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HYDRA GC Series
GRID CONNECTED – AUTONOMOUS INVERTERS / CHARGERS
VERSION 1.6.1

1. Introduction

HYDRA GC series are advanced technology, high efficiency power inverters / chargers, able to work in all four operating quadrants, with low sinusoidal voltages and currents, in grid connected or island modes.

- They may either absorb energy from, or sell energy to the power grid.
- They support uninterruptedly local charge equal to their nominal power connected at their output, when no grid is present, working as islanding or autonomous systems.
- They charge the connected batteries from the external ac power source with a power factor almost equal to unity.
- When no local batteries are present, they may be programmed to sell energy to the power grid optimally, tracking the maximum power point of the connected renewable energy source (MPPT).
- They include zero transfer time power switch to support the local load, working as an on-line ups.
- They include an 8 A contact to support voltametric charge controller function either locally, or by driving external relays for higher currents.
- They include software and appropriate contacts to start and stop external power generators.
- They include advanced sensing software as well as two automatic switches (electronic and electro-mechanical) to isolate the external power grid in case of low quality or loss of the grid.
- They include an isolated RS-232 output, as well as complete software for Windows environment, for monitoring, recording and printing all the operational parameters, including cumulative energy flow to and from the power grid.

HYDRA products are built around a latest technology, high speed, and large program memory RISC microcontroller. The operating software offers the user with simple and user friendly way, using a multiple message LED display and two push buttons (MENU and ENTER), full information and continuous control of the ***HYDRA*** operation, of the state of the connected accumulators, of the connected alternating power source, of the flow of energy to and from the grid, of the local load. Additionally, all the functional parameters are user programmable and stored in a non-volatile memory.

2. Operating modes

HYDRA has two main and distinct operating modes. It functions either as:

- **Stand-alone Inverter,** supporting local loads, or as
- **Grid Connected system,** able to have bi-directional energy flow.

HYDRA starts operating always as an autonomous system, feeding its local load, when the user sets the main switch in the active **(ON)** position.
The selection of the final operating mode is done automatically, depending on the characteristics of the connected external ac power source.

The connection to the grid is selected only if the ac power source at the input of ***HYDRA*** has acceptable characteristics both in RMS value and frequency for more than 5 consecutive seconds. After the acceptance of the quality of the external grid, the connection is done in a fast and synchronous way.

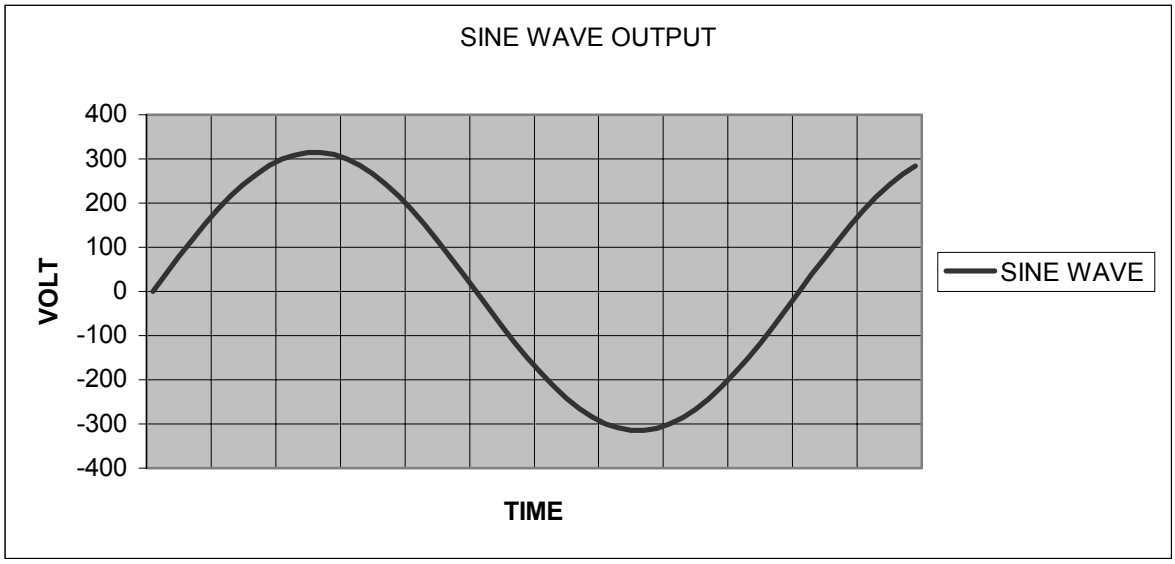
During grid connection the local load is practically fed by two sources, simultaneously from the inverter and the external ac source.

2.1. Stand-alone Inverter mode operation

HYDRA automatically selects the stand-alone mode when the external ac source either is missing, or its quality is not within the acceptable (and programmable) frequency and voltage limits.

Additionally ***HYDRA*** includes a load scanning circuit, in order to start operation only when the locally connected load is greater than the selected threshold, as set by the external **Starting Load** potentiometer. In this way the self-consumption while idle, is practically eliminated. During the load-scanning mode **(Scanning Load)**, short voltage pulses are produced at the output every 0.5sec, and simultaneously the **Inverter led** blinks with the same rhythm, while the multi-message display remains inactive. As soon as a suitable load is detected, the inverter starts up delivering power at its output. If the load is removed, the inverter automatically returns to the scanning mode within **1sec**.

The output voltage waveform is a **pure sine wave.** This waveform, which is shown in the picture below, is suitable for all applications.



Picture 2.1

The microcontroller continuously controls the RMS value of the output voltage **(Vout rms),** in order to keep it equal to the nominal one (programmable from 220 to 230 Volt with 1,5 V steps). This is important in order to power the load with constant alternating current, independent from the battery voltage and the load variations.

The inverter is designed to provide up to five times the nominal power, for duration of 0.2 sec. The inverter shuts down when the output power exceeds **125 %** of the nominal power for more than 5 sec. These important power margins enable the inverter to start normally electric refrigerators, pumps, circulators, motors, or incandescent lamps, or other loads which necessitate 3 to 10 times their rated current to start. Additionally, ***HYDRA*** includes specialized power circuitry with the capability to absorb loss less the returned energy from inductive or capacitive loads. This enables the inverter to power normally even highly reactive loads.

Alarms and errors of the stand-alone mode.

The microcontroller continuously monitors the state of the batteries, the internal and external temperature, the internal cooling system, the stability of the output voltage, the external power source and the load. In case of output short circuit it reacts instantly to protect the inverter as well as the load.

The microcontroller issues two levels of warnings and one level of errors for the above parameters.

The microcontroller warns in the first level the user, through coded visual and slowly alternating audible messages **(Alarm - warnings)**, without interrupting the operation of the inverter, for any deviation from the usual operating limits of the following parameters:

- Temperature of the internal transformer **Tint.**
- Temperature of the power module **T2.**
- Output **Load.**
- Battery voltage **Vbat.**
- Current (**Idc)** from and to the battery, or the dc power source.
- Effective output voltage in Volt rms **Vout.**

If the above parameters continue to deviate from their usual operating limits and are about to exceed their tolerated values, then second level warnings are issued, accompanied by fast alternating audible signals.

If the problem persists for more than 5 seconds, then the inverter senses an **Error** and shuts down to protect the battery, the internal circuits, or the load.

After an automated shut down on **Error**, the inverter checks at regular time intervals all the operating parameters, and if the cause of the error is removed, or the parameter regained its acceptable operating limit (e.g. lower temperature), then the inverter restart automatically its operation. If not, then the inverter repeats the above procedure after a programmable time interval (**restart time, Pr01**).

