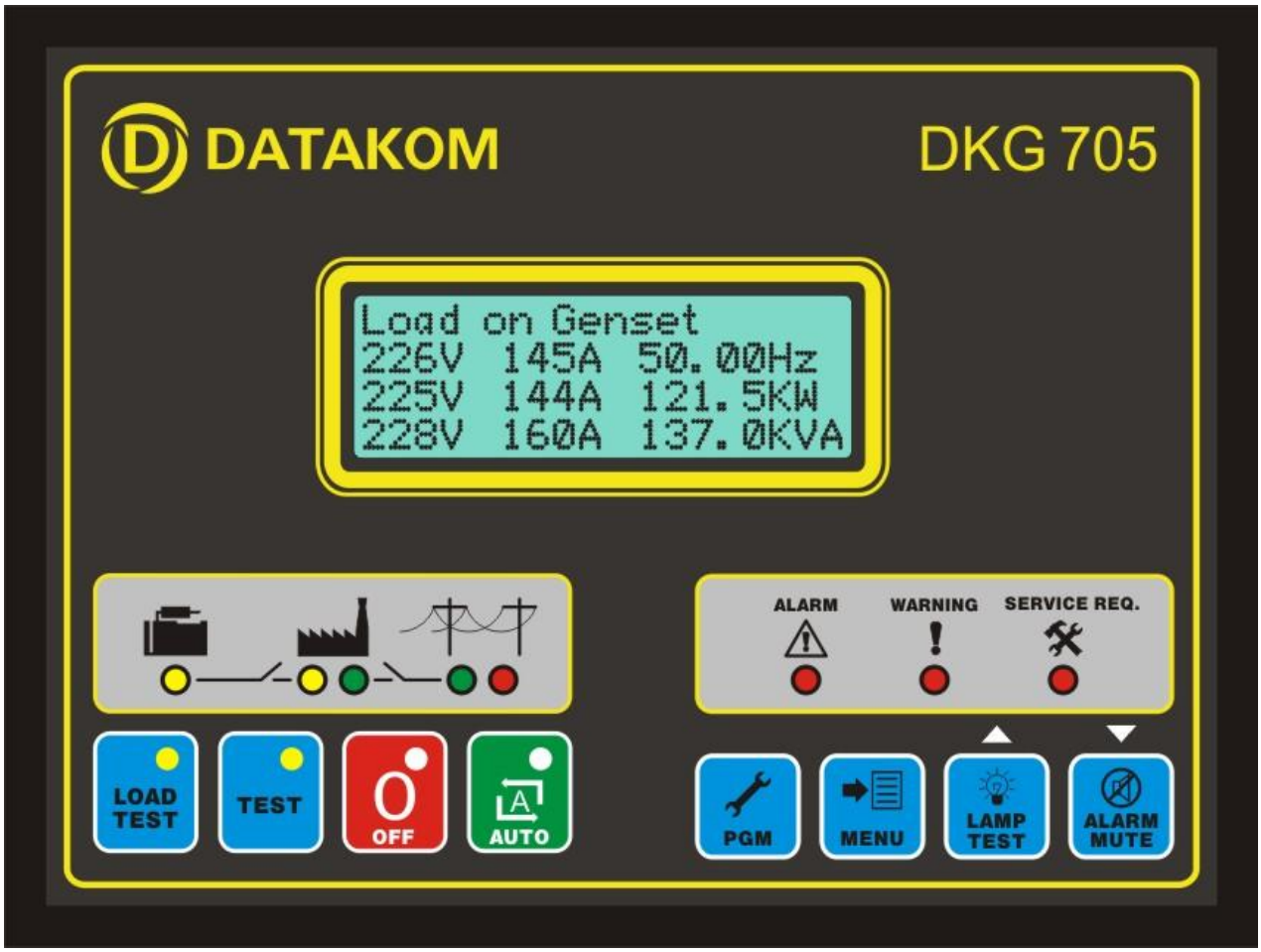
DATAKOM
Tel: +90-216-466 84 60
Fax: +90-216 364 65 65
datakom@datakom.com.tr
http://www.datakom.com.tr

DKG-705 AMF, PARALLEL TO MAINS AND DUAL GENSET SYNCHRONIZATION UNIT WITH J1939 INTERFACE



MODBUS COMMUNICATION

The unit offers the possibility of MODBUS communication via its RS232 serial port.

