LAFERT
RTU MODBUS ON RS485
MANUAL

Release 1.4b

Date 16/01/2023

INDEX

Tables and Figures:

REFERENCE DOCUMENTS:

- *Lafert User Guide*

TERMS AND ABBREVIATIONS

EMCY	Emergency Parameter.
EMC	Electromagnetic compatibility.
HMI	Human Machine Interface.
I/O	Input/output.
LSB	Least significant bit/byte.
LSD	Lafert Servo Drives.
MASTER	It is a device that controls and communicates with drive.
MSB	Most significant bit/byte.
MSM	Macro State Machine of Lafert Servo Drives.
IdNode	Node address assigned to a device on the network.
PDS	Power Drive System.
REG	Register.
RO	Denotes read-only access.
RW	Denotes read/write access.
RX	Messages sent by Main Control Board and received by Drive.
STO	Safe Torque Off
TX	Messages sent by Drive and received by Main Control Box

FIRMWARE AND MANUAL RELEASED

This table shows the correlation between firmware and Modbus Manual.

Lafert Servo Drive	Firmware Released	Modbus Manual
SMARTRIS	2.3.1	1.4a

1. | MODBUS OPERATION

1.1 RS485 - Modbus Communication Settings

WRITE SINGLE HOLDING REGISTER (0x06) / READ HOLDING REGISTERS (0x03)

Physical Address

Variable	Address (WR)	Default Value	Choice
Address	0x0028	1	1 ÷ 247

Baud Rate

Variable	Address (WR)	Default Value	Choice
BaudRate	0x0035	192 ➔ 19200	96 ➔ 9600
			192➔ 19200
			384 ➔ 38400
			576 ➔ 57600
			1152 ➔ 115200

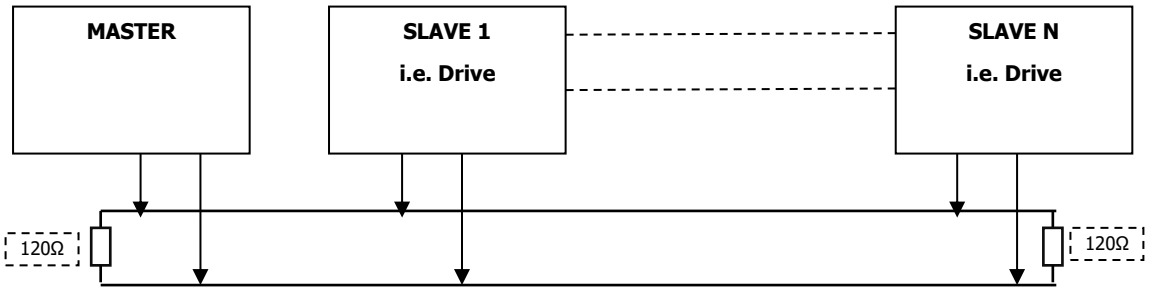
COM Settings

Variable	Address (WR)	Default Value	Choice
Parity/ Stop Bits / Data Bits	0x002B	0 ➔ NO Parity / 2 Stop Bits / 8 Data Bits	0 ➔ NO Parity / 2 Stop Bits / 8 Data Bits
			1 ➔ ODD Parity / 1 Stop Bit / 8 Data Bits
			2 ➔ EVEN Parity / 1 Stop Bit / 8 Data Bits

Warning

The Modbus Address is the physical address and depends if there are more devices togheter.

WARNING: The modifies of Baudrate or Parity can cause communication issues. They depend to Hardware connection. In case of sending different value drive gives the Exception Code 0x03



Picture 1 – Modbus Connection

Warning

Lafert Drive is always set as a slave

	**Warning** Broadcast communication it is not implemented

RTU Mode - Bits per Byte

Start Bit	Data Bits	Parity	Stop Bits
1	8 data bits, least significant bit sent first	1 bit for even / odd parity-no bit for no parity	1 stop bit if parity is used-2 bits if no parity

1.2 Examples: Change Modbus Communication Settings

	**Warning** The Modbus doesn't allow more devices with same address To Change Address it is mandatory connect one drive on the time with Master Controller

1.2.1 Change Address Sequence

In case of more devices connected it is necessary to change the address of devices (default value 1).

Variable	Address (WR)	Default Value	Choice
Address	0x0028	1	1 ÷ 247

Example: change address from 1 to 2

In this case connect the Drive where is necessary to change the address (0x0028) from 1 to 2:

Address	Function	Address (WR)		Data		CRC
01	06	00	28	00	02	16 bit

Save to EEProm (0x0000)

Address	Function	Address (WR)		Data		CRC
01	06	00	00	00	01	16 bit

System Reset (0xA5A5)

Address	Function	Address (WR)		Data		CRC
01	06	A5	A5	00	01	16 bit

After this procedure the drive has Modbus Address set at 2

1.2.2 Change Baud Rate Sequence

Example: In case is necessary to change the Baud Rate (0x0035) from 19200 (default) to 9600 (96 = 0x60):

Address	Function	Address (WR)		Data		CRC
01	06	00	35	00	60	16 bit

Save to EEProm (0x0000)

Address	Function	Address (WR)		Data		CRC
01	06	00	00	00	01	16 bit

System Reset (0xA5A5)

Address	Function	Address (WR)		Data		CRC
01	06	A5	A5	00	01	16 bit

After this procedure the drive has Modbus Baud Rate is set at 9600

1.2.3 Change COM Setting Sequence

Example: In case is necessary to change the COM Setting (0x002B) from 0 (default) to 1 (1 ➔ ODD Parity / 1 Stop Bit / 8 Data Bits):

Address	Function	Address (WR)		Data		CRC
01	06	00	2B	00	01	16 bit

Save to EEProm (0x0000)

Address	Function	Address (WR)		Data		CRC
01	06	00	00	00	01	16 bit

System Reset (0xA5A5)

Address	Function	Address (WR)		Data		CRC
01	06	A5	A5	00	01	16 bit

After this procedure the drive has Modbus COM Setting is set at 1 ➔ ODD Parity / 1 Stop Bit / 8 Data Bits

* depends by COM Settings (0x002B)

1.3 Examples: Read Messages

1.3.1 Read Input Register

Example: Single - In case is necessary to read the Drive Status (0x0060) :

Address	Function	Address (RD)		Num of registers		CRC
01	04	00	60	00	01	16 bit

Example: Multiple – Read multiple Input Registers from Drive Status (0x0060) toVolt Reference (0x0070) - 17 registers.

Set the address of first register and the number of registers to read

Address	Function	Address (RD)		Num of registers		CRC
01	04	00	2B	00	**17**	16 bit

1.3.2 Read Holding Register

Example: Read the COM Setting (0x002B)

Address	Function	Address (WR)		Num of registers		CRC
01	03	00	2B	00	01	16 bit

Example: Read Multiple Holding register from PID VELOCITY KP (0x003C) to SPEED RAMP DOWN (0x0041) - 6 registers

Set the address of first register and the number of registers to read

Address	Function	Address (WR)		Num of registers		CRC
01	03	00	3C	00	06	16 bit

2. | READ INPUT REGISTERS (0X04)

2.1 List of Read Input Registers

	READ FROM DRIVE (0x04)		UNIT
HEX	DEC		
0x0042	66	SPEED SETPOINT	[RPM]
0x0047	71	CURRENT TORQUE SETPOINT	[Arms / 100]
0x005E	94	DIGITAL INPUTS	
0X005F	95	DIGITAL OUTPUTS	
0x0060	96	DRIVE STATUS	
0x0061	97	WARNING CODE LOW	
0x0062	98	WARNING CODE HIGH	
0x0063	99	ERROR CODE	
0x0064	100	BUS DC LINK	[V / 100]
0x0065	101	MOTOR TEMPERATURE	[°C / 10]
0x0066	102	HEAT-SINK TEMPERATURE	[°C / 10]
0x0067	103	BOARD TEMPERATURE	[°C / 10]
0x0068	104	VELOCITY (AVERAGE)	[RPM]
0x0069	105	TORQUE CURRENT	[Arms / 100]
0x006A	106	I2T ENERGY VALUE	[%]
0x006B	107	AXIS POSITION LOW	[Pulse]
0x006C	108	AXIS POSITION HIGH	[Pulse]
0X006D	109	IMPULSES	[Pulse]
0X006E	110	ACTUAL VELOCITY – USER FEEDBACK	[RPM]
0x006F	111	TQ CURRENT WIND	[Arms / 100]
0x0070	112	VOLT REFERENCE (ANALOG INPUT)	
0x0100	256	FEEDBACK TYPE	
0x0101	257	FEEDBACK RESOLUTION	
0x0102	258	FEEDBACK INIT POSITION LOW	
0x0103	259	FEEDBACK INIT POSITION HIGH	
0x0104	260	FEEDBACK ACTUAL POSITION LOW	
0x0105	261	FEEDBACK ACTUAL POSITION HIGH	
0x0106	262	FEEDBACK ENCODER TYPE	
0x0107	263	RESERVED	
0x0108	264	RESERVED	
0x0109	265	FEEDBACK INIT ROUNDS	