Any error that caused an automated shut down is memorized and presented on the multi message display, with its own code number. Therefore the user can easily identify the error, even if the inverter automatically restarted after its removal.

ALARM				**Cause**					**ERROR**		
Code	First level warning	Second level warning	Alarm relay activation						**Code**	Automatic restart	Activate grid connection
					Vcell	12V	24V	48V			
AL14	•			**<**	1.8V	10.8V	21.6V	43.2V			
AL13		•		**<**	1.58V	9.5V	19V	38V	**Er10**	•	
AL16		•		**>**	3.8V	22.8V	45.6V	91.2V	**Er19**	•	
AL36	•			Load > 105%							
AL37	•		•	Load > 115%							
AL38		•	•	Load > 125%					**Er39**	•	
AL56	•		•	Tint > 85°C							
AL57		•	•	Tint > 110°C					**Er59**	•	
AL66	•		•	T2 > 75°C							
AL67		•	•	T2 > 100°C					**Er69**	•	
AL73		•	•	Vout < 180Vac					**Er70**	•	
AL74	•		•	Vout < 190Vac							
AL76	•			Vout > 250Vac							
AL77		•		Vout > 260Vac					**Er79**	•	
			•	Load >120 % while entering the stand-alone mode					**Er08**		
---				Output short circuit (Fault)					Er01		
---				Extremely high output load					Er03		
---				Transient Max Idc Very high transient output load					Er06		
---				Continuous Max Idc Very high continuous output load					Er07	•	

Table 2.1 Alarms & Errors of the stand-alone mode

The ALARM relay is also activated when the battery voltage lays below **1.66 Volt/cell** for more than **5 sec**, or when *HYDRA* failed to start the external power generator.

Monitoring and Display of the stand-alone mode:

During the operation of the inverter, the user has the option to monitor in a successive and cyclic way, by pressing momentarily the **MENU** push button, the data of the following table. For some data we may visualize additional information by pushing momentarily the Enter button:

Pushing **MENU** button	**Primary displayed data**	Pushing **ENTER** button	**Secondary displayed data**	**Pushing steadily ENTER**
0	**Display off** Reduction by 100 mA of the current consumption of *Hydra*	—	—	—
1	Effective value in Volt rms of the Inverter output **(Vout)**.	—	—	—
2	Load in **%** of the nominal one, actually connected to the inverter output (**Load**).	Change to ↔	Mean value of the current drawn from the dc source in A dc	—
3	Voltage in **Volt dc** of the dc source connected to Hydra (**Vbatt)**.	—	—	—
4	Temperature Ttrf of the power transformer **(ºC)**.	—	—	—
5	Effective value in Volt rms of the input voltage provided by the external ac source (**Vline**).	Change to ↔	frequency of the input voltage **(Vline)**.	—
6	Effective value in I rms of the input current provided by the external ac source (**Iacgrid**).	Change to ↔	Real power in KWatt Pline.	—
7	Last detected **Alarm** code. Valid actually in the system if blinking.	—	—	—
8	Last detected **Error** code. Valid actually in the system if blinking.	—	—	—
9	'**±Enr**' (+) Energy to the ac grid (-) Energy from the ac grid	Change to ↔	Real value of the exchanged energy in KWHours.	Reset counter
10	**'I–Ah'** Consumed Ah counter	Change to ↔	Energy in **Ahours** drawn from the dc source.	Reset counter
11	**'C–Ah'** Stored Ah counter	Change to ↔	Energy stored in the battery in **Ahours**,	Reset counter
12	**'So—'** State of operational mode	—	—	—
13	**'Ch–S' Standard** charging or **'Ch–E' Equalizing** charging	Alternate selection	New selected option	—
14	**'bu–1'** Buzzer On or **'bu–0'** Buzzer Off	Alternate selection	New selected option	—

15	**'dL–S' Standard** messages or **'dL–E' Extended** messages	Alternate selection	New selected option	—

Table 2.3 Standard displayed messages

Pushing **MENU** button	**Primary displayed data**	Pushing **ENTER** button	**Secondary displayed data**	**Pushing steadily ENTER**
16	Temperature **Tint** of the power transformer **(°C)**.	—	—	—
17	Temperature **T2** of the power module **(°C)**.	—	—	—
18	External temperature, used to sense the battery temperature for charging compensation **Text (°C)**.	—	—	—
19	Manual control of the external power source **EP - I** or **EP - 0**	Alternate selection	New selected option	Execution
20	Effective value in A rms of the load current (**IacLoad**).	—	—	—
21	Time of the day in **hh.mm** To adjust time, first press steadily Enter, and then…	Select new value	Current value of the selected field (Hours or minutes)	Selection of the field to modify and final validation
22	Rejection code of the ac source cd-0 → LowSinewave cd-1 → HighSinewave cd-2 → RejectVrms cd-3 → ExtFrequency cd-4 → LowIac(line)	—	59 —	—
23	Enter the user parameter programming mode **'UPro'**	—	—	Execution
24	Enter the factory parameter programming mode **'FPro'**	Select new value	Current value of the access code	Validation of the selected code to enter in the programming mode
25	**Version** of the software	—	—	—

Table 2.4 Extended display messages

The Alarm or Error indication is blinking to identify an actually happening event, is stable when showing the last memorized event and is blank (--) when no event was detected since the last main switch starting of the system.

The battery voltage, the temperature of the transformer Ttrf or of the power Tpwr, are blinking if the corresponding parameter has exceeded the normal threshold value (alarm) to facilitate the user in the recognition of the alarm source.

2.2 Grid connected mode

When the external ac power source satisfies the acceptance quality criteria, then ***HYDRA*** is automatically connected to the external grid, becoming an active node able to transfer energy in both ways, to and from the grid.

In this operating mode, ***HYDRA*** may offer energy to the external grid working as a **grid connected** or "**paralleled" Inverter,** or may absorb energy from the grid in order to charge the connected batteries, acting as a "**paralleled" Charger,** or / and feed the locally connected load, in case the energy from the renewable source is not adequate to fully support it.

In the usual application, the energy flow is automatic and transparent to the local load. ***HYDRA*** functions as a bi-directional energy flow node, with positive, negative or zero flow, according to the locally produced energy, to the demand of the local load and the condition of the connected batteries.

In order to adapt to different installation conditions and configurations, ***HYDRA*** may be programmed through the factory parameter PrSystemConfig **(FP02)** to function in 4 different modes, while grid connected, as follows:

- **PrSystemConfig = 0.** ***HYDRA*** allows bi-directional energy flow without performing Maximum Power Point Tracking Control (MPP) of the dc source. This Mode is selected when the installation is composed from batteries, local renewable source and local load.
- **PrSystemConfig = 1.** ***HYDRA*** only sells energy without Maximum Power Point Tracking Control (MPP). This mode is selected when the installation contains renewable sources not needing MPP control, without local load and usually without batteries.
- **PrSystemConfig = 2.** ***HYDRA*** only sells energy with Maximum Power Point Tracking Control enabled **(MPP).** This mode is selected when the installation contains only renewable sources needing MPP control, without any local load or batteries.
- **PrSystemConfig = 3.** ***HYDRA*** only absorbs energy either to charge the batteries, or to support a local load. This mode is selected when the installation does not contain any local energy source. Its function is very similar to a double source ups using as energy source both the local batteries and the external ac grid.