The connection to the MODBUS master may be done in 3 ways:

1) RS232 connection using directly the RS232 port provided.
2) RS422/485 connection using external RS422/485 converter.
3) Modem connection using external modem.

The MODBUS mode is activated by assigning a controller address to the unit using parameter **P_650**. The possible address range is 1 to 250. Setting the address 0 will **disable** the MODBUS mode and allow communication under RAINBOW protocol.

The MODBUS properties of the unit are:
-Data transfer mode: RTU
-Serial data: 9600 bps, 8 bit data, no parity, 1 bit stop
-Supported functions:
-Function 3 (Read multiple registers)
-Function 6 (Write single register)
-The answer to an incoming message is sent with a minimum of 4.3ms delay after message reception.

Each register consists of 2 bytes (16 bits). Larger data structures contain multiple registers.

Detailed description about the MODBUS protocol is found in the document "**Modicon Modbus Protocol Reference Guide"**. This document may be downloaded at:
www.modbus.org/docs/PI_MBUS_300.pdf

Data Reading

The function 03 (read multiple registers) will be used for data reading. The MODBUS master will send a query. The answer will be one of the below:
-A response containing the requested data
-An exceptional response indicating a read error.

The maximum number of registers read in one message is 16. If more registers are requested, the unit will send only the first 16 registers.

The query message specifies the starting register and quantity of registers to be read. The message structure is below:

Byte	Description	Value
0	Controller address	1 to 144
1	Function code	3
2	Starting address high	See below the description of available registers
3	Starting address low	
4	Number of registers high	always 0
5	Number of registers low	max 10h (16 decimal)
6	CRC low byte	See below for the checksum calculation
7	CRC high byte	

Here is the sequence to read 16 registers starting from address 20h (32 decimal):
01 03 00 20 00 10 45 CC (each byte is expressed as 2 hexadecimal characters)

The checksum value in the above message may be used for the verification of checksum calculation algorithm.

The normal response will be:

Byte	Description	Value
0	Controller address	same as in the query
1	Function code	3
2	Data lenght in **bytes** (L)	number of registers * 2
3	High byte of 1st register	
4	Low byte of 1st register	
5	High byte of 2nd register	
6	Low byte of 2nd register	
....		
L+1	High byte of the last register	
L+2	Low byte of the last register	
L+3	CRC low byte	See below for the checksum calculation
L+4	CRC high byte	

The exceptional response will be:

Byte	Description	Value
0	Controller address	same as in the query
1	Function code	131 (function code + 128)
2	Exception code	2 (illegal address)
3	CRC low byte	See below for the checksum calculation
4	CRC high byte	

Data Writing

The function 06 (write single register) is used for data writing. Only **one register** can be written at a time.

The MODBUS master will send a query containing data to be written. The answer will be one of the below:

-A normal response confirming successful write,

-An exceptional response indicating a write error.

Only some of the available registers are authorized to be written. An attempt to write a write protected register will result to the exceptional response.

