Description Energy 3000

0. Content

VE3PUID digitally programmable (FW: 01.02.xx)

Description Energy 3000

1. Definition ot the Output Data

VE3PUID digitally programmable (FW: 01.02.xx)

EMC + Safety tested

1.1 Deviation at Load Variation (static)

On all regulators applied in practice there is a small change in the regulating variable (voltage, current or power) as a reaction to the change in the load, the so called deviation. In the data sheet it is given as a maximum magnitude of change caused by a load variation between 0% and 100% of the regulated variable.
Measurement is conducted directly on the female connector with sense leads connected at the measuring point.

1.2 Deviation in the Event of a Variation in the Mains (static)

If the mains is varied, the regulating variable will also vary slightly (voltage, current or power).
The data sheets specify the maximum system deviation of the regulating variable caused by a change of the mains between V_{inmin} and V_{inmax} .
Measurements are conducted directly at the device output with sense leads connected at the measuring point.

1.3 Residual Ripple (300Hz)

When rectifying the three-phase 50Hz AC current, a 300Hz superimposition on the DC voltage results. This 300Hz ripple is measurable as a residual ripple on the output voltage.
Measurement is conducted directly on the female connector with sense leads connected.

1.4 Operating Frequency Ripple

The output voltage of primary switched power supplies is characterised by a small superimposed AC voltage component, the operating frequency ripple. See figure 1.
This results from charging and discharging of the secondary energy stores at the switching frequency.
Measurements are conducted directly at the device output with sense leads connected at the measuring point.
The value in the data sheet is the peak to peak value $V_{R\,PP}$ as shown in figure 1.

1.5 Superimposed Switching Spikes

Fast current and voltage variations occur when the power transistors are switched on and off. This results in high-frequency transient impulses superimposed on the output voltage of the power supply. See figure 1.
These switching spikes are poor in energy.
The data sheet values are measured directly on the female connector without sense leads with a bandwidth of 20MHz.
They are peak to peak values V_{SPP} as shown in figure 1.

1.6 Dynamic Voltage Deviation and Regulation Time

Voltage overshoot and undershoot occur in case of abrupt load variations. See figure 2.
Causes of the voltage deviation (ΔV) are the energy stored in the output circuit and the limited speed of the controller.
The regulation time (Δt) is defined as the time until the output voltage returns to remain within a tolerance band after a load variation. The tolerance band is defined as ± 50mV.
The voltage and current characteristics as a function of time are shown in figure 2.
Values are measured directly on the female connector with sense leads connected at the measuring point.

Figure 1
Output voltage

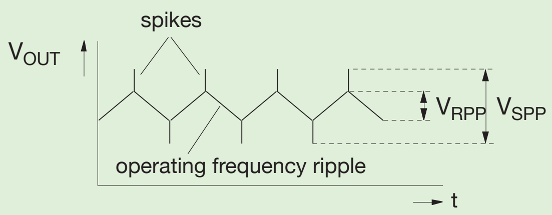
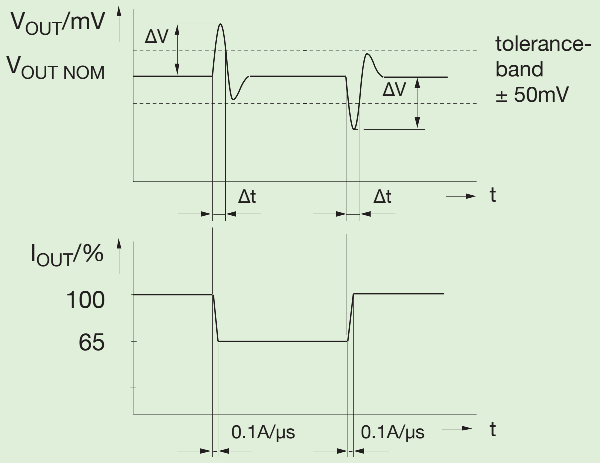


Figure 2
Voltage variation of the output when subject to a defined sudden load variation



2. Applications

VE3PUID digitally programmable (FW: 01.02.xx)

2.1 Preface

The sections below explain the characteristics of the **energy 3000 digital** device family.
They provide the user with the required information for correct installation and cabling and for both placing into operation and actual operation of the power supply

> Please read the section on electrical safety before placing into operation and operating the unit!
>
> ⚠

2.2 Electrical Safety

Protection against electric shock from the housing in the event of fault is ensured only if the PE wire in the **device input connector X1** has perfect electrical contact.
(Device of safety class 1)
This also includes adequate conductor cross-section and correct screwed connection (see pin assignment).

Professional crimping and adequate conductor cross-section are required when wiring the **output lead** in **connector X2** in order to prevent the risk of overheating and fire (see pin assignment).

If the **output is shorted**, very high currents will flow when the output capacitor is discharging until the current limitation function cuts in. The resultant arc at the shorting point may lead to splashes of hot molten metal.

The **energy 3000 digital** device family provides a voltage that is **electrically isolated** from the mains at its output terminals.
On devices whose output voltage can be set to above 60Vdc, the user must ensure that the output terminals, load terminals and the measuring set-up itself cannot be touched!
If the output voltage is earthed, the PE terminal of output connector X2 must be used to earth the device.
The output circuit will not be discharged until up to 12 seconds in unloaded condition even after switching off the mains power supply or switching over to standby mode.
Please ensure that the unit is not disconnected electrically from the mains with the switch set to position **"standby"**. The full mains voltage will still be applied in the device. The standby switch simply disconnects power transfer from the mains to the output end.
If the user wishes to disconnect the unit electrically from the mains, he or she must provide an interrupter upstream of the device input.
If the output voltage is connected to a different, earthed voltage, the maximum value of 300 V DC at the output terminals with respect to earth may not be exceeded.

2.3 Installation and Cabling

When installing the power supply, ensure that the lateral air inlet openings are not closed off. This also applies to the air outlet on the rear side of the device.
The air flow rate per air inlet is approx. 0.7 m3/min.

Please follow the instructions on electrical safety when wiring mains terminal X1 and DC output terminal X2. See also chapter pin assignment.

> The power supply unit does not feature a power switch and is consequently immediately electrically live internally as soon as voltage is applied to the mains input connector.
> The connections on the device (mains input, load output and interface) may be connected and disconnected only after disconnection from the electrical power supply.
> The plug-in contacts could otherwise be damaged or destroyed.
>
> ⚠

2.4 Scope of Delivery

The scope of delivery includes a 15-pin D-Sub connector (HD) with integrated jumpers.
The mains cable socket, the load connector and further D-Sub connectors for individual assignment of the interface are available as accessories.
(See ordering information data sheet.)

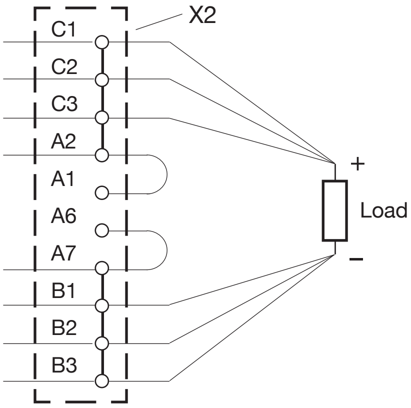
2. Applications

VE3PUID digitally programmable (FW: 01.02.xx)

EMC + Safety tested

2.5 Operation without Sense Lead

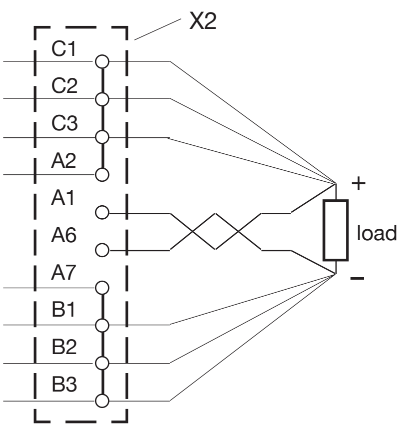
Two jumpers must be connected in the output device connector X2 (accessory) in bay A, one from contact A1 to contact A2 and one from contact A6 to contact A7, for operation without sense leads.



2.6 Operation with Sense Lead

Terminal A1 must be connected to the positive terminal of the load and terminal A6 must be connected to the negative terminal of the load in order to correct voltage drops on the load lines.
The sense leads to the load should be tightly twisted in order to ensure trouble-free operation.
Terminals A2 and A7 may not be connected to the load (see operation without sense lead).

The load lines may not be disconnected before the sense leads, or the sense leads may not be connected before the load lines, as this will lead to the destruction of the device.



2.7 Setting, Indicators and Operation

In the condition as delivered, a D-Sub connector is enclosed with the device, allowing you to place the device into operation without customer signal connector.
If the D-Sub connector is disconnected, this deactivates the device.
The pins in the user connector must be assigned in accordance with the interface description and the safety instructions.
Before connecting the mains voltage, set the slide switch on the front to position "standby", or disconnect the current from the Enable optocoupler.
The three-phase power can now be connected by the user.
The power supply will be in Standby mode and is ready to be enabled after a brief ramp-up time.
The device operates as set if the slide switch on the front side is set to position "on", if the voltage is applied to the Enable optocoupler and if the output is digitally enabled.
The output must also be enabled in Remote mode.

