DIGITAL-MULTIFUNCTION TRANSFORMER DIFFERENTIAL PROTECTION RELAY

TYPE

MD33-T

DATA BASE

1 - Supported MODBUS functions.

Both the communication ports support the following MODBUS RTU commands:

- Read N words (codes 3 and 4).
- Write N words (code 16).

Warning: the 'Write N words' command is limited to 4 words per message (due to internal memory limitations)

2 - Latency time.

Latency time is the time taken by a synchronization message to reach destination. Such time (and generally speaking all known delays) can be automatically compensated by the unit. A special setting (TLat) is available for such purpose. TLat is added to the current time when a synchronization message is received.

3 - ACTUAL MEASUREMENTS

All the following words are READ ONLY

Word Number	Name	Meaning	Notes
61	C_T_1	Current time: Years (format: 00YY (BCD))	5
62	C_T_2	Current time: Months, Days (format: MMDD (BCD))	5
63	C_T_3	Current time: Hours, Minutes (format: HHMM (BCD))	5
64	C_T_4	Current time: Seconds, Hundredths of second (format: SSTT (BCD))	5
70	dA	R.M.S. value of differential current of phase A	1
71	dB	R.M.S. value of differential current of phase B	1
72	dC	R.M.S. value of differential current of phase C	1
74	1A	R.M.S. value of current of phase A of transformer's side 1	Molt In1, Div 796
75	1B	R.M.S. value of current of phase B of transformer's side 1	Molt In1, Div 796
76	1C	R.M.S. value of current of phase C of transformer's side 1	Molt In1,Div 796
77	2A	R.M.S. value of current of phase A of transformer's side 2	Molt In2, Div 796
78	2B	R.M.S. value of current of phase B of transformer's side 2	Molt In2, Div 796
79	2C	R.M.S. value of current of phase C of transformer's side 2	Molt In2, Div 796
80	d2A	2nd Harmonic component of differential current of phase A	-
81	d5A	5th Harmonic component of differential current of phase A	-
82	d2B	2nd Harmonic component of differential current of phase B	-
83	d5B	5th Harmonic component of differential current of phase B	-
84	d2C	2nd Harmonic component of differential current of phase C	-
85	d5C	5th Harmonic component of differential current of phase C	-
160	IR	R.M.S. value of restraint current	Div 796

4 - MAXIMUM DEMAND VALUES

All the following words are read only.

Word Number	Name	Meaning	Notes
1060	dA	Differential current of phase A ,p.u. of rated phase input current	1
1061	dB	Differential current of phase B ,p.u. of rated phase input current	1
1062	dC	Differential current of phase C ,p.u. of rated phase input current	1
1064	1A	R.M.S. value of current of phase A of transformer's side 1	1
1065	1B	R.M.S. value of current of phase B of transformer's side 1	1
1066	1C	R.M.S. value of current of phase C of transformer's side 1	1
1067	2A	R.M.S. value of current of phase A of transformer's side 2	1
1068	2B	R.M.S. value of current of phase B of transformer's side 2	1
1069	2C	R.M.S. value of current of phase C of transformer's side 2	1
1070	d2A	2nd Harmonic component of differential current of phase A	-
1071	d5A	5th Harmonic component of differential current of phase A	-
1072	d2B	2nd Harmonic component of differential current of phase B	-
1073	d5B	5th Harmonic component of differential current of phase B	-
1074	d2C	2nd Harmonic component of differential current of phase C	-
1075	d5C	5th Harmonic component of differential current of phase C	-

5 - LAST TRIP

All the following words are read only.

