

APPLICATION NOTE

HIGHPROTEC↔EASYGEN | APPLICATION NOTE |

PROTECTION TECHNOLOGY MADE SIMPLE

MODBUS COMMUNICATION OF AN EASYGEN GENERATOR CONTROL WITH A HIGHPROTEC PROTECTION DEVICE



Modbus Communication of a Generator Control easYgen-XT (Woodward GmbH) with a HighPROTEC Protection Device (SEG Electronics GmbH)

Original Document

English

Application Note (Original)

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1. Safety Messages

1.1 Important Definitions

The types of messages shown below serve the safety of life and limb as well as for the appropriate operating life of the device.

DANGER

DANGER! indicates an immediately dangerous situation that will result in death or serious injury if it is not avoided.

WARNING



WARNING! indicates a hazardous situation that can result in death or serious injury if it is not avoided.

CAUTION

CAUTION! indicates a possibly hazardous situation that can result in minor or moderate injuries if it is not avoided.

NOTICE

NOTICE! is used to address practices not related to personal injury.

1.2 Prerequisites

This Application Note demonstrates the settings that have to be made at the HighPROTEC and at the Modbus-Master of the easYgen.

WARNUNG Image: A state of the products of the products. All safety aspects and messages and all national standards – if applicable – must be followed. Failure to follow instructions can cause personal injury and/or property damage.

Any unauthorized modifications to or use of this equipment outside its specified mechanical, electrical, or other operating limits may cause personal injury and/or property damage, including damage to the equipment.

Any such unauthorized modifications: (1) constitute "misuse" and/or "negligence" within the meaning of the product warranty thereby excluding warranty coverage for any resulting damage, and (2) invalidate product certifications or listings.

HINWEIS

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2. General Information

easYgen/ModbusMasterMapper ↔ HighPROTEC:

- As of version 2.10, easYgen devices support being operated as a Modbus/TCP-Master. With this functionality they can communicate with up to 5 external devices.
- Woodward makes available the software tool "ModbusMasterMapper". It is compatible with Windows 7 or higher, and it can be used to create a setup file for any easYgen-XT device (as of SW version 2.10-0). With this setup file, the easYgen-XT can communicate via Modbus/TCP with several slave devices, i.e. it can read or write data.
- The user defines the devices to be accessed, the type of data transfer and the Modbus address ranges to be transferred.
- The ModbusMasterMapper generates an SCP file that can be uploaded to an easYgen-XT via the software "Toolkit". (Select the menu item "LOAD APPLICATION" and follow the steps.)
- This way the easYgen-XT can be configured in a way such that measurement values are transferred from the HighPROTEC (slave) onto the easYgen-XT (master).
- The Modbus function codes 3 and 4 are supported. It is possible to read different values from a device, such as currents, voltages and temperatures.
- These read values can be scaled freely and stored in 99 available slots for analog data or 99 Boolean values. The easYgen application can use these data in various ways.
- The easYgen-XT offers a function for communication diagnosis, so that the user can check easily which external devices are available for communication.
- The easYgen-XT has two special user-defined screens available for display. Each of these two screens can display up to 9 analog measurement values.

3. Device Variants (Example)

3.1 HighPROTEC

Select a HighPROTEC that meets your protection needs. For the Modbus Master application described here, it is important to select a device with TCP/IP interface. Every HighPROTEC device with Ethernet/TCP/IP also makes the Modbus TCP protocol available.

In the following we will use a HighPROTEC **MCDGV4-2A0ACA** as an example.

Generator	Protection										
MCDGV4						-2	#	#	#	#	#
Housing	Display	DigitalIn puts	Binaryou tputrelay s	Analogin puts / Outputs	Interf.for ext.RTD Box						
B2	LCD, 128x 128pixel	16	11	0/0	*		A				
B2	LCD, 128x 128pixel	8	11	2/2	•		В				
B2	LCD, 128x 128pixel	24	11	0/0	•		С				
B2	LCD, 128x 128pixel	16	16	0/0	•		D				
Hardware	Hardware variant 2										
Phase Current 5 A/1 A, Ground Current 5 A/1 A 0											
Phase Curre	ent 5 A/1 A, S	Sensitive Gro	und Current	5 A/1 A				1			
Housing a	nd mountin	g									
Housing su	itable for doo	or mounting							Α		
Housing sui	itable for 19"	rack mounti	ng						В		
Communic	ation proto	col ^(*)									
Without pro	otocol									Α	
Modbus RT	U, IEC60870-	5-103, DNP3	.0 RTU <i>RS48</i>	35 / terminal:	S					B	
Brofbus DB	P, DNP3.0 TC	/ ST connect	0870-5-104	Ethernet 100	і MB / RJ45						
Profbus-DP		SUB	01							F	
Modbus BT		5-103 DNP3	0 BTU Loptic	fber / ST co	nnector					F	
Modbus RT	U. IEC60870-	5-103, DNP3	.0 RTU <i>R</i> .548	35 / D-SUB						G	
IEC61850, I	Modbus TCP,	DNP3.0 TCP/	UDP, IEC608	70-5-104 <i>Et</i>	hernet 100M	1B / F	R/45			Н	
IEC60870-5	-103, Modbu	s RTU, DNP3	.0 RTU <i>RS48</i>	35 / terminal:	5]		
Modbus TC	P, DNP3.0 TC	P/UDP, IEC60	870-5-104	Ethernet 100) MB/RJ45				5	I	