> Please note that the device is not disconnected electrically from the mains with the switch set to position "standby". The full mains voltage will still be applied in the device.
> The Standby switch and the Enable optocoupler simply disconnect power transfer from the mains circuit to the output end.

If the actual value at the device output reaches the preset setpoint, the controller cuts in and maintains the electrical variable in question constant.
Control mode is indicated by LEDs on the front panel.
If LED (CC) for instance lights, this signals that the device is in Current Control mode.

One of the three controller LEDs (CV = control voltage, CP = control power, CC = control current) lights and the device-internal fan operates in normal mode.
If the operating point shifts as the result of a load impedance change, this may result in a change to the control mode.
Several control indicators may light in the transitional phase.

2.8 Switch-off

There are several ways to deactivate the output:
- by cutting the power transfer from the mains circuit to the output using the slide switch on the front panel,
- by disconnecting the current from the Enable optocoupler
  or by deactivating digital Enable.

The user must provide an interrupter upstream of the mains input for electrical disconnection from the power supply mains.

2.9 Load-Share (LS)

A Load-Share function ensures active load sharing if power supply units are connected in parallel (or redundantly).
The Load-Share function is active only in Voltage Control mode.
The output current of all power supply units connected in parallel (or redundantly) is balanced at each load point with an accuracy of 10% of the maximum output current. The LS terminals of the power supply units connected in parallel (or redundantly) must be interconnected for this purpose.
Since these leads intervene directly in the closed-loop control circuit, it must be ensured that the design is EMC-compatible.
We recommend a twisted or screened lead with a cross-section of at least 0.25mm^2 and a maximum length of 5m.
On a screened version, you must test in the system whether single-point or double-point bonding achieves better results.

2.10 Phase Failure

The power supply is able to maintain operation in the event of failure of one mains lead phase if the output power is below 2/3 of the nominal load. The device fuses trip after a few minutes at nominal load.

2.11 Temperature Coefficient

The temperature coefficient indicates how the set output voltage value can change at maximum as a function of ambient temperature.

2.12 Overvoltage Protection (output)

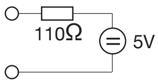
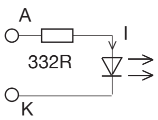
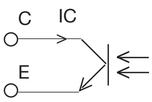
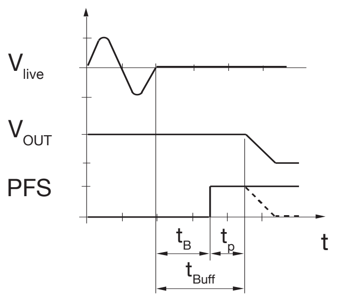
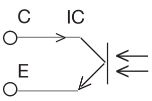
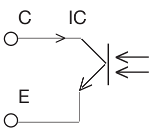
The overvoltage protection (OVP) feature integrated as standard switches off the power supply in latching mode via a second path independent of the control loop.
The output circuit is discharged unless power is injected externally.
The error must be reset with the Enter key or with the "Confirm" command in order to switch back on.

2.13 Discharge Circuit / Current Sink

An incorporated discharge circuit ensures that the output voltage can be quickly reduced by programming even unloaded or with low load. The discharge circuit acts for as long as the actual voltage value is greater than 102 % of the setpoint.
Reverse currents from the load, such as those supplied by motors in braking mode, are also absorbed by the discharge circuit, consequently avoiding excessive increases in output voltage.
The circuit absorbs peak power up to 350W and sustained power loss of 40W. The maximum discharge currents depend on the particular device.

2.14 D-Sub Interface

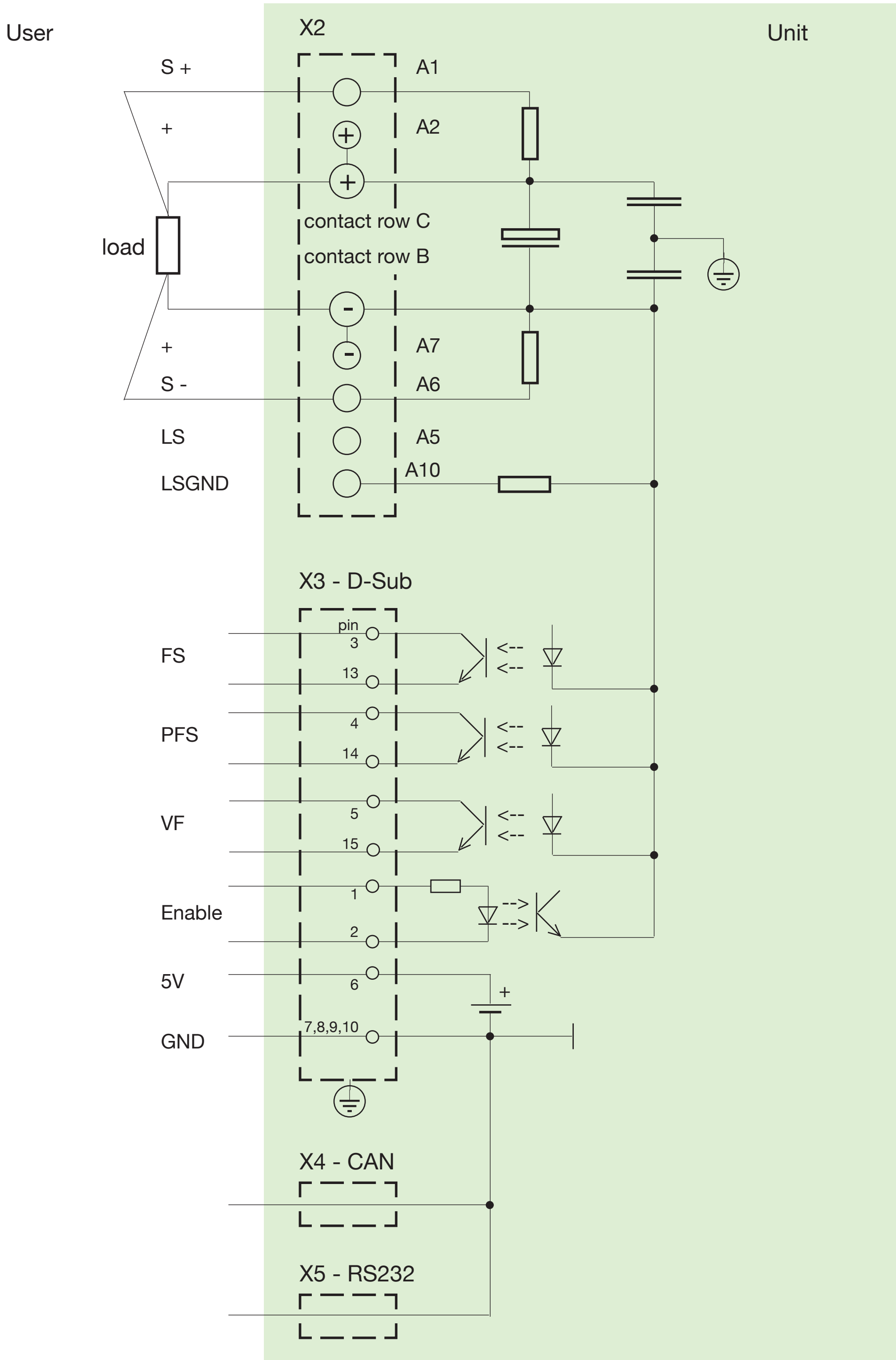
In the condition as delivered, a D-Sub connector is enclosed, containing the required jumpers for switching the device on (1--> 6, 2 --> 7).

signal name	pin number/symbol	explanations
5V **GND**	6  7, 8, 9, 10	The 5 V auxiliary voltage source features an internal resistance of 110 Ω. It can be used to power the Enable optocoupler. The auxiliary supply voltage is electrically isolated from the output voltage.
Enable	1 2 	The optocoupler's terminals are floating terminals. If a current (2mA ≤ I ≤ 10mA) flows, the device is switched "on". If current flow is interrupted, the device is in Standby mode. (V_{AK} = 5V , I_{max} = 10mA)
PFS (Power Fail Signal)	4 14 	The terminals are floating terminals. V_{CEmax} = 50V / I_{Cmax} = 10mA The transistor is reverse-biased in the case of mains failure  (t_B, t_p, t_{Buff} see technical data) ----- = when using the internal auxiliary voltage (pin 6) —— = when using an external voltage
VF (Voltage Fail)	5 15 	The terminals are floating terminals. V_{CEmax} = 50V / I_{Cmax} = 10mA The transistor is reverse-biased if the actual voltage value is more than 5 % below the setpoint. This is possible in current control mode in power limitation or in the event of a fault.
FS (Failure Signal)	3 13 	The terminals are floating terminals. V_{CEmax} = 50V / I_{Cmax} = 10mA The transistor is forward-biased in the event of an error signal. The error signal is activated in the case of DC output overvoltage (OVP) or device overtemperature.