Word Number	Name	Meaning	Notes
2000	Cause	Function which caused the last trip (Last Trip - 0)	7
2030	Cause1	Function which caused the trip #1 (Last Trip - 1)	7
2035	Cause2	Function which caused the trip #2 (Last Trip - 2)	7
2040	Cause3	Function which caused the trip #3 (Last Trip - 3)	7
2045	Cause4	Function which caused the trip #4 (Last Trip - 4)	7
2070	dA	Differential current of phase A ,p.u. of rated phase input current	1
2071	dB	Differential current of phase B ,p.u. of rated phase input current	1
2072	dC	Differential current of phase C ,p.u. of rated phase input current	1
2074	1A	R.M.S. value of current of phase A of transformer's side 1	1
2075	1B	R.M.S. value of current of phase B of transformer's side 1	1
2076	1C	R.M.S. value of current of phase C of transformer's side 1	1
2077	2A	R.M.S. value of current of phase A of transformer's side 2	1
2078	2B	R.M.S. value of current of phase B of transformer's side 2	1
2079	2C	R.M.S. value of current of phase C of transformer's side 2	1
2080	1d2A	2nd Harmonic component of differential current of phase A	-
2081	1d5A	5th Harmonic component of differential current of phase A	-
2082	1d2B	2nd Harmonic component of differential current of phase B	-
2083	1d5B	5th Harmonic component of differential current of phase B	-
2084	1d2C	2nd Harmonic component of differential current of phase C	-
2085	1d5C	5th Harmonic component of differential current of phase C	-
2086	1dA	Differential current of phase A ,p.u. of rated phase input current	1
2087	1dB	Differential current of phase B ,p.u. of rated phase input current	1
2088	1dC	Differential current of phase C ,p.u. of rated phase input current	1
2090	11A	R.M.S. value of current of phase A of transformer's side 1	1
2091	11B	R.M.S. value of current of phase B of transformer's side 1	1
2092	11C	R.M.S. value of current of phase C of transformer's side 1	1
2093	12A	R.M.S. value of current of phase A of transformer's side 2	1
2094	12B	R.M.S. value of current of phase B of transformer's side 2	1
2095	12C	R.M.S. value of current of phase C of transformer's side 2	1
2096	2d2A	2nd Harmonic component of differential current of phase A	-
2097	2d5A	5th Harmonic component of differential current of phase A	-
2098	2d2B	2nd Harmonic component of differential current of phase B	-
2099	2d5B	5th Harmonic component of differential current of phase B	-
2100	2d2C	2nd Harmonic component of differential current of phase C	-
2101	2d5C	5th Harmonic component of differential current of phase C	-
2102	2dA	Differential current of phase A ,p.u. of rated phase input current	1
2103	2dB	Differential current of phase B ,p.u. of rated phase input current	1
2104	2dC	Differential current of phase C ,p.u. of rated phase input current	1
2106	21A	R.M.S. value of current of phase A of transformer's side 1	1
2107	21B	R.M.S. value of current of phase B of transformer's side 1	1
2108	21C	R.M.S. value of current of phase C of transformer's side 1	1
2109	22A	R.M.S. value of current of phase A of transformer's side 2	1
2110	22B	R.M.S. value of current of phase B of transformer's side 2	1
2111	22C	R.M.S. value of current of phase C of transformer's side 2	1
2112	3d2A	2nd Harmonic component of differential current of phase A	-
2113	3d5A	5th Harmonic component of differential current of phase A	-
2114	3d2B	2nd Harmonic component of differential current of phase B	-
2115	3d5B	5th Harmonic component of differential current of phase B	-
2116	3d2C	2nd Harmonic component of differential current of phase C	-
2117	3d5C	5th Harmonic component of differential current of phase C	-