0x010A	266	FEEDBACK INIT RELATIVE POSITION	
0x010B	267	RESERVED	
0x010C	268	RESERVED	
0x010D	269	ANALOG OUTPUT VALUE DAC	
0x0110	272	DIGIN 1 STATE	
0x0111	273	DIGIN 2 STATE	
0x0112	274	DIGIN 3 STATE	
0x0113	275	DIGIN 4 STATE	
0x0114	276	DIGOUT 1 STATE	
0x0115	277	DIGOUT 2 STATE	
0x0116	278	DIGOUT 3 STATE	
0x0117	279	DIGOUT 4 STATE	

Warning

If is written an address not present in list above the drive gives the Exception Code 0x02

2.2 Description of Read Input Registers

SPEED SETPOINT [rpm]

PDU Address (HEX)	Description
0x0042	SPEED SETPOINT **i.e.** 0x0042 = 0x64 (100) → Speed Motor = 100 rpm 0x0042 = 0xF448 (62536 = -3000) → Speed Motor = -3000 rpm

CURRENT TORQUE SETPOINT

PDU Address (HEX)	Description
0x0047	Current SETPOINT **i.e.** 0x0047 = 0xC8 (200) ➔ 2 Arms 0x0047 = 0xFF38 (65336 = -200) ➔ - 2 Arms

DIGITAL INPUTS

PDU Address (HEX)	Description
0x005E	Reads DIGITAL INPUTS state The default DIGITAL INPUT configuration in Modbus Command Mode is: • DIGIN1 = DCW • DIGIN2 = DCCW

	• DIGIN3 = EMERGENCY INPUT ENABLE • DIGIN4 = RESET (see table below for further informations about digital inputs configurations)

0x005E	DIG IN 4	DIG IN 3	DIG IN 2	DIG IN 1
0x0001	0	0	0	1
0x000F	1	1	1	1

Contact Manufacturer to modify program of Digital Inputs

Bit	Configuration
0	"RUN" (used only in Analog Mode): this input is the command to move the drive in RUN state.
1	"STOP" (used only in Analog Mode): this input is the command to move the drive in STOP state
2	"EMERGENCY INPUT ENABLE": when the option of digital input 3 is defined "Emergency Input Enable" this input is the command to move the drive in STANDBY state.
3	"RESET": when this function is enabled the input configured can put the drive in reset (it is an hardware reset). If the digital input is configured as reset, the reset has a filter with 100ms.
4	"DCW": this function is to configure the input with an actuator for clockwise. If the input state is 1 the drive goes in STOP state.
5	"DCCW": this function is to configure the input with an actuator for counter clockwise. If the input state is 1 the drive goes in STOP state
6	"SETVEL1" (used only in Analog Mode): This function is to configure the Set Point value defined by "File Parameters". If the digital inputs are set with this function, then the Set Points available are 2.
7	"SETVEL2" (used only in Analog Mode): This function is to configure the Set Point value defined by "File Parameters". If the digital inputs are set with the functions "SETVEL1" and "SETVEL2", then the Set Points available are 4.
8	"SETVEL3" (used only in Analog Mode): This function is to configure the Set Point value defined by "File Parameters". If the digital inputs were set with the functions "SETVEL1", "SETVEL2" and "SETVEL3", then the Set Points available are 8.
9	"SETVEL4" (used only in Analog Mode): This function is to configure the Set Point value defined by "File Parameters". If the digital inputs were set with the functions "SETVEL1", "SETVEL2", "SETVEL3" and "SETVEL4", then the Set Points available are 15. If this function is set then all digital inputs are used. When all dital inputs are 0 the drive is in STANDBY, to have the RUN function it needs to have at least one digital input as 1.
10	"VEL/CUR" (used only in Analog Mode): If the digital Input is selected with this function then the drive change the mode operation (Velocity Profile and Torque Profile), the function can be used only in standby state.
11	"DIR" (used only in Analog Mode): This function changes the direction of the motor. The set point changes the polarity.

Table 1 – Programmable Inputs

DIGITAL OUTPUTS

PDU Address (HEX)	Description
0x005F	Reads DIGITAL OUTPUTS **DIG-OUT1:** shows if the drive is: • '1' = Drive OK • '0' = Drive in FAULT **DIG-OUT2** Warning **DIG-OUT3** Drive Ready **DIG-OUT4** shows the BRAKE status: • '1' = brake released, motor axis free • '0' = brake active, motor blocked **i.e.** 0x005F = 0x0001 → Drive OK is ON, the drive doesn't have alarm

0x005E	DIG OUT 4	DIG OUT 3	DIG OUT 2	DIG OUT 1
0x0001	0	0	0	1
0x000F	1	1	1	1

DRIVE STATUS

PDU Address (HEX)	Description
0x0060	Status of the drive: • 0x0001 – Run in Velocity mode • 0x0002 – Drive in StandBy • 0x0004 – Drive in STOP • 0x0008 – reserved • 0x0010 – Drive in Alarm (see Error code) • 0x0020 – Run in Torque mode • 0x0040 – Drive in Init state (CANOpen) • 0x0080 – Drive in SAFE (STO active) • 0x0100 – reserved **i.e.** 0x0060 = 0x0002: the drive is ready in standby

Warning

The warning message is 32 bit data, while the Modbus parameters are 16 bit: the 32 bit are separated in 2 parameters of 16 bit, 0x0061 contains the lower 16 bit, while 0x0062 contains the higher part

WARNING CODE LOW

PDU Address (HEX)	Bit	Warning	Warning description
0x0061	0-7	free	
	8	Heat Sink Temperature	Warning Heat Sink Temperature
	9	Logic Board Temperature	Warning Logic Board Temperature
	10	Motor Temperature	Warning Motor Temperature
	14-15	free	

WARNING CODE HIGH

PDU Address (HEX)	Bit	Warning	Warning description
0x0062	0-15	free	

ERROR CODE

PDU Address (HEX)	Bit	Error Code	Error description
0x0063	0	**See table below**	**See table below**

Error	Error Code	Description	Meaning	F W	Led Code
NO ERROR	**0x0000**	**No Error**	The Fault Reset command has been executed or there was a reset with power cycle	-	-
ALARM CURRENT					

SHORT CIRCUIT MOTOR	**0x2340**	**Short circuit (motor-side)**	Alarm Over Current has been occurred	**F**	**3,1**
LOAD LEVEL FAULT	**0x2350**	**Load level fault (I2t, thermal state)**	Alarm Over Current with integral i^2t (Over Load)	**F**	**5,2**
	0x2352	Load Level (i2t) not rearmed	Alarm Over Current with integral i^2t (Over Load) not Rearmed	**F**	**5,2**
		ALARM VOLTAGE			
OVER VOLTAGE	**0x3210**	**DC link over-voltage**	Over Voltage alarm has been occurred	**F**	**4,2**
DC LINK UNDER VOLTAGE	**0x3220**	**DC link under-voltage**	Under Voltage alarm has been occurred	**F**	**4,1**
		ALARM TEMPERATURE			
TEMPERATURE DRIVE	**0x4300**	**Temperature Drive**	Over Temperature Heat Sink (value depends by Manufacturer)	**F**	**1,1**
	0x4301	Warning temperature drive	Warning temperature drive (value depends by Manufacturer)	**W**	**-**
	0x4310	Excess temperature drive	Heat Sink Temperature too high of max Range	**F**	**1,3**
	0x4320	Too low temperature drive	Heat Sink Temperature too low of minimum Range	**F**	**1,3**
TEMPERATURE INT 1 – BOARD	**0x4500**	**Temperature Logic Board**	Over Board Temperature	**F**	**1,4**
	0x4501	Warning Logic Board temperature	Warning Logic Board temperature	**W**	**-**
	0x4510	Excess Logic Board temperature	Board Temperature too high of maximum Range	**F**	**1,5**
	0x4520	Too low Logic Board temperature	Board Temperature too low of minimum Range	**F**	**1,5**
TEMPERATURE EXT 1 - MOTOR	**0x4A00**	**Temperature Motor**	Over Motor Temperature	**F**	**1,10**
	0x4A01	Warning temperature Motor	Warning Motor Temperature	**W**	**-**
	0x4A10	Excess temperature Motor	Motor Temperature too high of maximum Range	**F**	**1,6**
	0x4A20	Too low temperature Motor	Motor Temperature too low of minimum Range	**F**	**1,6**
		ALARM HARDWARE			
INPUT STAGES	0x5431	Offset Sensor	Offset Sensor	**F**	**3,10**
HARDWARE MEMORY	0x5501	HardwareError Write EEprom: Vbus too Low	Write is not possible because the Bus Voltage is too low to guarantee the writing complete	**F**	**5,3**
HW MEMORY E^2PROM - USER	**0x5530**	**E^2PROM**	Generic Error E^2prom	**F**	**6,1**
	0x5531	E^2prom General Error	Generic Error E^2prom Writing	**F**	**6,1**
	From 0x5532 to 0x556F	E^2prom Error Parameter 1 - 61	Error Writing E^2prom Parameters (contact Manufacturer)	**F**	**6,1**
HW MEMORY E^2PROM - FACTORY PARAMETERS	0x5A02	Error Data Golden Image	Data Golden Image is not written	**F**	**8,1**
		ALARM PARAMETERS			
DATA SET	**0x6300**	**Data Set Parameters Table**	Data Set Programming Error	**F**	**7,1**
	From 0x6301 To 0x6409	Data record no. 1 - 24	Programming Error Data Set (contact Manufacturer)	**F**	**7,1**
PARAMETER ERROR	**0x6320**	**Parameter Error**	Generic Parameter Error	**F**	**6,4**
	0x6321	Incongruity Data Configuration 1	Configuration Error (contact Manufacturer)	**F**	**6,4**

