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 address 12) connected to an XJ500 (whose "System ID" is 0001). The structure of the reading command will be the following (please reefer to page 2):

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

XJ 500 NETWORK RUN-TIME DEVICE INFORMATION (read address 13056+Adr)			
Register	**DESCRIPTION**	**SIZE** (Register)	**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 6**
9	• Status (I°)	1	**See table 6**
10	• Status (II°)	1	**See table 6**

(*) for each status byte, if bit 6=1 the probe resolution is decimal

TABLE 6 : ALARMS FOR XJ500 DEVICE NETWORK

Register Alarms (I°)	**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 Alarms (II°)		**ALARMS**	
MSByte		**LSByte**	
bit0		*bit0*	**Probe 1**: **1**-LA **2**-HA **3**-PF
Bit1		*bit1*	
bit2	Digital Input alarm	*bit2*	**Probe 2**: **1**-LA **2**-HA **3**-PF
bit3	Digital Input alarm	*bit3*	
bit4	Real Time clock alarm	*bit4*	**Probe 3**: **1**-LA **2**-HA **3**-PF
bit5		*bit5*	
bit6		*Bit6*	
bit7	No Link alarm	*Bit7*	

Register Status (I°)		**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 Status (II°)		**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