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MODBUS COMANDS

1.- Modbus protocol.

The Modbus protocol is a communications standard in the industry which permits the network connection of multiple equipments, where exists a master and several slaves.
It permits the master-stave individual dialogue and also permits the commands in broadcast format. Modbus fixes the communication format, from the format of the commands to the message plots. In this equipment it has implemented Modbus with RTU plots. In the RTU mode the start and the end of the message is detected by silence of a minimum of 3,5 characters and it is used the method for error detection CRC of 16 bits. The length of the characters is fixed at 8 bits, permits the parity of pair, even or without parity, and 1 or 2 bits of stop.

A typical Modbus message has the following format:

Start	Address	Function	Data	CRC	End
3,5 bytes	8 bits	8 bits	n x 8 bits	16 bits	3,5 bytes

Modbus tolerates networks with equipments which work with different speeds, and as was mentioned before, the end of the messages are done by minimum silences of 3,5 bytes. This means that in the same network, there can be faster or slower equipments producing longer or shorter silences. This is why normally a big silence is left between the end of a message and the start of the answer from the slave. By this way, we can avoid that any equipment answers before than other equipments have detected the end of the message. In case is not done in this way, the message from the master and the answer from the slave would concatenate.

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2.- Implemented functions

Function 01 (01 Hex): Reading of compacted relays.
Function 03 y 04 (03 y 04 Hex): Reading of integer registers.
Function 05 (05 Hex): Writing of a relay.
Function 15 (0F Hex): Writing of multiple compacting relays.
Function 16 (10 Hex): Writing of multiple integer registers.
Function 20/6 (14 Hex / 06 Hex): File reading.
Function 21/6 (15 Hex / 06 Hex): File Writing.

Legend:
AAAA – Hexadecimal address
RRRR – Number of relays or integer registers in hexadecimal
FFFF – File number
BB - Number of bytes
DD – Data
NP – Peripheral number
CRC - 16 bits code for error detection.
The spaces are to indicate the different parameters.

Function 01:
Tx: NP 01 AAAA RRRR *CRC*
Rx: NP 01 BB DD...DD*CRC*

Function 03 or 04:
Tx: NP 04 AAAA RRRR *CRC*
Rx: NP 04 BB DD...DD*CRC*

Function 05:
Activate a relay
Tx: NP 05 AAAA FF00 *CRC*
Rx: NP 05 AAAA FF00 *CRC*
Deactivate a relay
Tx: NP 05 AAAA 0000 *CRC*
Rx: NP 05 AAAA 0000 *CRC*

Function 15:
Tx: NP 0F AAAA RRRR BB DD.....DD *CRC*
Rx: NP 0F AAAA RRRR *CRC*

Function 16:
Tx: NP 10 AAAA RRRR BB DD ..... DD *CRC*
Rx: NP 10 AAAA RRRR*CRC*

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EXCEPTION CODES

If the bit of bigger weight of the byte corresponds to function 1, this indicates that the following byte is an exception code.
The answer is type:

Rx: NP XX DD *CRC*

XX = Function of the bit 7 to 1 (i.e.: if the function is 04 it would be a 84 in hexadecimal)

DD = Exception code.

Code	Description
01	Wrong function. The number of the function is not implemented
02	Wrong address or number of registers out of limits
04	Wrong peripheral. There has been an error in the access to the peripheral (EEPROM, card, etc)

3.- Modbus map of relay variables

The modbus map of relay variables are divided into zones:

	@ Start (Hex)	@ End (Hex)
//General relays	0000	2FFF
//Function relays	3000	5FFF
//Expansion	6000	8FFF
//Free	9000	BFFF

Description	@ Start (Hex)	@End (Hex)	# relays	Function
Digital outputs				
Digital inputs				
System Reset	3000	3001	1	0F
Erase maximums and minimums	3010	3011	1	0F
Erase actual energy	3020	3021	1	0F
Erase Temperature alarm	3030	3031	1	0F
Erase voltage alarm	3031	3032	1	0F
Erase thdv alarm	3032	3033	1	0F
Erase thdixi alarm	3033	3034	1	0F
Erase tdhi stage alarm	3034	3035	1	0F
Erase thdic alarm	3035	3036	1	0F
Erase not compensated kvar alarm	3036	3037	1	0F
Erase cos alarm	3037	3038	1	0F
Erase low current alarm	3038	3039	1	0F
Erase leakage current alarm	3039	303A	1	0F
Erase IC lost alarm	303A	303B	1	0F

The writing of the relay is done in the same way for all, changing the address.
For example: Plot to send to Reset the system: 010F**3000**00080101
Plot to send to Erase the cos alarm: 010F**3037**00080101

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4.- Modbus map of integer variables

The modbus map of integer variables are divided into zones:

	@ Start (Hex)	@ End (Hex)
//Measurement variables	0000	2FFF
//Configuration parameters	3000	5FFF
//Expansion	6000	8FFF
//Free	9000	BFFF

