MODBus RTU for AKOCAM and AKOPRO controllers

1. INTRODUCTION

The purpose of this document is to describe to the user the functioning of the MODBus RTU series communications protocol implemented by AKO in AKOCAM (AKO-15613, AKO-156131, AKO-15633, AKO-156331 and AKO-156332) and AKOPRO (AKO-15640, AKO-15643, AKO1565x and AKO1568x)controllers. It is assumed in this document that a user wishing to interact with any of our systems with communication capacity has a minimum knowledge of the protocol.

2. VERSIONS COVERED

From version 4.0.1.

3. TECHHNICAL SPECIFICATIONS

3.1 RS-485 COMMUNICATIONS

At the hardware level, AKOCAM can be connected to other systems via an RS-485 communications bus. This is a multi-point connection with a maximum distance o 1200 m. This bus configuration must be exactly as detailed in the following table:

RS-485 SERIES CONFIGURATION	
Baud Rate	9600 bauds
Data length	8 bits
Parity bit	No
Stop bits	1 bit

3.2 MODBus PROTOCOL

The protocol defines a network configuration in which a network administrator device (master) cohabits with one or several slaves, up to a maximum of 32 devices connected in network (250 where placing repeaters on the RS-485 network).

Of the two transmission modes defined by the protocol: ASCII and RTU (Remote terminal unit), AKO adopts RTU. We should point out that on a network of devices connected by means of the MODBUS protocol devices that use different transmission modes cannot be shared.

The datagram format in RTU mode is:

Frame Start	Address	Function	Data	CRC	Frame End
3.5T*	1 byte Range [1..249]	1 full	Max 125 full	1 full	3.5T*

Maximum length 255 bytes

- *NOTE: the minimum data unit is the full unit (2 bytes)*

* T being the tranmission time for one character.

4. MODB FUNCTIONS DEFINED

AKO administrates its devices using several basic functions of the MODBus protocol:

Function	Definition	How it works
03	Read Holding Registers	Reads multiple registers
06	Preset Single Register	Writes a register
16	Preset Multiple Registers	Writes multiple registers

4.1 FUNCTION 03: Read Holding Registers

This function code is used to read the content of a continual block of registers in a remote device. In the data request executed by the network's master device, MODBus indicates the initial register and the total number of registers to read. In the response to the request data registers are packaged in full format, i.e., 2 bytes per register, with the binary content left-justified in each byte. For each register the first byte contains the higher order bits and the second the lower order bits.

Read Register Request Format		
Function Code	Size 1 Byte	0x03
Initial Register	Size 2 Bytes	Range in Hexadecimal [0x0000:0xFFFF] Range in Decimal [0:65535]
No. Registers	Size 2 Bytes	1 to 125 [0x7D in hexadecimal]

Read Register Response Format		
Function Code	Size 1 Byte	0x03
No. of Bytes	Size 1 Byte	2 x N*
No. Registers	N* x 2 Bytes	

* N = Number of registers.

Error in Read Register Request Format		
Error Code	Size 1 Byte	0x83
Exception Code	Size 1 Byte	01 or 02 or 03 or 04

4.2 FUNCTION 06: Preset Single Register

This function code is used to read the content of a continual block of registers in a remote device. In the data request executed by the network's master device, MODBus indicates the initial register and the total number of registers to read. In the response to the request data registers are packaged in full format, i.e., 2 bytes per register, with the binary content left-justified in each byte. For each register the first byte contains the higher order bits and the second the lower order bits.

Write Register Request Format		
Function Code	Size 1 Byte	0x06
Register Index	Size 2 Bytes	Range in Hexadecimal [0x0000:0xFFFF] Range in Decimal [0:65535]
Register value	Size 2 Bytes	Range in Hexadecimal [0x0000:0xFFFF] Range in Decimal [0:65535]

Write Register Response Format		
Function Code	Size 1 Byte	0x06
Register Index	Size 2 Bytes	Range in Hexadecimal [0x0000:0xFFFF] Range in Decimal [0:65535]
Register value	Size 2 Bytes	Range in Hexadecimal [0x0000:0xFFFF] Range in Decimal [0:65535]

Error in Write Register Request Format		
Error Code	Size 1 Byte	0x86
Exception Code	Size 1 Byte	01 or 02 or 03 or 04

4.3 FUNCTION 16: Write Multiple Registers

This function code is used to read the content of a continual block of registers in a remote device (maximum length from 1 to 123 registers). In the data request executed by the network's master device, MODBus indicates the initial register and the total number of registers to write. In the response to the request data registers are packaged in full format, i.e., 2 bytes per register, with the binary content left-justified in each byte. For each register the first byte contains the higher order bits and the second the lower order bits.

