1.- ORION ITALIA SERIES MODBUS PROTOCOL.

The ORION ITALIA SERIES implement a subset of the AEG Modicon Modbus serial communication standard. Many devices support this protocol directly with suitable interface card, allowing direct connection of relays. The Modbus protocol is hardware-independent; that is, the physical layer can be any of variety of standard hardware configurations, this includes RS232, RS422, RS485, fibber optics, etc. The ORION ITALIA RELAYS include rear terminals that can be RS232 or RS485 ports. Modbus is a single master multiple slave protocol suitable for a multi-drop configuration as provided by RS485 hardware. In this configuration up to 32 slaves can be daisy-chained together on a single communication channel.

The IPR-A - ORION ITALIA Relay is always a Modbus slave. It cannot be programmed as a Modbus master. The Modbus protocol exists in two versions: Remote Terminal Unit (RTU, binary) and ASCII. Only the RTU version is supported by the Orion Italia Relay. Monitoring, programming and control functions are possible using read and write register commands.

2.- ELECTRICAL INTERFACE.

The hardware or electrical interface is any of the following:

a. Two two-wire RS485 for Com2 and Com3 rear terminals connector.

b. One RS232 for Com1 rear terminal connector.

In a two-wire RS485 link, data flow is bi-directional. RS232 port uses 3-pin Rx for receive data, Tx for Transmit data and signal ground. Different ports Com1, Com2 and Com3 can be used at the same time. Data flow is half duplex. That is, data is never transmitted and received at the same time.

In RS485 lines should be connected in a daisy chain configuration (avoid star connections) with terminating resistors and capacitors installed each end of the link, i.e. at the master end and the slave farthest from the master. That value of the terminating resistors should be equal to the characteristic impedance of the line. This is approximately 120 Ohms for standard 24 AWG twisted pair wire. The value of the capacitors should be 1 nF. Shielded wire should always be used to minimize noise. Polarity is important in RS485 communications. See figure below for more details.

3.- DATA FRAME FORMAT AND DATA RATE.

One data frame of an asynchronous transmission to or from a Orion Italia Relay consists of 1 start bit, 8 data bits, not parity and 1 stop bit (8N1). This produces a 10 bit frame. This is important for the correct transmission of the data.

The rear RS485 communication ports of the Orion Italia Relay supports operation at 1200,2400,4800, 9600 and 19200 baud.

4.- DATA PACKET FORMAT.

A complete request/response consists of the following bytes transmitted as separate data frames:

Master Query Message:

SLAVE ADDRESS	(1 byte)
FUNCTION CODE	(1 byte)
DATA	(variable number of bytes depending on FUNCTION CODE)
CRC	(2 bytes)

Slave Response Message:

SLAVE ADDRESS	(1 byte)
FUNCTION CODE	(1 byte)
DATA	(variable number of bytes depending on FUNCTION CODE)
CRC	(2 bytes)

A message is terminated when no data is received for a period of 3½ character transmission times. Consequently, the transmitting device must not allow gaps between bytes larger than this interval (about 3ms at 9600 baud).

Slave Address: This is the first byte of every message. This byte represents the user-assigned address of the slave device that is to receive a message sent by the master. Each slave device must be assigned a unique address, and only the addressed slave will respond to a message that starts with its address. In a master query message the SLAVE ADDRESS represents the address of the slave to which the request is being sent. In a slave response message the SLAVE ADDRESS is a confirmation representing the address of the slave that is sending the response. A master query message with a SLAVE ADDRESS of 0 indicates a broadcast command. All slaves on the communication link will take action based on the message, but no one will respond to the master.

Function Code: This is the second byte of every message. Modbus defines function codes of 1 to 127. The Orion Italia Relay implements some of this functions. See section 7 for details of the function codes supported by the Orion Italia Relay Series Modbus Protocol. In a master query message the FUNCTIONS CODE tells the slave what action to perform. In a slave response message, if the FUNCTION CODE sent from the slave is the same as the FUNCTION CODE sent from the master then the slave performed the function as requested.

Data: This will be a variable number of bytes on the FUNCTION CODE. This may include actual values, setpoints or addresses sent by the master to the slave or by the slave to the master. See section 7 for a description of the Orion-supported functions and the data required for each.