2. Applications

VE3PUID digitally programmable (FW: 01.02.xx)

Figure 3 Output circuit **Energy 3000 digital**



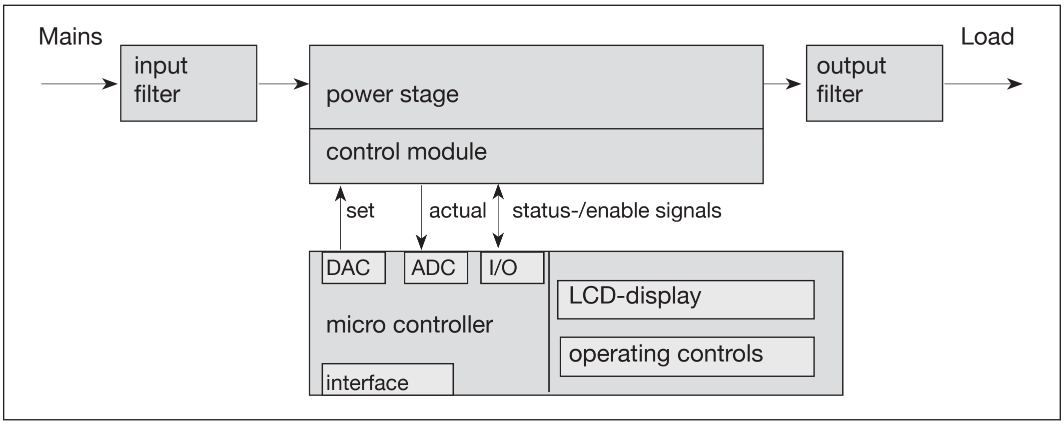
3. Description of Function

VE3PUID digitally programmable (FW: 01.02.xx)

EMC + Safety tested

3.1. Introduction

3.1.1 Mode of Operation



The unit is powered from a three-phase power system without neutral conductor. The internal supply voltage is generated via the input filter. This voltage is used, in turn, to power the output stage. Actual conversion to an electrically isolated output voltage that is supplied to the load terminals via the output filter occurs in this output stage.

The control module assumes the functions of activating the output stage and actual value acquisition. It ensures that the device output stabilises to the required values.

The device is controlled via signal exchange between control module and microcontroller, in conjunction with corresponding signal matching:

Enable signal
The Enable signal is forwarded to the control module to switch on the output.

Status signals
Various status signals such as Overtemperature are transferred from the control module to the microcontroller. They are used to generate corresponding signals on the one hand and to generate the precondition for device Enable on the other.

Setpoints
The setpoints for voltage and current are preset via the Digital-to-Analogue converter (DAC) of the control module according to the settings made. The converters are 12-bit DACs allowing the setpoints to be set in 4096 steps.

Actual values
The monitor signals of the current actual values of the device output (voltage, current and power) are fed in via Analogue-to-Digital converter (ADC) and conditioned for further processing. The resolution of the ADCs is also 12 bit.

The settings on the device are made by the user with the liquid-crystal display (LCD) and the operating controls or via the selected interface. In the reverse direction, the status signals and actual values of the device are provided to the liquid-crystal display (LCD) or interface, allowing them to be evaluated by the user.

3.1.2 Overview of Functions

- Current and Voltage Control with adjustable setpoints (12-bit resolution)
- Permanently set power limitation
- Visualisation of controller status with LEDs (CV, CC, CP)
- Actual value acquisition of voltage, current and power at device output (12-bit resolution)
- Permanently set overvoltage protection (OVP)
- Thermal overload protection (OTP)
- Adjustable setpoint limitation (Limit):
  - for voltage and current separately (VLIM, CLIM)
  - upper and lower limit adjustable separately (LOW, HIGH)
  - behaviour of the value pairs configurable (OFF, LOW ACTIVE, HIGH ACTIVE, BOTH ACTIVE)
  - status flags for all four limit values can be evaluated via the interface
- Adjustable actual value monitoring (protection):
  - for voltage, current and power separately (VPRT, CPRT, PPRT)
  - upper and lower limit separately adjustable (LOW, HIGH)
  - behaviour of the value pairs configurable (OFF, LOW ACTIVE, HIGH ACTIVE, BOTH ACTIVE)
  - separately adjustable delay times* for voltage, current and power faults
  - status flags for all six monitoring values can be evaluated via the interface.
- "LAB" operating mode for simplified setpoint setting in laboratory operation.
- "SEQ" operating mode allowing sequences to be programmed:
  - manual or automatic mode selectable
  - the device status for the end of the sequence can be configured (switched on-off) in automatic mode
  - adjustable number of cycles (0 = infinite ; 1..255)
  - adjustable number of steps per cycle (1..100)
  - memory bank (0...29) and dwell time* (0.01...600.00 s) can be set separately for each step.
- Liquid-crystal display (LCD) (2 x 16 characters) for display of settings and status values
- Lockable operating controls
- Menu prompting for simple configuration directly on the device
- Remote control of the device with electrically isolated digital interfaces (RS232 and CAN)
- Variable transfer rates:
  - RS232: 1200, 2400, 4800, 9600, 19200 Bit/s
  - CAN: 10, 20, 50, 125, 250, 500, 800, 1000 kBit/s
- 30 memory banks for setpoint and limit value settings allow fast change of configuration of device output
- Save/Recall- function for saving and recalling the settings from non-volatile memory
- Easy recall of factory default settings
- Auto re-start after mains activation is configurable
- Temperature-controlled fans
- Integrated discharge circuit for fast reprogramming even under no load
- Electrically isolated hardware signals (FS, PFS, VF and Enable) allow easy interfacing with test stands or automation systems.

⚠ Changes to the device settings must always be made with very great care so as to prevent the device output assuming an unforeseen state and consequently posing a risk as the result of a switch of memory bank for instance.

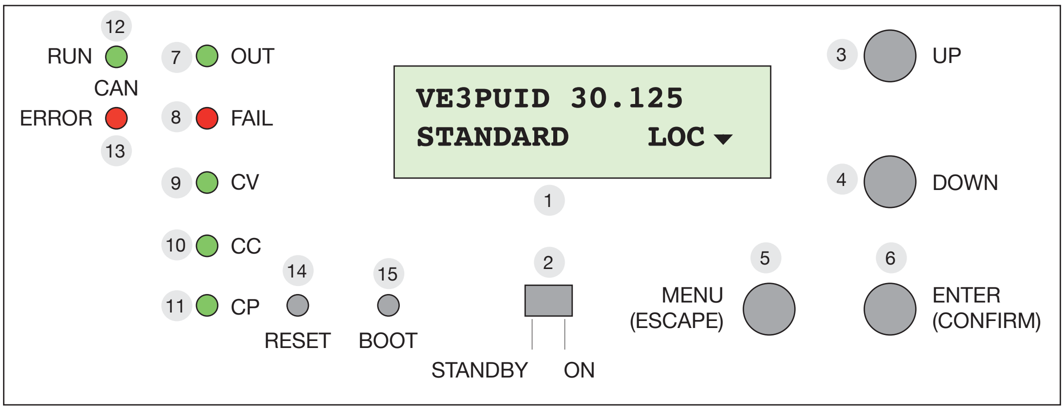
* Programmed times have an accuracy o ±1%.

3. Description of Function

VE3PUID digitally programmable (FW: 01.02.xx)