Selling energy

When selling of energy is allowed and ***HYDRA*** is in the paralleled Inverter condition, exporting of energy may start either manually (through the selection menu) or

automatically if the dc voltage of the dc source is greater than the **VPrStartLevel (Pr09)**.
Exporting of energy starts by absorbing from the dc source constant current equal to 3.3% of the nominal, and this is called **stage SOP1.** Then, if the voltage of the dc source is **>Vpset**, ***HYDRA*** smoothly transits to the **SOP2 stage,** where the current grows until the dc power source voltage reaches the value set by parameter **VPset (Pr08).** When MPP is not activated, ***HYDRA*** keeps constant this voltage by varying the absorbed current according to the capability of the renewable source. If during this feedback control the absorbed energy from the dc source exceeds 105% of the nominal value, then power limitation control is also applied, allowing the dc voltage of the source to grow, **stage SOP3**.

If **MPP** is **activated (FP02=2)**, then ***HYDRA*** automatically searches the optimum dc voltage of the source**,** which maximizes the drawn energy.

The maximum allowed voltage deviation from the above set point VPset (Pr08) during the search is defined by parameter **Pr17, MaxDVPsetForMPPTracking.** ***HYDRA*** renews the search of the optimum operating point approximately every 40 sec in order to adapt to the possible variations of the renewable energy source (sunshine, air-speed, temperature).

Under normal operating conditions, selling of energy continuous until the dc voltage of the energy source becomes smaller than parameter **VPrStopLevel (Pr10),** or until the user stops it from the selection menu.

Charging

While working as a "**paralleled" Charger,** ***HYDRA*** acts as a two stage electronic lead acid battery charger, with maximum charging current continuously selectable by the user, through the external **Charge Rate (Iset)** potentiometer.

Charging may **start** either manually by the user, through the selection menu, or automatically if the dc voltage of the batteries is less than parameter **VChStartLevel (Pr16).** In both cases a non-zero charging current **Iset** must be selected from the front panel potentiometer before the above conditions are met.
The **charging current (Idc)** rises smoothly up to the selected charging current **(Iset).**

Hydra provides two different charging modes, the standard and the equalizing, notified as **Ch-S** or **Ch-E**. The selection is done using the multi message display. The default charging mode is the standard one, Ch - S.

- The **Ch-S, Standard charging** mode implements the **IU** DIN characteristic, with two discrete stages, namely the constant current, and the constant voltage notified in the multi message display as SoC 1 and SoC 2 respectively.
    1. **SoC-1**. The battery is charged with constant current, as selected by the Iset potentiometer. The battery voltage is allowed to gradually rise, until it reaches the selected value, programmed by the **Pr12** parameter, which automatically leads the charging process to the next stage.

2. **SoC-2**. The battery is charged with constant voltage, as selected by the programmable **Pr12** parameter. The battery is allowed to gradually absorb less current, until the charging current reaches zero or becomes slightly "negative", which automatically stops the charging process. The maximum allowed duration of the SoC-2 stage is limited to the programmable time set by the **Pr14** parameter.

- The **Ch-E, Equalizing** charging mode implements the above two stage **IU** DIN characteristic, but with augmented transfer limits from one stage to another, and is mainly needed to equalize the density of the electrolyte among the cells. This charging mode is manually selectable by the user, at time intervals as required by the battery manufacturer.

    1. **SoC-1**. The battery is charged with constant current, as selected by the Iset potentiometer. The battery voltage is allowed to gradually rise, until it reaches the selected value, programmed by the **Pr13** parameter, which automatically leads the charging process to the next stage.
    2. **SoC-2**. The battery is charged with constant voltage, as selected by the programmable **Pr13** parameter. The maximum allowed duration of the SoC-2 stage is limited to the programmable time set by the **Pr15** parameter.

In the table below are shown the **default** transfer limits between charging stages for the two charging methods, and for a 12, 24, 48, and 60 Volt battery system, as well as per cell.

Battery voltage Volt	Standard Charging SoC - 2	Equalizing charging SoC - 2
12	15	15.6
24	30	31.2
48	60	62.4
60	75	78
per cell	2.5	2.6

Table 2.5

The above values are valid for a battery temperature of 25°C. When the provided temperature sensor **(Text)** is connected to the Hydra terminals, the microcontroller compensates the above values by a factor of **- 4mVolt per degree** and **per cell**.

The charging of the batteries stops if one of the following conditions is met:

- The user selects a zero charging current from the front panel potentiometer
- The user selects to stop the charging manually through the selection menu
- ***HYDRA*** being in stage **SoC2** (constant voltage charging stage) detects the charging currents to be zero or negative.
- The maximum allowed time in **SoC2** stage expires

Power grid detection and rejection.

We may observe two different cases of power grid rejection. The first involves the quality criteria of the supplied power, or the clear interruption from the provider. In the second case, the grid may be absent “silently”, as for instance when a local fuse is blown, and this demands special detection procedures, in order to isolate the system from the rest of the grid, and also to avoid self-oscillation of the system.

Quality criteria:
The external power grid is usually rejected when its frequency or its voltage are beyond the programmable thresholds set by Pr01, 02 και 03. This case usually covers also the clear interruption of the power grid from the provider.

Active detection of power grid loss:
In order to avoid feeding parts of the external grid, or external loads, in the case where the power grid is lost “silently”, special security features exist both in software and hardware, to isolate ***HYDRA*** from the rest of the grid.

When the inverter is active, and if the effective value of the incoming current from the grid is below a programmable threshold, the software initiates the **active grid search mode**.
During this search mode, ***HYDRA*** measures continuously, in every half period, the internal resistance and the electromotive force of the power grid. In case where the internal resistance of the grid is too high, or the electromotive force too low, the grid is rejected, and ***HYDRA*** is isolated from it by two automatic switches in series.

Alarms and Errors during grid-connected mode

The operating software offers the user in a simple and friendly way complete and continuous monitoring of the charging process, of the energy flow, of the load and of the battery status.

The microcontroller monitors continuously the charging current, the battery voltage, the dissipated temperature inside the charger and in the vicinity of the batteries, the internal cooling system, the energy flow, even the eventual battery failure, and issues two levels of warnings or alarms concerning the charging process.

The first level of warning activates a slowly varying audible signal. The second level activates a fast varying audible signal, and warns the user that a forced interruption of the charging process will follow if within 5 sec the monitored variable does not regain an acceptable value. The forced interruption generates an **error**, which is memorized for monitoring purposes. Any warning generates an **alarm**, which is also memorized. Both messages can be displayed using the multi-purpose display, as follows:

ALARM				**Cause**					**ERROR**		
Code	First level warning	Second level warning	Alarm relay activation						**Code**	automatic restart	bypass activation
					Vcell	12V	24V	48V			
AL26		•		>	3.8V	22.8V	45.6V	91.2V	**Er29**	•	•

AL38	•		•	Load current IacLoad > 120%			**→ Er08**
AL56	•		•	Ttrf > 85°C			
AL57		•	•	Ttrf > 110°C	**Er59**	•	•
AL66	•		•	Tpwr > 75°C			
AL67		•	•	Tpwr > 100°C	**Er69**	•	•
---		**---**		Internal Fault	**Er03**		•
---		**---**		Max Transient Current dc	**Er06**		•
---		**---**		Max Steady State Current dc	**Er07**	•	•

Table 2.6 Alarms & Errors

Additionally, the ALARM relay is activated when the dc source voltage lays below **1.66 Volt/cell** for a duration of more than **5 sec**, or when Hydra fails to start the external generator **(FAIL),** as explained in the relevant section.