CRC: This is a two byte error checking code. CRC is sent LSByte first followed by the MSByte. The RTU version of Modbus includes a two byte CRC-16 (16 bit cyclic redundancy check) with every message. The CRC-16 algorithm essentially treats the entire data stream (data bits only; start, stop and parity ignored) as one continuous binary number. This number is first shifted left 16 bits and then divided by a characteristic polynomial (11000000000000101B). The 16 bit remainder of the division is appended to the end of the message, MSByte first. The resulting message including CRC, when divided by the same polynomial at the receiver will give a zero remainder if no transmission errors have occurred. If a Orion Modbus slave device receives a message in which an error is indicated by the CRC-16 calculation, the slave device will not respond to the message. A CRC-16 error indicates that one or more bytes of the message were received incorrectly and thus the entire message should be ignored in order to avoid the slave device performing any incorrect operation. The CRC-16 calculation is an industry standard method used for error detection. An algorithm is included in section 5 CRC-16 algorithm to assist programmers in situations where no standard CRC-16 calculation routines are available.

5.- CRC-16 ALGORITHM

Once the following algorithm is completed, the working register "A" will contain the CRC value to be transmitted. Note that this algorithm requires the characteristic polynomial to be reverse bit ordered. The most significant bit of the characteristic polynomial is dropped, since it does not affect the value of the remainder. The following symbols are used in the algorithm:

Symbols:

-->	data transfer
A	16 bit working register
Alow	low order byte of A
Ahigh	high order byte of A
CRC	16 bit CRC-16 value
i,j	loop counter
(+)	logical EXCLUSIVE-OR operator
N	total number of data bytes
Di	i-th data byte (i=0 to N-1)
G	16 bit characteristic polynomial =1010000000000001(binary) with MSbit dropped and bit order reversed
shr(x)	right shit operator (the LSbit of x is shifted into a carry lag, a '0' is shifted into the MSbit of x, all other bits are shifted right one location)

Algorithm:

1.	**FFFF(hex) --> A**	
2.	**O --> i**	
3.	**O --> j**	
4.	**Di (+) Alow --> Alow**	
5.	**j + 1 --> j**	
6.	**shr (A)**	
7.	**Is there a carry ?**	**No: go to step 8**
		Yes: G (+) A --> A and continue
8.	**Is j = 8 ?**	**No: go to 5**
		Yes: continue
9.	**i + 1 --> i**	
10.	**Is i = N ?**	**No: go to 3**
		Yes: continue
11.	**A ----> CRC**	

6.- MESSAGE TIMING

Communication message synchronization is maintained by timing constraints. The receiving device must measure the time between the reception of characters. If three and one half character times elapse without a new character or completion of the message, then the communication link must be reset (i.e. all slaves start listening for a new query message from the master). Thus at 1200 baud a delay of greater than 3.5 x 1/1200 x 10 = 29.2 ms cause the communication link to be reset. At 9600 baud a delay of greater than 3.5 x 1/9600 x 10 = 3.6 ms will cause the communication link to be reset. Most master query messages will be responded to in less than 50 ms. The maximum time for the Orion Italia Relays to return a slave response message for any function code will never exceed 1 second.

7.- SUPPORTED FUNTION CODES

The second byte of every message is the function code. Modbus defines function codes of 01h to 7Fh. The Orion Italia Relay Modbus protocol supports some of these functions, as summarized in Table No. 1

TABLE No. 1

FUNCTION CODE MODBUS PROT. (HEX)	*FUNCTION CODE ORION ITALIA (HEX)*	*DEFINITION*
03	03	READ SETPOINTS or ACTUAL VALUES
04	04	READ SETPOINTS or ACTUAL VALUES
05	05	EXECUTE OPERATION
06	06	STORE SINGLE SETPOINTS
10	10	STORE MULTIPLES SETPOINTS

Since some programmable logic controllers only support function codes 03h (or 04h) and 10h, most of the above Modbus commands can be performed by reading from or writing to special addresses in the Orion Italia Relay memory map using these function codes.

7.1.- FUNCTION CODE 03H or 04H - READ SETPOINTS OR ACTUAL VALUES.

Modbus implementation: Read Holding Registers

Orion Italia Relay implementation: Read Actual Values or Setpoint

The Orion Italia Relay implementation of Modbus views "holding registers" as any setpoint or actual values register in the Orion Italia Relay memory map. Registers are 16 (two byte) values transmitted high order byte first. Thus all Orion Italia Relay setpoints and actual values in the memory map are sent as two byte registers. This function code allows the master to read one or more consecutive setpoints or actual values from addressed slave device.

The slave response to these function codes is the slave address, function code, a count of the number of data bytes to follow, the data itself and the CRC. Each data item is sent as a two byte number with the high order byte sent first. The CRC is sent as a two byte number with the low order byte sent first.

MESSAGE FORMAT EXAMPLE:

Request to read 4 register values starting address 0102h from slave device 1.