The query message specifies the register address and data. The message structure is below:

Byte	Description	Value
0	Controller address	1 to 144
1	Function code	6
2	Register address high	See below the description of available registers
3	Register address low	
4	Data high byte	
5	Data low byte	
6	CRC low byte	See below for the checksum calculation
7	CRC high byte	

Here is the sequence to write the value 0010h to the register 40h (64 decimal):

01 06 00 40 00 10 89 D2 (each byte is expressed as 2 hexadecimal characters)

The checksum value in the above message may be used for the verification of checksum calculation algorithm

The normal response will be the same as the query:

Byte	Description	Value
0	Controller address	1 to 144
1	Function code	6
2	Register address high	See below the description of available registers
3	Register address low	
4	Data high byte	
5	Data low byte	
6	CRC low byte	See below for the checksum calculation
7	CRC high byte	

The exceptional response will be:

Byte	Description	Value
0	Controller address	same as in the query
1	Function code	134 (function code + 128)
2	Exception code	2 (illegal address) or 10 (write protection)
3	CRC low byte	See below for the checksum calculation
4	CRC high byte	

CRC calculation

Here is a procedure for generating a CRC:

1) Load a 16–bit register with FFFF hex (all 1's). Call this the CRC register.

2) Exclusive OR the first 8–bit byte of the message (the function code byte) with the low–order byte of the 16–bit CRC register, putting the result in the CRC register.

3) Shift the CRC register one bit to the right (towards the LSB), zero–filling the MSB. Extract and examine the LSB. The LSB is the least significant bit of the CRC **before** the shift operation.

4) If the LSB is 1: Exclusive OR the CRC register with the polynomial value A001 hex.

5) Repeat Steps 3 and 4 until 8 shifts have been performed. Thus, a complete 8–bit byte will be processed.

6) Repeat Steps 2 through 5 for the next 8–bit byte of the message. Continue doing this until all bytes have been processed.

7) The final contents of the CRC register is the CRC value.

8) Place the CRC into the message such that the low byte is transmitted first. The algorithm should give the correct CRC for below messages:

01 03 00 20 00 10 45 CC
01 06 00 40 00 10 89 D2

Error codes

Only 3 error codes are used:
01: illegal function code
02: illegal address
10: write protection (attempt to write a read_only register)

Data types

Each register consists of 16 bits (2 bytes)
If the data type is a byte, only the low byte will contain valid data. High byte is don't care.
For data type longer than 16 bits, consecutive registers are used. The least significant register comes first.

Register definitions

ADDRESS (hex)	R / W	DATA SIZE	COEFFICIENT	DESCRIPTION
0000	R	16bit	x10	Phase R voltage
0001	R	16bit	x10	Phase S voltage
0002	R	16bit	x10	Phase T voltage
0003	R	16bit	x10	Phase U voltage
0004	R	16bit	x10	Phase V voltage
0005	R	16bit	x10	Phase W voltage
0006	R	16bit	x10	Phase U current
0007	R	16bit	x10	Phase V current
0008	R	16bit	x10	Phase W current
0009	R	16bit	x10	Phase R current
000A	R	16bit	x10	Phase S current
000B	R	16bit	x10	Phase T current
000C	R	16bit	x10	Phase RS voltage
000D	R	16bit	x10	Phase ST voltage
000E	R	16bit	x10	Phase TR voltage
000F	R	16bit	x10	Phase UV voltage
0010	R	16bit	x10	Phase VW voltage
0011	R	16bit	x10	Phase WU voltage
0012	R	16bit	x10	Mains frequency
0013	R	16bit	x10	Genset frequency
0014	R	8bit	x1	Genset phase order Bit_7=0 if genset phase order is correct Other bits are don't care
0015	R	8bit	x1	Mains phase order Bit_7=0 if mains phase order is correct Other bits are don't care
0016-0017	R	32bit	x100	Genset active power multiplied by 100. High 8 bits are sign and low 24 bits are the absolute value. Least significant 16 bits are in the register 0016h. Most significant 16 bits are in the register 0017h.
0018	R	16bit	x100	Genset power factor multiplied by 100 (signed byte). Negative values indicate a capacitive power factor.
0019-001A	R	32bit	x100	Genset apparent power multiplied by 100. Least significant 16 bits are in the register 0019h. Most significant 16 bits are in the register 001Ah.
001B-001C	R	32bit	x100	Genset reactive power multiplied by 100. High 8 bits are sign and low 24 bits are the absolute value.Least significant 16 bits are in the register 001Bh. Most significant 16 bits are in the register 001Ch.
001D-001E	R	32bit	x100	Mains active power multiplied by 100. High 8 bits are sign and low 24 bits are the absolute value. Least significant 16 bits are in the register 001Dh. Most significant 16 bits are in the register 001Eh.
001F	R	16bit	x100	Mains power factor multiplied by 100 (signed byte). Negative values indicate a capacitive power factor.
0020-0021	R	32bit	x100	Mains apparent power multiplied by 100. Least significant 16 bits are in the register 0020h. Most significant 16 bits are in the register 0021h.
0022-0023	R	32bit	x100	Mains reactive power multiplied by 100. High 8 bits are sign and low 24 bits are the absolute value.Least significant 16 bits are in the register 0022h. Most significant 16 bits are in the register 0023h.