Description	@ Start (Hex)	@End (Hex)	# relays	Function
//Measurement variables	**0000**	**2FFF**	**12287**	
Instant electric variables	0000	200	512	04
Maximum electric variables and its dates	200	400	512	04
Minimum electric variables and its dates	400	600	512	04
Actual energy	600	700	256	04
Harmonics (V1)	A00	B40	64	04
Harmonics (V2)	B40	B80	64	04
Harmonics (V3)	B80	BC0	64	04
Harmonics (I1)	B00	B40	64	04
Harmonics (I2)	B40	B80	64	04
Harmonics (I3)	B80	BC0	64	04
Harmonics (IC1)	C00	C40	64	04
Harmonics (IC2)	C40	C80	64	04
Harmonics (IC3)	C80	CC0	64	04
Compensation	1500	1700	512	04
Operation variables	1700	1730	48	04
Capacitors Status	1730	1740	16	04
Alarm Temperature	1800	1810	16	04
Alarm Voltage ph-ph	1810	1820	16	04
Alarm thdv	1820	1830	16	04
Alarm thdil x il	1830	1840	16	04
Alarm difference thdil	1840	1850	16	04
Alarm thdic	1850	1860	16	04
Alarm not compensated kvar	1860	1870	16	04
Alarm cos	1870	1880	16	04
Alarm current il	1880	1890	16	04
Alarm leakage current	1890	18C0	48	04
Alarm IC out of margin	18C0	18F0	48	04
Global status alarm	18F0	18F8	8	04
Global status relay alarm	18F8	1900	8	04
Temperature alarm date	1900	1910	16	04
Voltage ph-ph alarm date	1910	1920	16	04
thdv alarm date	1920	1930	16	04
thdil x il alarm date	1930	1940	16	04
Difference thdil alarm date	1940	1950	16	04
thdic alarm date	1950	1960	16	04
Not compensated kvar alarm date	1960	1970	16	04

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Cos alarm date	1970	1980	16	04
Ic current alarm date	1980	1990	16	04
Special alarm for current failure	19A0	19A8	8	04
Special alarm for toroidal failure	19A8	19B0	8	04
//Parameters configuration	**3000**	**5FFF**	**12287**	
Version	3010	3030	32	04
Serial number	3030	3050	32	04
Product number	3050	3070	32	04
Transformation relation	3070	3080	16	04
Communications configuration COM1	3080	3090	16	04
Communications configuration COM2	3090	30A0	16	04
Lock configuration A	30A0	30C0	32	04
Capacitor measurement transformation relation	30C0	30C4	4	04
Measurement I leakage transformation relation	30C4	30C8	4	04
Current connection configuration	30D0	30E0	16	04
Display configuration	30E0	30F0	16	04
Capacitors bank configuration	30F0	3120	48	04
Connection time configuration	3120	3130	16	04
Objective cos configuration	3130	3140	16	04
Operation variables configuration	3140	3150	16	04
Capacitors bank addition	3150	3160	16	04
Mode configuration	3160	3170	16	04
Objective cos configuration for the 9 tariffs	3170	3190	32	04/10
Capacitors transformers connection configuration	3190	3195	5	04
Capacitors current connection configuration	3195	31A0	11	04
Temperature alarm configuration	3200	3210	16	04/10
Voltage ph-ph alarm configuration	3210	3220	16	04/10
thdv alarm configuration	3220	3230	16	04/10
thdil x il alarm configuration	3230	3240	16	04/10
Difference thdil alarm configuration	3240	3250	16	04/10
thdic alarm configuration	3250	3260	16	04/10
Not compensated kvar alarm configuration	3260	3270	16	04/10
Cos alarm configuration	3270	3280	16	04/10
Ic current alarm configuration	3280	3290	16	04/10
Leakage currant alarm configuration	3290	32A0	16	04/10
IC out of margin alarm configuration	32A0	32B0	16	04/10
Global alarm habilitation configuration	32B0	32B8	8	04/10
Tariffs configuration	5000	5020	32	04/10
Day type tariff	5020	5200	480	04/10
Profile tariff 1	5200	5220	32	04/10
Profile tariff 2	5220	5240	32	04/10
Profile tariff 3	5240	5260	32	04/10
Profile tariff 4	5260	5280	32	04/10

Profile tariff 5	5280	52A0	32	04/10
Profile tariff 6	52A0	52C0	32	04/10
Profile tariff 7	52C0	52E0	32	04/10
Profile tariff 8	52E0	5300	32	04/10
Profile tariff 9	5300	5320	32	04/10