Master query message	Example(hex)	
SLAVE ADDRESS	01	query message for slave 01 = 01h
FUNCTION CODE	03	read Setpoints
DATA STARTING ADDRESS-high order	01	data starting at address 0102h
DATA STARTING ADDRESS-low order byte	02	
NUMBER OF REGISTERS-high order byte	00	4 register value = 4 word total
NUMBER OF REGISTER-low order byte	04	
CRC-low order byte	E4	CRC calculated by the master
CRC-high order byte	35	

If the function code or the address of any of the requested data is illegal, the slave will **not** respond the message. Otherwise, the slave will respond as follows:

Slave response message	Example (hex)	
SLAVE ADDRESS	01	response message from slave 1 = 01h
FUNCTION CODE	03	read Setpoints
BYTE COUNT	08	4 register values = 8 bytes total
DATA #1-high order byte	00	register value in address 0102= 0064h
DATA #1-low order byte	64	
DATA #2-high order byte	00	register value in address 0103=0064h
DATA #2-low order byte	64	
DATA #3-high order byte	03	register value in address 0104=03E8h
DATA #3-low order byte	E8	
DATA #4-high order byte	00	register value in address 0105=0064h
DATA #4-low order byte	64	
CRC-low order byte	40	CRC calculated by the slave
CRC-high order byte	42	

7.2.- FUNCTION CODE 05H - EXECUTE OPERATION

Modbus implementation: Force Single Coil
Orion Italia Relay implementation : Execute Operation

This function code allows the master to request a IPR-A to perform specific command operation. The commands Number Listed in the table 2: Commands; correspond to operations codes for function code 05h.

The Slave Response to this function is to echo the entire master transmission.

TABLE 2. COMMANDS

ACTION	***COMMAND (HEX)***
No Action	00
Remote Reset	01
Remote Trip	02
Set Clock	05
Clear Maintenance Data	08
Clear All Events	09
Clear Pulse Counter	0A
Set Aux1	20
Set Aux2	21
Set Aux3	22

MESSAGE FORMAT EXAMPLE:
Request to Remote Reset IPR-A Relay.

Master query message	Example(hex)	
SLAVE ADDRESS	01	Query message for slave 01 = 01h
FUNCTION CODE	05	Execute Operation
OPERATION CODE-high order	00	Reset Relay Command
OPERATION CODE-low order byte	01	
NUMBER OF REGISTERS-high order byte	FF	Perform Function
NUMBER OF REGISTER-low order byte	00	
CRC-low order byte	DD	CRC calculated by the master
CRC-high order byte	FA	

Slave response message	Example (hex)	
SLAVE ADDRESS	01	Message from slave 01 = 01h
FUNCTION CODE	05	Execute Operation
DATA STARTING ADDRESS-high order	00	Reset Relay Command
DATA STARTING ADDRESS-low order byte	01	
NUMBER OF REGISTERS-high order byte	FF	Perform Function
NUMBER OF REGISTER-low order byte	00	
CRC-low order byte	DD	CRC calculated by theSlave
CRC-high order byte	FA	

7.3.- FUNCTION CODE 06H - STORE SINGLE SETPOINTS

Modbus implementation: Preset Single Register
Orion Italia Relay implementation : Store Single Setpoints

This function code allows the master to store single setpoints into the memory map of the IPR-A. The Slave Response to this function is to echo the entire master transmission.

MESSAGE FORMAT EXAMPLE:
Request slave device 01h to write the value 0190h at setpoint address 0102h

Master query message	Example(hex)	
SLAVE ADDRESS	01	query message for slave 01 = 01h
FUNCTION CODE	06	Store Single Setpoints
DATA STARTING ADDRESS-high order	01	Setpoint Address 0102h
DATA STARTING ADDRESS-low order byte	02	
NUMBER OF REGISTERS-high order byte	01	Data for Address 0102h = 0190h
NUMBER OF REGISTER-low order byte	90	
CRC-low order byte	28	CRC calculated by the master
CRC-high order byte	0A	

Slave response message	Example (hex)	
SLAVE ADDRESS	01	Message from slave 01 = 01h
FUNCTION CODE	06	Store Single Setpoints
DATA STARTING ADDRESS-high order	01	Setpoint Address 0102h
DATA STARTING ADDRESS-low order byte	02	
NUMBER OF REGISTERS-high order byte	01	Data Stored in Address 0102h = 0190h
NUMBER OF REGISTER-low order byte	90	
CRC-low order byte	28	CRC calculated by the Slave
CRC-high order byte	0A	

7.4.- FUNCTION CODE 10H -STORE MULTIPLE SETPOINTS

Modbus implementation: Preset Multiple Register
Orion Italia Relay implementation : Store Multiple Setpoints

This function code allows the master to modify the contest of a one or more consecutive setpoint in the addressed slave device. Setpoint registers are 16 bit (two byte) values transmitted high order byte first.
The IPR-A Setpoint data starts at address 0100h.