Write Register Request Format		
Function Code	Size 1 Byte	16 [0x10 in Hexadecimal]
Initial Register	Size 2 Bytes	Range in Hexadecimal [0x0001:0x007B] Range in Decimal [0:123]
No. Registers	Size 2 Bytes	2 x N*
Value of Registers	N* x 2 Bytes	value

* N = Number of registers.

Write Register Response Format		
Function Code	Size 1 Byte	16 [0x10 in Hexadecimal]
Initial Register	Size 2 Bytes	2 x N*
No. Registers	Size 2 Bytes	Range in Hexadecimal [0x0001:0x007B] Range in Decimal [0:123]

* N = Number of registers.

Error in Write Register Request Format		
Error Code	Size 1 Byte	0x90
Exception Code	1 byte	01 or 02 or 03 or 04

5. PARAMETERS OF AKOCAM/AKOPRO CONTROLLERS

Symbols used:

FIELD	MEANING
Unit	Basic measuring unit used in the parameter.
Flow	Indicates whether the parameter is a write (W) read (R) or both (RW).
Index	Access index, the "+" sign indicates the number of registers to read/write (by default 1).
Function	Modbus function code [mode of accessing the data logger's internal registers].
Value	Values assignable to the parameter defined.

5.1 GENERAL STATUS

		MODBUS COMMUNICATION			
Description	**Unit**	**FLOW**	**INDEX**	**FUNCTION**	**VALUE**
Program version		R	68	03	
Password to access programming menu		RW	54	03/06	-
Password to access the set point		RW	55	03/06	-
Recording interval (min.)	min.	RW	57	03/06	-
Address for systems with communication		RW	58	03/06	-
Connected probes		RW	60	03/06	0= Probe 1 1= Probe 1 & 2 2= Probe 1 & 3 3= Probe 1,2 & 3
Probe to display:		RW	61	03/06	1= Probe 1 2= Probe 2 3= Probe 3
Display mode		RW	62	03/06	0= One probe and clock 1= One probe and text 2= Sensors, clock & text
Input Units		RW	63	03/06	0= ºC 1= ºF
Decimal point		RW	64	03/06	0= No 1=Yes
Probe setting		Rw	65	03/06	0=TEMP on S1/REG on S3 1=TEMP and REG on S3
Delay of all functions On power up	min.	RW	66	03/06	
Type of operation		RW	67	03/06	0= Direct (cold) 1= Reverse (heat)
Duration of continuous cycle	h.	RW	69	03/06	
Set point During energy saving	ºC/ºF	RW	70	03/06	
Duration of energy saving	h.	RW	71	03/06	
HACCP event recording delay after temperature alarm	h.	RW	72	03/06	

5.2 LANGUAGE

		MODBUS COMMUNICATION			
Description	**Unit**	**FLOW**	**INDEX**	**FUNCTION**	**VALUE**
Language		RW	73	03/06	1= ESP 2= ENG 3= FRA 4= DEU