5.- Measurement parameters

ELECTRICAL PARAMETERS	Instant		Maximum		Minimum		Units
Variables	@ Start (HEX)	# registers	@ Start (HEX)	# registers	@ Start (HEX)	# registers	
PHASE 1							
Phase voltage	0000	2	0200	4			V x 100
Line voltage	0002	2	0204	4			V x 100
Current	0004	2	0208	4			mA x 10
Active power	0006	2	020C	4			W x 10
Inductive power	0008	2	0210	4			VarL x 10
Capacitive power	000A	2	0214	4			VarC x 10
Apparent power	000C	2	0218	4			VA x 10
Power factor	000E	2	021C	4	0400	4	x 1000
Cos phi	0010	2	0220	4	0404	4	x 1000
PHASE 2							
Phase voltage	0012	2	0224	4			V x 100
Line voltage	0014	2	0228	4			V x 100
Current	0016	2	022C	4			mA x 10
Active power	0018	2	0230	4			W x 10
Inductive power	001A	2	0234	4			VarL x 10
Capacitive power	001C	2	0238	4			VarC x 10
Apparent power	001E	2	023C	4			VA x 10
Power factor	0020	2	0240	4	0408	4	x 1000
Cos phi	0022	2	0244	4	040C	4	x 1000
PHASE 3							
Phase voltage	0024	2	0248	4			V x 100
Line voltage	0026	2	024C	4			V x 100
Current	0028	2	0250	4			mA x 10
Active power	002A	2	0254	4			W x 10
Inductive power	002C	2	0258	4			VarL x 10
Capacitive power	002E	2	025C	4			VarC x 10
Apparent power	0030	2	0260	4			VA x 10
Power factor	0032	2	0264	4	0410	4	x 1000
Cos phi	0034	2	0268	4	0414	4	x 1000
Frequency	0036	2	026C	4			Hz x 100
Neutral current	0038	2	0270	4			mA x 10
Average Phase voltage	003A	2	0274	4			V x 100
Average Line voltage	003C	2	0278	4			V x 100
Average Current	003E	2	027C	4			mA x 10
Three-phase Active power	0040	2	0280	4			W x 10
Three-phase Inductive power	0042	2	0284	4			VarL x 10

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Three-phase Capacitive power	0044	2	0288	4			VarC x 10
Three-phase Apparent power	0046	2	028C	4			VA x 10
Three-phase Power factor	0048	2	0290	4	0418	4	x 1000
Three-phase Cos phi	004A	2	0294	4	041C	4	x 1000
THD V1	004C	2	0298	4			% x 10
THD V2	004E	2	029C	4			% x 10
THD V3	0050	2	02A0	4			% x 10
THD I1	0052	2	02A4	4			% x 10
THD I2	0054	2	02A8	4			% x 10
THD I3	0056	2	02AC	4			% x 10
Temperature	0059	1	02B1	1+2			ºC x 10

NOTICE: The instant variables are composed by 2 integer registers (1 long) which indicates its value

NOTICE: The maximum variables are composed by 4 integer registers (2 long) which indicates its value and the date/time which is detected.

Supporting files: inst.var ; max1.var ; max2.var, min.var

The cosine and the Power Factor signs (3 phases and line) means: positive → Inductive
negative→Capacitive

To know the quadrant in which we are we will get as reference the sign of the Three-phase powers:

kW & kvar (+)→ cos (+) (Ind) → Quadrant 1
kW (-) & kvar (+)→ cos (+) (Ind) → Quadrant 2
kW & kvar (-)→ cos (-) (Cap) → Quadrant 3
kW (+) & kvar (-)→ cos (-) (Cap) → Quadrant 4

For cosines and the Power Factors the register of maximums means the minimum inductance (MinL)
For cosines and the Power Factors the register of minimums means the minimum capacitance (MinC)

To pass the register of date/time to an “understandable” date and time, there is a specific function.

These new instant variables only can be got if we have a model Txx-CDI and furthermore the current transformers have to be connected (variable Connection in part 6. Configuration parameters. → Configuration of the capacitor transformers) (except the variable of Leakage current IF)

For the leakage variable, the conditions are that it has to be a model Txx-CDI and furthermore it has to have the differential leakage current transformer connected.

ELECTRICAL PARAMETERS	Instantaneous		Maximum		Time/Date		Units
Variables	@ start (HEX)	# registers	@ start (HEX)	# registers	@ start (HEX)	# registers	
Capacitor current IC1	0150	2	0350	2	035C	2	mA x 10
Capacitor current IC2	0152	2	0352	2	035E	2	mA x 10
Capacitor current IC3	0154	2	0354	2	0360	2	mA x 10
Capacitor neutral current ICN	0156	2	0356	2	0362	2	mA x 10
**Leakage current IF	0158	2	0358	2	0364	2	**mA x 10 ****

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THD IC1	0176	2	0370	2	0372	2	% x 10
THD IC2	0178	2	0374	2	0376	2	% x 10
THD IC3	017A	2	0378	2	037A	2	% x 10

NOTICE: The instant variables are compound by 2 integer registers (1 long) which indicates its value

**NOTICE: The unit for the leakage current variable is the milliamp and always will be shown as xx.x mA

To detect is the differential transformer is connected or not, we will do it by reading the value of a variable in the following way:

Variables	@ start (HEX)	# registers	Result
Transformer connection IF	19B0	1	0→ Connected; 1→ Disconnected

Because introducing the possibility of working with different tariffs, we will use different energy meters (one for each tariff, and a global one which adds the 9 possible tariffs). If this possibility is not selected, the active tariff will be tariff 1.

Only the models Txx-C and Txx-CDI from software version 2.20 have the possibility of working with different tariffs.