To store the value of one or more setpoints in the internal memory of the IPR-A, the following steps shall be realized:
a) First shall be read setpoint group to modify with function 03h or 04h.
b) Then, modify the values of setpoints according to memory map.
c) Send setpoint group back to relay with function 10h.

The IPR-A response to this function code is to echo the slave address, function code, starting address, the number of setpoints stored, and the CRC.

MESSAGE FORMAT AND EXAMPLE:

Request slave device 11h to write the value 0190h at setpoint address 0102h, and the value 012Ch at setpoint address 0103h.

Master query message	Example (hex)
SLAVE ADDRESS	11 query for slave 11h
FUNCTION CODE	10 store multiple setpoint values
DATA STARTING ADDRESS-high order byte	01 data starting at address 0102
DATA STARTING ADDRESS-low order byte	02
NUMBER OF SETPOINTS-high order byte	00 2 setpoint values = 2 word
NUMBER OF SETPOINTS-low order byte	02
BYTE COUNT	04 4 byte of data
DATA #1-high order byte	01 data for address 0102h=012Ch
DATA #1-low order byte	2C
DATA #2-high order byte	01 data for address 0103h=012Ch
DATA #2-low order byte	2C
CRC-low order byte	9E CRC calculated by the master
CRC-high order byte	46

If the function code or the address or value of any of the data, is illegal, the slave will not respond to the message. Otherwise, the slave will respond as follows:

Master query message	Example (hex)
SLAVE ADDRESS	11 Message from slave 11h
FUNCTION CODE	10 store multiple setpoint values
DATA STARTING ADDRESS-high order byte	01 data starting at address 0102h
DATA STARTING ADDRESS-low order byte	02
NUMBER OF SETPOINTS-high order byte	00 2 setpoint values = 2 word
NUMBER OF SETPOINTS-low order byte	02
CRC-low order byte	E1 CRC calculated by the slave
CRC-high order byte	5E

8.- MEMORY MAP INFORMATION

The data stored in the IPR-A is grouped generally on Setpoints, Actual Values and Product ID. Setpoints can be read and written by a master computer. Actual Values & Product ID are read only. All data is stored as two bytes values (16 bit Word). Addresses are listed in hexadecimal. Data values (Setpoint ranges, increments, factory value) are in decimal.

See Memory Map below.