5.3 CLOCK

		MODBUS COMMUNICATION			
Description	**Unit**	**FLOW**	**INDEX**	**FUNCTION**	**VALUE**
Date (Year)		RW	74 + 1	03/16	
Date (Month)		RW	74 + 2	03/16	
Date (Day)		RW	74 +3	03/16	
Time (Day of Week)		RW	75 +1	03/16	
Time (Hour)		RW	75 +2	03/16	
Time (minute)		RW	75 +3	03/16	
Defrost 1 (day)		RW	76 +1	03/16	
Defrost 1 (hour)		RW	76 +2	03/16	
Defrost 1 (minute)		RW	76 +3	03/16	
Defrost 2 (day)		RW	77 +1	03/16	
Defrost 2 (hour)		RW	77 +2	03/16	
Defrost 2 (minute)		RW	77 +3	03/16	
Defrost 3 (day)		RW	78 +1	03/16	
Defrost 3 (hour)		RW	78 +2	03/16	
Defrost 3 (minute)		RW	78 +3	03/16	
Defrost 4 (day)		RW	79 +1	03/16	
Defrost 4 (hour)		RW	79 +2	03/16	
Defrost 4 (minute)		RW	79 +3	03/16	
Defrost 5 (day)		RW	80 +1	03/16	
Defrost 5 (hour)		RW	80 +2	03/16	
Defrost 5 (minute)		RW	80 +3	03/16	
Defrost 6 (day)		RW	81 +1	03/16	
Defrost 6 (hour)		RW	81 +2	03/16	
Defrost 6 (minute)		RW	81 +3	03/16	
Defrost 7 (day)		RW	82 +1	03/16	
Defrost 7 (hour)		RW	82 +2	03/16	
Defrost 7 (minute)		RW	82 +3	03/16	
Defrost 8 (day)		RW	83 +1	03/16	
Defrost 8 (hour)		RW	83 +2	03/16	
Defrost 8 (minute)		RW	83 +3	03/16	
Defrost 9 (day)		RW	84 +1	03/16	
Defrost 9 (hour)		RW	84 +2	03/16	
Defrost 9 (minute)		RW	84 +3	03/16	

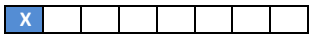
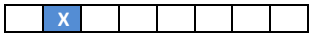
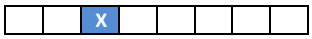
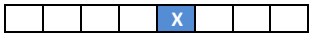
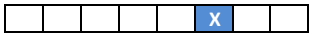
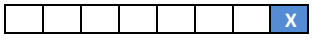
5.4 CURRENT TEMPERATURES REGISTER

		MODBUS COMMUNICATION			
Description	**Unit**	**FLOW**	**INDEX**	**FUNCTION**	**VALUE**
Temperature probe 1		R	101	3	Temperature x 10
Temperature probe 2		R	102	3	Temperature x 10
Temperature probe 3		R	103	3	Temperature x 10

5.5 ALARM REGISTER.

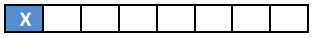
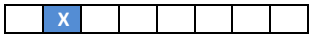
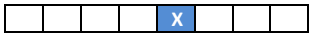
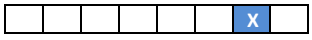
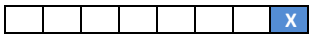
		MODBUS COMMUNICATION			
Description	**Unit**	**FLOW**	**INDEX**	**FUNCTION**	**VALUE**
Alarms Register		R	105	03	

Low byte

Alarm bit	Meaning of alarm register bits
	-
	Comp. Safe. Alarm
	L. Pressure alarm:
	External alarm
	Severe external alarm
	Probe 3 alarm (1)*
	Probe 2 alarm
	Probe 1 alarm (3)*

*** According to "Probe setting "parameter.**

High byte.

Alarm bit	Meaning of alarm register bits
	-
	-
	-
	-
	-
	-
	Low temp. Alarm
	High temp. Alarm

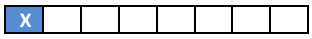
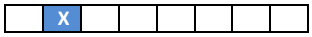
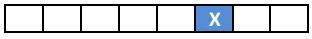
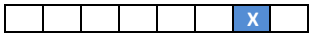
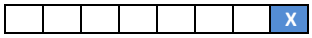
Alarms are effective when the alarm relay turns on (delay).