Generator Protection						
MCDGV4	-2	#	#	#	#	#
IEC61850, Modbus TCP, DNP3.0 TCP/UDP, IEC60870-5-104 Optical Ethernet 100MB / LC duplex connector					К	
Modbus TCP, DNP3.0 TCP/UDP, IEC60870-5-104 Optical Ethernet 100MB / LC duplex connector					L	
IEC60870-5-103, Modbus RTU, DNP3.0 RTU RS485 / terminals]	-	
IEC61850, Modbus TCP, DNP3.0 TCP/UDP, IEC60870-5-104 Ethernet 100 N	1B /	RJ45		ſ	•	
Harsh Environment Option						
None						Α
Conformal Coating						В
Available menu languages						
English (USA) / German / Spanish / Russian / Polish / Portuguese (BR) / Frer	nch /	Ron	nania	an		
Miscellaneous Functions						

Control functions for up to 6 switchgears and logic up to 80 equations.IRIG-B interface for time synchronization.

3.2 easYgen

For this kind of application one needs a generator control device of type easYgen-XT (with a recent firmware version).

In the following we will use an **easYgen 3200XT-P1** as an example.

		easYgen-3000XT Series						
ERSYGED 3000 ^{XT}	Model	3100XT	320	OXT				
	Package	P1	P1	P1-LT				
Measuring T								
Generator voltage (3-phase/4-wire)								
Generator current (3x true r.m.s.)								
Mains voltage (3-phase/4-wire)			×					
Mains or ground current (1x true r.m.s.; Mains o	r ground current selectable)							
Busbar voltage (1-phase/2-wire)				-				
Control								
Breaker control logic (open and closed transition	<100 ms) FlexApp [™]		2					
Automatic, Manual, Stop, and test operating mo	des							
Mains parallel multiple-unit operation (up to 32 u AME (auto mains failure) and stand by operation	inits)		*					
Solar and diesel support			~					
Critical mode operation			×					
GCB and MCB synchronization (±slipping / phase	se matching)		×					
Import / export control (kW and kvar)			×					
Load-dependent start/stop			×					
n/t, V, P, Q, and PF control via analog input or in	nterface		×					
Load/var sharing for up to 32 gensets			2					
Preely conligurable PID controllers	I		3					
HMI Color Display with Softkey operation	Dunamical CD#							
Start/stop logic for diesel / nas engines	DynamicsLCD	-	· · · ·					
Counters for operating hours / starts / maintenar	nce / active/reactive energy		×					
Configuration via PC (serial connection and Too	Kit software (included))		×					
Event recorder entries with real time clock (batte	ery backup)		1000					
Operating Temperature		-40 to 70 °C	-20 to 70 °C	-40 to 70 °C				
Protection	Equivalent ANSI#							
Generator: voltage / frequency	59 / 27 / 810 / 81U							
Generator: overload, reverse/reduced power	32 / 32R / 32F							
Generator: Synch Check	25							
Generator: unbalanced load	46							
Generator: Instantaneous overcurrent Generator: time overcurrent /IEC 255 compliant	51/51/							
Generator: ground fault (measured ground curre	ont) 50G							
Generator: power factor	55		~					
Generator: Pole slip monitor	78 PS							
Engine: overspeed / underspeed	12/14							
Engine: speed / frequency mismatch								
Engine: D+ auxiliary excitation failure								
Engine: Cylinder temperature								
Mains: voltage / frequency / synch check	59/27/810/810/25							
Mains: phase shift / rotation field / ROCOF (dt/d	1) 78							
I/Os								
Speed input: magnetic / switching; Pickup			12 (10)					
Discrete alarm inputs (configurable)	LogicsManager ⁷⁸		max 12					
External discrete inputs / outputs via CANopen	Logicomanager		32/32					
Analog inputs #1, configurable	FlexIn [™]		3					
Analog outputs: +/- 10V, +/- 20mA, PWM; config	urable		2					
External analog inputs / outputs via CANopen			16/4					
Display and evaluation of J1939 analog values,	"supported SPNs"		100					
Ethernet Modhus TCP Slave interface #3	FIEXCAN		1					
USB Serial interface			1					
RS-485 Modbus RTU Slave interface			1					
Listings/Approvals								
UL / cUL Listing (61010 ,6200), VDE, EAC, VDE	-AR-N 4105/ 4110							
CSA (USA and Canada)			1					
LR, ABS Marine			v					
CE Marked								
Part Numbers								
Front panel mounting with display #4		•	8440-2082	8440-2083				
Cabinet back mounting w/o display		8440-2081						
Spare connector kit		8923-2318	8923-2318	8923-2318				