	0x6322	Incongruity Data Configuration 2	Configuration Error (contact Manufacturer)	**F**	**6,4**
		ALARM ADDITIONAL MODULE			
ENCODER SINCOS	**0x7350**	**Encoder SinCos**	Error Generic Encoder SinCos	**F**	**2,6**
	0x7351	Rx Error	Error Message Received	**F**	**2,6**
	0x7352	Tx Error	Error Message Transmitted	**F**	**2,6**
	0x7353	Comand Read Position Error	Error Read Position	**F**	**2,6**
	0x7354	Comand Status Error	Error Status Encoder SinCos	**F**	**2,6**
	0x7355	Comand Type Error	Error Type Encoder SinCos	**F**	**2,6**
	0x7356	Comand Init Timeout	Error Timeout during Initialization SinCos	**F**	**2,6**
CONVERTER SINCOS	**0X7360**	**Converter Sin/Cos**	Error Generic Converter Sin/Cos	**F**	**6,3**
	0x7361	E^2prom Ext	First programming E^2prom external, we must reset the driver	**F**	**6,3**
	0x7362	Nerr Signal Amp	Fault has been occurred: Amplitude Error	**F**	**6,3**
	0x7363	Nerr Signal Freq	Fault has been occurred: Frequency Error	**F**	**6,3**
	0x7364	Nerr Signal Other	Fault has been occurred: configuration or Under voltage or System Error	**F**	**6,3**
	0x7365	Error Gen	General Error	**F**	**6,3**
RESOLVER	0x7374	Resolver Initialization	Resolver Fault Initialization has been occurred		**2,4**
	0x7375	Resolver Hardware Fault LOS (Loss of Signal)	Manufacturer specific value describes the cause of the triggering of the fault detection output pins	**F**	**2,10**
	0x7376	Resolver Hardware Fault DOS (Degradation of Signal)	Manufacturer specific value describes the cause of the triggering of the fault detection output pins	**F**	**2,10**
	0x7377	Resolver Hardware Fault LOT (Loss of Tracking)	Manufacturer specific value describes the cause of the triggering of the fault detection output pins	**F**	**2,10**
	0x7378	Resolver Hardware Fault LOS, DOS, LOT during phasing initialisation	Manufacturer specific value describes the cause of the triggering of the fault detection output pins	**F**	**2,10**
INCR ENCODER	**0x7390**	**Incremental Encoder**	Error Generic Incremental Encoder	**F**	**2, 5**
	0x7391	Encoder error init	Encoder has initialization error due to sequence Hall or value null	**F**	**2, 1**
	0x7392	Encoder error congruence	Encoder has congruence error between Hall	**F**	**2, 2**
	0x7393	Encoder error phasing	Encoder has phasing error	**F**	**2, 3**
	0x7394	Encoder error Distance	Encoder Error Distance Hall	F	**2, 4**
COMMUNICATION	**0X7520**	**MODBUS**	Modbus Generic Error	**F**	**9,1**
	0x7521	Modbus Communication Lost	The drive didn't receive any valid message during the Communication Loss Timer (see Modbus func. 03 or 06 - addr.0x0036).	**F**	**9,1**
		ALARM PROTOCOL			
TORQUE PROFILE CONTROL	**0x8300**	**Torque control**	**General Error for Profile Torque Controller**	**F**	**6,6**
	0x8341	Torque Type	Error type selected is not managed	**F**	**6,6**
	0x8351	Torque Dynamic Stop	Error Dynamic Stop is not implemented	**F**	**6,6**
VELOCITY SPEED CONTROLLER	**0x8400**	**Velocity speed controller**	**General Error for Profile Velocity Controller**	**F**	**6,7**

	0x8410	Following error Current Mode	The difference between the velocity command and the actual velocity is greater than the value that is set in maximum velocity error. The drive is in Torque Profile	**F**	**5,10**
	0x8411	Following error Velocity Mode	The difference between the velocity command and the actual velocity is greater than the value that is set in maximum velocity error. The drive is in Velocity Profile	**F**	**5,10**
	0x8412	Over Speed	Actual speed exceeds the velocity over speed value	**F**	**5,8**
	0x8611	Following error	The difference between the position command and the actual position is greater than the value that is set in maximum position error	**F**	**-**
EEPROM	**0x8B00** 0x8B02	**Store and Restore Process**	**General Error for Store and Restore Process**	**F**	**8,2**

Table 2 - Error code Description

	**Warning**
	The alarm can be Fault (F) or warning (W), if it is a fault the drive will stop.

BUS DC LINK

PDU Address (HEX)	Description
0x0064	Bus Dc Link [V / 100] **i.e.** 0x0064 = 0x1356 (4950) → Bus Dc Link = 49.5 Vdc

MOTOR TEMPERATURE

PDU Address (HEX)	Description
0x0065	Temperature of motor [°C / 10] **i.e.** 0x0065 = 0x0163 (355) → Motor temperature = 35.5 °C

HEAT-SINK TEMPERATURE

PDU Address (HEX)	Description
0x0066	Heat-sink drive temperature [°C / 10] **i.e.** 0x0066 = 0x0163 (355) → Heat-sink temperature = 35.5 °C

BOARD TEMPERATURE

PDU Address (HEX)	Description
0x0067	Internal drive temperature [°C / 10] **i.e.** 0x0067 = 0x0163 (355) → Internal drive temperature = 35.5 °C

VELOCITY (AVERAGE)

PDU Address (HEX)	Description
0x0068	Motor Speed in rpm. Average value of speed Filter on Speed was a mobile average of 512 samples.

	Variable suitable to monitor the motor speed **i.e.** 0x0068 = 0x01F4 (500) → Motor is running at 500 rpm 0x0068 = 0xFC18 (64536 = -1000) → Motor Speed = -1000 rpm

TORQUE CURRENT

PDU Address (HEX)	Description
0x0069	Torque current [Arms/100]. This value is updated every 512 ms. **i.e.** 0x0069 = 0x01F4 (500) → Torque current = 5 Arms

I2T ENERGY VALUE

PDU Address (HEX)	Description
0x006A	I2T Energy Level [% of rated current] **i.e.** 0x006A = 0x0032 (50) → Torque current = 50% of rated current 0x006A = 0x0096 (150) → Torque current = 150% of rated current – drive it could go in alarm

AXIS POSITION LOW

PDU Address (HEX)	Description
0x006B	Low part of mechanical axis position [lower 16 bits of total 32 bit] **i.e.** Position axis = 1000000 / 0x000F4240 0x006B = 0x4240

AXIS POSITION HIGH

PDU Address (HEX)	Description
0x006C	High part of mechanical axis position [higher 16 bits of total 32 bit] **i.e.** Position axis = 1000000 / 0x000F4240 0x006C = 0x000F

Warning

The (mechanical) Axis Position message is 32 bit data, while the Modbus parameters are 16 bit: the 32 bit are separated in 2 parameters of 16 bit, 0x006B contains the lower 16 bit, while 0x006C contains the higher part

IMPULSES

PDU Address (HEX)	Description
0x006D	Electrical impulse read – Electrical gear (electrical position of axis) This parameter is the electrical angle (it depends on feedback's resolution and number of motor pole pairs) with increment units. The electrical angle is in range of [0; feedback's resolution] for any motor pole pair

	For a feedback with 14 bits the range value is [0:16384] **i.e.** 0x006D = 0x1000 → the motor axis is at position 4096/16384 → it is at 90°

ACTUAL VELOCITY (USER)

PDU Address (HEX)	Description
0x006E	This Parameter communicates the value of Velocity filtered. The filter is a Low Pass one pole filter for velocity [Hz] (default value is 50Hz) Variable suitable for monitor the velocity feedback. **i.e.** 0x006E = 0x03E8 → Actual Average Speed → it is at 1000 RPM

TQ CURRENT WIND

PDU Address (HEX)	Description
0x006F	This object communicates the value of Torque Current with a mobile average window of 32 samples (programmable).