ADDRESS (hex)	R / W	DATA SIZE	COEFFICIENT	DESCRIPTION
0024	R / W	8bit	x1	Year as a BCD byte. Values are from 0 to 63h.
0025	R / W	8bit	x1	Month as a BCD byte. Values are from 1 to 0Ch.
0026	R / W	8bit	x1	Date as a byte. Values are from 1 to 1Fh.
0027	R / W	8bit	x1	Hours as a byte. Values are from 0 to 17h.
0028	R / W	8bit	x1	Minutes as a byte. Values are from 0 to 3Bh.
0029	R / W	8bit	x1	Seconds as a byte. Values are from 0 to 3Bh.
002A	R	16bit	x1	Engine speed (rpm)
002B	R	16bit	x10	Oil pressure multiplied by 10 in bars.
002C	R	16bit	x1	Coolant temperature in degrees C.
002D	R	16bit	x1	Fuel level as %
002E	R	16bit	x1	Oill temperature in degrees C.
002F	R	16bit	x10	Battery voltage
0030	R	8bit	x1	Charge input voltage as a ratio of the battery voltage. 00h means 0%, 80h means 50% and 0FFh means 100%. All intermediate values are supported.
0031	R	16bit	x10	External DC voltage
0032	R	16bit	-	**Shutdown alarm bits** bit_00: external input_0 shutdown alarm bit_01: external input_1 shutdown alarm bit_02: external input_2 shutdown alarm bit_03: external input_3 shutdown alarm bit_04: external input_4 shutdown alarm bit_05: external input_5 shutdown alarm bit_06: external input_6 shutdown alarm bit_07: external input_7 shutdown alarm bit_08: - bit_09: genset under frequency shutdown alarm bit_10: genset over frequency shutdown alarm bit_11: high battery voltage shutdown alarm bit_12: low fuel level (measured) shutdown alarm bit_13: high oil temperature (measured) shutdown alarm bit_14: high coolant temp. (measured) shutdown alarm bit_15: low oil pressure (measured) shutdown alarm
0033	R	16bit	-	**Shutdown alarm bits** bit_00: fail to stop shutdown alarm bit_01: fail to start shutdown alarm bit_02: genset low voltage fail shutdown alarm bit_03: genset high voltage fail shutdown alarm bit_04: slave unavailable shutdown alarm bit_05: genset phase sequence fail shutdown alarm bit_06: genset low rpm shutdown alarm bit_07: genset high rpm shutdown alarm bit_08: - bit_09: - bit_10: - bit_11: J1939 ECU communication fail shutdown alarm bit_12: - bit_13: - bit_14: communication lost shutdown alarm bit_15: -