PRESENT ENERGY	**kWh / kvarh / kVAh**		**Units**
Variables	@ start (HEX)	# registers	
THREE-PHASE			
Total active energy	0600	2	kWh
Total inductive energy	0602	2	kvarLh
Total capacitive energy	0604	2	kvarCh
Total generated active energy	0606	2	kWh
Total generated inductive energy	0608	2	kvarLh
Total generated capacitive energy	060A	2	kvarCh
Active energy tariff 1	060C	2	kWh
Inductive energy tariff 1	060E	2	kvarLh
Capacitive energy tariff 1	0610	2	kvarCh
Generated active energy tariff 1	0612	2	kWh
Generated inductive energy tariff 1	0614	2	kvarLh
Generated capacitive energy tariff 1	0616	2	kvarCh
Active energy tariff 2	0618	2	kWh
Inductive energy tariff 2	061A	2	kvarLh
Capacitive energy tariff 2	061C	2	kvarCh
Generated active energy tariff 2	061E	2	kWh
Generated inductive energy tariff 2	0620	2	kvarLh
Generated capacitive energy tariff 2	0622	2	kvarCh
Active energy tariff 3	0624	2	kWh
Inductive energy tariff 3	0626	2	kvarLh
Capacitive energy tariff 3	0628	2	kvarCh
Generated active energy tariff 3	062A	2	kWh
Generated inductive energy tariff 3	062C	2	kvarLh
Generated capacitive energy tariff 3	062E	2	kvarCh
Active energy tariff 4	0630	2	kWh
Inductive energy tariff 4	0632	2	kvarLh
Capacitive energy tariff 4	0634	2	kvarCh

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Generated active energy tariff 4	0636	2	kWh	
Generated inductive energy tariff 4	0638	2	kvarLh	
Generated capacitive energy tariff 4	063A	2	kvarCh	
Active energy tariff 5	063C	2	kWh	
Inductive energy tariff 5	063E	2	kvarLh	
Capacitive energy tariff 5	0640	2	kvarCh	
Generated active energy tariff 5	0642	2	kWh	
Generated inductive energy tariff 5	0644	2	kvarLh	
Generated capacitive energy tariff 5	0646	2	kvarCh	
Active energy tariff 6	0648	2	kWh	
Inductive energy tariff 6	064A	2	kvarLh	
Capacitive energy tariff 6	064C	2	kvarCh	
Generated active energy tariff 6	064E	2	kWh	
Generated inductive energy tariff 6	0650	2	kvarLh	
Generated capacitive energy tariff 6	0652	2	kvarCh	
Active energy tariff 7	0654	2	kWh	
Inductive energy tariff 7	0656	2	kvarLh	
Capacitive energy tariff 7	0658	2	kvarCh	
Generated active energy tariff 7	065A	2	kWh	
Generated inductive energy tariff 7	065C	2	kvarLh	
Generated capacitive energy tariff 7	065E	2	kvarCh	
Active energy tariff 8	0660	2	kWh	
Inductive energy tariff 8	0662	2	kvarLh	
Capacitive energy tariff 8	0664	2	kvarCh	
Generated active energy tariff 8	0666	2	kWh	
Generated inductive energy tariff 8	0668	2	kvarLh	
Generated capacitive energy tariff 8	066A	2	kvarCh	
Active energy tariff 9	066C	2	kWh	
Inductive energy tariff 9	066E	2	kvarLh	
Capacitive energy tariff 9	0670	2	kvarCh	
Generated active energy tariff 9	0672	2	kWh	
Generated inductive energy tariff 9	0674	2	kvarLh	
Generated capacitive energy tariff 9	0676	2	kvarCh	

Supporting files: energy.var

There are no measuring registers for apparent energy.

HARMONICS V	PHASE 1		PHASE 2		PHASE 3		Units
Variables	@ start (HEX)	# registers	@ start (HEX)	# registers	@ start (HEX)	# registers	
V fundamental	0A00	2	0A40	2	0A80	2	V x 100
V harmonic 2	0A02	1	0A42	1	0A82	1	% x 10
V harmonic 3	0A03	1	0A43	1	0A83	1	% x 10
V harmonic 4	0A04	1	0A44	1	0A84	1	% x 10
V harmonic 5	0A05	1	0A45	1	0A85	1	% x 10
V harmonic 6	0A06	1	0A46	1	0A86	1	% x 10
V harmonic 7	0A07	1	0A47	1	0A87	1	% x 10
V harmonic 8	0A08	1	0A48	1	0A88	1	% x 10
V harmonic 9	0A09	1	0A49	1	0A89	1	% x 10
V harmonic 10	0A0A	1	0A4A	1	0A8A	1	% x 10
V harmonic 11	0A0B	1	0A4B	1	0A8B	1	% x 10
V harmonic 12	0A0C	1	0A4C	1	0A8C	1	% x 10