IPR-A1 - MODBUS MEMORY MAP

Add (Hex)	MODBUS REG. ADD (Dec)	Size	Description	Unit	Range	Step	Initial Value	Format	Read/ Write
Product ID									
0000	300001	1 W	Product Code	---	---	---	12	F2	R
0001	300002	1 W	Product Model	---	---	---	2	F2	R
0002	300003	1 W	Version Number	---	---	---	1.07	F6	R
0003	300004	1 W	Product Language	---	---	---	1	F24	R
Commands									
0080	400129	1 W	Command Operation Code	---	---	---	---	F23	R/W
TimeSet									
0090	400145	3 W	Date & Time Preset Data	---	---	---	---	F8	R/W
Common Setpoints									
0100	400257	1 W	Access Code	---	111~999	1	111	F10	R/W
0101	400258	1 W	System Setup	BitField	---	---	544	F9	R/W
0102	400259	1 W	Phase CT Rating Primary	A	5~5000	5	100	F2	R/W
0103	400260	1 W	Ground CT Rating Primary	A	5~5000	5	100	F2	R/W
0104	400261	1 W	Disconnector Nominal Current	A	10~5000	5	100	F2	R/W
0105	400262	1 W	Fuse Nominal Current	A	5~5000	5	100	F2	R/W
0106	400263	1 W	Output Relays Config	BitField	---	---	0	F11	R/W
0107	400264	1 W	TRIP Relay Pulse Time	Sec	0.1 ~ 2.0	0.1	0.2	F4	R/W
0108	400265	1 W	AUX1 Relay Pulse Time	Sec	0.1 ~ 2.0	0.1	0.2	F4	R/W
0109	400266	1 W	AUX2 Relay Pulse Time	Sec	0.1 ~ 2.0	0.1	0.2	F4	R/W
010A	400267	1 W	AUX3 Relay Pulse Time	Sec	0.1 ~ 2.0	0.1	0.2	F4	R/W
010B	400268	1 W	Block Trip Delay	Sec	0.05~1.00	0.01	0.15	F6	R/W
010C	400269	1 W	Reserved						R/W
010D	400270	1 W	Digital Inputs Config	BitField	---	---	0	F12	R/W
010E	400271	1 W	Input 1 Function		0~7	1	0	F13	R/W
010F	400272	1 W	Input 2 Function		0~7	1	0	F13	R/W
0110	400273	1 W	Input 3 Function		0~7	1	0	F13	R/W
0111	400274	1 W	Reserved						R/W
0112	400275	1 W	Reserved						R/W
0113	400276	1 W	Reserved						R/W
0114	400277	1 W	Event Recorder Config	BitField	---	---		F14	R/W
0115	400278	1 W	Breaker Driscrepancy Relays	---	0~7	1	0	F15	R/W
0116	400279	1 W	Breaker Driscrepancy Delay	ms	10~2500	10	1000	F2	R/W
0117	400280	1 W	Mechanical Operations Relays	---	0~7	1	0	F15	R/W
0118	400281	1 W	Mechanical Operations Maximum	---	5~9995	5	3000	F2	R/W
0119	400282	1 W	Accumulated Amp Relays	---	0~7	1	0	F15	R/W
011A	400283	1 W	Accumulated Amp Level	KA	10~5000	1	300	F2	R/W
011B	400284	1 W	Reserved						R/W
011C	400285	1 W	Reserved						R/W
011D	400286	1 W	Reserved						R/W
011E	400287	1 W	Reserved						R/W
011F	400288	1 W	Slave Address	---	1~247	1	1	F2	R/W
0120	400289	1 W	Com1 (RS-232) Baud Rate	Baud	0~4	1	3	F17	R/W
0121	400290	1 W	Com2 (RS-485) Baud Rate	Baud	0~4	1	3	F17	R/W
0122	400291	1 W	Com3 (RS-485) Baud Rate	Baud	0~4	1	3	F17	R/W
Protections Setpoints									
0180	400385	1 W	Phase Timed OverCurrent Relays	---	0~7	1	1	F15	R/W
0181	400386	1 W	Phase Timed OverCurrent Pickup	%CT	4~300	1	4	F2	R/W
0182	400387	1 W	Phase Timed OverCurrent Curve	---	0~12	1	1	F16	R/W
0183	400388	1 W	Phase Timed OverCurrent Curve Multiplier	---	0.1~20.0	0.1	1.0	F4	R/W
0184	400389	1 W	Phase Timed OverCurrent Delay	Sec	0.05~600	0.01/0.1/1	1.0	F6	R/W
0185	400390	1 W	Phase Inst. OverCurrent Relays	---	1~7	2	1	F15	R/W
0186	400391	1 W	Phase Inst. OverCurrent Pickup	%CT	4~1800	1/10	40	F2	R/W
0187	400392	1 W	Phase Inst. OverCurrent Delay	ms	0~2000	10	0	F2	R/W
0188	400393	1 W	Phase OverCurrent Alarm Relays	---	0~7	1	0	F15	R/W
0189	400394	1 W	Phase OverCurrent Alarm Pickup	%CT	4~300	1	4	F2	R/W
018A	400395	1 W	Phase OverCurrent Alarm Delay	Sec	0.05~600	0.01/0.1/1	1.0	F6	R/W
018B	400396	1 W	Ground Timed OverCurrent Relays	---	0~7	1	1	F15	R/W
018C	400397	1 W	Ground Timed OverCurrent Pickup	%CT	4~300	1	12	F2	R/W
018D	400398	1 W	Ground Timed OverCurrent Curve	---	0~12	1	1	F16	R/W
018E	400399	1 W	Ground Timed OverCurrent Curve Multiplier	---	0.1~20.0	0.1	1.0	F4	R/W
018F	400400	1 W	Ground Timed OverCurrent Delay	Sec	0.05~600	0.01/0.1/1	1.0	F6	R/W
0190	400401	1 W	Ground Inst. OverCurrent Relays	---	0~7	1	1	F15	R/W
0191	400402	1 W	Ground Inst. OverCurrent Pickup	%CT	4~1800	1/10	120	F2	R/W
0192	400403	1 W	Ground Inst. OverCurrent Delay	ms	0~2000	10	0	F2	R/W

