Photovoltaik / PV with generator sets

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As an upfront information, there are two video trainings available for photovoltaik / PV support in a network with generator sets:

easYgen Training: Solar Diesel:

https://easygen.org/wp-content/uploads/2023/11/easYgen_6.7.mp4

Webinar recording:
https://wss.woodward.com/manuals/Support/Webinar_Recordings/easYgen-3000XT_v2.15/Webinar_easYgenXT%20Software%20Version%202.15-0.mp4

Connecting existing or new Gensets with superimposed PV-DIESEL CONTROLLER via Woodward's easYgen3000XT and/or Woodward's MFR 300

Introduction

Conventional Power Generation in rural regions with weak grids or on islands is often based on Power Stations (reciprocating engines) fired by fossil fuels. Beside the required maintenance for these types of Gensets, the dominating cost factor is the fuel itself. The logistics in rural regions/islands also increase the local fuel price. Independent Power Producer aim to get rid of this continuously increasing cost factor and are therefore highly interested in any kind of reduction potential.

As before described applications can often be found in the Sunbelt region, PV power is considered as an appropriate source to offer grid support for lowest cost. But in order to grant stable grid conditions, island grids require some additional considerations as:

- Providing sufficient spinning reserve for load jumps
- Providing sufficient over-current capacity to trigger fuses and secure installation in the event of short circuits
- Operating Genset at its optimal operating point and avoid increasing wear due under-load
- Providing common control functions for more than single Genset as
    - Load dependent Start/Stop
    - Automatic synchronizing to bus-bar
    - Predictive maintenance of Genset
    - Managing automatic load share of Gensets
    - Leveling utilization of Gensets (operating hours)

Woodward with its partners in conventional Power Generation and in systems and solutions in Photovoltaic have developed a System to extend Genset installations with PV-Power in order to reduce fuel consumption and according OPEX-cost. By using PV as “negative load”, amortization times for the required PV-Plant extension of 3-4 years are achievable. Given that PV plants are designed for a lifetime of at least 20 years, investors can run such Hybrid systems with highest profitability. The trend of dropping PV-cost and increasing fuel cost is an additional factor and reduces risk for operators and investors.

easYgen3000XT

(software version 2.15 and higher)

The ‘easYgen’ is a Genset Controller which manages the control of the single Genset as well as the control of up to 32 Gensets working on the same bus bar. Thus it accommodates common control functions as

- Load dependent Start/Stop
- Automatic synchronizing to bus-bar
- Predictive maintenance of Genset
- Managing automatic load share of Gensets
- Leveling utilization of Gensets (operating hours)

The Gensets are linked via the CAN bus line and operate in a multi master mode. The data on this CAN bus are arranged as below.

CAN-Bus-Address	Detail	Data Type	Unit
Easygen[x].GenRealLoadInW	Generator Real Load in W	DINT	W
Easygen[x].GenReactLoadInVar	Generator Reactive Load in var	DINT	var
Easygen[x].GenRealLoadInProm	Generator Real Load per mill	DINT	Per mill
Easygen[x].GenReactLoadInProm	Generator Reactive Load per mill	DINT	Per mill
Easygen[x].GenRatRealPower	Generator Rated Real Power in kW	DINT	kW
Easygen[x].GenRatReactPower	Generator Rated Reactive Power in kvar	DINT	kvar
Easygen[x].OperMode	Operation Mode	INT (0…3)	
Easygen[x].EngineState	Engine State	INT (0…11)	
Easygen[x].RealLoadContrState	Real Load Control State	INT (0…11)	
Easygen[x].ReactLoadContrState	Reactive Load Control State	INT (0…11)	
Easygen[x].GenVoltFreqOk	Generator Voltage and Frequency ok	BOOL	
Easygen[x].BbVoltFreqOk	Busbar Voltage and Frequency ok	BOOL	
Easygen[x].MainsVoltFreqOk	Mains Voltage and Frequency ok	BOOL	
Easygen[x].FourthSysVoltFreqOk	System Voltage and Frequency ok	BOOL	
Easygen[x].BusbarxDead	Busbar 1 is dead	BOOL	
Easygen[x].Busbar2Dead	Busbar 2 is dead	BOOL	
Easygen[x].LoadSharOn	Load Sharing switched on	BOOL	
Easygen[x].ReactLoadSharOn	Reactive Load Sharing switched on	BOOL	
Easygen[x].GcbClosed	GCB is closed	BOOL	
Easygen[x].McbClosed	MCB is closed	BOOL	
Easygen[x].GenGroupCbClosed	Gen Group Breaker is closed	BOOL	
Easygen[x].DeadBusDeterm	Dead Bus Determination	BOOL	
Easygen[x].MainsSetTimeAct	Mains Settling Time is active	BOOL	
Easygen[x].ShutdownAlarmAct	Shutdown Alarm is active	BOOL	
Easygen[x].RunHours	Running Hours	BOOL	
Easygen[x].AlarmClassA	Alarm Class A occured	BOOL	
Easygen[x].AlarmClassB	Alarm Class B occured	BOOL	
Easygen[x].AlarmClassC	Alarm Class C occured	BOOL	
Easygen[x].AlarmClassD	Alarm Class D occured	BOOL	
Easygen[x].AlarmClassE	Alarm Class E occured	BOOL	

Easygen[x].AlarmClassF	Alarm Class F occured	BOOL
Easygen[x].AlarmClassWarn	Alarm Class Warning occured	BOOL

MULTI FUNCTION RELAY MFR 300

Alternative to the MFR300, could an Modbus protocol provide these measurements.

The ‘MFR 300’ can be integrated in the system to measure Voltage/Frequency in order to sense the load flow in a meshed grid with its characteristic values for active/reactive power and according power factor for each phase. The ‘MFR 300’ is used in the PV-Diesel application to either measure the values for PV power generation or to detect values for the load. The ‘MFR 300’ is connected to the superimposed ‘DER PV-DIESEL CONTROLLER’ via the CAN bus line according to description below.

CAN-Bus-Address	Detail	Data Type	Unit
MFR300Pdo3[x].Frequency	Frequency in Hz	REAL	Hz
MFR300Pdo3[x].TotalActPower	Total active power in W	REAL	W
MFR300Pdo3[x].TotalReactPower	Total Reactive Power in var	REAL	var
MFR300Pdo3[x].GenRatRealPower	Generator Rated Real Power in kW	REAL	kW
MFR300Pdo3[x].GenRatReactPower	Generator Rated Reactive Power in kvar	REAL	kvar
MFR300Pdo3[x].PowerFactorL1	Power Factor L1	REAL	
MFR300Pdo3[x].VoltageL1L2	Voltage L1-L2 in V	REAL	V
MFR300Pdo3[x].PowerFactorL2	Power Factor L2	REAL	
MFR300Pdo3[x].VoltageL2L3	Voltage L2-L3 in V	REAL	V
MFR300Pdo3[x].PowerFactorL3	Power Factor L3	REAL	
MFR300Pdo3[x].VoltageL3L1	Voltage L3-L1 in V	REAL	V
MFR300Pdo3[x].CurrentL1	Current L1 in A	REAL	A
MFR300Pdo3[x].CurrentL2	Current L2 in A	REAL	A
MFR300Pdo3[x].CurrentL3	Current L3 in A	REAL	A

Visualization	Detail	Data Type	Range
CobidArrayMfr[x].CobidNoPdo3	Cobid number of PDO3	INT	1380-1429
CobidArrayMfr[x].Mode	Reading Mode of MFR300	INT	1380-1429

Explanation: x= 1…32