4. Settings

4.1 HighPROTEC MCDGV4-2A0ACA

The setting and operating software *Smart view* can be downloaded here: http://docs.segelectronics.de/smart_view

Launch *Smart view* and select the menu item [Device planning]. There you can doubleclick the parameter *»Scada . Protocol«* and set it to "Modbus TCP".

File Device Edit View Settings Tools Window Help	Device planning		×
	Module . Name	Value	^
	🖉 delta phi - 78V . Mode		Apply
Shortcuts 👲 Data from Device	Se Intertripping . Mode		
→ → MCDGV4			Edit
K late S Sh Operation	🖉 Q - 32 . Mode		Coursel
	A HVRT[1] - 59, Mode		Cancel
Operation OP Device Dava	HVBT[2] - 59, Mode		Help
S (S) Device Para	& LVRT[1] - 27 . Mode		- Top
	& LVBT[2] - 27 Mode		
Protection Para	J VG[1] - 27A, 59N A . Mode		
Device planning	Q VG[1] - 27A, 59N A , Superv. only	no	
> 10 Logics	J VG[2] - 27A, 59N A . Mode		
Service Service	Q VG[2] - 27A 59N A. Superv only	no	
	& V012[11-47 Mode		
Device Para	& V012[2]-47 Mode		
	& V012131-47 Mode		
36 50/60	& V012[4] - 47 Mode		
3€-↔	Sa V012[4] 47 Mode		-
Field Para	Sa V012[6], 47, Mode		
	Sa ff11, 81 Mode	ł.	
READ	Ga #21, 91 Mode	6	
	Ga f[2] - 01 . Mode		
Protection Para	Ga EAL OI Mode		
The contract	Ga #EL 91 Mode		
	Galifel Of Mode		
	Ga DOCI11 22 27 Made	•	
Control	G DOCIDI 22, 37 Mode		
control	Ga DOCI21 - 22, 37 . Mode	•	
	Ga DOCIAL 22, 27 Mode	•	
	Ga DOCIEL 33, 37 . Mode	•	
Logics	G DOCICI 33 37 Mode		
Ebgics	@ PUS[6] - 32, 37 . Mode	•	
	Capron FF H L	•	
	PF[2]-55. Mode	•	
Fanica	Gr D. C. HI H. H.	•	
Service	ReLon[1]. Mode	•	
	ReLon[2]. Mode	•	
	UFLS . Mode	•	
	AR - 79. Mode	•	
	Sync - 25 . Mode	•	-
	SUIF. Mode	•	
	CLPU . Mode	•	
	ExP[1]. Mode	•	
		•	
	ExP[3] . Mode	•	
	ExP[4]. Mode	•	
	Second CBF - 50BF, 62BF . Mode	•	
	JCS - 74TC . Mode	•	
	🌽 CTS - 60L . Mode	•	
	🖉 LOP . Mode	•	
	🖉 SysA . Mode	•	
	🖉 Syslog . Mode	•	
	🎏 Scada . Protocol	Modbus TCP	
	🔑 IRIG-B . Mode		
	CONTR 11		

Enter the menu branch [Device Para] and set »TCP/IP config« to a valid IP address (with subnet mask and gateway).