IPR-A1 - MODBUS MEMORY MAP

Add (Hex)	MODBUS REG. ADD (Dec)	Size	Description	Unit	Range	Step	Initial Value	Format	Read/ Write
0193	400404	1 W	Ground OverCurrent Alarm Relays	---	0~7	1	0	F15	R/W
0194	400405	1 W	Ground OverCurrent Alarm Pickup	%CT	4~300	1	12	F2	R/W
0195	400406	1 W	Ground OverCurrent Alarm Delay	Sec	0.05~600	0.01/0.1/1	1.0	F6	R/W
Actual Values									
0200	300513	3 W	Relay Date & Time	---	---	---	---	F8	R
0203	300516	1 W	Front Panel Leds Status	BitField	---	---	---	F18	R
0204	300517	1 W	Front Panel Leds Blink Status	BitField	---	---	---	F18	R
0205	300518	1 W	Output Relays Status	BitField	---	---	---	F20	R
0206	300519	1 W	Digital Inputs Status	BitField	---	---	---	F21	R
0207	300520	1 W	Status Flags	BitField	---	---	---	F22	R
0208	300521	1 W	Pickup Flags	BitField	---	---	---	F22	R
0209	300522	2 W	Phase A RMS Current	A	---	---	---	F6	R
020B	300524	2 W	Phase B RMS Current	A	---	---	---	F6	R
020D	300526	2 W	Phase C RMS Current	A	---	---	---	F6	R
020F	300528	2 W	Ground RMS Current	A	---	---	---	F6	R
0211	300528	3 W	Last Trip Cause, Date & Time	---	---	---	---	F8	R
0214	300530	2 W	Pre-Trip Phase A RMS Current	A	---	---	---	F6	R
0216	300533	2 W	Pre-Trip Phase B RMS Current	A	---	---	---	F6	R
0218	300535	2 W	Pre-Trip Phase C RMS Current	A	---	---	---	F6	R
021A	300537	2 W	Pre-Trip Ground RMS Current	A	---	---	---	F6	R
Maintenance Data									
0280	300641	1 W	Trips Counter	---	---	---	---	F2	R
0281	300642	1 W	Accumulated Amp on Phase A	KA	---	---	---	F2	R
0282	300643	1 W	Accumulated Amp on Phase B	KA	---	---	---	F2	R
0283	300644	1 W	Accumulated Amp on Phase C	KA	---	---	---	F2	R
0284	300645	1 W	Phase O/C Trips	---	---	---	---	F2	R
0285	300646	1 W	Ground O/C Trips	---	---	---	---	F2	R
0286	300647	1 W	Openning Counter	---	---	---	---	F2	R
Events									
0600	301537	1 W	Last Event Number	---	---	---	---	F2	R
0601	301538	3 W	Last Event Clear Date & Time	---	---	---	---	F8	R
0610	401553	1 W	Selected Event Number	---	1~65535	1	1	F2	R/W
0611	301554	3 W	Selected Event Date & Time	---	---	---	---	F8	R
0614	301557	2 W	Selected Event Phase A RMS Current	A	---	---	---	F6	R
0616	301559	2 W	Selected Event Phase B RMS Current	A	---	---	---	F6	R
0618	301561	2 W	Selected Event Phase C RMS Current	A	---	---	---	F6	R
061A	301563	2 W	Selected Event Ground RMS Current	A	---	---	---	F6	R

IPR-A DATA FORMATS

Format Code	Type	Value	Definition
F1	**Integer**		**Signed Integer Value**
			Example: -123 saved as -123
F2	**Integer**		**Unsigned Integer Value**
			Example: 123 saved as 123
F3	**Integer**		**Signed Integer Value with 1 decimals**
			Example: -1.0 saved as -10
F4	**Integer**		**Unsigned Integer Value with 1 decimals**
			Example: 1.0 saved as 10
F5	**Integer**		**Signed Integer Value with 2 decimals**
			Example: -1.00 saved as -100
F6	**Integer**		**Unsigned Integer Value with 2 decimals**
			Example: 1.00 saved as 100
F7	**Floating Point**		**(4 Byte) Floating Point Value**

4-byte floating-point format

The memory layout of 4-byte floating-point numbers is:

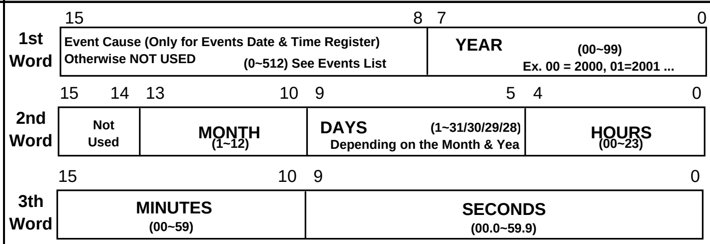
The value of the number is:

$(-1)^{S} * 2^{(Exponent-127)} * 1.Mantissa$

Zero is represented by 4 bytes of zeros.

The precision of the float operators (+ , -, *, and /) is approximately 7 decimal digits.