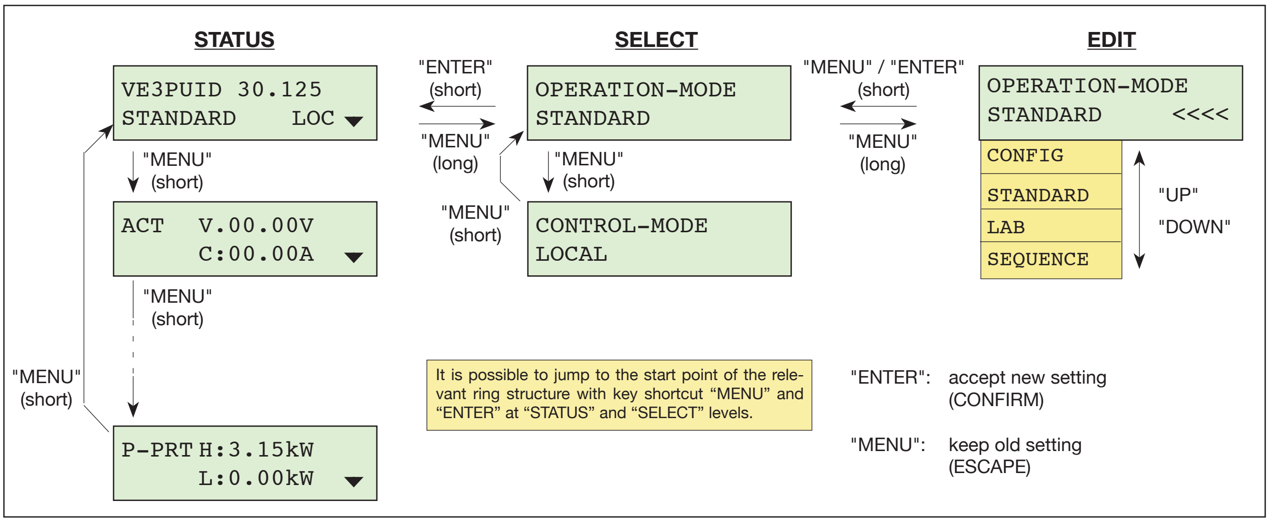
3.2. Operation of the Unit

3.2.1 Front Panel Elements



1	**Display**	The two-line liquid-crystal display (LCD) displays the settings and status values. In the case of menu items with more than two lines, the text can be scrolled down. This is indicated by symbols " ▼ " and " ▲ ".
2	**"STANDBY/ON"**	This slide switch has the function of activating and deactivating the output. It is arranged recessed in the front panel in order to prevent it being operated inadvertently. ⚠ No disconnection from the mains occurs if the output is deactivated.
3 4	**"UP"** **"DOWN"**	These buttons allow you to scroll through multi-line displays. At the EDIT level (see Menu prompting), they are used to edit settings. The value can be incremented or decremented in single steps by pressing the buttons briefly. If the user intends to set extensive value ranges, the buttons can also be pressed for a longer period. The setting is incremented or decremented automatically, whereby the rate of change increases the longer the button is pressed.
5	**"MENU"** **(ESCAPE)**	This button primarily serves the purpose of menu prompting. Pressing the button briefly allows you to select a required menu item within a menu level. If the button is pressed for longer (> 1 second), you switch to the next level. One other function is to prevent values changed at EDIT level (see Menu prompting) from being accepted (ESCAPE function).
6	**"ENTER"** **(CONFIRM)**	This button is also used to change levels within menu prompting. It is also used to accept values changed at EDIT level (see Menu prompting) (ENTER function). Another function is to reset or confirm error signals (CONFIRM).
7	**"OUT"**	This LED indicates the status of the device output, i.e. whether it is activated or deactivated.
8	**"FAIL"**	This LED flashes if an error has occurred.
9 10 11	**"CV"** **"CC"** **"CP"**	These LEDs show the control state. "CV" lights if the voltage controller is active and "CC" lights if the current controller is active. "CP" shows the status of power limitation. It is possible for several LEDs to light simultaneously.
12 13	**"RUN"** **"ERROR"**	These LEDs show the status of the CAN interface in accordance with CANopen Indicator Specification DR303-3.
14 15	**"RESET"** **"BOOT"**	These buttons are assigned to the microcontroller. "RESET" allows you to reset the microcontroller. Note that any settings not yet saved will be lost in this case. "BOOT" is used to update the firmware. Here as well, both buttons are arranged behind the front panel so as to prevent them being operated inadvertently.

3.2.2 Menu Prompting



You can navigate within the menus with buttons "MENU" and "ENTER". The menu structure consists of three levels:

STATUS:

This level consists of displays of the various function groups, starting from the basic display with the device data. These displays are generally multi-line displays and contain the related status values. Briefly pressing "MENU" selects the required function group. You can cycle through the looped array of menu items, i.e. you skip back to the first menu item at the end of the list. If the required function group has been selected, pressing "MENU" for a longer period switches to SELECT level.

Function of the buttons:	"MENU"	- Switch to the next STATUS display (short) - Switch to the SELECT level (long)
	"ENTER"	- No function
	"MENU" & "ENTER"	- Switch to start point of STATUS level
	"UP" / "DOWN"	- Scroll through multi-line displays

SELECT:

The required setting of a function group can be selected at SELECT level. As with STATUS level, you can cycle through the looped array of menu items. Here as well, pressing "MENU" for a brief period selects the required menu item. When this has been done, you can switch to EDIT level by pressing "MENU" for a longer period. The menu items of SELECT level are always two-line items. Consequently, no scrolling is necessary or offered.

Function of the buttons:	"MENU"	- Switch to the next SELECT display (short) - Switch to EDIT level (long)
	"ENTER"	- Switch to STATUS level
	"MENU" & "ENTER"	- Switch to start point of SELECT level
	"UP" / "DOWN"	- No function

EDIT:

You will see "<<<<" to indicate that you are at EDIT level. The setting can now be changed with "UP" and "DOWN". Press "ENTER" to accept the new value. The value is not accepted if you press "MENU" (ESCAPE). In both cases, you switch back to SELECT level. The menu items at EDIT level are also two-line items.

Function of the buttons:	"MENU"	- Do not accept value and switch to SELECT level
	"ENTER"	- Accept value and switch to SELECT level
	"UP" / "DOWN"	- Edit value

3. Description of Function

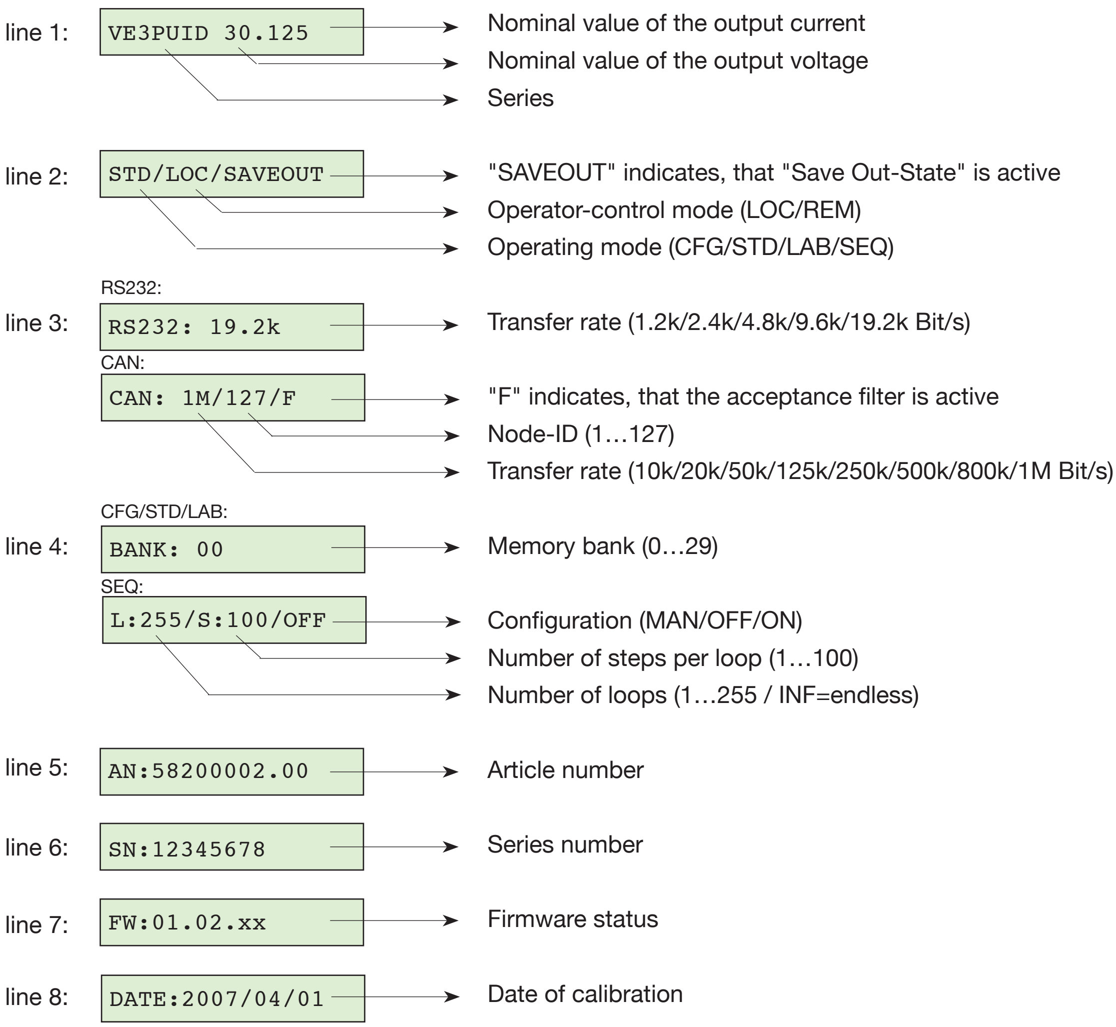
VE3PUID digitally programmable (FW: 01.02.xx)

NOTE: If no key is pressed after 60 seconds in "CFG", "STD" or "SEQ" operating mode, the system automatically moves back to the standard display of the STATUS level. This is generally the basic display with the device data. If the device is switched on, the system switches to the "ACT" display that displays the actual values. The system remains in the last menu item selected in "LAB" operating mode.

3.2.3 Basic Display

The basic display provides a fast overview of the device settings. Besides providing the user with device-specific data, the display also provides information on the current configuration of the device. This is the starting point for all the various menu structures and is also the starting point for changing the operating mode and the operator-control mode of the device. Key shortcut "MENU" and "ENTER" allows you to switch directly to the basic display at STATUS level.