5.6 RELAY AND MODEL REGISTER.

AKOCAM Model: High Byte Register 106 where:

58

Relay output status: Low Byte Register 106 where:

Alarm bit	Meaning of alarm register bits
	-
	Auxiliary relay
	Alarm relay
	Fan Relay
	Light Relay
	Defrost Relay
	Buzzer
	Com Relay

32767 register= 15658. 3PH series

5.7 COOLING REGISTERS.

		MODBUS COMMUNICATION			
Description	**Unit**	**FLOW**	**INDEX**	**FUNCTION**	**VALUE**
Set Point	ºC/ºF	RW	1	03/06	
Probe 1 differential (histeresis)	ºC/ºF	RW	2	03/06	
Calibration of probe 1	ºC/ºF	RW	3	03/06	
Upper blocking of the set point	ºC/ºF	RW	4	03/06	
Lower blocking of the set point	ºC/ºF	RW	5	03/06	
Type of delay for protection of compressor	ºC/ºF	RW	6	03/06	0= OFF/ON 1= ON
Compression protection delay time	min.	RW	7	03/06	
"COOL" relay time (compressor) On where probe 1 faulty (if 0 the relay will always be Off, disconnected)	min.	RW	8	03/06	
"COOL" relay time (compressor) On where probe 1 faulty (if 0 the relay will always be On, disconnected)	min.	RW	9	03/06	
Compressor shutdown on opening door?		RW	10	03/06	0= No (connected) 1=Yes (disconnected)

5.8 DEFROST REGISTERS

		MODBUS COMMUNICATION			
Description	**Unit**	**FLOW**	**INDEX**	**FUNCTION**	**VALUE**
Defrost type		RW	11	03/06	0= Electrical heater 1= Reverse cycle
Defrost count		RW	12	03/06	0= frequency 1= Compressor sum 2= Real time clock
Defrost frequency (Time between 2 starts)	h.	RW	13	03/06	
Maximum duration of defrost	min.	RW	14	03/06	
Message during defrost		RW	15	03/06	0= Current temp. 1= Defrost start temp. 2= DEFROST Message
Maximum duration of message (Time added at the end of defrost)	min.	RW	16	03/06	
Final defrost temperature for probe 2	ºC/ºF	RW	17	03/06	
Defrost on connecting equipment		RW	18	03/06	0= No 1= Yes
Defrost start delay on system power up	min.	RW	19	03/06	
Indication of defrost ended by time		RW	20	03/06	0= No 1= Yes
Drip time	min.	RW	21	03/06	

5.9 FAN REGISTERS.

		MODBUS COMMUNICATION			
Description	**Unit**	**FLOW**	**INDEX**	**FUNCTION**	**VALUE**
Fan shutdown temperature via probe 2 if configured	ºC/ºF	RW	22	03/06	
Probe 2 differential	ºC/ºF	RW	23	03/06	
Stop fans on compressor shutdown?		RW	24	03/06	0= No 1= Yes
Status of fans during defrost		RW	25	03/06	0= Disconnected 1= Connected
Start delay after defrost	min.	RW	26	03/06	
Fan shutdown on opening door?		RW	27	03/06	0= No 1= Yes

5.10 ALARM REGISTER.

		MODBUS COMMUNICATION			
Description	**Unit**	**FLOW**	**INDEX**	**FUNCTION**	**VALUE**
Configuration of temperature alarms		R	28	03/06	0= Relative to SP 1= Absolute
Maximum alarm on probe 1	ºC/ºF	R	29	03/06	
Minimum alarm on probe 1	ºC/ºF	R	30	03/06	
Temperature Alarm Differential	ºC/ºF	R	31	03/06	
Temperature alarms delay from when they should be activated by temperature	min.	R	32	03/06	
Temperature alarm delay during start-up.	min.	R	33	03/06	
Temperature alarm delay from completion of a defrost	min.	R	34	03/06	
Temperature alarm delay from deactivation of the digital input	min.	R	35	03/06	
Temperature alarm delay from activation of the digital input	min.	R	36	03/06	
Alarm relay status		R	37	03/06	0= Disconnected 1= Connected

5.11 DIGITAL INPUT REGISTERS.

		MODBUS COMMUNICATION			
Description	**Unit**	**FLOW**	**INDEX**	**FUNCTION**	**VALUE**
Configuring digital input 1		RW	38	03/06	0= Disabled 1= Door Contact 2= External alarm 3= Severe external alarm 4= Remote defrost 5= Remote energy saving 6= AUX activation 7= Low pressure input 8=Thermostat control
Delay to digital input no. 1 alarms	min.	RW	39	03/06	
Polarity of digital input 1		RW	40	03/06	0= Normally open 1= Normally closed
Configuring digital input 2		RW	41	03/06	0= Disabled 1= Door Contact 2= External alarm 3= Severe external alarm 4= Remote defrost 5= Remote energy saving 6= AUX activation 7= Low pressure input 8=Thermostat control
Delay to digital input no. 2 alarms	min.	RW	42	03/06	
Polarity of digital input 2		RW	43	03/06	0= Normally open 1= Normally closed
Inact. With door open	min.	RW	44	03/06	
Cold room light timing	min.	RW	45	03/06	