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V harmonic 13	0A0D	1	0A4D	1	0A8D	1	% x 10
V harmonic 14	0A0E	1	0A4E	1	0A8E	1	% x 10
V harmonic 15	0A0F	1	0A4F	1	0A8F	1	% x 10
V harmonic 16	0A10	1	0A50	1	0A90	1	% x 10
V harmonic 17	0A11	1	0A51	1	0A91	1	% x 10
V harmonic 18	0A12	1	0A52	1	0A92	1	% x 10
V harmonic 19	0A13	1	0A53	1	0A93	1	% x 10
V harmonic 20	0A14	1	0A54	1	0A94	1	% x 10
V harmonic 21	0A15	1	0A55	1	0A95	1	% x 10
V harmonic 22	0A16	1	0A56	1	0A96	1	% x 10
V harmonic 23	0A17	1	0A57	1	0A97	1	% x 10
V harmonic 24	0A18	1	0A58	1	0A98	1	% x 10
V harmonic 25	0A19	1	0A59	1	0A99	1	% x 10
V harmonic 26	0A1A	1	0A5A	1	0A9A	1	% x 10
V harmonic 27	0A1B	1	0A5B	1	0A9B	1	% x 10
V harmonic 28	0A1C	1	0A5C	1	0A9C	1	% x 10
V harmonic 29	0A1D	1	0A5D	1	0A9D	1	% x 10
V harmonic 30	0A1E	1	0A5E	1	0A9E	1	% x 10
V harmonic 31	0A1F	1	0A5F	1	0A9F	1	% x 10
V harmonic 32	0A20	1	0A60	1	0AA0	1	% x 10

Supporting files: harmV1_32.var ; harmV2_32.var ; harmV3_32.var

HARMONICS I	**PHASE 1**		**PHASE 2**		**PHASE 3**		**Units**
Variables	@ start (HEX)	# registers	@ start (HEX)	# registers	@ start (HEX)	# registers	
I fundamental	0B00	2	0B40	2	0B80	2	mAx10
I harmonic 2	0B02	1	0B42	1	0B82	1	% x 10
I harmonic 3	0B03	1	0B43	1	0B83	1	% x 10
I harmonic 4	0B04	1	0B44	1	0B84	1	% x 10
I harmonic 5	0B05	1	0B45	1	0B85	1	% x 10
I harmonic 6	0B06	1	0B46	1	0B86	1	% x 10
I harmonic 7	0B07	1	0B47	1	0B87	1	% x 10
I harmonic 8	0B08	1	0B48	1	0B88	1	% x 10
I harmonic 9	0B09	1	0B49	1	0B89	1	% x 10
I harmonic 10	0B0A	1	0B4A	1	0B8A	1	% x 10
I harmonic 11	0B0B	1	0B4B	1	0B8B	1	% x 10
I harmonic 12	0B0C	1	0B4C	1	0B8C	1	% x 10
I harmonic 13	0B0D	1	0B4D	1	0B8D	1	% x 10
I harmonic 14	0B0E	1	0B4E	1	0B8E	1	% x 10
I harmonic 15	0B0F	1	0B4F	1	0B8F	1	% x 10
I harmonic 16	0B10	1	0B50	1	0B90	1	% x 10
I harmonic 17	0B11	1	0B51	1	0B91	1	% x 10
I harmonic 18	0B12	1	0B52	1	0B92	1	% x 10
I harmonic 19	0B13	1	0B53	1	0B93	1	% x 10
I harmonic 20	0B14	1	0B54	1	0B94	1	% x 10
I harmonic 21	0B15	1	0B55	1	0B95	1	% x 10
I harmonic 22	0B16	1	0B56	1	0B96	1	% x 10
I harmonic 23	0B17	1	0B57	1	0B97	1	% x 10
I harmonic 24	0B18	1	0B58	1	0B98	1	% x 10
I harmonic 25	0B19	1	0B59	1	0B99	1	% x 10

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I harmonic 26	0B1A	1	0B5A	1	0B9A	1	% x 10
I harmonic 27	0B1B	1	0B5B	1	0B9B	1	% x 10
I harmonic 28	0B1C	1	0B5C	1	0B9C	1	% x 10
I harmonic 29	0B1D	1	0B5D	1	0B9D	1	% x 10
I harmonic 30	0B1E	1	0B5E	1	0B9E	1	% x 10
I harmonic 31	0B1F	1	0B5F	1	0B9F	1	% x 10
I harmonic 32	0B20	1	0B60	1	0BA0	1	% x 10

Supporting files : harmI1_32.var ; harmI2_32.var ; harmI3_32.var

These new instantaneous variables only can be got if we have a model Txx-CDI and furthermore the current transformers have to be connected (variable Connection in part 6. Configuration parameters. → Configuration of the capacitor transformers) (except the variable of Leakage current IF)