The basic display is a multi-line display. Consequently, the text must be scrolled with buttons "UP" and "DOWN". The contents of the individual lines are outlined below:



3.2.4 Value change

Settings are changed at EDIT level using the menu. The value can be changed with keys "UP" and "DOWN", and the rate of change is dependent on how long the key is pressed:

short key actuation (< 0.2s)

Briefly pressing a key increments or decrements the value by one single step. The single step increment depends on the value base:

voltage:	10mV / step
current:	10mA / step
power:	1W / step

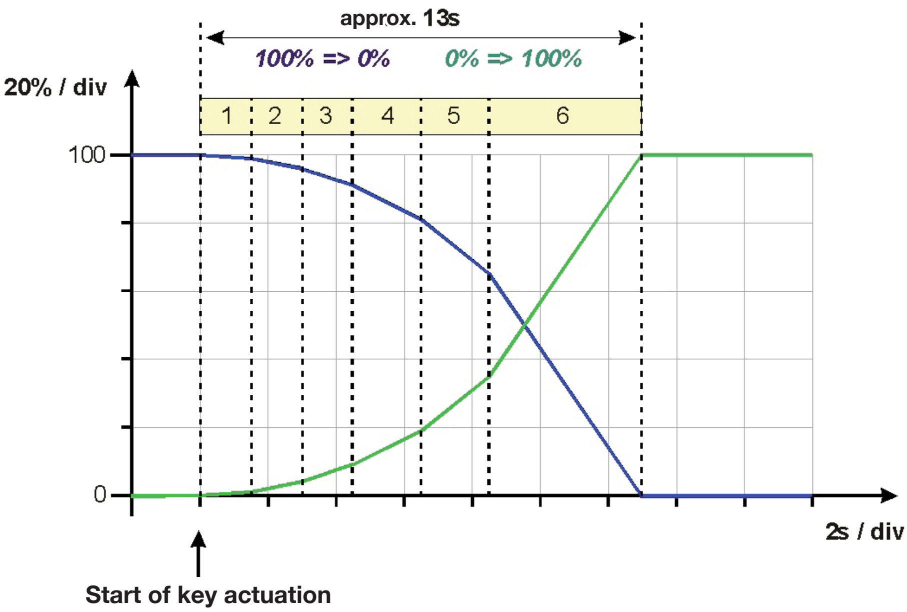
long key actuation (> 0.2s)

Pressing a key for a long period cyclically increments or decrements the value every 50ms. The change value is increased in six steps. The response as of the instant the key is pressed is outlined below. The description lists after what actuating time the corresponding step is activated and for how long it is active:

step 1:	0.2 up to 1.7s (duration: 1.5s)
step 2:	1.7 up to 3.2s (duration: 1.5s)
step 3:	3.2 up to 4.7s (duration: 1.5s)
step 4:	4.7 up to 6.7s (duration: 2s)
step 5:	6.7 up to 8.7s (duration: 2s)
step 6:	from 8.7s

The change values for the individual steps on the device and are initialised on power-up. This achieves a uniform rate of change for all device types.

The diagram below shows the response for a value change from 0 to 100% or from 100 to 0%:



3.3. Functionality and Local Operation

3.3.1 Operating Modes

The device has been designed to be used in an extremely wide variety of applications. The following modes are provided for configuring it for operation:

Operating Mode Setting options:
- CONFIG
- STANDARD *(condition as delivered for STD-units)*
- LAB *(condition as delivered for LAB-units)*
- SEQUENCE

The Operation-Mode defines the operating mode of the device:

"CONFIG" is actually not an operating mode but the mode in which the basic settings such as interface and transfer rate etc. can be set on the device.

"STANDARD" is the normal operating mode of the device in which, for instance, the output can be connected or setpoints can be changed.

"LAB" is used for laboratory operation. This operating mode allows simplified setting of setpoints using the operating controls on the front panel.

"SEQUENCE" allows programming and output of sequences.

The corresponding menu structure is loaded depending on which operating mode has been selected. The annex provides an overview of the various menu structures.

Control-Mode Setting options:
- LOCAL *(condition as delivered)*
- REMOTE

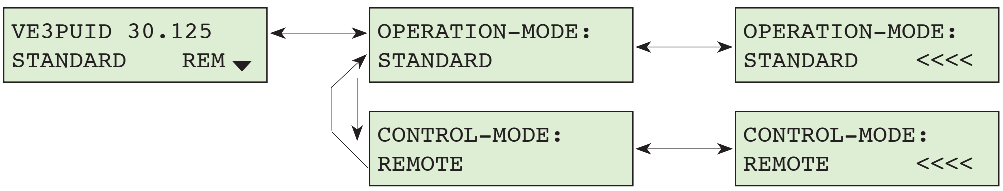
The control mode defines from where the settings can be made on the device:

"LOCAL" means local operation, i.e. the settings on the device can be made directly with the operating controls on the front panel.

"REMOTE" is set if the device is to be operated by a Host PC or an interface.

NOTE: If Device Enable has been issued (slide switch "STANDBY/ON" set to ON and Enable signal applied to signal connector) in the case of a switch from "REMOTE" to "LOCAL", Device Enable must first be reset before you can continue working with the device. This is for safety reasons in order to prevent unintentional connection of the device output when switching control mode.

The modes are set at Status level, starting from the basic display. After a switch to Select level, the required mode can be selected and then changed at Edit level.



NOTE: The modes can be changed in any operating mode and any control mode. The output may not be activated for reasons relating to safety.

3.3.2 Switching on and Error Management

The device is switched on and off, i.e. the device output is connected and disconnected, by transfer of the Enable signal from the microcontroller to the control module. No error may be pending if this signal is to be generated. If this condition is met, the device output can be controlled with the following components:

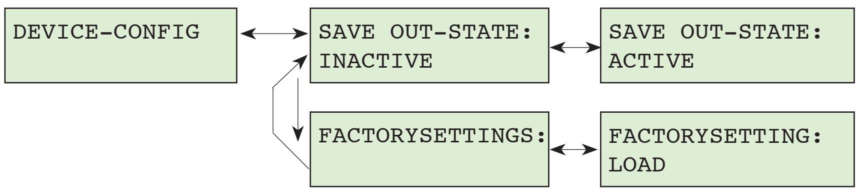
"STANDBY/ON" (Slide switch)	The slide switch must be set to "ON" in order to switch the device on. The "STANDBY" position signals to the controller that the output should be switched off.
"ENABLE" (Signal connector)	A floating optocoupler assumes the task of signalling to the microcontroller. The device is switched on if a current ($2mA \leq I \leq 10mA$) flows. The device is switched off again by interrupting current flow. ($V_{AK} = 5V$, $I_{max} = 10mA$)

"STANDBY/ON" and "ENABLE" are AND-ed, i.e. both switch-on conditions must be met in order to enable the device output.

NOTE: Switching the device on and off merely connects and disconnects power transfer from the mains input to the device output. The user must provide an interrupter in the mains circuit if the device is to be electrically isolated from the mains.

NOTE: Only the "STANDBY" switch and the "ENABLE" input are required in order to switch on the device in Local mode. If both switch-on conditions are met, the device output is switched on directly after the mains power supply is switched on. In Remote mode, the Enable signal is also required for switching on, with the corresponding command via the selected interface. The switch-on response after Power-On can be configured in this case via "SAVE OUT-STATE". If this function is active, the status of the device output is saved in a flag when the supply voltage is switched off, using the PFS signal. This flag is evaluated when the device is switched back on again, and the device output is switched on or off. After device start-up, the flag is reset, ensuring that the output is not switched on unintentionally after a Reset. If "SAVE OUT-STATE" is not activated, the device output remains switched off after Power-On.

This function is configured in "CONFIG" mode.
From the "DEVICE CONFIG" display at Status level, switch to Select level and then select the "SAVE OUT-STATE" screen, after which the required value can then be set at Edit level.



Various monitoring functions are provided for protecting the device itself against external influences and also, for instance, protecting voltage-sensitive loads against overvoltage:

Overtemperature	The temperature is detected at important points inside the device. If the temperature exceeds the limit value, an Error signal is generated.
Overvoltage Protection	Overvoltage protection has the task of protecting the device's output circuit. This is a permanently set voltage threshold which, if exceeded, generates an error.
Protection	The corresponding error is generated if the monitoring values set by the user are overshot or undershot. A precise description is given in chapter "Protection".

In the event of an error, the device is switched off in latching mode. A signal is issued accordingly, whereby a plain text message is displayed on the display and the red "FAIL" LED flashes. The error message must be reset by pressing the "ENTER" button. The device must be in Standby mode for resetting for reasons relating to safety, i.e. in order to prevent the device being switched back on again directly.

3.3.3 Setpoints and Actual Values

The purpose of a programmable power supply is to allow its device output to be set in accordance with the application. The corresponding setpoints must be preset and the actual state must be checked for this.

The user has the option of setting setpoints for the output voltage and the output current. The settings are made via Digital-to-Analogue Converter (DAC) of the control module, the control module, in turn, ensuring that the device output is set accordingly. The settings are displayed on the "SET" display at Status level.

The control module generates monitor signals for actual voltage value and actual current value in order to detect the status of the device output. These monitor signals are read in by the microcontroller with Analogue-to-Digital Converters (ADCs). The actual power value is computed from these values. The actual values are displayed on the "ACT" display at Status level.

The setpoint setting range extends from 0 through to the device-specific maximum value. For example, a VE3PUID 30.125 has a maximum output voltage of 30V and a maximum output current of 125A. The accuracy with which the setpoints can be set is dependent on the resolution of the DAC on the one hand and the calibration settings on the other. The resolution in this case is approx. 4000 increments (4096 DAC resolution less calibration reserves).

The value range of the actual values extends from 0 to 105% of the nominal value. The resolution in this case as well is approx. 4000 increments (4096 ADC resolution less calibration reserves).