VOLT REFERENCE

PDU Address (HEX)	Description
0x0070	This object is the reference voltage in Analog Input

FEEDBACK TYPE

PDU Address (HEX)	Description
0x0100	0 = resolver, 1 = encoder, 2 = SinCos

FEEDBACK RESOLUTION

PDU Address (HEX)	Description
0x0101	Resolution of feedback. **i.e.** 0x0101 = 4000h → Resolution = 16384 for revolution

FEEDBACK INIT POSITION LOW

PDU Address (HEX)	Description
0x0102	**Absolute position L (initial) - 16 bit LSB** **i.e.** 0x0102 = = 0x7421 → pos = 0x297421 value = 0x7421

FEEDBACK INIT POSITION HIGH

PDU Address (HEX)	Description
0x0103	**Absolute position H (initial) - 16 bits MSB** **i.e.** 0x0102 = = 0x7421 → pos = 0x297421 value = 0x0029

FEEDBACK ACTUAL POSITION LOW

PDU Address (HEX)	Description
0x0104	**Absolute position L (Actual) - 16 bits LSB** Absolute position is 24 bits for multi turn / 12 bit for single turn At the beginning initial and actual position are the same. Actual position is updated only after a read position command **i.e.** 0x0102 = = 0x7421 → pos = 0x297421 value = 0x7421

FEEDBACK ACTUAL POSITION HIGH

PDU Address (HEX)	Description
0x0105	**Absolute position H (Actual) - 16 bits MSB** Absolute position is 24 bits for multi turn / 12 bit for single turn At the beginning initial and actual position are the same. Actual position is updated only after a read position command **i.e.** 0x0102 = = 0x7421 → pos = 0x297421 value = 0x0029

ENCODER TYPE

PDU Address (HEX)	Description
0x0106	Singleturn = 0x32, Multiturn = 0x37 **i.e.** 0x0106 = = 0x37→ Encoder SinCos is Multi-Turn

FEEDBACK INIT ROUNDS

PDU Address (HEX)	Description
0x0109	Initial Number of encoder gears

FEEDBACK INIT RELATIVE POSITION

PDU Address (HEX)	Description
0x010A	**Relative position (initial)** **i.e.** 0x297421 N° of gear = 0x0421

ANALOG OUTPUT VALUE DAC

PDU Address (HEX)	Description
0x010D	**Digital value of Analog Output**

	Value to set analog output [0 ...4095] → [0 ... 10] V

DIGITAL INPUT 1 STATE

PDU Address (HEX)	Description
0x0110	**Digital value of Digital Input** Value of digital Input 1

DIGITAL INPUT 2 STATE

PDU Address (HEX)	Description
0x0111	**Digital value of Digital Input** Value of digital Input 2

DIGITAL INPUT 3 STATE

PDU Address (HEX)	Description
0x0112	**Digital value of Digital Input** Value of digital Input 3

DIGITAL INPUT 4 STATE

PDU Address (HEX)	Description
0x0113	**Digital value of Digital Input** Value of digital Input 4

DIGITAL OUTPUT 1 STATE

PDU Address (HEX)	Description
0x0114	**Digital value of Digital Output** Value of digital Output 1

DIGITAL OUTPUT 2 STATE

PDU Address (HEX)	Description
0x0115	**Digital value of Digital Output** Value of digital Output 2

DIGITAL OUTPUT 3 STATE

PDU Address (HEX)	Description
0x0116	**Digital value of Digital Output** Value of digital Output 3

DIGITAL OUTPUT 4 STATE

PDU Address (HEX)	Description
0x0117	**Digital value of Digital Output** Value of digital Output 4

3. | READ HOLDING REGISTERS (0X03)

3.1 List of Read Holding Registers

	READ ONLY (0x03)		UNIT	DEFAULT VALUE
HEX	DEC			
0x0001	1	CONTROL WORD		0
0x0003	3	FULL SCALE VELOCITY	[RPM]	Depends by motor: • L=3000 • M=4500 • S=4500
0x0028	40	MODBUS ADDRESS		1
0x002B	43	COM SETTINGS		0
0x0035	53	MODBUS BAUD RATE		192
0x0036	54	COMMUNICATION LOSS TIME		0
0x003C	60	PID VELOCITY KP	[IU]	Depends by motor
0x003D	61	PID VELOCITY KI	[IU]	Depends by motor
0x003E	62	PID VELOCITY KV	[IU]	Depends by motor
0x003F	63	SPEED RAMP STATE		1 : Ramp enabled
0x0040	64	SPEED RAMP UP	[ms]	2000
0x0041	65	SPEED RAMP DOWN	[ms]	2000
0x0043	67	SPEED POLARITY		0
0x0044	68	LIMIT TORQUE POSITIVE	[%]	100
0x0045	69	LIMIT TORQUE NEGATIVE	[%]	100
0x0046	70	SLOPE RAMP (TORQUE)	[rated current / (1000 * s)]	1000
0x004E	78	BRAKE MANAGED		1
0x004F	79	BRAKE MODE		1
0x0050	80	BRAKE TYPE		Depends by motor: • Magnetic Brake = 1 • Spring Brake = 2
0X0051	81	DYNAMIC STOP ENABLE		1
0X0053	83	READ CONFIG ANALOG OUTPUT		
0X0054	84	AN. OUTPUT VALUE (GEN PURPOSE)		
0X0055	85	DYNAMIC STOP STEP RAMP	[rpm*100/sec]	
0X0056	86	SPEED VELOCITY FILTERED		
0X0080	128	DIGIN 1 CONFIG		See User Guide
0X0081	129	DIGIN 2 CONFIG		See User Guide
0X0082	130	DIGIN 3 CONFIG		See User Guide
0X0083	131	DIGIN 4 CONFIG		See User Guide
0X0084	132	DIGOUT 1 CONFIG		See User Guide
0X0085	133	DIGOUT 2 CONFIG		See User Guide
0X0086	134	DIGOUT 3 CONFIG		See User Guide

0X0087	135	DIGOUT 4 CONFIG		See User Guide
0X0088	136	DIGIN 1 LEVEL		0 = OFF / 1 = ON
0X0089	137	DIGIN 2 LEVEL		0 = OFF / 1 = ON
0X008A	138	DIGIN 3 LEVEL		0 = OFF / 1 = ON
0X008B	139	DIGIN 4 LEVEL		0 = OFF / 1 = ON
0X008C	140	DIGOUT 1 LEVEL		0 = OFF / 1 = ON
0X008D	141	DIGOUT 2 LEVEL		0 = OFF / 1 = ON
0X008E	142	DIGOUT 3 LEVEL		0 = OFF / 1 = ON
0X008F	143	DIGOUT 4 LEVEL		0 = OFF / 1 = ON
0x01FF	511	FW RELEASE CUSTOMER		Depends by FW release
0x0201	513	HW RELEASE		• 12 if STO • 22 if NO STO
0x0202	514	PARAMETER RELEASE		Depends by parameter release
0x0203	515	MOTOR TYPE		Depends by motor type: • 0 = None, • 1 = B40, • 2 = B63, • 3 = B71, • 100=RESERVED
0x0204	516	STO CHECK		• 1 → STO present • 2 → NO STO
0x0205	517	FEEDBACK		• 0 → Resolver • 1 → Incr Encoder • 2→ SinCos Encoder
0x0207	519	OPERATION MODE		• 1 → Torque mode • 2 → Velocity mode
0x0208	520	READ MOT POLES		Motor poles couple
0x0209	521	MOTOR TEMP SENSOR		
0x020A	522	MAX MOTOR SPEED	[rpm]	

	**Warning**
	If is written an address not present in list above the drive gives the Exception Code 0x02

3.2 Description of Read Holding Registers

CONTROL WORD

PDU Address (HEX)	Description
0x0001	Reads CONTROL WORD bits status: • **Bit 0:** RUN bit ➔ 0 Run Disabled | 1 Run Enabled • **Bit 1:** STOP bit ➔ 0 Stop Enabled | 1 Stop Disabled • **Bit 2:** BRAKE bit ➔ 0 Brake can be disabled manually | 1 Brake can be enabled manually **Warning:** BRAKE bit is a DON'T CARE bit if the brake is NOT ACTIVE and is set to AUTO. Brake can be managed by modbus addess 0x004E Brake mode (manual/auto) can be changed by modbus address 0x004F

	**Warning**
	In case of brake set in Manual Mode it is possible to set the brake ON/OFF with bit 2 on Control Word. In our documentation we add a "Warning" label in case of: If brake is in Automatic Mode: user can not change status of Motor brake because is managed by the drive in automatic mode. So those bits will be "ignored" (don't care). • If brake is in Automatic Mode: user can not change status of Motor brake because is managed by the drive in automatic mode. So those bits will be "ignored" (don't care). • If brake is disabled: user can not change Status of Motor because motor brake is disabled. Also in this case bit is "ignored" (don't care).

FULL SCALE VELOCITY

PDU Address (HEX)	Description
0x0003	Velocity Full Scale [rpm] **i.e.** if the motor is 4500 rpm 0x0003 = 0x1194 (4500) → Velocity Full Scale = 4500 rpm

MODBUS ADDRESS

PDU Address (HEX)	Description
0x0028	Modbus Address - Default 1 **i.e.** 0x0028 = 1 → Modbus Address = 1

COM SETTINGS

PDU Address (HEX)	Description
0x002B	COM Settings - Default 0 - Modbus COM settings related to parity, stop Bits and Data Bits: • 0 - No Parity, 2 stop bits • 1 - Odd Parity, 1 stop bit • 2 - Even Parity 1 stop bit

MODBUS BAUD RATE

PDU Address (HEX)	Description
0x0035	Modbus Baud Rate - Default 192 **i.e.** 0x0035 = 0x00C0 (192) → ModBus Baud Rate = 19200

COMMUNICATION LOSS TIME

PDU Address (HEX)	Description
0x0036	Default - 0 Reads the timer (in ms) that is set to recognize modbus communication loss when the motor is running. In this time window the drive doesen't receive a VALID Modbus Message, the drive goes in alarm state and the motor will stops with inertia. If the value of this command is set to 0, this function is disabled.

PID VELOCITY KP

PDU Address (HEX)	Description
0x003C	Proportional PID Velocity -The parameter controls equivalent of PID speed parameters. **i.e.** The PID are defined by application It is possible to change the Speed Pid in run time.

PID VELOCITY KI

PDU Address (HEX)	Description
0x003D	Integral PID Velocity -The parameter controls equivalent of PID speed parameters. **i.e.** The PID are defined by application It is possible to change the Speed Pid in run time.