ADDRESS (hex)	R / W	DATA SIZE	COEFFICIENT	DESCRIPTION
0034	R	16bit	-	**Loaddump alarm bits** bit_00: external input_0 loaddump alarm bit_01: external input_1 loaddump alarm bit_02: external input_2 loaddump alarm bit_03: external input_3 loaddump alarm bit_04: external input_4 loaddump alarm bit_05: external input_5 loaddump alarm bit_06: external input_6 loaddump alarm bit_07: external input_7 loaddump alarm bit_08: - bit_09: - bit_10: - bit_11: - bit_12: - bit_13: genset reverse power loaddump alarm bit_14: genset excess power loaddump alarm bit_15: alternator overcurrent loaddump alarm
0035	R	16bit	-	**Warning bits** bit_00: - bit_01: - bit_02: - bit_03: - bit_04: - bit_05: - bit_06: - bit_07: - bit_08: - bit_09: - bit_10: - bit_11: J1939 ECU warning bit_12: genset on load warning bit_13: mains on load warning bit_14: service request warning bit_15: -
0036	R	16bit	-	**Warning bits** bit_00: external input_0 warning bit_01: external input_1 warning bit_02: external input_2 warning bit_03: external input_3 warning bit_04: external input_4 warning bit_05: external input_5 warning bit_06: external input_6 warning bit_07: external input_7 warning bit_08: synchronization fail warning bit_09: genset under frequency warning bit_10: genset over frequency warning bit_11: high battery voltage warning bit_12: low fuel level (measured) warning bit_13: high oil temperature (measured) warning bit_14: high coolant temperature (measured) warning bit_15: low oil pressure (measured) warning

ADDRESS (hex)	R / W	DATA SIZE	COEFFICIENT	DESCRIPTION
0037	R	16bit	-	**Warning bits** bit_00: mains phase sequence fail warning bit_01: - bit_02: charge fail warning bit_03: low battery voltage warning bit_04: AVR control fail warning bit_05: GOV control fail warning bit_06: genset low rpm warning bit_07: genset high rpm warning bit_08: mains failure at parallel warning bit_09: mains recerse power at parallel warning bit_10: mains frequency fail at parallel warning bit_11: no mains frequency at parallel warning bit_12: ROCOF (df/dt) failure at parallel warning bit_13: vectorshift (df/dt) failure at parallel warning bit_14: communication lost warning bit_15: -
0039	R	8bit	-	**Relay output statuses (on board relays)** bit_0: - bit_1: relay_1 status (terminal_36) bit_2: relay_2 status (terminal_33), start relay bit_3: relay_3 status (terminal_37) bit_4: relay_4 status (terminal_1), genset contactor bit_5: relay_5 status (terminal_10), mains contactor bit_6: relay_6 status (terminal_32), fuel relay bit_7: relay_7 status (terminal_35),
003A	R	16bit	-	**Relay extension module, relay statuses** bit_0: module_1, relay_1 status bit_1: module_1, relay_2 status bit_2: module_1, relay_3 status bit_3: module_1, relay_4 status bit_4: module_1, relay_5 status bit_5: module_1, relay_6 status bit_6: module_1, relay_7 status bit_7: module_1, relay_8 status bit_8: module_2, relay_1 status bit_9: module_2, relay_2 status bit_10: module_2, relay_3 status bit_11: module_2, relay_4 status bit_12: module_2, relay_5 status bit_13: module_2, relay_6 status bit_14: module_2, relay_7 status bit_15: module_2, relay_8 status

ADDRESS (hex)	R / W	DATA SIZE	COEFFICIENT	DESCRIPTION
003B	R	16bit	-	**Relay function statuses** bit_0: choke bit_1: preheat bit_2: crank bit_3: alarm (timed) bit_4: genset contactor bit_5: mains contactor bit_6: fuel bit_7: stop bit_08: load shedding bit_09: alarm (not timed) bit_10: load contactor bit_11: auto ready bit_12: master relay bit_13: exerciser on bit_14: fuel pump bit_15: -
003C	R	16bit	-	**Relay function statuses** bit_00: external DC fail bit_01: idle speed operation bit_02: gas engine gas solenoid bit_03: - bit_04: - bit_05: flashing relay bit_06: - bit_07: - bit_08: - bit_09: - bit_10: bit_11: - bit_12: - bit_13: - bit_14: - bit_15: -
003D	R	8bit	-	**Operating mode** bit_0: - bit_1: - bit_2: - bit_3: - bit_4: auto mode bit_5: off mode bit_6: test mode bit_7: load test mode
003E	R	16bit	x1	Operation timer. Different actions are taken when this register switches from 1 to 0.