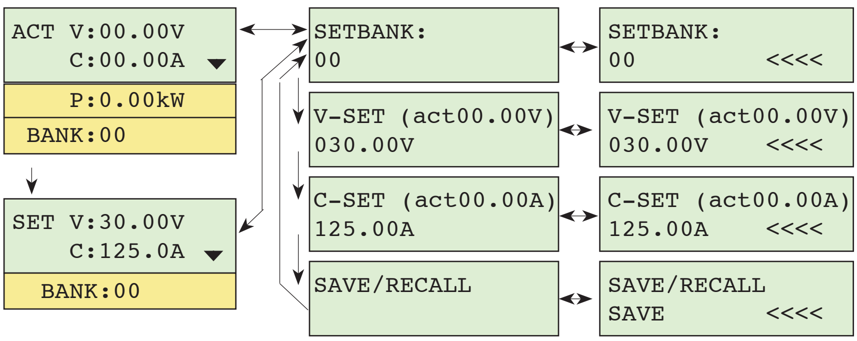
The table below shows the various increments for the various standard types:

Type	Vmax / V	mV/Bit (set)	mV/Bit (actual)	Cmax / A	mA/Bit (set)	mA/Bit (actual)
VE3PUID 30.125	**30**	7.50	7.88	**125**	31.25	32.81
VE3PUID 52.75	**52**	13.00	13.65	**75**	18.75	19.69
VE3PUID 60.63	**60**	15.00	15.75	**63**	15.75	16.54
VE3PUID 90.42	**90**	22.50	23.63	**42**	10.50	11.03
VE3PUID 150.25	**150**	37.50	39.38	**25**	6.25	6.56
VE3PUID 180.20	**180**	45.00	47.25	**20**	5.00	5.25
VE3PUID 300.12,5	**300**	75.00	78.75	**12.5**	3.13	3.28

The setpoints can be set in operating modes "STD", "LAB" and SEQ", and the device must also be switched off in operating mode "SEQ".

The starting point is the "ACT" display or the "SET" display at Status level. The corresponding setpoint can be selected after switching to Select level, and it can then be edited at Edit level.

In "LAB" operating mode, newly set values are transferred directly, and they are transferred only after "ENTER" is pressed in the other operating modes.



NOTE: The related actual values are also displayed on the Select and Edit displays for setpoint setting ("V-SET" and "C-SET").

3.3.4 Limit Values

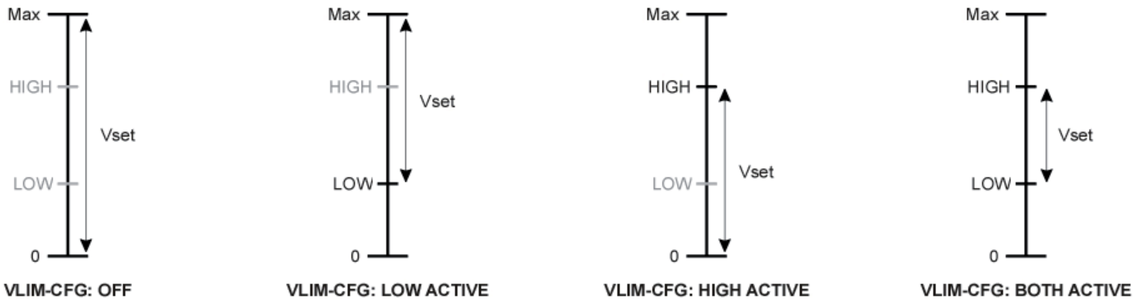
Certain applications necessitate limiting the ranges in which voltage and current may be set so as to protect the connected electrical load (setpoint). The following settings are available to the user for this:

VLIM: Low, High	lower/upper voltage limit value
CLIM: Low, High	lower/upper current limit value

The functions of the value pairs for voltage and current can each be configured:

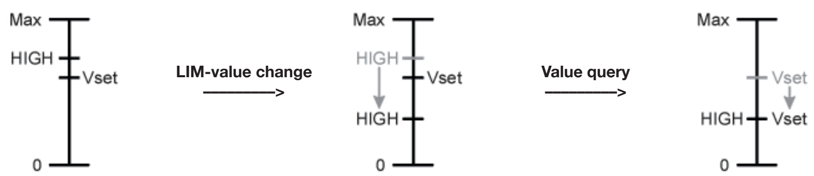
OFF	Both limit values are deactivated. *(condition as delivered)*
LOW-ACTIVE	The setpoint is limited to the lower limit value, i.e. it cannot be set lower than the lower limit.
HIGH-ACTIVE	The setpoint is limited to the upper limit value, i.e. it cannot be set higher than the upper limit.
BOTH-ACTIVE	Both limit values are activated, i.e. the setpoint can be set only within the upper and lower limit.

The mode of operation of the various configurations will now be illustrated on the basis of the examples below:

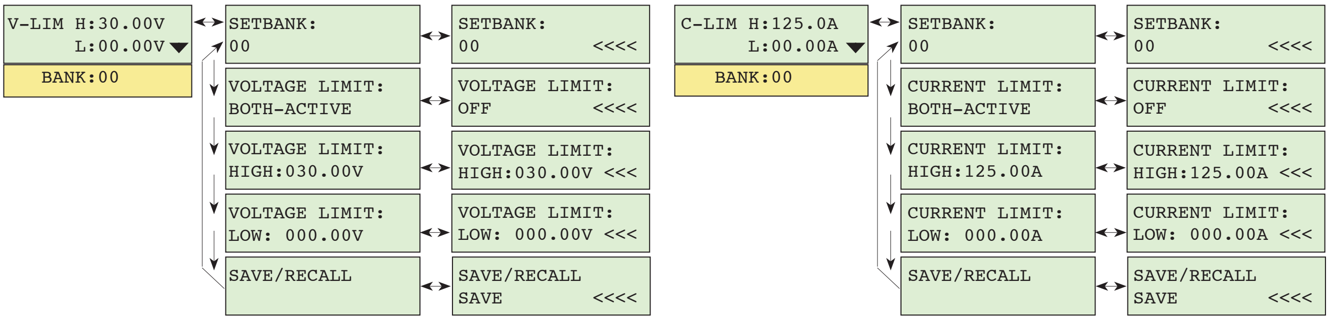


The setting range for the limit values is generally 0 to nominal value. In the case of configuration "BOTH ACTIVE", HIGH limits the setting range from LOW upwards and LOW limits the setting range from HIGH downwards.

NOTE: If a limit value is configured as "ACTIVE", it must be noted that, in the case of a change of the limit value, the setpoint assigned to the limit value is adapted automatically after the value is accepted, i.e. if an upper limit value is set lower than the actual setpoint or if a lower limit value is set higher than the actual setpoint, the setpoint is set to the corresponding limit value. This interrelationship is shown in the example below:



The limit values can be configured in operating modes "STD", "LAB" and "SEQ". In "SEQ" operating mode, the device must also be switched off. The starting point is the "V-LIM" or "C-LIM" display at Status level. After a switch to Select level, the corresponding value can be selected and it can then be edited at Edit level. New values set are not accepted until you press "ENTER".



3.3.5 Monitoring Values (Protection)

Certain applications necessitate monitoring the actual values of the device output in order to protect the load and consequently switch off the output quickly in the case of an illegal operating state. The following monitoring values are available to the user for this:

VPRT: Low, High lower/upper voltage monitoring value

CPRT: Low, High lower/upper current monitoring value

PPRT: Low, High lower/upper power monitoring value

The functions of the value pairs for voltage, current and power can each be configured:

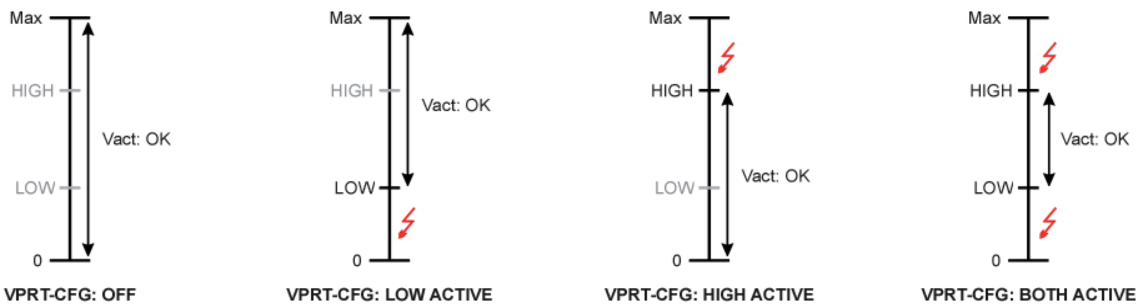
OFF Both monitoring values are deactivated. *(condition as delivered)*

LOW-ACTIVE The lower monitoring value is active, i.e. if the actual value drops below the Low value, an error message is generated and the device output is deactivated. The unit cannot be switched back on again until the error message has been reset.

HIGH-ACTIVE The upper monitoring value is active, i.e. if the actual value rises above the High value, an error message is generated and the device output is deactivated. The unit cannot be switched back on again until the error message has been reset.

BOTH-ACTIVE Both monitoring values are active, i.e. an error generated and the device output is deactivated if the actual value is not within the monitoring window defined with the Low and High values.

The mode of operation of the various configurations will now be illustrated on the basis of the examples below:



The monitoring values can generally be set between 0 and 105 % of the nominal value. If "BOTH ACTIVE" is configured, HIGH limits the adjustment range from LOW upwards and LOW limits the adjustment range from HIGH downwards.