PID VELOCITY KV

PDU Address (HEX)	Description
0x003E	Parameter PID Velocity -The parameter controls equivalent of PID speed parameters. **i.e.** The PID are defined by application. It is possible to change the Speed Pid in run time.

RAMP STATE

PDU Address (HEX)	Description
0x003F	Reads if the ramps (torque and speed ramps) are enabled or not (default enabled). **i.e.** 0x003F = 1 : Ramp enabled 0x003F = 0 : Ramp disabled If value it is different from 0 or 1 the drive gives the Exception Code 0x03

SPEED RAMP UP

PDU Address (HEX)	Description
0x0040	Speed ramp up in ms (Default 2000) **i.e.** 0x0040 = 1000 : Speed ramp up from 0 to max velocity = 1 sec

SPEED RAMP DOWN

PDU Address (HEX)	Description
0x0041	Speed ramp down in ms (Default 2000) **i.e.** 0x0040 = 1000 : Speed ramp down from max velocity to 0 = 1 sec

SPEED POLARITY

PDU Address (HEX)	Description
0x0043	Polarity of Speed/Torque setpoint - range [-Full scale velocity: Full scale velocity] - Default 0 The following value definition is valid: • bit value = 0: multiply the demand value by 1 • bit value = 1: multiply the demand value by -1 **i.e.** In case of speed setpoint = 3.000 rpm, sending 0x0043 = 1 the motor begins to run at -3000 rpm

TORQUE LIMIT POSITIVE

PDU Address (HEX)	Description
0x0044	Torque limit positive - Default 100 This parameter shall indicate the configured maximum positive torque in the motor. The value shall be given percent of peak current. Positive torque takes effect in the case of motive operation is positive velocity or regenerative operation is negative velocity. This parameter is used also Profile Velocity **i.e.** 0x0044= 0x0032 (50), the maximum torque positive is 50% of rated current

TORQUE LIMIT NEGATIVE

PDU Address (HEX)	Description
0x0045	Torque limit negative - Default 100 This parameter shall indicate the configured maximum negative torque in the motor. The value shall be given percent of peak current. Negative torque takes effect in the case of motive operation is negative velocity or regenerative operation is negative velocity. This parameter is used also Profile Velocity **i.e.** 0x0045= 0x0032 (50), the maximum torque negative is 50% of rated current

SLOPE RAMP (TORQUE)

PDU Address (HEX)	Description
0x0046	Slope Torque Ramp [rated current/ (1000*s)] in Torque Control Mode (Default 1000) This parameter shall indicate the configured rate of change of torque. The value shall be given in units of per thousand of rated torque per second. It is controlled by some limits of drive. If the value is not correct the drive sends an Abort Code. If the value is not correct during initialization the drive sends an error messages with Emergency Protocol. **i.e.** 0x0046 = 0x03E8 (1000) → Torque ramp up from 0 to motor rated current = 1 sec

BRAKE MANAGED

PDU Address (HEX)	Description
0x004E	Brake Managed (value admitted 0/1) (Default 1) **i.e.** 0x004E = 1 → Brake managed

	0x004E = 0 → NO Brake

BRAKE MODE

PDU Address (HEX)	Description
0x004F	Brake Mode Manual/Automatic (value admitted 0/1) (Default 1) **i.e.** 0x004F = 1 → Manual Brake enabled 0x004F = 0 → Automatic Brake enabled

BRAKE TYPE

PDU Address (HEX)	Description
0x0050	Selection of type of brake (in case of brake enabled) (value admitted 1/2): **i.e.** 0x0050 = 1 → Magnetic Brake 0x0050 = 2 → Spring Brake It depends to brake type mounted on motor.

DYNAMIC STOP ENABLE

PDU Address (HEX)	Description
0x0051	Dynamic Stop (electronic controlled stop) Enable (value admitted 0/1) (Default 1) **i.e.** 0x0051 = 1 → Dynamic Stop enabled 0x0051 = 0 → NO Dynamic Stop

CONFIG ANALOG OUTPUT

PDU Address (HEX)	Description
0x0053	Config Analog Output Function: • 0 = Disable Analog Outpu • 1 = General Purpose • 2= Speed [0:4095] = [-Max Speed: Max Speed] • 3= Current [0:4095] = [- Peak current: Peak current] • **i.e.** 0x0053 = 1 → General Purpose

SET ANALOG OUTPUT VALUE

PDU Address (HEX)	Description
0x0054	In case of 0x0053 = 1 this value can set the value of Analog Output value: **i.e.** 0x0054 = 4095 → Analog Output = 10V

DYN STOP STEP RAMP

PDU Address (HEX)	Description
0x0055	Value of Ramp of Dynamic stop: "Decrement step ramp" parameter, set value 100 [rpm*100/sec] **i.e.** 0x0055

SPEED VELOCITY FILTERED

PDU Address (HEX)	Description
0x0056	Velocity filtered: Read velocity (rpmx4) with a one pole filter

DIGITAL INPUT 1 CONFIG

PDU Address (HEX)	Description
0x0080	Shows as is set the Digital Input 1 **i.e.** 0 = none function 1 = Digital Input configured as "RUN" function 2 = Digital Input configured as "STOP" function 3 = Digital Input configured as "EMERGENCY" function 4 = Digital Input configured as "RESET" function 5 = Digital Input configured as "DCW" function 6 = Digital Input configured as "DCCW" function 7 = Digital Input configured as "SETVEL1" function 8 = Digital Input configured as "SETVEL2" function 9 = Digital Input configured as "SETVEL3" function 10 = Digital Input configured as "SETVEL4" function 11 = Digital Input configured as "VEL/CUR" function 12 = Digital Input configured as "DIR" function

DIGITAL INPUT 2 CONFIG

PDU Address (HEX)	Description
0x0081	Shows as is set the Digital Input 2 **i.e.** 0 – 14 As Digital Input 1

DIGITAL INPUT 3 CONFIG

PDU Address (HEX)	Description
0x0082	Shows as is set the Digital Input 3

	i.e. 0 – 14 As Digital Input 1

DIGITAL INPUT 4 CONFIG

PDU Address (HEX)	Description
0x0083	Shows as is set the Digital Input 4 **i.e.** 0 – 14 As Digital Input 1

DIGITAL OUTPUT 1 CONFIG

PDU Address (HEX)	Description
0x0084	Shows as is set the Digital Output 1 **i.e. DIG-OUT1:** shows if the drive is: • '1' = Drive OK • '0' = Drive in FAULT

DIGITAL OUTPUT 2 CONFIG

PDU Address (HEX)	Description
0x0084	Shows as is set the Digital Output 2 **i.e. DIG-OUT2** shows if the drive is: • '1' = There is a Warning activate • '0' = No warning

DIGITAL OUTPUT 3 CONFIG

PDU Address (HEX)	Description
0x0085	Shows as is set the Digital Output 3 **i.e. DIG-OUT3** Drive Ready • '1' = Ready • '0' = Not Ready

DIGITAL OUTPUT 4 CONFIG

PDU Address (HEX)	Description
0x0086	Shows as is set the Digital Output 4 **i.e. DIG-OUT4** shows the BRAKE status: • '1' = brake released, motor axis free • '0' = brake active, motor blocked

FIRMWARE RELEASE CUSTOMER

PDU Address (HEX)	Description
0x01FF	Read the device firmware version **i.e.** 0x01FF = 0x00E1 (226) → Firmware release 2.2.6

HARDWARE RELEASE

PDU Address (HEX)	Description
0x0201	Read the device hardware version **i.e.** 0x0201 = 0x000B (11) → Hardware release 1.1

PARAMETER RELEASE

PDU Address (HEX)	Description
0x0202	Read parameter release: **i.e.** 0x0202 = 0x0136 (310) → Parameter release 3.1.0

MOTOR TYPE

PDU Address (HEX)	Description
0x0203	Read motor type: • 0 = None, • 1 = B40, • 2 = B63, • 3 = B71, • 100 = TCF - RESERVED TO MANUFACTURER **i.e.** 0x0203 = 1 → Selected Motor Type S

STO CHECK

PDU Address (HEX)	Description
0x0204	Reads if the drive has STO (Safe Torque Off) **i.e.** 0x0204 = 1 STO present 0x0204 = 2 NO STO

FEEDBACK TYPE

PDU Address (HEX)	Description
0x0205	Reads what type of feedback control has the drive • 0x0205 = 0 → Resolver

	• 0x0205 = 1 → Incremental Encoder • 0x0205 = 2 → SinCos Encoder

OPERATION MODE

PDU Address (HEX)	Description
0x0207	Reads operation Mode: • 0x0207 = 0 → No Operation mode • 0x0207 = 1 → Torque mode • 0x0207 = 2 → Velocity mode

MOTOR POLES

PDU Address (HEX)	Description
0x0208	Reads Motor Poles Couple Mode: **i.e.** 0x0208 = 4 → the motor has 4 couple of poles.

MOTOR TEMP SENSOR

PDU Address (HEX)	Description
0x0209	Motor Sense Type can be the following values: 1. KTY83 2. PT1000 3. KTY84 4. PTC ON/OFF

MOTOR MAX SPEED

PDU Address (HEX)	Description
0x020A	Max Motor SPeed: **i.e.** 0x020A = 4500 → the motor cannot run over 4500 rpm.