Word Number	Name	Meaning	Notes
2118	3dA	Differential current of phase A ,p.u. of rated phase input current	1
2119	3dB	Differential current of phase B ,p.u. of rated phase input current	1
2120	3dC	Differential current of phase C ,p.u. of rated phase input current	1
2122	31A	R.M.S. value of current of phase A of transformer's side 1	1
2123	31B	R.M.S. value of current of phase B of transformer's side 1	1
2124	31C	R.M.S. value of current of phase C of transformer's side 1	1
2125	32A	R.M.S. value of current of phase A of transformer's side 2	1
2126	32B	R.M.S. value of current of phase B of transformer's side 2	1
2127	32C	R.M.S. value of current of phase C of transformer's side 2	1
2128	4d2A	2nd Harmonic component of differential current of phase A	-
2129	4d5A	5th Harmonic component of differential current of phase A	-
2130	4d2B	2nd Harmonic component of differential current of phase B	-
2131	4d5B	5th Harmonic component of differential current of phase B	-
2132	4d2C	2nd Harmonic component of differential current of phase C	-
2133	4d5C	5th Harmonic component of differential current of phase C	-
2134	4dA	Differential current of phase A ,p.u. of rated phase input current	1
2135	4dB	Differential current of phase B ,p.u. of rated phase input current	1
2136	4dC	Differential current of phase C ,p.u. of rated phase input current	1
2138	41A	R.M.S. value of current of phase A of transformer's side 1	1
2139	41B	R.M.S. value of current of phase B of transformer's side 1	1
2140	41C	R.M.S. value of current of phase C of transformer's side 1	1
2141	42A	R.M.S. value of current of phase A of transformer's side 2	1
2142	42B	R.M.S. value of current of phase B of transformer's side 2	1
2143	42C	R.M.S. value of current of phase C of transformer's side 2	1
2144	5d2A	2nd Harmonic component of differential current of phase A	-
2145	5d5A	5th Harmonic component of differential current of phase A	-
2146	5d2B	2nd Harmonic component of differential current of phase B	-
2147	5d5B	5th Harmonic component of differential current of phase B	-
2148	5d2C	2nd Harmonic component of differential current of phase C	-
2149	5d5C	5th Harmonic component of differential current of phase C	-
2360	LT0_C_T_1	LT0_Current time: Years (format: 00YY (BCD))	5
2361	LT0_C_T_2	LT0_Current time: Months, Days (format: MMDD (BCD))	5
2362	LT0_C_T_3	LT0_Current time: Hours, Minutes (format: HHMM (BCD))	5
2363	LT0_C_T_4	LT0_Current time: Seconds, Hundredths of second (format: SSTT (BCD))	5
2366	LT1_C_T_1	LT1_Current time: Years (format: 00YY (BCD))	5
2367	LT1_C_T_2	LT1_Current time: Months, Days (format: MMDD (BCD))	5
2368	LT1_C_T_3	LT1_Current time: Hours, Minutes (format: HHMM (BCD))	5
2369	LT1_C_T_4	LT1_Current time: Seconds, Hundredths of second (format: SSTT (BCD))	5
2372	LT2_C_T_1	LT2_Current time: Years (format: 00YY (BCD))	5
2373	LT2_C_T_2	LT2_Current time: Months, Days (format: MMDD (BCD))	5
2374	LT2_C_T_3	LT2_Current time: Hours, Minutes (format: HHMM (BCD))	5
2375	LT2_C_T_4	LT2_Current time: Seconds, Hundredths of second (format: SSTT (BCD))	5
2378	LT3_C_T_1	LT3_Current time: Years (format: 00YY (BCD))	5
2379	LT3_C_T_2	LT3_Current time: Months, Days (format: MMDD (BCD))	5
2380	LT3_C_T_3	LT3_Current time: Hours, Minutes (format: HHMM (BCD))	5
2381	LT3_C_T_4	LT3_Current time: Seconds, Hundredths of second (format: SSTT (BCD))	5
2384	LT4_C_T_1	LT4_Current time: Years (format: 00YY (BCD))	5
2385	LT4_C_T_2	LT4_Current time: Months, Days (format: MMDD (BCD))	5
2386	LT4_C_T_3	LT4_Current time: Hours, Minutes (format: HHMM (BCD))	5
2387	LT4_C_T_4	LT4_Current time: Seconds, Hundredths of second (format: SSTT (BCD))	5

6 - TRIP NUMBER

All the following words are read only.

Word Number	Name	Meaning	Notes
3000	I>	Overcurrent element	-
3061	dA>	Low set differential element phase A (MD33T)	-
3062	dB>	Low set differential element phase B (MD33T)	-
3063	dC>	Low set differential element phase C (MD33T)	-
3064	dA>>	High set differential element phase A (MD33T)	-
3065	dB>>	High set differential element phase B (MD33T)	-
3066	dC>>	High set differential element phase C (MD33T)	-

7 – SETTINGS

All the following words can always be read. To write them the user must first write a password (2295) into word 8001. Such password is valid for 30s.