In addition, the user has the option of defining delay times:

V-DELAY Indicates how long the error state of a voltage monitoring value must occur until the error message is generated and the device output is deactivated.

Setting range: 0.01 ... 600.00s (increment 0.01s)

C-DELAY Indicates how long the error state of a current monitoring value must occur until the error message is generated and the device output is deactivated.

Setting range: 0.01 ... 600.00s (increment 0.01s)

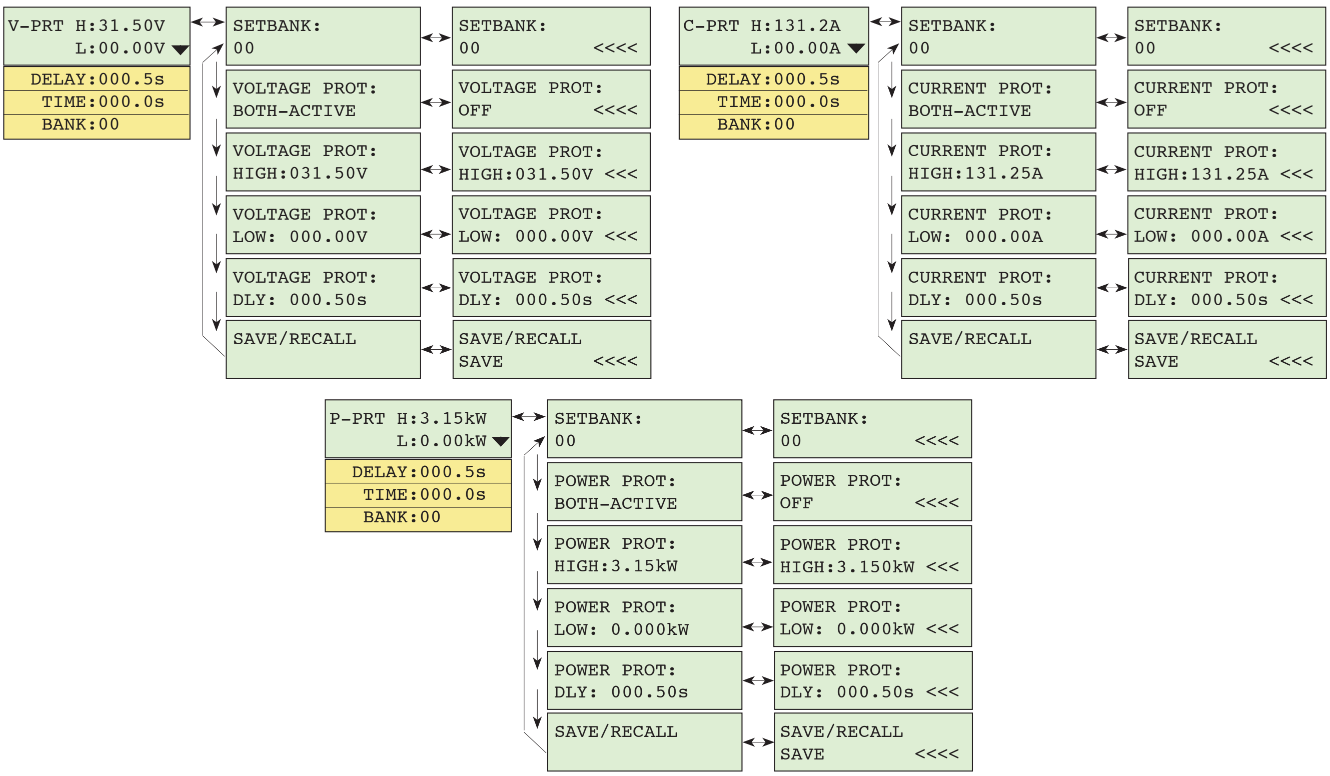
P-DELAY Indicates how long the error state of a power monitoring value must occur until the error message is generated and the device output is deactivated.

Setting range: 0.01 ... 600.00s (increment 0.01s)

It must be noted that the corresponding monitoring time applies both to the High value and to the Low value.

NOTE: Any delay time started is reset if the memory bank is changed.

The monitoring values can be configured in operating modes "STD", "LAB" and "SEQ". In "SEQ" operating mode, the device must also be switched off. The starting point is the "V-PRT", "C-PRT" or "P-PRT" display at Status level. After a switch to Select level, the corresponding value can be selected and then edited at Edit level. New values set are not accepted until you press "ENTER".



NOTE: The currently elapsed time since occurrence of the error state is indicated in the fourth line with "TIME" in the case of the Protection Status displays. This allows you to estimate the time through to deactivation of the device.

3.3.6 Status Flags

The device also features a special function in relation to limit values and monitoring values:

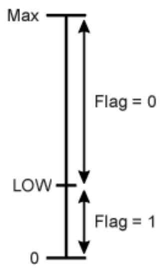
A comparison with the assigned actual value is conducted regardless of whether the device is configured with limit values or monitoring values, with all above-described thresholds. The result of each individual comparison is shown in a status flag. The status flags, in turn, are saved in a status word that can be evaluated via the selected interface.

The following status flags for voltage, current and power are thus available to the user:

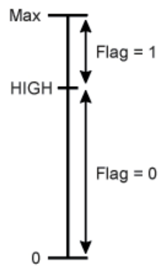
Voltage:	VLIM-Low VLIM-High	**Current:**	CLIM-Low CLIM-High	**Power:**	PPRT-Low PPRT-High
	VPRT-Low VPRT-High		CPRT-Low CPRT-High		

These status flags can be used to implement extensive monitoring functions within an application.

Note the logic on the basis on which the flags are set and reset. In line with the description for "Protection", a Low flag is set if the actual value drops below the Low value. A High flag is set if the actual value exceeds the High value. The examples below show this interrelationship:



LOW-FLAG



HIGH-FLAG

3.3.7 Memory Banks

The device features 30 memory banks. These memory banks allow fast change of configuration of the device output. They allow different loads to be operated with the device easily without the bother of complex programming. They can also be used to test various operating points on a load. It is also possible to use the memory banks to implement simple sequences.

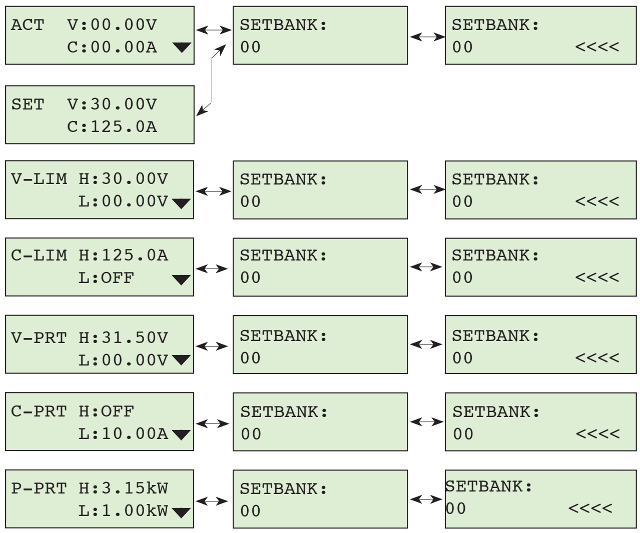
The following settings are saved in each memory bank:

Set:	VSet	**Limit:**	VLim-Cfg	**Protection:**	VPrt-Cfg
	CSet		VLim-Low		VPrt-Low
			VLim-High		VPrt-High
					VPrt-Delay
			CLim-Cfg		CPrt-Cfg
			CLim-Low		CPrt-Low
			CLim-High		CPrt-High
					CPrt-Delay
					PPrt-Cfg
					PPrt-Low
					PPrt-High
					PPrt-Delay

The required memory bank can be selected in operating modes "STD", "LAB" and "SEQ" wherever a value that is saved to the memory banks is set.

The starting point is the "ACT"-, "SET"-, "V-LIM"-, "C-LIM"-, "V-PRT"-, "C-PRT"- or "P-PRT"- display at Status level. After a switch to Select level, the "SETBANK" display can be selected and then the required memory bank can be selected at Edit level.

The new memory bank is adopted directly in "LAB" operating mode. It is not adopted until "ENTER" is pressed in the other operating modes.



NOTE: The selected memory bank is always active, i.e. its settings are assigned directly to the device output and only these settings can be edited. Settings from inactive memory banks cannot be edited.

NOTE: In "SEQ" operating mode, the memory bank may be changed only if the device is switched off since, in On state, the memory bank is preset by the sequence.

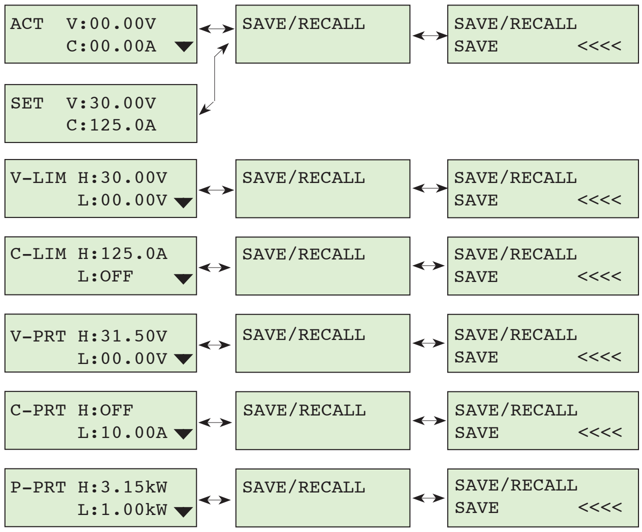
3.3.8 Saving and Retrieving the Settings

The device features an EEPROM used to save the device settings. These device settings are the device configuration (interface, transfer rate and operating mode etc.), the calibration values, the settings of the device output (values of the memory banks) and the sequence settings.