5.12 AUXILIARY RELAY REGISTERS.

		MODBUS COMMUNICATION			
Description	**Unit**	**FLOW**	**INDEX**	**FUNCTION**	**VALUE**
Configuration of AUX relay		RW	46	03	0= Disabled 1= Activated by key 2= Activated by input 3= Equal state equipment 4= 2nd defrost 5= Pump down control 6= Equal compressor state
Maximum duration of defrost 2	min.	RW	47	03	
Final temperature of defrost 2	ºC/ºF	RW	48	03	
Defrost 2 probe		RW	49	03	0= Disabled 1= Probe 2 2= Probe 3
Pump down duration	seg.	RW	50	03	
Pump down ON delay	seg.	RW	51	03	
Press. controller config		RW	52	03/06	0= Combined HP-LP 1= LP indep. AC input 2= LP indep. digital input

5.13 READING OF THE REGISTERS STORED IN THE RECORDING MEMORY.

The data logger's recording memory is made up of 366 registers and the recording path is cyclic and therefore when the memory fills up recording continues in the older registers.

To locate the register the information is being stored in, and therefore, the register that contains the most recent data, we access position 200 (current register) reading with the READ HOLDING REGISTERS function. Position 566 will be the position of the oldest register.

Description Description of Register Header Data	Function
(1) Number of samples stored (max. 96) 1BYTE X | | | | | | | | The highest bit indicates the status: X =1 channel enabled X = 0 Channel disabled.	Read Holding Registers
(2) (1) + number of samples, date, time, sampling time. YEAR (00 - 99) 1BYTE MES (01 - 12) 1BYTE DAY (01 -31) 1BYTE HOUR (00 -24) 1BYTE MINUTE (00 -59) 1BYTE SAMPLING TIME (1 - 5 - 15 - 30) 1BYTE	Same
(3) (2) + description (of probe 1 only) 10 BYTES	Same
(4) (3) + probe units 1*N [N is the number of probes]. - The maximum would be for 10 probes (65 bytes in total) 2*N BYTES	Same

- Note: we can read all the information in a single frame, acquiring the total possible bytes.

To read the content of each of the registers we use the READ FILE RECORD function to capture the number of samples we have as indicated by positions 20000 to 21199.

5.13.1 REQUESTING A REGISTER'S SAMPLES.

These are located in position 600 (samples referring to the current block) and 966.

Writes a register	Format
96 samples	Signed Int Temperature value x 10 (inverted)
Register 600 has position 200 as header data ..... Register 966 has position 566 as header data	in order

5.14 EXAMPLES OF ACCESS TO DATALOGGER.

Examples of access to headers:

200 +1 = number of current block (total 2 bytes).
200 +5 = number of current block (2 bytes) + header of current block (8 bytes) (total 10 bytes).
200 +9 = no. of current block + header of current block + header of current block - 1 (total 18 bytes).
201 +1 = number of current block –1, (2 bytes).
201 +5 = number of current block–1 + header of current block -1 (total 10 bytes).
201 +9 = number of current block–1 + header of current block –1+ header of current block - 2 (total 18 bytes).

Examples of access to registers:

600 + N = block samples 0, (header + temperatures).
601 + N = block samples 1, (header + temperatures).

5.15 ACCESS TO HACCP

There are 16 registers in positions MODBus 1000 and 1016 where:

HACCP register data (10 bytes)
1 BYTE = YEAR 1 BYTE = MONTH 1 BYTE = DAY 1 BYTE = HOUR 1 BYTE = MINUTE
1 BYTE DURATION
1 STANDARD BYTE [0 = NORMAL 1 = LACK OF CURRENT]
2 BYTES [FORMAT = TEMPERATURE VALUE X 10]

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