HARMONICS IC	PHASE 1		PHASE 2		PHASE 3		Units
Variables	@ start (HEX)	# registers	@ start (HEX)	# registers	@ start (HEX)	# registers	
I fundamental	0C00	2	0C40	2	0C80	2	mAx10
I harmonic 2	0C02	1	0C42	1	0C82	1	% x 10
I harmonic 3	0C03	1	0C43	1	0C83	1	% x 10
I harmonic 4	0C04	1	0C44	1	0C84	1	% x 10
I harmonic 5	0C05	1	0C45	1	0C85	1	% x 10
I harmonic 6	0C06	1	0C46	1	0C86	1	% x 10
I harmonic 7	0C07	1	0C47	1	0C87	1	% x 10
I harmonic 8	0C08	1	0C48	1	0C88	1	% x 10
I harmonic 9	0C09	1	0C49	1	0C89	1	% x 10
I harmonic 10	0C0A	1	0C4A	1	0C8A	1	% x 10
I harmonic 11	0C0B	1	0C4B	1	0C8B	1	% x 10
I harmonic 12	0C0C	1	0C4C	1	0C8C	1	% x 10
I harmonic 13	0C0D	1	0C4D	1	0C8D	1	% x 10
I harmonic 14	0C0E	1	0C4E	1	0C8E	1	% x 10
I harmonic 15	0C0F	1	0C4F	1	0C8F	1	% x 10
I harmonic 16	0C10	1	0C50	1	0C90	1	% x 10
I harmonic 17	0C11	1	0C51	1	0C91	1	% x 10
I harmonic 18	0C12	1	0C52	1	0C92	1	% x 10
I harmonic 19	0C13	1	0C53	1	0C93	1	% x 10
I harmonic 20	0C14	1	0C54	1	0C94	1	% x 10
I harmonic 21	0C15	1	0C55	1	0C95	1	% x 10
I harmonic 22	0C16	1	0C56	1	0C96	1	% x 10
I harmonic 23	0C17	1	0C57	1	0C97	1	% x 10
I harmonic 24	0C18	1	0C58	1	0C98	1	% x 10
I harmonic 25	0C19	1	0C59	1	0C99	1	% x 10
I harmonic 26	0C1A	1	0C5A	1	0C9A	1	% x 10
I harmonic 27	0C1B	1	0C5B	1	0C9B	1	% x 10
I harmonic 28	0C1C	1	0C5C	1	0C9C	1	% x 10
I harmonic 29	0C1D	1	0C5D	1	0C9D	1	% x 10
I harmonic 30	0C1E	1	0C5E	1	0C9E	1	% x 10
I harmonic 31	0C1F	1	0C5F	1	0C9F	1	% x 10
I harmonic 32	0C20	1	0C60	1	0CA0	1	% x 10

Supporting files : harmI1C_32.var ; harmI2C_32.var ; harmI3C_32.var

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VARIABLES	Instantaneous		Maximum		Units
Operation variables	@ start (HEX)	# registers	@ start (HEX)	# registers	
Activated capacitors power PHASE 1	1700	2	170A	4	VarC x 10
Activated capacitors power PHASE 2	1702	2	170E	4	VarC x 10
Activated capacitors power PHASE 3	1704	2	1712	4	VarC x 10
Activated capacitors power Three-phase	1706	2	1716	4	VarC x 10

NOTICE: The instant variables are composed by 2 integer registers (1 long) which indicates its value

NOTICE: The maximum variables are composed by 4 integer registers (2 long) which indicates its value and the date/time which is detected.

VARIABLES	Instantaneous		Observations
Capacitors Status	@ start (HEX)	# registers	
Capacitor 1	1730	1	0-> not connected; 1->connected
Capacitor 2	1731	1	0-> not connected; 1->connected
Capacitor 3	1732	1	0-> not connected; 1->connected
Capacitor 4	1733	1	0-> not connected; 1->connected
Capacitor 5	1734	1	0-> not connected; 1->connected
Capacitor 6	1735	1	0-> not connected; 1->connected
Capacitor 7	1736	1	0-> not connected; 1->connected
Capacitor 8	1737	1	0-> not connected; 1->connected
Capacitor 9	1738	1	0-> not connected; 1->connected
Capacitor 10	1739	1	0-> not connected; 1->connected
Capacitor 11	173A	1	0-> not connected; 1->connected
Capacitor 12	173B	1	0-> not connected; 1->connected
Capacitor 13	173C	1	0-> not connected; 1->connected
Capacitor 14	173D	1	0-> not connected; 1->connected
Capacitor 15	173E	1	0-> not connected; 1->connected
Capacitor 16	173F	1	0-> not connected; 1->connected

Supporting files: var_man.var & cap.var

ALARM	PHASE 1		Units
Variables	@ start (HEX)	# registers	
Al. Temperature. Value HI	1800	2	ºC
Al. Temperature. Value LO	1802	2	ºC
Al. Temperature. Delay	1804	2	sec
Al. Temperature. Output	1806	2	0DIS;1OFF;2ON
Al. Temperature. Relay	1808	2	0OFF;1ON
Al. Voltage. Value HI	1810	2	V
Al. Voltage. Value LO	1812	2	V
Al. Voltage. Delay	1814	2	sec
Al. Voltage. Output	1816	2	0DIS;1OFF;2ON
Al. Voltage Relay	1818	2	0OFF;1ON
Al. THDV. Value HI	1820	2	%
Al. THDV. Value LO	1822	2	%
Al. THDV. Delay	1824	2	sec
Al. THDV. Output	1826	2	0DIS;1OFF;2ON
Al. THDV. Relay	1828	2	0OFF;1ON
Al. THDIxI. Value HI	1830	2	A