Format Code	Type	Value	Definition
F8	**Clock**		**Date & Time Format**



Format Code	Type	Value	Definition
F9	**16 Bits BitMap**		**System Setup Register Format**
		Bit 0 ~ Bit 1	**System Frequency:** 0 = 50hz, 1 = 60hz
		Bit 2 ~ Bit 4	**Not Used**
		Bit 5 ~ Bit 7	**Ground Sensing:** 1 = Residual, 2 = Zero Sequence
		Bit 8	**Breaker Type:** 0 = Circuit Breaker, 1 = Disconnector
		Bit 9	**Disconnector with fuses ?:** 0 = No, 1 = Yes
		Bit 10	**Out of Service on AUX3 ?:** 0 = No, 1 = Yes
		Bit 11 ~ Bit 15	**Not Used**
F10	**Integer**		**Unsigned Integer Access Code Value Register Format**
			Example: 111 saved as 111 **(only digits 1~9 accepted, digit 0 is NOT ALLOWED)**
F11	**16 Bits BitMap**		**Outputs Relays Configuration Register Format**
		Bit 0	**TRIP Relay Config.:** 0 = "LATCHED", 1 = "PULSED"
		Bit 1	**Not Used**
		Bit 2	**AUX1 Relay Config.:** 0 = "LATCHED", 1 = "PULSED"
		Bit 3	**Not Used**
		Bit 4	**AUX2 Relay Config.:** 0 = "LATCHED", 1 = "PULSED"
		Bit 5	**Not Used**

IPR-A DATA FORMATS			
Format Code	Type	Value	Definition
		Bit 6	**AUX3 Relay Config.:** 0 = "LATCHED", 1 = "PULSED"
		Bit 7 ~ Bit 15	**Not Used**
F12	**16 Bits BitMap**		**Digital Input Configuration Register Format**
		Bit 0	**INPUT 1 SET ON:** 0 = "CONTACT CLOSED", 1 = "CONTACT OPEN"
		Bit 1	**INPUT 2 SET ON:** 0 = "CONTACT CLOSED", 1 = "CONTACT OPEN"
		Bit 2	**INPUT 3 SET ON:** 0 = "CONTACT CLOSED", 1 = "CONTACT OPEN"
		Bit 3	**Not Used**
		Bit 4	**INPUT 5 SET ON:** 0 = "CONTACT CLOSED", 1 = "CONTACT OPEN"
		Bit 5	**INPUT 6 SET ON:** 0 = "CONTACT CLOSED", 1 = "CONTACT OPEN"
		Bit 6 ~ Bit 15	**Not Used**
F13	**Integer**		**Digital Input Functions**
		0	NONE
		1	BREAKER EARTHED
		2	EXTERNAL RESET
		3	REMOTE TRIP
		4	BLOCK TRIP
		5	AUX1
		6	AUX2
		7	AUX3
F14	**16 Bits BitMap**		**Events Recorder Configuration Register Format**
		Bit 0	Ph. Protections Events { 0 = Off , 1 = On }
		Bit 1	Gnd. Protections Events { 0 = Off , 1 = On }
		Bit 2	System Events { 0 = Off , 1 = On }
		Bit 3	Output Relays Events { 0 = Off , 1 = On }
		Bit 4	Digital Inputs Events { 0 = Off , 1 = On }
		Bit 5 ~ Bit 15	Not Used
F15	**Integer**		**Output Relay Selection**
		Bit 0	TRIP OUTPUT RELAY
		Bit 1	AUX.1 OUTPUT RELAY
		Bit 2	AUX.2 OUTPUT RELAY
		Bit 3	AUX.3 OUTPUT RELAY
F16	**Integer**		**Protection Curve Definition Format**
		0	DefiniteTime
		1	ANSI Moderate Inverse
		2	ANSI Normal Inverse
		3	ANSI Very Inverse
		4	ANSI Extrem Inverse
		5	IAC Moderate Inverse
		6	IAC Normal Inverse
		7	IAC Very Inverse
		8	IAC Extrem rInverse
		9	IEC ShortTime
		10	IEC A Normal Inverse
		11	IEC B Very Inverse
		12	IEC C Extrem Inverse
F17	**Integer**		**BaudRate Definitions**
		0	1200 Bps
		1	2400 Bps
		2	4800 Bps
		3	9600 Bps
		4	19200 Bps
F18	**16 Bits BitMap**		**Led Status 1 Register Format**
		Bit 0	**TRIP LED:** 0 = "OFF", 1 = "ON", 2 = "BLINKING"
		Bit 1	**ALARM LED:** 0 = "OFF", 1 = "ON", 2 = "BLINKING"
		Bit 2	**OUT OF SERVICE LED:** 0 = "OFF", 1 = "ON", 2 = "BLINKING"
		Bit 3	**BREAKER CLOSED LED:** 0 = "OFF", 1 = "ON", 2 = "BLINKING"
		Bit 4	**BREAKER OPEN LED:** 0 = "OFF", 1 = "ON", 2 = "BLINKING"