Monitoring and Display during grid-connected mode.

During grid connection, the user has the option to monitor in a successive and cyclic way, by pressing momentarily the **MENU** push button, the data of the following table. For some data we may visualize additional information by pushing momentarily the Enter button:

pushing **MENU** button	**Primary displayed data**	pushing **ENTER** button	**Secondary displayed data**	**pushing steadily ENTER**
0	**Display off** Reduction by 100 mA of the current consumption of *Hydra*	—	—	—
1	Mean value of the battery charging current **(-)**, or of the current drawn from the dc source **(+)**	Change to ↔	Charging power (-), drawn power (+), in % of the nominal Pdc.	—
2	Selected charging current - Iset in A	—	—	—
3	Voltage in **Volt dc** of the dc source connected to Hydra (**Vbatt)**.	—	—	—
4	Temperature Ttrf of the power transformer **(ºC)**.	—	—	—
5	Effective value in Volt rms of the input voltage provided by the external ac source (**Vline**).	Change to ↔	Frequency of the input voltage **(Vline)**.	—
6	Effective value in A of the ac current at the node connecting to the external grid. (Iacgrid). (+) Energy to the grid. (-) Energy from the grid.	—	Real value in KWatt Of the power Pline through the node (+) Energy to the grid. (-) Energy from the grid.	—

7	Last detected **Alarm** code. Valid actually in the system if blinking.	—	—	—
8	Last detected **Error** code. Valid actually in the system if blinking.	—	—	—
9	'**±Enr**' (+) Energy to the ac grid (-)Energy from the ac grid	Change to ↔	Real value of the exchanged energy in KWHours.	Reset counter
10	**'I–Ah'** Consumed Ah counter	Change to ↔	Energy in **Ahours** drawn from the dc source.	Reset counter
11	**'C–Ah'** Stored Ah counter	Change to ↔	Energy stored in the battery from the external ac grid, in **Ahours**,	Reset counter
12	'So--' bridge inactive 'SoC1' or 'SoC2' Charging 'SoP1' or 'SoP2 or 'SoP3' Selling	Alternate selection	Display to select and manually start or stop the various operational modes	Execution
13	**'Ch–S' Standard** charging or **'Ch–E' Equalizing** charging	Alternate selection	New selected option	—
14	**'bu–1'** Buzzer On or **'bu–0'** Buzzer Off	Alternate selection	New selected option	—
15	**'dL–S' Standard** messages or **'dL–E' Extended** messages	Alternate selection	New selected option	—

Table 2.3 Standard displayed messages

Pushing **MENU** button	**Primary displayed data**	Pushing **ENTER** button	**Secondary displayed data**	**Pushing steadily ENTER**
16	Temperature Ttrf of the power transformer **(°C)**.	—	—	—
17	Temperature Tpwr of the power module **(°C)**.	—	—	—
18	External temperature, used to sense the battery temperature for charging compensation **Text (°C)**.	—	—	—
19	Manual control of the external power source **EP - I** or **EP - 0**	Alternate selection	New selected option	Execution
20	Effective value in A rms of the load current (**IacLoad**).	—	—	—
21	Time of the day in **hh.mm** To adjust time, first press steadily Enter, and then…	Select new value	Current value of the selected field (Hours or minutes)	Selection of the field to modify and final validation

22	cd--	—	—	—
23	Enter the user parameter programming mode **'UPro'**	—	—	Execution
24	Enter the factory parameter programming mode **'FPro'**	Select access code	Current value of the access code	Validation of the selected code to enter in the programming mode
25	**Version** of the software	—	—	—

Table 2.8: Extended display messages

The Alarm or Error indication is blinking to identify an actually happening event, is stable when showing the last memorized event and is blank (--) when no event was detected since the last main switch starting of the system.

The temperature of the transformer Ttrf or of the power Tpwr, are blinking if the corresponding parameter has exceeded the normal threshold value (alarm) to facilitate the user in the recognition of the alarm source.

The display of the selected charge current Iset is blinking if for security reasons ***HYDRA*** automatically limited the actual charging current **(Derated Charging).**

This limitation is activated when one of the Ttrf or Tpwr temperatures enters the first alarm stage, or if the total incoming current from the power grid **Iacgrid** (load current + charging current) exceeds **160%** of the nominal one.

The above limitation is necessary to securely support the local load as well as to protect ***HYDRA,*** especially when operating in extreme ambient and low grid quality conditions.

3. Programming mode.

HYDRA series products have internal non-volatile EEPROM memory to store all the operating parameters. There are two sets of parameters, **factory** and **user** programmable.

The programming mode allows the user to adapt ***HYDRA*** at his own environment, providing very advanced operational flexibility and product adaptability to practical all (un)expected conditions.

For each programmable operational parameter there is a default, factory preset value, which fully satisfies most of the common installations.

During programming ***HYDRA*** stops any other activity, including the service of the auxiliary contacts, except of the control of the internal cooling system.

The programming of the parameters is done using the multi message display and the two push buttons of the front panel, by observing the following steps:

1. By pressing the **MENU** push button we select the **'UPro'** message for the user programmable parameters or the **'FPro'** message for the factory ones**.**
2. **'UPro':** By pressing steadily the **ENTER** push button we enter the programming mode. **All other Hydra functions are interrupted during this mode**. We may alternatively enter the programming mode by pressing momentarily both MENU and ENTER push buttons shortly after an activation of the main ON/OFF switch.
3. Alternatively for **factory** parameters **'FPro':** By pressing shortly the **ENTER** push button the current value of the access code is cyclically incremented and displayed. Once the correct access code is selected, then by pressing steadily the **ENTER** push button we enter the programming mode
4. By successively pressing the **MENU** button, we may display in a circular way all the programmable parameters, starting from parameter '**Pr00' (FP00)** followed by **'Pr01' (FP01)** and so on.
5. After displaying the desired parameter, we may monitor its current value by momentarily pressing the **ENTER** button.
6. By successively pressing the **ENTER,** button we may change its value within the allowed limits **(MIN, MAX)** as described in **table 3.1 and 3.2.**
7. When the desired value is reached, a steady push of the **ENTER** button memorizes the new selected value. The successful programming is acknowledged by a short audible signal and by a short blinking of the display. To skip to the next parameter we may press the MENU button at any time.
8. By repeating steps 4 to 7 we may program all the available parameters.
9. To exit the programming mode a restart of ***HYDRA*** using the main **ON/OFF** switch is necessary. ***HYDRA*** restarts using the new parameter set.

By displaying the **'dEFL'** message, last choice in the Programmable parameters, and selecting it through a steady press of the **ENTER** button, the user may regain and memorize the default factory preset values for all the parameters of Hydra.