Word Number	Name	Min	Max	Step	Meaning	Notes
5000	Node	1	250	1	Identification number on serial bus. This is the relay's address for MODBUS communication.	It is taken into account ONLY AT POWER UP.
5001	Fn	50	60	10	System frequency	0 => 50Hz, 1 => 60Hz
5152	In1	1	9999	1	Rated primary current of Cts on Transformer's side 1	-
5153	In2	1	9999	1	Rated primary current of Cts on Transformer's side 2	-
5154	1V	20	38000	0.01	Rated voltage of Tramsformer's side 1 (phase to phase voltage)	-
5155	2V	20	38000	0.01	Rated voltage of Tramsformer's side 2 (phase to phase voltage)	-
5156	Group	0	17	1	Vector group of Transformer (side 1 = High voltage)	0 = Yy0, 1 = Yy6 2 = Yd1, 3 = Yd5 4 = Yd7, 5 = Yd11 6 = Dd0, 7 = Dd6 8 = Dy1, 9 = Dy5 10 = Dy7, 11 = Dy11 12 = Yz1, 13 = Yz5 14 = Yz7, 15 = Yz11 16 = Dz0, 17 = Dz6
5157	d>	10	51	0.01	Basic minimum pick-up level of low set phase differ. elem.	51 = Dis.
5158	d>>	20	171	0.1	Basic minimum pick-up level of low set phase differ. elem.	171 = Dis.
5159	R	10	50	1	Bias percentage	-
5160	2H	10	31	1	2nd harmonic restraint level	31 = Dis
5161	5H	20	41	1	5th harmonic restraint level	41 = Dis
5162	R2H	50	100	1	Reduced 2nd harmonic restraint level during the time tH from Transformer	-
5163	R5H	50	100	1	Reduced 2nd harmonic restraint level during the time tH from Transformer	-
5164	tH	1	9000	0.01	Time during which harmonic restraint level's reduction is active	-
5165	I>	5	170	0.01	Minimum pick-up level of overcurrent element	171 = Dis
5166	tI>	5	999	0.01	Time delay of overcurrent element	-

Word Number	Name	Min	Max	Step	Meaning	Notes
5176	BI>	0	1	1	Overcurrent element can be blocked during tH (BI> = ON) or active (BI> = OFF)	-
5168	B1	0	7	1	Digital input B1 blocks the function selected	0 = Dis, 1 = dL 2 = dH, 3 = dHdL 4 = I>, 5 = I>dL 6 = I>dH, 7 = I>dHdL
5169	TRG	0	3	1	Trigger for oscillography records is Internal or External via digital input B3	0 = Ext, 1 = d> 2 = d>>, 3 = I>
5119	Tsyn	0	5	1	Synchronization period	0 => 5min, 1 => 10min 2 => 15min, 3 => 30min 4 => 60min, 5 => Dis
5025	tFres	0	1	1	Reset after tripping mode (manual , auto)	0 => Manual, 1 => Auto
5120	C_T_1	-	-	-	Current time: Years (format: 00YY (BCD))	5
5121	C_T_2	-	-	-	Current time: Months, Days (format: MMDD (BCD))	5
5122	C_T_3	-	-	-	Current time: Hours, Minutes (format: HHMM (BCD))	5
5123	C_T_4	-	-	-	Current time: Seconds, Hundredths of second (format: SSTT (BCD))	5

8 - F->RELAYS

All the following words can always be read. To write them the user must first write a password (2295) into word 8001. Such password is valid for 30s.

Word Number	Name	Min	Max	Step	Meaning	Notes
6069	d>	0	1	1	Low set differential element	9
6070	d>>	0	1	1	High set differential element	9
6071	I>	0	1	1	Instantaneous overcurrent element	9
6072	tI>	0	1	1	Time delayed overcurrent element	9

9 - TRIP STATUS

All the following bits are read only.