ADDRESS (hex)	R / W	DATA SIZE	COEFFICIENT	DESCRIPTION
003F	R	8bit	x1	**Genset operating status:** 0:load on mains 1:waiting before fuel (preheat) 2:waiting before/between cranks 3:cranking 4:engine heating 5:synchronization for load transfer to genset 6:genset contactor timer (synch mode) 7:genset contactor timer (non synch mode) 8:load on genset 9:synchronization for load transfer to mains 10:mains contactor timer (synch mode) 11:mains conntactor timer (non synch mode) 12:cooldown operation 13:stopping 14:soft transfer from gen to mains 15:soft transfer from mains to gen 16-255:not used
0040	R/W	8bit	-	Last pressed key. This byte is also used in order to change operation mode through MODBUS. bit_0: - bit_1: - bit_2: - bit_3: - bit_4: auto mode bit_5: off mode bit_6: test mode bit_7: load test mode
0041	R	16bit	x1	GOV control output analog value as a percentage of the full scale. 0000h means 0%, 8000h means 50% and 0FFffh means 100%. All intermediate values are supported.
0042	R	16bit	x1	AVR control output analog value as a percentage of the full scale. 0000h means 0%, 8000h means 50% and 0FFffh means 100%. All intermediate values are supported.
0043	R	16bit	x1	Synchroscope phase angle. Msb is the sign and other bits are the absolute value.

ADDRESS (hex)	R / W	DATA SIZE	COEFFICIENT	DESCRIPTION
0060	R	16bit	x8	J1939: Engine speed
0061	R	16bit	x1	J1939: Coolant temperature (-40°C offset)
0062	R	16bit	x10	J1939: Oil pressure
0063-0064	R	32bit	x20	J1939: Total engine hours
0065	R	16bit	x100	J1939: Air filter differential pressure
0066	R	16bit	x50	J1939: Boost pressure in bars
0067	R	16bit	x10	J1939: Fuel pressure in bars
0068	R	16bit	x1	J1939: Fuel Temperature (-40°C offset)
0069	R	16bit	x10	J1939: Fuel rate (lt/hr)
006A	R	16bit	x1	J1939: Instantaneous fuel economy
006B	R	16bit	x1	J1939: Oil temperature (-40°C offset)
006C	R	16bit	x1	J1939: Ambient air temperature (-40°C offset)
006D	R	16bit	x1	J1939: Air inlet temperature (-40°C offset)
006E	R	16bit	x1	J1939: Intake manifold_1 temperature (-40°C offset)
006F	R	16bit	x1	J1939: exhaust gas temperature
0070	R	8bit	x1	J1939 warning_1_FMI
0071	R	16bit	x1	J1939 warning_1_SPN
0072	R	8bit	x1	J1939 warning_2_FMI
0073	R	16bit	x1	J1939 warning_2_SPN
0074	R	8bit	x1	J1939 warning_3_FMI
0075	R	16bit	x1	J1939 warning_3_SPN
0076	R	8bit	x1	J1939 warning_4_FMI
0077	R	16bit	x1	J1939 warning_4_SPN
0078	R	8bit	x1	J1939 warning_5_FMI
0079	R	16bit	x1	J1939 warning_5_SPN
007A	R	8bit	x1	J1939 warning_6_FMI
007B	R	16bit	x1	J1939 warning_6_SPN
007C	R	8bit	x1	J1939 warning_7_FMI
007D	R	16bit	x1	J1939 warning_7_SPN
007E	R	8bit	x1	J1939 warning_8_FMI
007F	R	16bit	x1	J1939 warning_8_SPN