	Parameter name	Parameter description	Min value	Factory preset value (default)	Max value
Pr00	InverterSetVoltage	Selection of the output voltage	220Vac	230Vac	230Vac
Pr01	AcceptDExtFreqFrom50Hz	Selection of the maximum allowed frequency deviation from 50Hz. Selection step 0.1Hz	2 (0.2Hz)	40 (4.0Hz)	40 (4.0Hz)
Pr02	Vline1HighLevel	Max acceptable voltage of the external power source Reject Voltage value is +10 Volt from it	233Vrms	245Vrms	250Vrms
Pr03	Vline1LowLevel	Min acceptable voltage of the external power source Reject Voltage value is -10 Volt from it	190Vrms	206Vrms	210Vrms
Pr04	-	-	-	-	-
Pr05	-	-	-	-	-
Pr06	-	-	-	-	-
Pr07	Restart_WaitTime	Time to wait before trying to restart	1min	2min	30min
Pr08	VPset	Equilibrium set Voltage of the dc power source while selling energy to the grid (SOP2).	1.8V/cell 10.8(12V) 21.6(24V) 43.2(48V) 54(60V)	2.66V/cell 15.96(12V) 31.92(24V) 63.84(48V) 79.8(60V)	3.3V/cell 19.8(12V) 39.6(24V) 79.2(48V) 99(60V)
Pr09	VPrStartLevel	Voltage threshold of the dc power source above which energy selling to the grid is automatically initiated.	2V/cell 12(12V) 24(24V) 48(48V) 60(60V)	2.72V/cell 16.32(12V) 32.64(24V) 65.28(48V) 81.6(60V)	3.4V/cell 20.4(12V) 40.8(24V) 81.6(48V) 102(60V)
Pr10	VPrStopLevel	Voltage threshold of the dc power source below which energy selling to the grid is automatically stopped.	1.75V/cell 10.5(12V) 21(24V) 42(48V) 52.5(60V)	2.1V/cell 12.6(12V) 25.2(24V) 50.4(48V) 63(60V)	3.2V/cell 19.2(12V) 38.4(24V) 76.8(48V) 96(60V)
Pr11	-	-	-	-	-
Pr12	VhighLimit	Voltage limit to switch to SOC2 (Standard Mode)	2.1V/cell 12.6(12V) 25.2(24V) 50.4(48V) 63(60V)	2.5V/cell 15(12V) 30(24V) 60(48V) 75(60V)	2.6V/cell 15.6(12V) 31.2(24V) 62.4(48V) 78(60V)
Pr13	VupperLimit	Voltage limit to switch to SOC2 (Equalize Mode)	2.2V/cell 13.2(12V) 26.4(24V) 52.8(48V) 66(60V)	2.6V/cell 15.6(12V) 31.2(24V) 62.4(48V) 78(60V)	2.7V/cell 16.2(12V) 32.4(24V) 64.8(48V) 81(60V)
Pr14	SOC2SMaxTime	Max allowed time of the SOC2 stage when in Standard Mode	0.1Hours	5.0Hours	20.0Hours
Pr15	SOC2EMaxTime	Max allowed time of the SOC2 stage when in Equalize Mode	0.1Hours	5.0Hours	20.0Hours
Pr16	VChStartLevel	Low voltage threshold below which charging of the batteries starts automatically, if non zero charging current is selected from the front panel potentiometer	1.7V/cell 10.2(12V) 20.4(24V) 40.8(48V) 51(60V)	2.0V/cell 12(12V) 24(24V) 48(48V) 60(60V)	2.4V/cell 14.4(12V) 28.8(24V) 57.6(48V) 72(60V)
Pr17	MaxDVPsetForMPPTracking	Maximum allowed voltage deviation (+-) from the set point (Pr08) of the dc source, while selling energy at stage (SOP2), and searching the maximum point of operation. **(MPP)**	0.1V/cell 0.6(12V) 1.2(24V) 2.4(48V) 3(60V)	0.3V/cell 1.8(12V) 3.6(24V) 7.2(48V) 9(60V)	0.5V/cell 3(12V) 6(24V) 12(48V) 15(60V)
Pr18	-	-	-	-	-
Pr19	-	-	-	-	-
Pr20	SGProfile	Selection of the external power generator remote control profile (0,1,2,3).	0	1	3
Pr21	EnableSGOnlyManual	Selection of **only** manual control of the external power generator **(1)** or also automatically by the Inverter **(0).**	-	0	-

Pr22	StartGen_VbattLimit	Low limit of the battery voltage below which the external power generator will automatically start (if allowed by **Pr21 = 0**).	1.66V/cell 10(12V) 19.9(24V) 39.8(48V) 49.8(60V)	1.73V/cell 10.38(12V) 20.76(24V) 41.52(48V) 51.9(60V)	2.16V/cell 12.96(12V) 25.92(24V) 51.84(48V) 64.8(60V)
Pr23	StartGen_MaxRetry	Maximum starting retries of the external power generator	1	5	10
Pr24	DisableOil_WaitTime	Time duration of the relay activation which stops the external power generator using a fuel choke (valid when profile **Pr20 = 1**).	10sec	90sec	180sec
Pr25	VbattStopR_Alevel	Max battery voltage beyond which the stop relay will be activated (valid when profile **Pr20 = 0**). **Solar charger control function - on**	2.42V/cell 14.52(12V) 29.04(24V) 58.08(48V) 72.6(60V)	2.58V/cell 15.48(12V) 30.96(24V) 61.92(48V) 77.4(60V)	2.75V/cell 16.5(12V) 33(24V) 66(48V) 82.5(60V)
Pr26	DVbattStopR_InALevel	Negative voltage hysterisis below the value of the **Pr25** parameter, below which the Stop Relay will be de-activated (Valid when profile **Pr20 = 0**). **Solar charger control function - off**	50mV/cell 0.3(12V) 0.6(24V) 1.2(48V) 1.5(60V)	90mV/cell 0.54(12V) 1.08(24V) 2.16(48V) 2.7(60V)	170mV/cell 1.02(12V) 2.04(24V) 4.08(48V) 5.1(60V)
Pr27	DtimeStopRelay	Min allowed time between activation and de-activation of the Stop Relay (valid when profile **Pr20 = 0**).	2sec	10sec	60sec
Pr28	VbattStartR_Alevel	Low voltage limit of the battery below which the Start Relay will be activated (Valid when profile **Pr20 = 0**).	1.66V/cell 10(12V) 19.9(24V) 39.8(48V) 49.8(60V	1.83V/cell 11(12V) 22(24V) 43.9(48V) 54.9(60V)	2V/cell 12(12V) 24(24V) 48(48V) 60(60V)
Pr29	DVbattStartR_InALevel	Positive voltage hysterisis above the value of the **Pr28** parameter, above which the Start Relay will be de-activated (Valid when profile **Pr20 = 0**).	50mV/cell 0.3(12V) 0.6(24V) 1.2(48V) 1.5(60V)	90mV/cell 0.54(12V) 1.08(24V) 2.16(48V) 2.7(60V)	170mV/cell 1.02(12V) 2.04(24V) 4.08(48V) 5.1(60V)
Pr30	DtimeStartRelay	Min allowed time between activation and de-activation of the Start Relay (valid when profile **Pr20 = 0**).	2sec	10sec	60sec
Pr31	EnableGenMaxTime	Selection **(1)** or not **(0)** of a limited time operation of the external power generator		0	
Pr32	GenMaxTime	Max allowed operation time of the external power generator. (Valid when Pr31 **= 1**).	0.1Hours	10Hours	25Hours
Pr33	Enable Gen start with timer	Enable the external generator according to the time of the day (0 or 1)		0	
Pr34	Start Gen time	The exact time to start the Gen (hh:mm) (Valid when Pr31 **= 1**).	00:00	8:00	23:00

Table 3.1

Remark: If the limits of automatic starting the charging of the batteries and stopping of energy exporting are intermixed, then selling of energy has priorority in its execution.