IPR-A DATA FORMATS			
Format Code	Type	Value	Definition
		Bit 5	**BREAKER EARTHED LED:** 0 = "OFF", 1 = "ON", 2 = "BLINKING"
		Bit 6	**PICKUP I> (51) LED:** 0 = "OFF", 1 = "ON", 2 = "BLINKING"
		Bit 7	**PICKUP I>> (50) LED:** 0 = "OFF", 1 = "ON", 2 = "BLINKING"
		Bit 8	**SWITCH CURRENT LED:** 0 = "OFF", 1 = "ON", 2 = "BLINKING"
		Bit 9	**PICKUP Io> (51N/G) LED:** 0 = "OFF", 1 = "ON", 2 = "BLINKING"
		Bit 10	**PICKUP Io>> (50N/G) LED:** 0 = "OFF", 1 = "ON", 2 = "BLINKING"
		Bit 11 ~ Bit 15	**Not Used**
F20	**16 Bits BitMap**		**Output Relays Status Register**
		Bit 0	Trip Output Relay { 0 = "Energized" , 1 = "De-energized" }
		Bit 1	Aux1 Output Relay { 0 = "Energized" , 1 = "De-energized" }
		Bit 2	Aux2 Output Relay { 0 = "Energized" , 1 = "De-energized" }
		Bit 3	Aux3 Output Relay { 0 = "Energized" , 1 = "De-energized" }
		Bit 4 ~ Bit 15	Not Used
F21	**16 Bits BitMap**		**Digital Input Status Register**
		Bit 0	Digital Input 1 { 0 = "OPEN" , 1 = "CLOSE" }
		Bit 1	Digital Input 2 { 0 = "OPEN" , 1 = "CLOSE" }
		Bit 2	Digital Input 3 { 0 = "OPEN" , 1 = "CLOSE" }
		Bit 3	Breaker Status Digital Input { 0 = "OPEN" , 1 = "CLOSE" }
		Bit 4	Digital Input 5 { 0 = "OPEN" , 1 = "CLOSE" }
		Bit 5	Digital Input 6 { 0 = "OPEN" , 1 = "CLOSE" }
		Bit 6 ~ Bit 15	Not Used
F22	**16 Bits BitMap**		**Status & Pickup Flags Format**
		Bit 0	Phase Timed OverCurrent Protection { 0 = OFF , 1 = ON }
		Bit 1	Phase Inst OverCurrent Protection { 0 = OFF , 1 = ON }
		Bit 2	Phase OverCurrent Alarm Protection { 0 = OFF , 1 = ON }
		Bit 3	Ground Timed OverCurrent Protection { 0 = OFF , 1 = ON }
		Bit 4	Ground Inst OverCurrent Protection { 0 = OFF , 1 = ON }
		Bit 5	Ground OverCurrent Alarm Protection { 0 = OFF , 1 = ON }
		Bit 6	Not Used
		Bit 7	Not Used
		Bit 8	Not Used
		Bit 9	Not Used
		Bit 10	Not Used
		Bit 11	Not Used
		Bit 12	Disconnector Block { 0 = OFF , 1 = ON }
		Bit 13	Breaker Driscrepancy Function { 0 = OFF , 1 = ON }
		Bit 14	Mechanical Operations Function { 0 = OFF , 1 = ON }
		Bit 15	Accumulated Amp Function { 0 = OFF , 1 = ON }
F23	**Integer**		**Commands Operation Codes**
		0	No Command
		1	Remote Reset
		2	Remote Trip
		5	Activate Date & Time Preset Data
		8	Clear Maintenance Data
		9	Clear All Events
		20	Set Aux1
		21	Set Aux2
		22	Set Aux3
F24	**Integer**		**Product Language**
		1	English
		2	Russian for ELTECHNIKA
		3	Russian for VEI

IPR-A1 Event Cause List :	
0	No Event
1	Events Clear
4	Trip Relay OFF
5	Trip Relay ON
6	Aux.1 Relay OFF
7	Aux.1 Relay ON
8	Aux.2 Relay OFF
9	Aux.2 Relay ON
10	Aux.3 Relay OFF
11	Aux.3 Relay ON
20	Digital Input 1 Deactive
21	Digital Input 1 Active
22	Digital Input 2 Deactive
23	Digital Input 2 Active
24	Digital Input 3 Deactive
25	Digital Input 3 Active
26	Breaker Status "OPENED"
27	Breaker Status "CLOSED"
32	Earth Released
33	Breaker Earthed
34	Remote Trip
35	Serial Comunication Trip
36	Block Trip Reset
37	Block Trip Set
40	Phase Timed OverCurrent
41	Phase Inst OverCurrent
42	Phase OverCurrent Alarm
43	Ground Timed OverCurrent
44	Ground Inst OverCurrent
45	Ground OverCurrent Alarm
50	Disconnector Block
51	Breaker Discrepancy Alarm
52	Mechanical Operation Alarm
53	Accumulated Amp Alarm
54	Maintenance Data Clear