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Al. THDIxI. Value LO	1832	2	A
Al. THDIxI. Delay	1834	2	sec
Al. THDIxI. Output	1836	2	0DIS;1OFF;2ON
Al. THDIxI. Relay	1838	2	0OFF;1ON
Al. THDIStep. Value HI	1840	2	%
Al. THDIStep. Value LO	1842	2	%
Al. THDIStep. Delay	1844	2	Num rep
Al. THDIStep. Output	1846	2	0DIS;1OFF;2ON
Al. THDIStep. Relay	1848	2	0OFF;1ON
Al. THDIC. Value HI	1850	2	A
Al. THDIC. Value LO	1852	2	A
Al. THDIC. Delay	1854	2	sec
Al. THDIC. Output	1856	2	0DIS;1OFF;2ON
Al. THDIC. Relay	1858	2	0OFF;1ON
Al. KVARNC. Value HI	1860	2	kvarC
Al. KVARNC. Value LO	1862	2	kvarC
Al. KVARNC. Delay	1864	2	sec
Al. KVARNC. Output	1866	2	0DIS;1OFF;2ON
Al. KVARNC. Relay	1868	2	0OFF;1ON
Al. Cos. Value HI	1870	2	-
Al. Cos. Value LO	1872	2	-
Al. Cos. Delay	1874	2	sec
Al. Cos. Output	1876	2	0DIS;1OFF;2ON
Al. Cos. Relay	1878	2	0OFF;1ON
Al. Low current Value HI	1880	2	A
Al. Low current Value LO	1882	2	A
Al. Low current Delay	1884	2	sec
Al. Low current Output	1886	2	0DIS;1OFF;2ON
Al. Low current Relay	1888	2	0OFF;1ON
Al. Leakage current Value Cap1	19C0	1	0DIS;1OFF;2ON
Al. Leakage current Value Cap2	19C1	1	0DIS;1OFF;2ON
Al. Leakage current Value Cap3	19C2	1	0DIS;1OFF;2ON
Al. Leakage current Value Cap4	19C3	1	0DIS;1OFF;2ON
Al. Leakage current Value Cap5	19C4	1	0DIS;1OFF;2ON
Al. Leakage current Value Cap6	19C5	1	0DIS;1OFF;2ON
Al. Leakage current Value Cap7	19C6	1	0DIS;1OFF;2ON
Al. Leakage current Value Cap8	19C7	1	0DIS;1OFF;2ON
Al. Leakage current Value Cap9	19C8	1	0DIS;1OFF;2ON
Al. Leakage current Value Cap10	19C9	1	0DIS;1OFF;2ON
Al. Leakage current Value Cap11	19CA	1	0DIS;1OFF;2ON
Al. Leakage current Value Cap12	19CB	1	0DIS;1OFF;2ON
Al. Leakage current Value Cap13	19CC	1	0DIS;1OFF;2ON
Al. Leakage current Value Cap14	19CD	1	0DIS;1OFF;2ON
Al. Leakage current Value Cap15	19CE	1	0DIS;1OFF;2ON
Al. Leakage current Value Cap16	19CF	1	0DIS;1OFF;2ON
Al. Leakage current Relay	19E2	2	0OFF;1ON
Al. IC loss Value HI Cap1	18C0	1	0DIS;1OFF;2ON
Al. IC loss Value HI Cap2	18C1	1	0DIS;1OFF;2ON
Al. IC loss Value HI Cap3	18C2	1	0DIS;1OFF;2ON
Al. IC loss Value HI Cap4	18C3	1	0DIS;1OFF;2ON
Al. IC loss Value HI Cap5	18C4	1	0DIS;1OFF;2ON