	Parameter name	Parameter description	Min value	Factory preset value (default)	Max value
FP00	VdcRange	Selection of the nominal dc voltage of the system 0=12Volt, 1=24Volt, 2=48Volt, 3=60Volt 4=108Volt, 5=144Volt, 6=192Volt, 7=240Volt 8=360Volt , 9=396Volt	-	-	-
FP01	IdcRange	Selection of the working current of the system 0=6A, 1=10A, 2=16A, 3=20A, 4=26A 5=30A, 6=40A, 7=50A, 8=60A, 9=70A 10=86A, 11=100A, 12=120A, 13=150A	-	-	-
FP02	PrSystemConfig	Selection of the grid connected mode 0=Charger/Selling 1=only Selling 2=only MPP Selling	-	-	-

		3= only Charger			
FP03	GeneralInitDelay	Initialization delay	50periods (1sec)	250periods (5sec)	250periods (5sec)
FP04	MaxVFaultCounter	Duration of continuous output low voltage before Er01 is validated	2 (0.6msec)	5 (1.5msec)	35 (10.5msec)
FP05	InverterZeroDuty	Modulation factor at the Inverter inialization.	7.8%	17.6%	35%
FP06	VFaultVoutLevel	Threshold of low ac output voltage (Er01)	50Volt	100Volt	150Volt
FP07	IacRange	Selection of the nominal ac grid current and of the nominal load of the system. 0=4A, 1=7A, 2=10A, 3=14A, 4=16.5A 5=22A, 6=25A, 7=30A, 8=37.5A, 9=45.5A	-	-	-
FP08	LowIacgridRMSLevel	Threshold of the RMS grid current to start the active search of the external grid.	0 (0% of nominal)	8 (6.66% of nominal)	40 (33% of nominal)
FP09	LowIacgridLevel	Threshold of the instantaneous value of the grid current to reject the external grid.	0 (0% of nominal)	6 (5% of nominal)	20 (16.66% of nominal)
FP10	TransientIdcMaxSamples	Duration of continuous over-current before Er06 is validated.	2 (0.3msec)	33 (5.15msec)	60 (9.3msec)
FP11	StrongPowerBridge	Power module transient tolerance 0= weak, 1=strong		-	
FP12	MaxFaultPinCounter	Duration of continuous absolute maximum over-current before Er03 is validated.	2 (0.3msec)	3 (0.45msec)	10 (1.5msec)
FP13	-	-	-	-	-
FP14	-	-	-	-	-

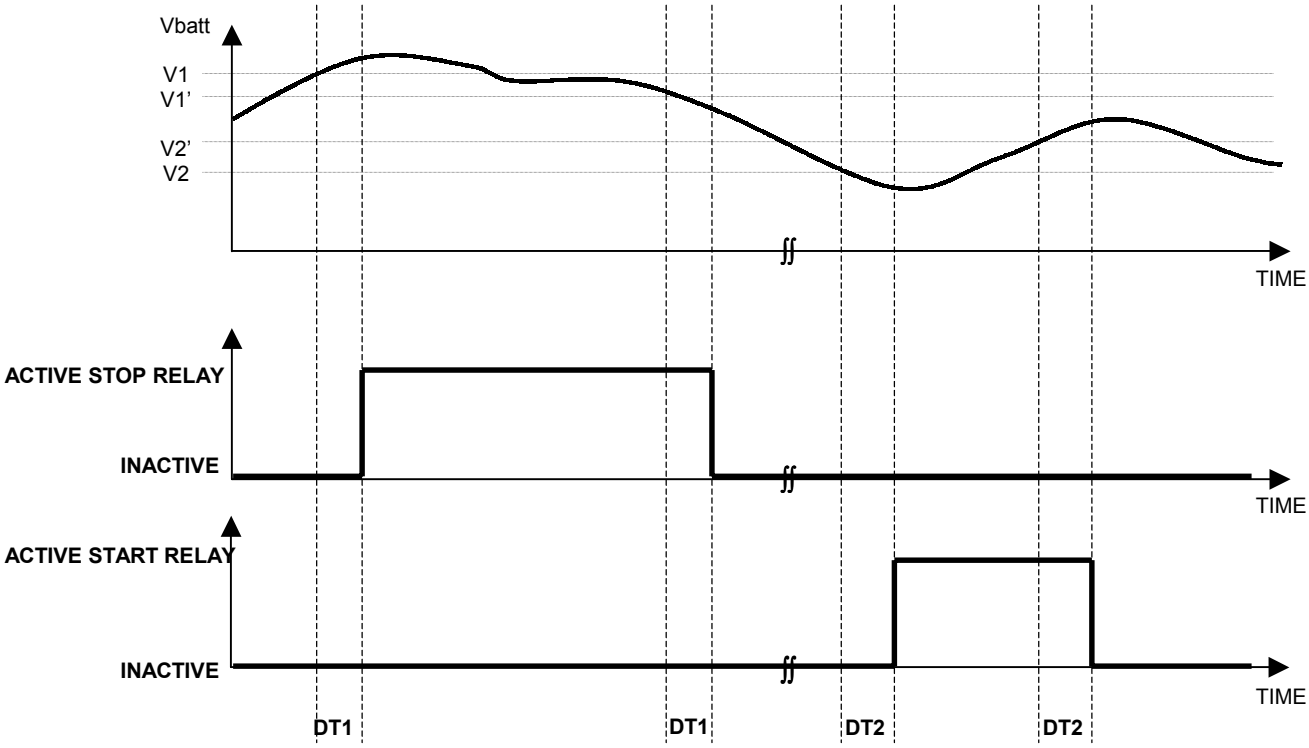
Table 3.2: Factory parameters

4. Auxiliary functions.

There are four independent, programmable function profiles of the auxiliary START and STOP relays. The selection is done using the parameter **Pr20.**

4.1. Charge controller function. Profile 0, parameter Pr20=0:

The system activates the **START, STOP** relays according to the battery voltage. The stop relay is used to implement the solar (or wind generator) charger control function, and the start relay to interface to existing automated diesel power generator controls, or to implement other automation functions. The system activates the relays while either in Inverter or Charger Mode.



The battery voltage limits **(V1, V1')** and **(V2, V2')** as well as the time delays **DT1** and **DT2** are user programmable.
The upper limit **(V1),** above which the **Stop Relay** is activated, is determined by parameter **25 (Pr25).** The low limit **(V1')** (below which the Stop **Relay** will be de-activated), is derived by subtracting the value **V1 (Pr25)** from the programmable parameter **DV1 (Pr26).** That is: **V1' = V1 – DV1.** The time delay to flip the Stop relay after a crossing of any limit, **DT1,** is also programmable, determined by the parameter **(Pr27).**