Word Number	Name	Min	Max	Step	Meaning	Notes
7009,0	dA>	---	---	---	Low set differential element phase A	-
7009,1	dB>	---	---	---	Low set differential element phase B	-
7009,2	dC>	---	---	---	Low set differential element phase C	-
7009,3	dA>>	---	---	---	Low set differential element phase A	-
7009,4	dB>>	---	---	---	Low set differential element phase B	-
7009,5	dC>>	---	---	---	Low set differential element phase C	-
7009,6	I>	---	---	---	Overcurrent element	-
7009,7	tI>	---	---	---	Delayed overcurrent element	-
7500,0	B1	---	---	---	B1 Input	-
7500,1	B2	---	---	---	B2 Input	-
7500,2	B3	---	---	---	B3 Input	-

10 – COMMANDS

The following word is write only

Word Number	Name	Meaning	Notes
8000	CMD	Remote commands	Commands are encoded as follows: 0 => no command 1 => Test W/O trip 2 => Test W trip 3 => Reset 4 => Reserved 5 => Reset counters 6 => Trigger event recording 7 => Enable trigger 8 => Disable trigger 9 => Time sync

11 - PASSWORD

The following word is write only. When the value 2295 (decimal) is entered, settings and F->relays can be modified for 30s

Word Number	Name	Meaning	Notes
8001	PWD	Password	-

12 - DIAGNOSTIC STATUS

The following bits are read only

Word Number	Name	Meaning	Notes
9000.0	ALU_FLT	C.P.U. ALU fault	1 => fault 0 => no fault
9000.1	ADC_FLT	Analog to Digital Converter fault	1 => fault 0 => no fault
9000.2	E2P_FLT	memory fault	1 => fault 0 => no fault
9000.4	KBD_FLT	Keyboard fault (stuck key)	1 => fault 0 => no fault
9000.6	DSP_FLT	Display fault	1 => fault 0 => no fault
9000.9	PRG_FLT		1 => fault 0 => no fault

13 - RELAY ID

This word allows the host P.C. to identify the type of relay.

Word Number	Name	Meaning	Notes
64647	REL_ID	Id of MD33-T	Value = 46

14 - OSCILLOGRAPHY

See operation manual.

Notes:

1) Currents are expressed in conventional units: 7.96 corresponds to the rated primary current of phase CT's. So if you read a value x from words 1..3 you can convert it into Amps using the following formula: I [A] = (x / 7.96).

2) Phase to phase voltages are expressed in conventional units: 1086 corresponds to UnP. If you read a value x form words 16..18 you can convert it into V using the following formula: U [V] = (x/1086) * UnP * 10 (where UnP can be read from word 5004).

3) Phase to neutral voltages are expressed in conventional units: 1086 corresponds to UnP. If you read a value x form words 20..22 you can convert it into V using the following formula: E [V] = (x/1086) * UnP * 10 (where UnP can be read from word 5004).

4) Powers are expressed in conventional units: 1000 correspond to the nominal value of power ((In * UnP) / 1.732). So for example if x is a value of active power you can convert it into kW using the following formula: P [kW] = (x * In * UnP * 10) / (1732 * 1000), where In and UnP can be read from words 5002 and 5004.

5) Date/time is expressed using 4 words containing BCD (Binary Coded Decimal) numbers. Each nibble represents a digit. The first word stores Years (in a 2 digits format), the second one Months and Days, the third one Hours and Minutes and the fourth one Seconds and Tenths of a second.

6) Time elapsed from the last max. val. reset is expressed using 2 words containing BCD (Binary Coded Decimal) numbers. Each nibble represents a digit. Such time can range from 0 to 99 hours, 59 mins, 59.99 secs. The first words stores Hours and Minutes, while the second one stores Seconds and Tenths of a Second.

7) Trip causes are coded as follows:

Code	Cause
0	No trip
1	dA>
2	dB>
3	dC>
4	dA>>
5	dB>>
6	dC>>
7	I>

8) Working modes are encoded as follows:

Code	Mode
0	-
1	+
2	-/+
3	Dis

9) F => relays words are encoded as follows: each element has its own F => relays word, whose bits 0, 1, 2, 3 respectively corresponds to output relays R4, R3, R2, R1. Bits 4..15 are ignored by the unit. So for example if 1U_REL is equal to 7, it means that relays R2, R3 and R4 will be energised as soon as the first voltage element trips.

10) 2 trip bits are assigned to each element with the following meaning:

XX_TRP_OVER	XX_TRP_UNDER	Meaning
0	0	No trip
0	1	XX element has tripped (under)
1	0	XX element has tripped (over)
1	1	XX element has tripped (under and over)

Energies only have ‘OVER’ bits.

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