ADDRESS (hex)	R / W	DATA SIZE	COEFFICIENT	DESCRIPTION
1000	R	8bit	x1	Idle timer
1001	R	16bit	x0.1	Current transfer ratio
1002	R	8bit	x1	bit_0: multi genset operation enable bit_1: single genset load enable bit_2: multi genset no break transfer bit_3: multi genset soft transfer bit_4: - bit_5: - bit_6: - bit_7: -
1005	R	8bit	x10	Low oil pressure shutdown limit
1006	R	8bit	x10	Low oil pressure warning limit
1007	R	8bit	x1	High temp shutdown limit
1008	R	8bit	x1	High temp warning limit
1009	R	8bit	x1	High frequency shutdown limit
100A	R	8bit	x1	High frequency warning limit
100B	R	8bit	x1	Low frequency shutdown limit
100C	R	8bit	x1	Low frequency warning limit
100D	R	8bit	x0.5	High voltage shutdown limit
100E	R	8bit	x0.5	Low voltage shutdown limit
100F	R	8bit	x0.5	Mains voltage high limit
1010	R	8bit	x0.5	Mains voltage low limit
1011	R	8bit	x1	Hysteresis voltage
1012	R	8bit	x5	High battery voltage shutdown limit
1013	R	8bit	x5	High battery voltage warning limit
1014	R	8bit	x5	Low battery voltage warning limit
1015	R	8bit	x0.1	Overcurrent load_duımp limit
1016	R	16bit	x1	Excess power load_dump limit
1017	R	8bit	x1	Overload timer
1018	R	8bit	x1	Number of start attempts
1019	R	8bit	x1	Engine heating temperature
101A	R	8bit	x1	Stop timer
101B	R	8bit	x1	Crank timer
101C	R	8bit	x1	Preheat timer
101D	R	8bit	x1	Wait between starts timer
101E	R	8bit	x1	Wait before fuel timer
101F	R	8bit	x0.5	Cooldown timer
1020	R	8bit	x0.5	Mains waiting timer
1021	R	8bit	x1	Genset contactor timer
1022	R	8bit	x1	Mains contactor timer
1023	R	8bit	x1	Engine heating timer
1024	R	8bit	x1	Horn timer

ADDRESS (hex)	R / W	DATA SIZE	COEFFICIENT	DESCRIPTION
1025	R	8bit	x1	Operation mode_1 bits: bit_0:no break transfer enable bit_1:soft transfer enable bit_2:GOV control enable bit_3:AVR control enable bit_4:GOV reverse polarity bit_5:AVR reverse polarity bit_6:ignore phase order bit_7:peak lopping enabled
1026	R	8bit	x1	Operation mode_2 bits: bit_0/1: 0/0=engine heating by timer 1/0=engine heating by timer+coolant temp x/1= engine heating by timer+oil temp bit_2: rpm from genset frequency bit_3: genset L_L voltage display bit_4: mains L_L voltage display bit_5: emergency backup operation bit_6: mains current transformers bit_7: modem enable
1027	R	8bit	x0.02	Engine hours between services
1028	R	8bit	x1	Days between services
102A	R	8bit	x1	Exercise time
102B	R	8bit	x10	Exercise duration
102C	R	16bit	x1	Operation mode_3 bits: bit_1-0: exerciser period (00:day 01:week 10:month) bit_2: exerciser type (0:test 1:load test) bit_3: SMS enable bit_4: automatic exercise with TEST & LOAD TEST buttons bit_5: modem call on load transfer bit_6:warning on service request bit_7: internal modem
102D	R	16bit	x1	Low byte: J1939 engine brand High byte: J1939 engine model