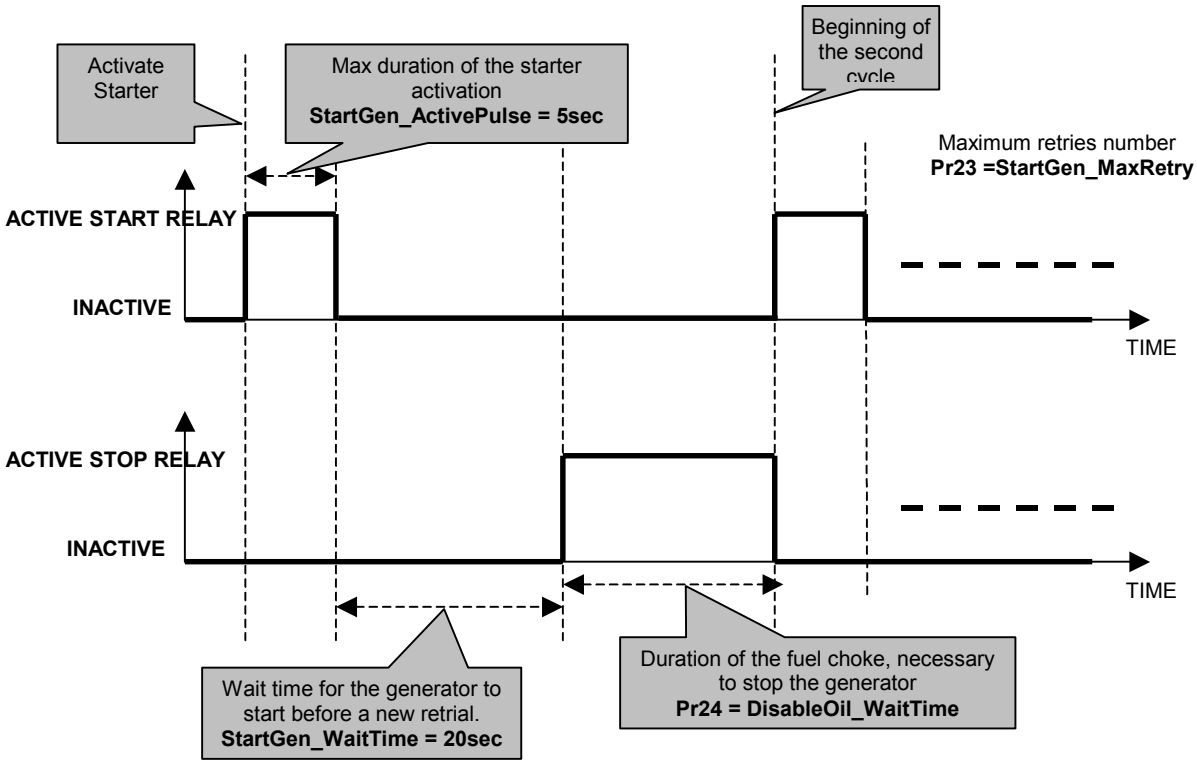
The low battery voltage limit **(V2),** below which the **Start Relay** will be activated**,** is determined by parameter **28 (Pr28).** The upper limit **(V2'),** beyond which the **Start Relay** will be de-activated, is derived by adding the value **V2** of the parameter **(Pr28)** to the value of the programmable parameter **DV2 (Pr29).** That is: **V2' = V2 + DV2.**

The time delay to flip the Start relay after a crossing of any limit, **DT2,** is programmable, determined by the parameter **(Pr30).**

4.2. **Diesel generator control - Profile 1. Profile 1, parameter Pr20=1:**

The **START** relay is used to activate the starter of the external power generator. The **STOP** relay is used to stop the generator by choking the fuel.

START GENERATOR PROCEDURE DESCRIPTION



The generator starting procedure is initiated automatically or manually, only when the system is in **Inverter** mode**.**

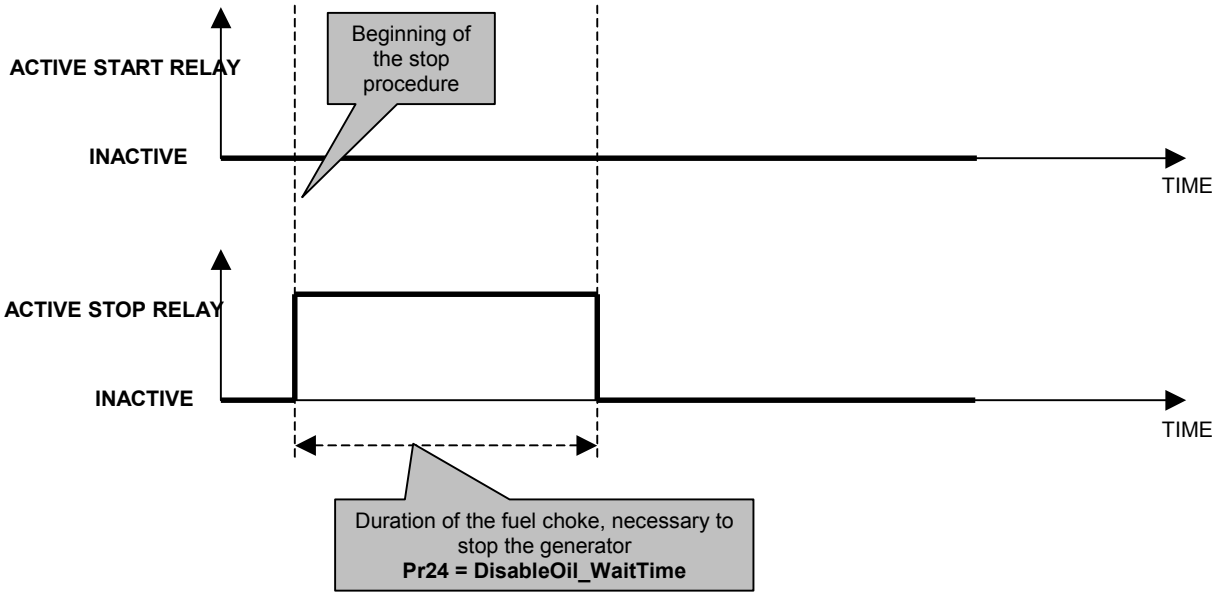
To manually start the generator, we select the **'EP-0'** message, found in the **Extended Display** selections. The zero data indicates that no acceptable external ac source (**E**xternal **P**ower) is actually connected to the system. A one data value is set when the external power source is actually working and its voltage characteristics are acceptable. We start the generator by pressing momentarily the ENTER button. The data value is set to 1, **'EP-1',** and the number one is blinking until the generator has properly started.

The generator starts automatically, if this profile is selected, when the battery voltage lyies below the programmed limit **StartGen_VbattLimit (Pr22)** for more than 10 consecutive seconds.

In both cases, the microcontroller performs a pre-programmed number of retries, until the generator starts. If the generator fails to start, this is signaled by

activating the alarm relay and by setting X, (**'FAIL')** in the data field of the external power **'EP-X'**.

STOP GENERATOR PROCEDURE DESCRIPTION



The stop generator procedure is manually or automatically initiated, only if the system is in **Charger Mode.**