4. | WRITE SINGLE HOLDING REGISTER (0X06)

4.1 List of Write Single Holding Registers

	WRITE PARAMETERS (0x06)		UNIT
HEX	DEC		
0x0000	0	STORE E2PROM	
0x0001	1	CONTROL WORD	
0x0028	40	MODBUS ADDRESS	
0x002B	43	COM SETTINGS	
0x0035	53	MODBUS BAUD RATE	
0x0036	54	COMMUNICATION LOSS TIME	[ms]
0x003C	60	PID VELOCITY KP	[IU]
0x003D	61	PID VELOCITY KI	[IU]
0x003E	62	PID VELOCITY KV	[IU]
0x003F	63	RAMP ENABLE	
0x0040	64	SPEED RAMP UP TIME	[ms]
0x0041	65	SPEED RAMP DOWN TIME	[ms]
0x0042	66	SPEED SETPOINT	[RPM]
0x0043	67	SPEED POLARITY	
0x0044	68	LIMIT TORQUE POSITIVE	[%]
0x0045	69	LIMIT TORQUE NEGATIVE	[%]
0x0046	70	SLOPE RAMP (TORQUE)	[Rated current / (1000 * s)]
0x0047	71	CURRENT TORQUE SETPOINT	[Arms / 100]
0x004E	78	BRAKE MANAGED	
0x004F	79	BRAKE MODE	
0X0051	81	DYNAMIC STOP ENABLE	
0X0052	82	SET CMD REQ FEEDBACK	
0X0053	83	CONFIG ANALOG OUTPUT	
0X0054	84	SET ANALOG OUTPUT VALUE (GEN PURPOSE)	
0X0055	85	DYN STOP STEP RAMP	
0X0207	519	OPERATION MODE	
0x5A5A	23130	RESTORE MANUFACTURER DATA	
0xA5A5	42405	RESET DRIVE	

Warning

Some commands need the following procedure to make the changes of their parameters effective:

1. Save in EEPROM (command [func.06 – addr.0x0000] STORE E2PROM)
2. Drive Reset (command [func.06 – addr.0xA5A5] RESET DRIVE)

List of Commands that need this procedure:

HEX	DEC	COMMAND NAME
0x0028	40	MODBUS ADDRESS
0x002B	43	COM SETTINGS
0x0035	53	MODBUS BAUD RATE
0x0036	54	COMMUNICATION LOSS TIME
0x003F	63	RAMP ENABLE
0x004F	79	BRAKE MODE
0X0207	519	OPERATION MODE

Warning

If is written an address not present in list above the drive gives the Exception Code 0x02

4.2 Description of Write Single Holding Registers

STORE E2PROM DATA

PDU Address (HEX)	Description
0x0000	Command to store data on E2prom. Not need to send a specific value of parameter **i.e.** 0x0000 → Store the parameters in E2prom

CONTROL WORD

PDU Address (HEX)	Description
0x0001	CONTROL WORD bits status: • Bit 0: RUN bit ➔ 0 Run Disabled | 1 Run Enabled • Bit 1: STOP bit ➔ 0 Stop Enabled | 1 Stop Disabled • Bit 2: BRAKE bit ➔ 0 Brake can be disabled manually | 1 Brake can be enabled manually **Warning:** BRAKE bit is a DON'T CARE bit if the brake is NOT ACTIVE and is set to AUTO. Brake can be activated by modbus addess 0x004E Brake mode (manual/auto) can be changed by modbus address 0x004F If value it is out of range [0:7] the drive gives the Exception Code 0x03

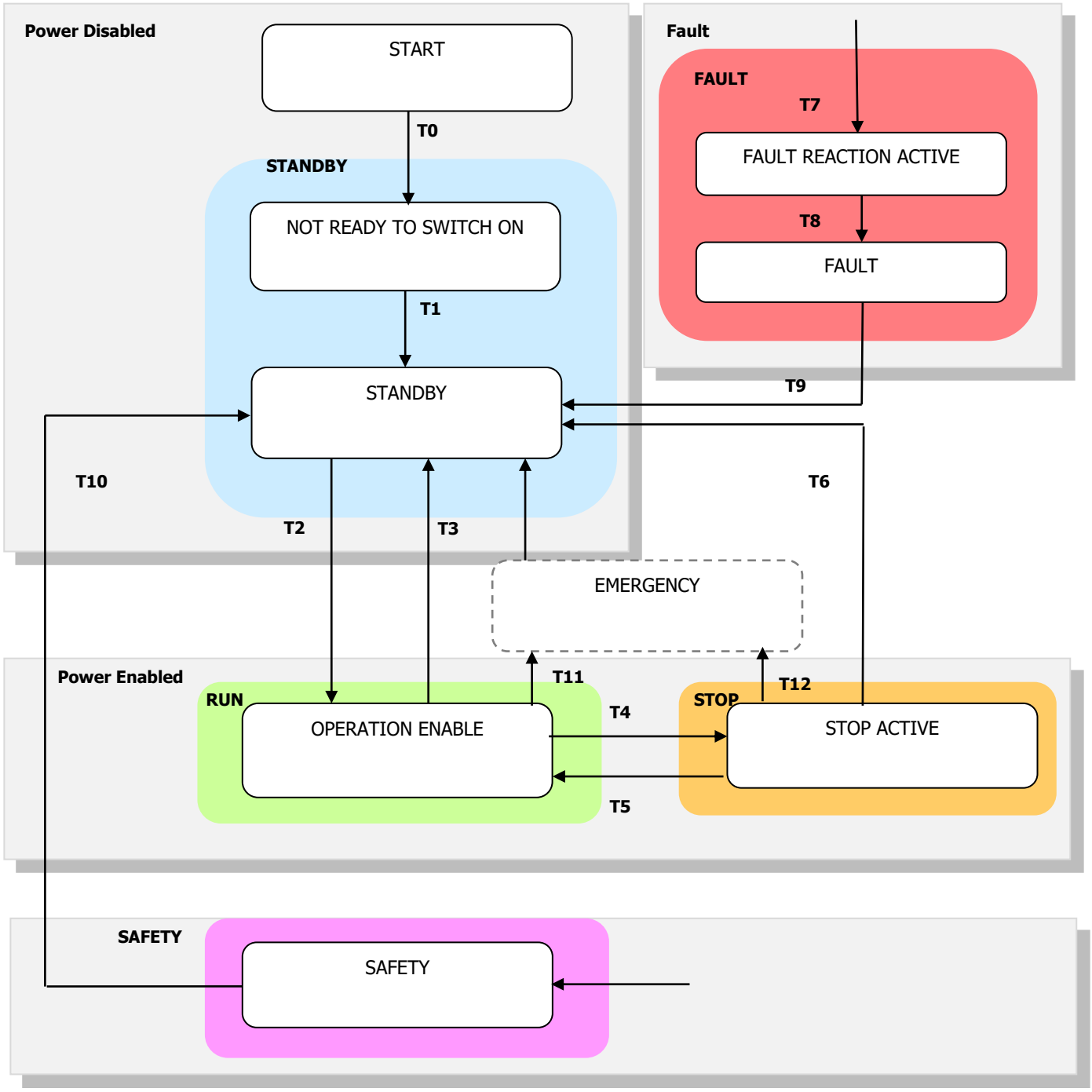
Warning

The alarm can be Fault (F) or warning (W), if it is a fault the drive will stop.

Warning

In case of Run/Stop state if is given an *Emergency Command* (Digital Input - **not Safety input**) the drive state goes to standby (T11/T12). Then if you need to give a run command (or stop command) is necessary the transition of command SAFETY → STANDBY → RUN

⚠	**Warning**
	In case of Run/Stop state if is given an *STO Command* (**Safety input**) the drive state goes to standby (T11/T11a). Then if you need to give a run command (or stop command) is necessary the transition of command SAFETY → STANDBY → RUN



Picture 2 - State Machine Modbus Mode with Safety State

4.2.1 Run Sequence

1) Switch ON Power Supply [**T0**]
2) Wait **Standby** (*SWITCHED ON*) State [**T1**]

3) Verify Operation Mode by reading [func. 0x03 – addr. 0x0207] Operation Mode:
   - Value equal to 1 → Torque Mode
   - Value equal to 2 → Velocity Mode

	Warning
	If the customer wants to switch from Torque Mode to velocity Mode or vice-versa he must set it by write to [func.06 – addr.0x0207] Operation Mode. To make changes effective, the customer must first save to memory with command [func.06 – addr. 0x0000] Store E2PROM Data and then reset drive with command [func.06 – addr.0xA5A5] System Reset.

4) Verify that the Smartris Drive is in SWITCHED ON
5) Set **OPERATION ENABLED** State: write [0x06] Control Word → 0x0001 = 0x0003 [**T2**]
6) Verify LED STATUS ENABLED
   - Verify by read [func. 0x03 - addr.0x0060], that the Smartris Drive is in ENABLED [Drive Status = 0x0001 → RUN)]
   - Verify that the brake is released
7) If [func. 0x06 - addr. 0x0207] - Operation Mode = 2 – Velocity mode → Write to [func.0x06 – addr. 0x0042] Speed Set Point → **i.e.** 0x03e8 (1000 → 1000 rpm)
   If [func. 0x06 - addr. 0x0207] - Operation Mode = 1 – Torque mode → Write to [func.0x06 – addr. 0x0047] Torque Set Point → **i.e.** 0x03e8 (1000 →10 Arms)
8) Verify if the motor is running
   - Verify the motor speed (after ramp) by read to [func. 0x04 – addr. 0x0068] Motor Speed
   - Verify the motor current by read to [func. 0x04 – addr. 0x0069] Torque Current
9) Stop the motor with Stop Command → write to [func. 0x06 - addr. 0x0001] - Control Word → 0x0001 [**T4**] – Drive goes immediately in Stop state with MAX torque (it's equal to a STOP command).
   If you want to Stop the motor with ramp, just write to [func.06 – addr.0x0042] Speed Set Point the value 0 (0 rpm).
   Stop the motor with Standby Command → write to [func. 0x06 - addr. 0x0001] - Control Word → 0x0002 [**T4**] – Drives goes in Standby state.