File Device Edit	View Settings Tools Window Help	2		
	Ł ₮ ₮ ◯ ¦₿ (?)			
Shortcuts	🛨 Data from Device			
Operation			TCP/IP Device Configuration Activate TCP/IP on the device TCP/IP Properties	×
Device planning	Binary Outputs Elebs		IP address:	192 . 168 . 178 . 100
B	Acknowledge	\searrow	Subnet mask:	255 . 255 . 252 . 0
Device Para			Default gateway:	10 . 25 . 16 . 1
Field Para	Control Contro Control Control Control Control Control Co		Ethernet Properties: Speed:	100 MBit/s
6.670	> - 🔁 Modbus		Link:	Full Duplex Up
Protection Para	Version		MAC address:	00-12-8c-00-91-65
Control	> ㎡ Field Para > ® Protection Para > 한 Control > 짧 Logics > झ Service		Access Level:	Supervisor-Lv3

Enter [Device Para / Modbus / TCP] and set the »Unit ID«. In the following we will use the example setting »Unit ID« = 1. (Note that this requires the same setting Modbus-ID = 1 within the Modbus-Mastersettings of the easYgen-XT, see below on page 12.)

4.2 easYgen / Modbus-Master

The software ModbusMasterMapper can be downloaded here: https://wss.woodward.com/manuals/PGC/easYgen-3000XT_series/SW_Tools/ModbusMasterMapper

Its main dialog window looks like this:

🝕 ModbusMas	terMapper											-		\times
Files Help										r	W.	woo	DWA	RD
										l	43			
DEVICE RATEGROUP	#	Enable	Connected	Timeout	ModbusID	IP1	IP2	IP3	IP4	Port				
WRITE READ														•
														*
														+
(F. 1)	Real			Y		aturad			_	-				
FAL	SE			Connec	not use	ed		J	Replace	L	escription			
Timeout [s] Floa	at AM			Modbu	Int				Add	n	nap file	map.mr	nap	
IP Address IPad	ldr			Port	Int			\rightarrow	Add at End	ŀ	landoff			
0	0 0	_ 0			0				Check	A	pplication			
										P	ackage			
										F	lelease			

Every new project requires a device description package to be set up.

The package contains settings for all necessary parameters and access points of the device that shall operate as a Modbus Master. Without loading a package the tool is not functional, i.e. all menu items are inactive.

440-2082_G_English_EDS.zip	14.05.2020 13:52	WinZip File	164 KB
1 8440-2082_G_Multilingual_Package.zip	14.05.2020 13:52	WinZip File	2.907 KB

After a package has been loaded the main dialog window shows menu items for several categories.

📲 ModbusMas	terMapper										-		\times
Files Help										W	wooi	DWA	RD
	#	Enable+	+Connected	Timeout	ModbusID	IP1	IP2	IP3	IP4	Port			
	√ 1	TRUE	-	2	1	192	168	178	11	502			
 WRITE READ 													•
													9,9
													+
Enable LM	Bool			Connec	ted LM N	lot used			Replace	Description			
	E			<u> </u>	not us	ed			Add	MCDGV	4-2_08Okt2	2020	
Timeout [s] Floa	at AM			Modbu	s- Int	-			Add	map file	map.mma	ар	
	Idr				Int				Add at End	Handoff	46141		
19 Address 11 dd	168 1	78 11		Port	502				Check	Application	EG3200X	TP1	
										Package	V1.1		
										Release	2.10-0		

The "Device" menu defines external devices, to which the easYgen-XT as Modbus Master will connect.

Every line in the list describes a device, and up to 5 devices are supported. In our example shown above the HighPROTEC MCDGV4 has already been defined.

First the IP address (of the Modbus-Master, i.e. of the easYgen-XT) and the Modbus-ID (of the Modbus-Slave, i.e. of the HighPROTEC device) have to be set.

The Modbus-ID (Slave-ID) has to be equal to the HighPROTEC setting, i.e. in our case: = 1.

📲 ModbusMaster	rMapper						- 🗆		×
Files Help						W.	VOODW	AF	R D
				Ν					
	#		Rate	45				٦.	
	√ 1 1								
 WRITE READ 									•
									*
									+
									-
Rate [s] Float	AM				Dealasa	Description			
+ 1		J			Replace	MCDGV4	-2_08Okt2020		
					Add	ap file	map.mmap		
					Add at End	Handoff	46141		
					Check	Application	EG3200XTP1		
						Package	V1.1		
						Release	2.10-0		
						l			
				With whi	ich				
				device	to				
				communi	cate				
					_				

The "Rategroup" menu defines groups that collect devices to be connected to by the easYgen-XT. In our case, the MCDGV4 is defined as the sole group member.

Every line in the list describes such a communication group.

- ____ The buttons move the position of an entry in the list.
- This button deletes an entry from the list.
- - This button adds a new group.
- A click onto a line selects the respective group, and its settings are shown in the editing panel underneath, where they can be modified.