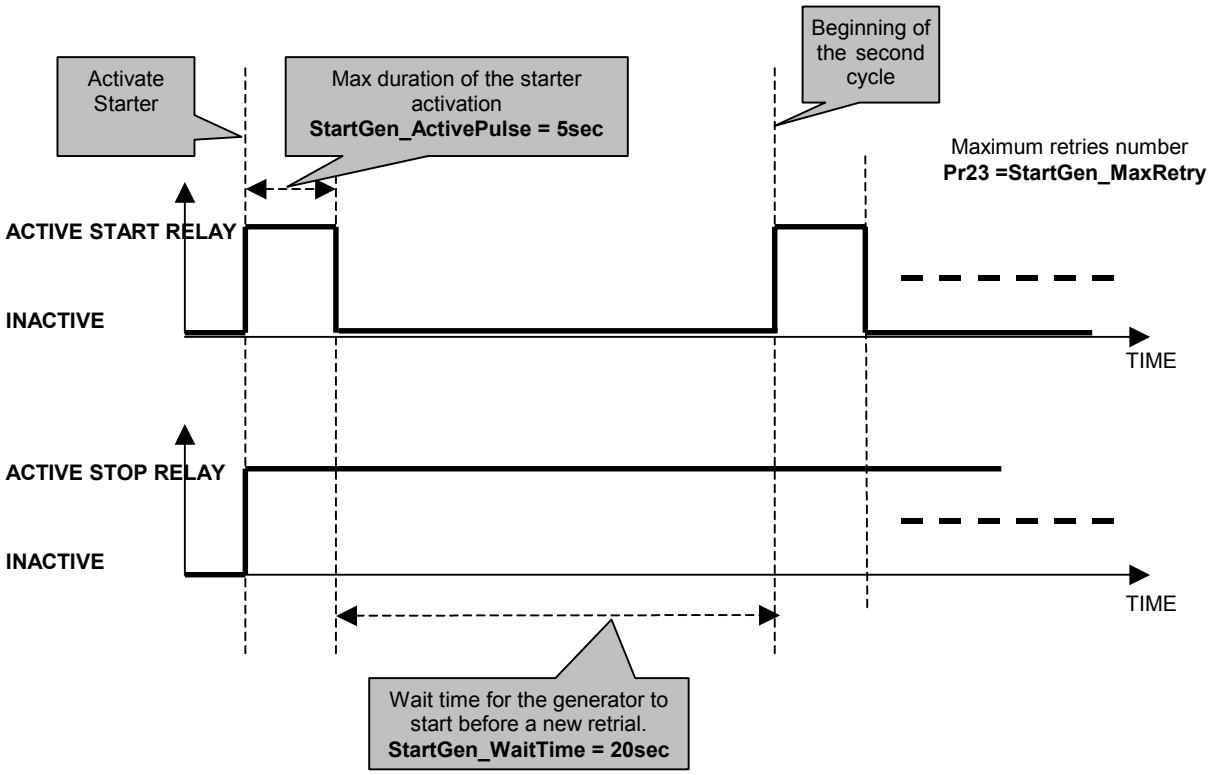
To manually stop the generator, we select the **'EP-1'** message, found in the **Extended Display** selections. The one data value is set when the external power source is actually working and its voltage characteristics are acceptable. We stop the generator by pressing momentarily the ENTER button. The data value is set to 0, **'EP-0',** and the zero is blinking until the generator stops.

The generator stops automatically, when this profile is selected, when the battery finishes the **SoC2** charging stage**.** If the generator fails to stop, then there will be continuous repetitions of the above stop procedure, with a delay of approximately 1 sec between them.

4.3. Diesel generator control – Profile 2. **Profile 2, Parameter Pr20=2:**

The **START** relay is used to activate the starter of the external power generator. The **STOP** relay is used to activate the electrical system of the generator

START GENERATOR PROCEDURE DESCRIPTION



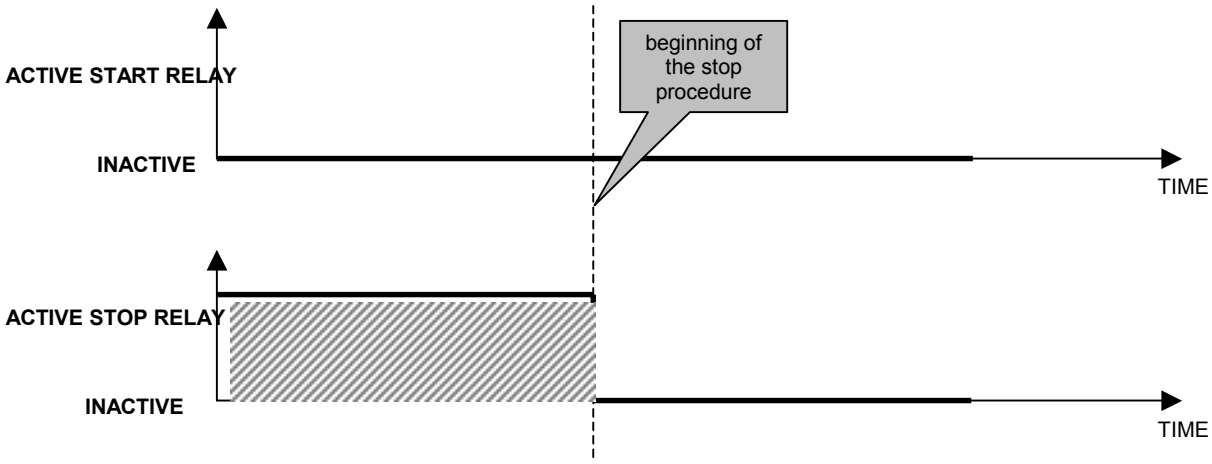
The generator starting procedure is initiated automatically or manually, only when the system is in **Inverter** mode**.**

To manually start the generator, we select the **'EP-0'** message, found in the **Extended Display** selections. The zero data indicates that no acceptable external ac source (**E**xternal **P**ower) is actually connected to the system. A one data value is set when the external power source is actually working and its voltage characteristics are acceptable. We start the generator by pressing momentarily the ENTER button. The data value is set to 1, **'EP-1',** and the number one is blinking until the generator has properly started.

The generator starts automatically, if this profile is selected, when the battery voltage lays below the programmed limit **StartGen_VbattLimit (Pr22)** for more than 10 consecutive seconds.

In both cases, the microcontroller performs a pre-programmed number of retries, until the generator starts. If the generator fails to start, this is signaled by activating the alarm relay and by setting X, **('FAIL')** in the data field of the external power **'EP-X'**. Also, both start and stop relays remain inactive.

STOP GENERATOR PROCEDURE DESCRIPTION



The stop generator procedure is manually or automatically initiated, only if the system is in **Charger Mode.**

To manually stop the generator, we select the **'EP-1'** message, found in the **Extended Display** selections. The one data value is set when the external power source is actually working and its voltage characteristics are acceptable. We stop the generator by pressing momentarily the ENTER button. The data value is set to 0, **'EP-0',** and the zero is blinking until the generator stops.

The generator stops automatically when the battery finishes the **SoC2** charging stage.

4.4. Diesel generator control – Profile 3. Profile 3, Parameter Pr20=3:

START GENERATOR PROCEDURE DESCRIPTION

The **START RELAY** is activated for **30 sec**.

The generator starting procedure is initiated automatically or manually, only when the system is in **Inverter** mode**.**

To manually start the generator, we select the **'EP-0'** message, found in the **Extended Display** selections. The zero data indicates that no acceptable external ac source (**E**xternal **P**ower) is actually connected to the system. A one data value is set when the external power source is actually working and its voltage characteristics are acceptable. We start the generator by pressing momentarily the ENTER button. The data value is set to 1, **'EP-1',** and the number one is blinking until the generator has properly started.

The generator starts automatically when the battery voltage lays below the programmed limit **StartGen_VbattLimit (Pr22)** for more than 10 consecutive seconds.
In the manual start, the system makes only one retry. In automatic start, the system will perform consecutive retries if the battery voltage lays below the limit set by parameter **Pr22.**

STOP GENERATOR PROCEDURE DESCRIPTION

The **STOP RELAY** is activated for **30 sec**.

The stop generator procedure is manually or automatically initiated, only if the system is in **Charger Mode.**

To manually stop the generator, we select the **'EP-1'** message, found in the **Extended Display** selections. The one data value is set when the external power source is actually working and its voltage characteristics are acceptable. We stop the generator by pressing momentarily the ENTER button. The data value is set to 0, **'EP-0',** and the zero is blinking until the generator stops.

The generator stops automatically when the battery finishes the **SoC2** charging stage**.** If the generator fails to stop, then there will be continuous repetitions of the above stop procedure, with a delay of approximately 1 sec between them. In the manual stop the system makes only one retry.