Transitions:

Transition	Description	Transition	
T0	Switch ON – Supply to drive	T7	Fault reaction active
T1	Drive after init – NO Alarm	T8	Fault – Drive in Alarm
T2	Run command–Drive Enabled Standby→Run	T9	Reset command Fault → Standby
T3	Standby command – Drive Disabled	T10	STO (**SAFETY**) Command
T4	Stop command – Drive Run→Stop	T11	Emergency (If active)→ the motor will decrement speed with a programmed ramp
T5	Run command–Drive Enabled Stop→Run		
T6	Standby command – Stop→Standby	T12	Emergency (If active)

Table 3 – Transition Description – State machine

NOTES:

- The STO (SAFETY) command may can stop the running command immediately
- The Stop Command can stop the running command immediately
- A FAULT (see table in Diagnostic) can stop the running command immediately

MODBUS ADDRESS

PDU Address (HEX)	Description
0x0028	Modbus Address. [1:247] **i.e.** 0x0028 = 1 → Modbus Address = 1 To change MODBUS ADDRESS is necessary save to E2prom and give a reset command If value it is out of range the drive gives the Exception Code 0x03

COM SETTINGS

PDU Address (HEX)	Description
0x002B	COM Settings. Modbus COM (Default 0) settings related to parity, stop Bits and Data Bits: • 0 - No Parity, 2 stop bits • 1 - Odd Parity, 1 stop bit • 2 - Even Parity 1 stop bit To change COM SETTINGS is necessary save to E2prom and give a reset command If value it is out of range the drive gives the Exception Code 0x03

MODBUS BAUD RATE

PDU Address (HEX)	Description
0x0035	Modbus Baud Rate (Default 19200) • 0x0035 = 96 → 9600 • 0x0035 = 192→ 19200 • 0x0035 = 384 → 38400 • 0x0035 = 576 → 57600 • 0x0035 = 1152 → 115200 **i.e.** 0x0035 = 0x00C0 (192) → ModBus Baud Rate = 19200 To change MODBUS BAUD RATE is necessary save to E2prom and give a reset command If value it is out of range the drive gives the Exception Code 0x03

COMMUNICATION LOSS TIME

PDU Address (HEX)	Description
0x0036	Communication Loss Time [ms] - (Defualt 0) **i.e.** 0x0036 = 0x03B8 (1000) → Loss Time = 1000 ms If 0x0036 = 0 → Communication Loss Time disabled If value it is out of range [0:32000] the drive gives the Exception Code 0x03

PID VELOCITY KP

PDU Address (HEX)	Description
0x003C	Proportional PID Velocity -The parameter controls equivalent of PID speed parameters. **i.e.** The PID are defined by application. It is possible to change the Speed Pid in run time. If value it is negative the drive gives the Exception Code 0x03

PID VELOCITY KI

PDU Address (HEX)	Description
0x003D	Integral PID Velocity -The parameter controls equivalent of PID speed parameters. **i.e.** The PID are defined by application. It is possible to change the Speed Pid in run time. If value it is negative the drive gives the Exception Code 0x03

PID VELOCITY KV

PDU Address (HEX)	Description
0x003E	Parameter PID Velocity -The parameter controls equivalent of PID speed parameters. **i.e.** The PID are defined by application. It is possible to change the Speed Pid in run time. If value it is negative the drive gives the Exception Code 0x03

RAMP ENABLE

PDU Address (HEX)	Description
0x003F	Reads if the ramps (torque and speed ramps) are enabled or not. **i.e.** 0x003F = 1: Speed ramp enabled 0x003F = 0: Speed ramp disabled To change RAMP STATE is necessary save to E2prom and give a reset command If value it is different from 0/1 the drive gives the Exception Code 0x03

SPEED RAMP UP

PDU Address (HEX)	Description
0x0040	Speed ramp up in ms **i.e.** 0x0040 = 0x03E8 (1000) → Speed ramp up from 0 to max velocity = 1 sec If value it is negative the drive gives the Exception Code 0x03

SPEED RAMP DOWN

PDU Address (HEX)	Description
0x0041	Speed ramp down in ms **i.e.** 0x0041 = 0x03E8 (1000) → Speed ramp down from max velocity to 0 = 1 sec

	If value it is negative the drive gives the Exception Code 0x03

SPEED SET POINT

PDU Address (HEX)	Description
0x0042	Speed setpoint - range [-Full scale velocity: Full scale velocity] The speed setpoint is available in range of - Full scale velocity Full scale velocity Considering a drive with Full scale velocity = 3.000 rpm Speed SetPoint (Write to VFD Function 0x06) has a range [-3000:3000] rpm **i.e.** 0x0042 = 0x0BB8 (3.000) is requested speed → Speed Motor = 3000 rpm 0x0042 = 0xF448 (-3.000) → Speed Motor = -3000 rpm If value it is out of range the drive gives the Exception Code 0x03

SPEED POLARITY

PDU Address (HEX)	Description
0x0043	Polarity of Speed/Torque/Position setpoint - range [-Full scale velocity: Full scale velocity] The following value definition is valid: • bit value = 0: multiply the demand value by 1 • bit value = 1: multiply the demand value by -1 **i.e.** In case of speed setpoint = 3.000 rpm, sending 0x0043 = 1 the motor begins to run at -3000 rpm If value it is different to 0/1 the drive gives the Exception Code 0x03

LIMIT TORQUE POSITIVE

PDU Address (HEX)	Description
0x0044	Torque limit positive [0:100] This parameter shall indicate the configured maximum positive torque in the motor. The value shall be given percent of rated current. Positive torque takes effect in the case of motive operation is positive velocity or regenerative operation is negative velocity. This parameter is used also Profile Velocity **i.e.** 0x0044= 0x0032 (50), the maximum torque positive is 50% of rated current If value it is out of range the drive gives the Exception Code 0x03

LIMIT TORQUE NEGATIVE

PDU Address (HEX)	Description
0x0045	Torque limit negative [0:100] This parameter shall indicate the configured maximum negative torque in the motor. The value shall be given percent of rated current. Negative torque takes effect in the case of motive operation is negative velocity or regenerative operation is negative velocity. This parameter is used also Profile Velocity. **i.e.** 0x0045= 0x0032 (50), the maximum torque negative is 50% of rated current If value it is out of range the drive gives the Exception Code 0x03

SLOPE RAMP (TORQUE)

PDU Address (HEX)	Description
0x0046	Slope Torque Ramp [rated current/ (1000*s)] in Torque Control Mode This parameter shall indicate the configured rate of change of torque. The value shall be given in units of per thousand of rated torque per second. It is controlled by some limits of drive. If the value is not correct the drive sends an Abort Code. If the value is not correct during initialization the drive sends an error messages with Emergency Protocol. **i.e.** 0x0046 = 0x01F4 (500) → Torque ramp up from 0 to rated current in (1000 / 500) secs = 2 sec If value it is negative the drive gives the Exception Code 0x03 If Operation Mode is set on Velocity drive gives the Exception Code 0x03

CURRENT TORQUE SETPOINT

PDU Address (HEX)	Description
0x0047	Torque Setpoint [Arms / 100] in Torque Control Mode. [-peak current, peak current] Torque Setpoint range: [-Peak Current; Peak Current] **i.e.** 0x0047 = 0xC8 (200) ➔ 2 Arms 0x0047 = 0xFF38 (65335 = -200) ➔ - 2 Arms If value it is out of range the drive gives the Exception Code 0x03

BRAKE MANAGED

PDU Address (HEX)	Description
0x004E	Enable / Disable Brake manage. • 0x004E = 1 ➔ Brake ON • 0x004E = 0 ➔ Brake OFF If value it is different to 0/1 the drive gives the Exception Code 0x03

BRAKE MODE

PDU Address (HEX)	Description
0x004F	Set brake mode (Auto / Manual) • 0x004F = 1 ➔ Manual Brake • 0x004F = 0 ➔ Automatic Brake If value it is different to 0/1 the drive gives the Exception Code 0x03

DYNAMIC STOP ENABLE

PDU Address (HEX)	Description
0x0051	Dynamic Stop (electronic controlled stop) Enable (value admitted 0/1) (Default 1) **i.e.** 0x0051 = 1 → Dynamic Stop enabled 0x0051 = 0 → NO Dynamic Stop

SET CMD REQ FEEDBACK

PDU Address (HEX)	Description
0x0052	SinCos encoder command. 1. READ ENCODER STATUS (encoder status) 2. READ OUT NAME PLATE (Encoder Type) 3. Reserved 4. READ POSITION (actual position) **i.e.** 0x0052 = 1 → Update of READ ENCODER STATUS