۸

 This button transfers / inserts / checks the settings of the editing panel into the currently selected line of the list.

🝕 ModbusMa	asterMappe	er									-	-		\times
Files Help										М	J.we	00	owa	RD
										6				
DEVICE RATEGROUP WRITE READ	Le	eng Device#	Rate# Addr.	Туре	Endianness	FC	Scale	Si	ource			Comm	ent	
Device- Int number 0		Rate- number	Int 0	Modbus- address	Int 0	Datatype	Type UINT16		Replace	Descrip	tion	000143	020	
Function- FC		Endian-	Endianness	Eactor/	*x+y	λ			Add	man file	ma	ip.mma	ip	
code 16		ness	littleEndian	offset	*: + 1.0	+: + 0.0			Check	Handof	f 46	141		
Source Inc + C	dex Float	AM Bitfield	J							Applica	tion EG	3200X	TP1	
Comment Str	ring									Package	e V1	.1		
										Release	2.1	10-0		

The "Write" menu defines a Modbus command to be transmitted. The easYgen-XT periodically sends a Modbus-command 16 "write multiple" to transfer data to the MCDGV4.

The lines can be grouped, so that they get transmitted within one command. The list is always displayed sorted as follows:

- 1. Device,
- 2. Rate,
- 3. Modbus address.

Files Help															_		×
														N.	woo	DW/	A R D
	ſ		Long	Device#	Pata#	Adde	Tune	Endianness	50	Scala	1		Taxaat		Com	mont A	
	D	1	1	1	1	20128	БОЛТ	bigEndian	A	*1.0±0.0	A-54.01		larget	Soli	Com	nment ^	98
		× ./	1	1	1	20120	FLOAT	bigEndian	4	*10+0.0	Δ.54.07			SpW	/ 1112	112	
READ		5	1	1	1	20132	FLOAT	bigEndian	4	*1.0+0.0	A:54.03			SpW	1 U23		+
		1	1	1	1	20134	FLOAT	bigEndian	4	*1.0+0.0	A:54.04	63		SpW	/ U31		{
		1	1	1	1	20136	FLOAT	bigEndian	4	*1.0+0.0	A:54.05			SpW	/ U1		
		1	1	1	1	20138	FLOAT	bigEndian	4	*1.0+0.0	A:54.06			SpW	/ U2		5.5
		~	1	1	1	20140	FLOAT	bigEndian	4	*1.0+0.0	A:54.07			SpW	/ U3		
		~	1	1	1	20232	FLOAT	bigEndian	4	*1.0+0.0	A:54.10			SfW	Netz IL1		
		<	1	1	1	20224	FLOAT	hisEndian	4	*10.00	A-5/L11			CAM	Note II 7		
																-	
Device-	Int	-	Rat	te-	Int		Modbus-	Int	Data	type Type			Papiasa	Description			
number	1		nui	mber	1		address	20128		FLOAT			Replace	MCDGV	4-2 080	kt2020	
Function-	FC		Enc	dian-	Endia	nness	Factor/	*x+y	~				Add	map file	map.m	map	
code	4		nes	55	bigEn	dian	offset	*: + 1.0	+:	+ 0.0			Check	Handoff	46141		
Target	Inde	xW AI	MBitfi	ield							/			nandon	40141		
	503	Remo	te con	trol 1			~					J		Application	EG320	OXTP1	
Comment	Strin	g										_		Package	V1.1		
	SpW	/ Frequ	Jenz											Release	2.10-0		
															L		

The "Read" menu allows for defining a Modbus read command.

The easYgen-XT periodically sends a Modbus-command 3 "read" to get data from the MCDGV4.

The functionality of the Modbus addresses, as defined within the MCDGV4, i.e. the assignment of Modbus addresses to MCDGV4 parameters, is listed in a separate document, the MCDGV4 Modbus Datapoint List. This document is available here: https://docs.segelectronics.de/library/HighPROTEC/ MCDGV4-2/04_SCADA_Communication/Modbus/

The lines can be grouped, so that the data get transmitted within one command. The list is always displayed sorted as follows:

- 1. Device,
- 2. Rate,
- 3. Modbus address.
 - This button deletes an entry from the list.
 - This button adds a new line (i.e. a new analog value).
 - This button ungroups all groups within the whole list.
 - This button collects the selected lines in a new group. This is only possible if the lines to be grouped have the same Modbus-ID and the same Baud rate.

Replace	
Add	
Add at End	
Check	

 This button transfers / inserts / checks the settings of the editing panel into the currently selected line of the list. After all, the easYgen periodically reads measurement values from the HighPROTEC and displays them.







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