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Al. IC loss Value HI Cap6	18C5	1	0DIS;1OFF;2ON
Al. IC loss Value HI Cap7	18C6	1	0DIS;1OFF;2ON
Al. IC loss Value HI Cap8	18C7	1	0DIS;1OFF;2ON
Al. IC loss Value HI Cap9	18C8	1	0DIS;1OFF;2ON
Al. IC loss Value HI Cap10	18C9	1	0DIS;1OFF;2ON
Al. IC loss Value HI Cap11	18CA	1	0DIS;1OFF;2ON
Al. IC loss Value HI Cap12	18CB	1	0DIS;1OFF;2ON
Al. IC loss Value HI Cap13	18CC	1	0DIS;1OFF;2ON
Al. IC loss Value HI Cap14	18CD	1	0DIS;1OFF;2ON
Al. IC loss Value HI Cap15	18CE	1	0DIS;1OFF;2ON
Al. IC loss Value HI Cap16	18CF	1	0DIS;1OFF;2ON
Al. IC loss Value LO Cap1	18D0	1	0DIS;1OFF;2ON
Al. IC loss Value LO Cap2	18D1	1	0DIS;1OFF;2ON
Al. IC loss Value LO Cap3	18D2	1	0DIS;1OFF;2ON
Al. IC loss Value LO Cap4	18D3	1	0DIS;1OFF;2ON
Al. IC loss Value LO Cap5	18D4	1	0DIS;1OFF;2ON
Al. IC loss Value LO Cap6	18D5	1	0DIS;1OFF;2ON
Al. IC loss Value LO Cap7	18D6	1	0DIS;1OFF;2ON
Al. IC loss Value LO Cap8	18D7	1	0DIS;1OFF;2ON
Al. IC loss Value LO Cap9	18D8	1	0DIS;1OFF;2ON
Al. IC loss Value LO Cap10	18D9	1	0DIS;1OFF;2ON
Al. IC loss Value LO Cap11	18DA	1	0DIS;1OFF;2ON
Al. IC loss Value LO Cap12	18DB	1	0DIS;1OFF;2ON
Al. IC loss Value LO Cap13	18DC	1	0DIS;1OFF;2ON
Al. IC loss Value LO Cap14	18DD	1	0DIS;1OFF;2ON
Al. IC loss Value LO Cap15	18DE	1	0DIS;1OFF;2ON
Al. IC loss Value LO Cap16	18DF	1	0DIS;1OFF;2ON
Al. IC loss Relay	18E0	1	0OFF;1ON
Alarms global status	18F0	1	0DIS;1OFF;2ON
Relays global status	18F8	1	0OFF;1ON

Date Al. Temperature. Value HI	1900	2	
Date Al. Temperature. Value LO	1902	2	
Date Al. Voltage. Value HI	1910	2	
Date Al. Voltage. Value LO	1912	2	
Date Al. THDV. Value HI	1920	2	
Date Al. THDV. Value LO	1922	2	
Date Al. THDIxI. Value HI	1930	2	
Date Al. THDIxI. Value LO	1932	2	
Date Al. THDIStep. Value HI	1940	2	
Date Al. THDIStep. Value LO	1942	2	
Date Al. THDIC. Value HI	1950	2	
Date Al. THDIC. Value LO	1952	2	
Date Al. KVARNC. Value HI	1960	2	
Date Al. KVARNC. Value LO	1962	2	
Date Al. Cos. Value HI	1970	2	
Date Al. Cos. Value LO	1972	2	
Date Al. Low current Value HI	1980	2	
Date Al. Low current Value LO	1982	2	

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Special alarm current failure	19A0	1	2→ON, other→ OFF
Special alarm leakage current failure	19A8	1	0→Connection; 1→Disconnection without alarm; 2→Disconnection + Alarm

NOTICE: The variables in light green exists, but it doesn't has to be shown

Supporting files: alarm_cos.var, alarm_ileak.var, alarm_kvarnc.var, alarm_lostic.var, alarm_lowcur.var, alarm_temp.var, alarm_thdic.var, alarm_thdv.var, alarm_thdii.var, alarm_thdistep.var, alarm_volt.var, alarm_Relay_global_status.var,

All the alarms (except 4) have 5 associated registers; two to save the high or low value for which the alarm had been activated, one for countdown or alarm delay, which is not necessary to visualize because its performance is internal, another for status or that alarm output and another one for status or relay output associated to that alarm.

There are two alarms associated to the 16 capacitors, and have 33 registers: 16 to know if the alarm had been activated for high value of any of the 16 capacitors, 16 more to know if had been activated for lower value, and the last register is associated to the relay of this alarm.

There are two special alarms, one for current failure and another for leakage current failure, which does not have configuration registers nor associated date/time. Its performance is internal and it is activated or not according the line current measurement or the measurement from the differential transformer fails or not.

Only for Txx-CDI versions 3 more alarms are added: Al.THDIC, Al.current of leakage and Al.special of Failure of leakage currents.

-The performance of the Alarm of THDIC x IC (A) follows the same way to the other "normal" alarms.

-The leakage current failure alarm is special and according to the value of its variable will show: 0→ Connection ; 1→ Disconnection (without activating the alarm) ; 2→ Disconnection (alarm visualization);

***-The performance of the Leakage alarm (mA) is the following:

It has to visualize the 16 (or 14 according to model) and its value will be: 0→DIS ; 1→ OFF y 2 →ON

It has to be shown a literal which according its value means:

0→ (Literal in white)
1→ Error I leakage in capacitors
2→ Error I leakage
3→ Error metering of I leakage

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It has to be shown the output of this alarm and according its value means:

0→ DIS
1→ OFF
2 and literal =0→ Alarm processing I leakage
2 and literal !=0→ ON (Alarm)

There is also a register for the relay of the alarm: 0→OFF; 1→ON

General performance of the alarms

There are two ranges (high and low) for configuration, and two ways to configure the alarm (NO normally open and NC normally closed).

NO: -if the alarm is activated due to high value, this value will be saved in register HI of the alarm with its date.
-if the alarm is activated due to low value, this value will be saved in register LO of the alarm with its date.

NC: - if the alarm is activated due to intermediate value between LO and HI, this value will be saved in HI and LO registers with its date, so the values and dates are the same for the two registers.