CONFIG ANALOG OUTPUT

PDU Address (HEX)	Description
0x0053	Config Analog Output Function: • 0 = Disable Analog Output • 1 = General Purpose • 2= Speed [0:4095] = [-Max Speed: Max Speed] • 3= Current [0:4095] = [- Peak current: Peak current] **i.e.** 0x0053 = 1 → Set General Purpose

SET ANALOG OUTPUT VALUE

PDU Address (HEX)	Description
0x0054	In case of 0x0053 = 1 this value can set the value of Analog Output value: **i.e.** 0x0054 = 4095 → Analog Output = 10V

DYNAMIC STOP STEP RAMP

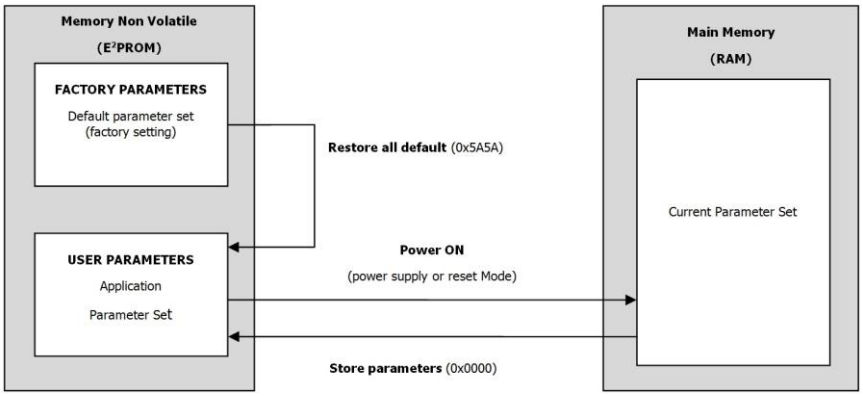
PDU Address (HEX)	Description
0x0055	Value of Ramp of Dynamic stop: "Decrement step ramp" parameter, set value 100 [rpm*100/sec] **i.e.** 0x0055

OPERATION MODE

PDU Address (HEX)	Description
0x0207	Set operation Mode: • 0x0207 = 1 → Torque mode • 0x0207 = 2 → Velocity mode To change OPERATION MODE is necessary save to E2prom and give a reset command. If value it is different from 1/2 the drive gives the Exception Code 0x03

RESTORE MANUFACTURER DATA

PDU Address (HEX)	Description
0x5A5A	Command to restore Manufacturer data on E2prom. Not need to send a specific value of parameter



Picture 3 - Store - Restore Function

SYSTEM RESET

PDU Address (HEX)	Description
0xA5A5	This command gives to drive a System reset: sending this parameter the drive reset to reboot it. It is useful if the drive is on error or to make effective changes after a save in EEPROM: not need to send a specific value of parameter Drive responds to PLC, after the drive is reset wait about 2 sec for new communication.

5.| DIAGNOSTIC

MACRO DRIVE STATE	Modbus STATE	STATUS 1 LED GREEN	STATUS 2 LED YELLOW	LED VIEW
INIT	Not Ready to Switch On	"BLINK" simultaneously	"BLINK" simultaneously	1 simultaneously 2 simultaneously
	Switch On Disabled Ready to Switch On	"BLINK" alternately	"BLINK" alternately	1 alternately 2 alternately
STANDBY	Switched On	"BLINK"	OFF	1 BLINK 50% 2 OFF
FAULT	Fault Fault reaction fault	"BLINK" [x]	"BLINK" [y]	1 see fault 2 chapter
RUN (RUNV / RUNC)	Operation Enabled	ON	OFF	1 ON 2 OFF
STOP	Stop Active	ON	ON	1 ON 2 ON
SAFETY	-	OFF	"BLINK"	1 OFF 2 BLINK

Table 4 - Led Status

Alarm	STATUS 1 CODE LED GREEN 1st Code	STATUS 2 CODE LED YELLOW 2nd Code	Alarm Description
A Group: (Temperature)			
Motor Over Temperature	**1**	**10**	Motor Temperature over threshold. Motor has reached a too high temperature for correct operation.
Heat Sink Over Temperature	**1**	**1**	Heat Sink Temperature over threshold. Heat Sink reached a too high temperature for correct operation.
Heat Sink Temp Out Of Range	**1**	**3**	Heat Sink Temperature Sensor is out of range. Potential malfunction of the temperature sensor. [1]
Board Over Temperature	**1**	**4**	Internal Board Temperature over threshold. Too high a temperature for correct operation inside the drive.
Board Temp Out Of Range	**1**	**5**	Internal Temperature Sensor out of range. Potential malfunction of the temperature sensor. [1]
Motor Temp Out Of Range	**1**	**6**	Motor Temperature Sensor is out of range. Potential malfunction of the temperature sensor. [1]
B Group: (Feedback)			
Resolver	**2**	**10**	Check resolver connections,connectors and wiring of both sides.
Encoder init	**2**	**1**	Encoder initialization error due to sequence Hall or value null
Enc congruence	**2**	**2**	Encoder has congruence error between Hall
Encoder phasing	**2**	**3**	Encoder has phasing error

Alarm	STATUS 1 CODE LED GREEN 1st Code	STATUS 2 CODE LED YELLOW 2nd Code	Alarm Description
Enc Distance	**2**	**4**	Encoder Error Distance Hall
Resolver Init	**2**	**4**	Initialization Fault for Resolver Device. [1]
Encoder	**2**	**5**	Incremental Encoder Fault
SinCos Fault	**2**	**6**	SinCos Encoder Fault
Hall	**2**	**7**	Hall Sensors Fault
Distance Hall	**2**	**8**	Hall Sensors Fault
C Group: (Current)			
Offset Current Sensor	**3**	**10**	Offset current sensor is out of range. [1]
Over Current	**3**	**1**	The current absorbed by the motor is beyond the set limit. Check Phase Motor connection and wire. Look for any short circuits.
D Group: (Voltage)			
Under Voltage	**4**	**1**	DC Bus voltage value lower than the limit threshold. Check mains voltage at terminals +, -.
Over Voltage	**4**	**2**	DC Bus voltage value higher than the limit threshold. Check mains voltage at terminals +, -
E Group: (Functionality)			
Velocity Fault	**5**	**10**	The actual speed differs from the target Speed.
I^2T Overload Protection	**5**	**2**	I2T overload motor protection reached.
Hardware	**5**	**3**	Error Hardware [1]
External HW	**5**	**4**	Error CAN Interface [1]
OverSpeed	**5**	**8**	Overspeed error - CAN
F Group: (Communication)			
E^2prom	**6**	**1**	Parameter Fault stored in E2prom.
CanOpen	**6**	**2**	Communication Fault with CANOpen
Sincos Fault	**6**	**3**	Internal Communication Fault [1]
Configuration Parameters	**6**	**4**	Configuration Parameters Fault [1]
Profile Generic	**6**	**5**	Error Configuration Profile: Mode of Operation
Torque Profile	**6**	**6**	Error Torque Profile
Velocity Profile	**6**	**7**	Error Velocity Profile
Homing Profile	**6**	**8**	Error Homing Profile
Configuration Parameters			
Program Fault	**7**	**X**	Code Programming Fault [1] (Contact the Manufacturer).
Manufacturer	**8**	**1**	Data Manufacturer image is not written
Store/Restore	**8**	**2**	General Error for Store and Restore Process

Alarm	STATUS 1 CODE LED GREEN 1st Code	STATUS 2 CODE LED YELLOW 2nd Code	Alarm Description
Modbus Error	**9**	**1**	Communication Fault with Modbus

Table 5 - Diagnostic

6. | EXCEPTION CODE

Following a request, there are 4 possible outcomes from the slave.

1. The request is successfully processed by the slave and a valid response is sent.
2. The request is not received by the slave therefore no response is sent.
3. The request is received by the slave with a parity, CRC or LRC error. The slave ignores the request and sends no response.
4. The request is received without an error, but cannot be processed by the slave for another reason. The slave replies with an exception response.

In a normal response, the slave echoes the function code. The first sign of an exception response is that the function code is shown in the echo with its highest bit set. All function codes have 0 for their most significant bit. Therefore, setting this bit to 1 is the signal that the slave cannot process the request.

Following the Function Code is the Exception Code. The exception code gives an indication of the nature of the problem. The possible codes are shown in the table below.

The exception code shown above *0x02* is an indication that parameter has an illegal address in the slave.

6.1 List of Exception Code

	Exception Code on Modbus Communication	
Exception Code	**Name**	**Meaning**
0x01	Illegal Function	The function code received in the request is not an authorized action for the slave. The slave may be in the wrong state to process a specific request.
0x02	Illegal Data Address	The data address received by the slave is not an authorized address for the slave.
0x03	Illegal Data Value	The value in the request data field is not an authorized value for the slave.

REVISION HISTORY

Rel.	Date	Description
1.0	30/04/2021	First Emission of Modbus Manual
1.0a	07/06/2021	Added new Modbus Commands
1.1	29/06/2021	Manual Review
1.2	30/07/2021	Added Exception Code Chapter
1.2a	25/08/2021	Manual Review to fix writing errors
1.3	19/10/2021	Added new Modbus Commands and Default value for Read Holding registers
1.4	28/11/2022	Added new Modbus Commands and Default value for Read Holding registers/ Input Registers Errata corrige for description of 0x0068 and 0x006E Errata corrige for measuring unit of 0x0069 and 0x006F