If values for the device configuration are edited, the new value is saved directly when the value is accepted. Saving must be initiated separately for the settings of the device output. It is also possible to recall saved values.

The settings of the device output are saved and recalled in operating modes "STD", "LAB" and "SEQ".

The starting point is the "ACT", "SET", "V-LIM", "C-LIM", "V-PRT", "C-PRT" or "P-PRT" display at Status level. After a switch to Select level, you can select the "SAVE/RECALL" display. After you switch to Edit level, select the required function and then run it by pressing "ENTER".



NOTE: Saving the settings requires approx. 3s and retrieving the settings is complete after approx. 1s.

NOTE: "SAVE" and "RECALL" always relate to the data records of all memory banks. It is not possible to save or recall only individual memory banks. The settings for device configuration and for the sequence, besides the memory banks, are also saved or retrieved with these functions.

⚠ The contents of the EEPROM are erased and completely written anew on saving. Values saved beforehand can no longer be retrieved after saving. Likewise, values in the RAM are overwritten when data is retrieved from the EEPROM. This means that values set beforehand are lost. Unforeseen states of the device output and any associated risk must not occur when the values are retrieved. Consequently, great care must be taken when using these functions.

3.3.9 Recalling the factory defaults

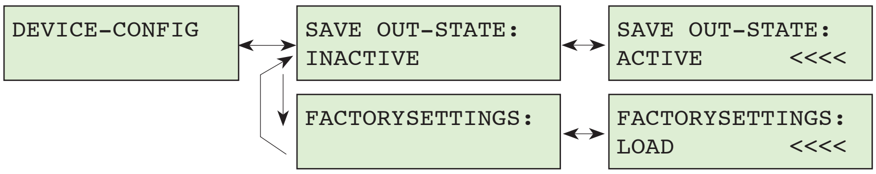
The user has the option of recalling the device's factory default settings. The basic settings loaded with this function are described below:

Operation-Mode:	Operation-Mode:	STANDARD				
	Control-Mode:	LOCAL				
Interface:	Remote Interface:	RS232				
	RS232: Baud rate:	19.2kBit/s				
	CAN: Node-ID:	1				
	Baud rate:	1000kBit/s				
	Filter:	ACTIVE				
Device-Config:	SAVE OUT-STATE:	INACTIVE				
	LOCK:	UNLOCK				
Setbank:	0					
Settings (Bank 0)	Vset:	max				
	Cset:	max				
Settings (Bank 1...29)	Vset:	0				
	Cset:	0				
Limits (Bank 0...29)	VLim-Cfg:	OFF	CLim-Cfg:	OFF		
	VLim-Low:	0V	CLim-Low:	0A		
	VLim-High:	max	CLim-High:	max		
Protection (Bank 0...29)	VPrt-Cfg:	OFF	CPrt-Cfg:	OFF	PPrt-Cfg:	OFF
	VPrt-Low:	0V	CPrt-Low:	0A	PPrt-Low:	0kW
	VPrt-High:	max	CPrt-High:	max	PPrt-High:	max
	VPrt-Dly:	0.5s	CPrt-Dly:	0.5s	PPrt-Dly:	0.5s
Sequence:	Configuration:	Auto (End-OFF)				
	Loop number:	1				
	Step number:	1				
	Bank (Step 0...99):	0				
	Time (Step 0...99):	0.5s				

The factory default settings can be retrieved only using the keyboard and in operating mode "CONFIG".

Starting from the "DEVICE-CONFIG" display at Status level, switch to Select level and then choose the "FACTORYSETTINGS" screen.

At Edit level, you can now choose "LOAD". Pressing button "ENTER" loads the factory default settings.



NOTE: Loading of the factory default settings also sets the CANopen communication parameters to their factory default settings. These can be seen in the overview of the object directory.

NOTE: After the factory default settings have been loaded, the controller is restarted automatically. This reinitialises the device.

⚠ All saved and non-saved settings are lost when the factory default settings are loaded. The operator-control mode is also set to "LOCAL". If the slide switch is set to "ON" and if the "ENABLE" signal is pending, the device output is activated with the subsequent restart of the device. The factory default settings may be loaded only if it would not pose a danger.

3.3.10 Button Lock

The user has the option of locking the buttons and also unlocking them again via the selected interface. One other unlocking option is available with the keypad:
Simultaneously pressing "UP" and "DOWN" during a restart procedure of the controller (press "RESET") cancels the button lock. Note that the button lock is active again if the controller is restarted. The button lock function can be cancelled permanently only via the selected interface.

3.3.11 Laboratory Mode

If a mains unit is used in a laboratory application, it will be desirable to be able to change the setpoints as easily as possible. In addition, it is frequently necessary to vary the voltage or current continuously so as to be able to observe the effects on the load. "LAB" operating mode is intended for this. The scope of functions in this operating mode is identical to that in "STANDARD" operating mode. The differences relate simply to certain aspects in relation to menu prompting:

VSET, CSET	When a setpoint is changed at EDIT level, a value change is transferred directly to the device output. It is not necessary to complete the entry with "ENTER". The old value can, however, still be restored by pressing "ESCAPE".
SETBANK	As with the setpoints, it is not necessary to complete the change to the memory bank with "ENTER". A value change is adopted directly. This function can also be used to run a sequence manually with the memory banks. Here as well, the old value is restored if "ESCAPE" is pressed.
Menu return	The system always remains in the last menu item set. The function that switches back to the standard display at STATUS level after 60 seconds if no key is pressed is deactivated in this operating mode.
Return to "Edit-VSET"	The "ENTER" key can be used at STATUS level to switch directly to "VSET" at EDIT level. This substantially simplifies operation.

NOTE: As described in Chapter "Value change", the change value is incremented in steps depending on how long "UP" or "DOWN" is pressed when editing a value using the keyboard. However, in the last step, the change value is so great that there is a risk of overshooting the target value. This may pose a problem when changing setpoints in "LAB" operating mode since setpoint changes are transferred directly to the output. Consequently, the user is advised to work with the setpoint limits so as to protect the load.

3.3.12 Sequences

When testing systems, it is frequently required to apply a specific test cycle, for example a specific, temporal sequence of various voltage values, to the unit under test. "SEQUENCE" operating mode is intended for this. The device is programmed with the required sequence and switched on in Local mode via the ENABLE input with a PLC. The test cycle is consequently run through automatically without the need for an additional programming unit for the device. For a remote-controlled application, this affords the user the option of configuring his or her application program far more simply using this functionality.

A sequence is basically a number of consecutive single steps in which a memory bank is activated for a specific time. This step sequence is supplemented by the option of repeating the sequence, i.e. using a loop structure. The following elements are used to program the sequence:

Configuration

Setting options:
- MANUAL
- AUTO (END-OFF) *(condition as delivered)*
- AUTO (END-ON)

"MANUAL" is used to check the settings. If the device is switched on, the current step can be incremented or decremented manually, starting at step "0". This allows the user to test the settings, step by step, and edit the values if necessary.

"AUTO (END-OFF)" allows the sequence to be run automatically. If the device is switched on, the step sequence is applied to the output dependent on loop and step configurations. When the dwell time of the last step elapses, the device output is deactivated.

In the case of "AUTO (END-ON)", the sequence is also run through automatically, the only difference being that the device remains switched on with the settings of the memory bank of the last step at the end of the sequence.

NOTE: If the device is switched on Automatic mode, it is not possible to edit values. The device must have been configured before start. This relates both to the settings of the sequence and to those of the memory banks.

Loop number

Setting range: 0 ... 255

The number of loops defines how frequently a step sequence is to be repeated. If you select value "0", the step sequence is repeated endlessly.

Step number

Setting range: 1 ... 100

The number of steps defines after how many steps a loop iteration is complete. It also simultaneously defines the step sequence. Starting with step 0, the system switches to the next step after the relevant dwell time through to the last step (number of steps - 1). Consequently, it is not possible, for instance, to have a sequence start with step 5. In accordance with the aforesaid configuration, a new loop iteration is started, the device is switched off or it remains on with the settings of the memory bank of the last step at the end of the step sequence.

Step parameter

"BANK" (setting range: 0...29)

The memory bank used must be defined for each step of the step sequence. This allows the user convenient setting options since he or she, here as well, is also able to use the "LIMIT" and "PROTECTION" functionality. The user can also program current ramps in addition to voltage ramps.

"TIME" (setting range: 0.01...600s ; increment: 0.01s)

The dwell time allows the user to define for how long the step, i.e. the set memory bank, is to be active.

NOTE: If using "PROTECTION", note that delay times are restarted with each step. In addition, there is no plausibility check of the delay times in relation to the dwell time of a step.

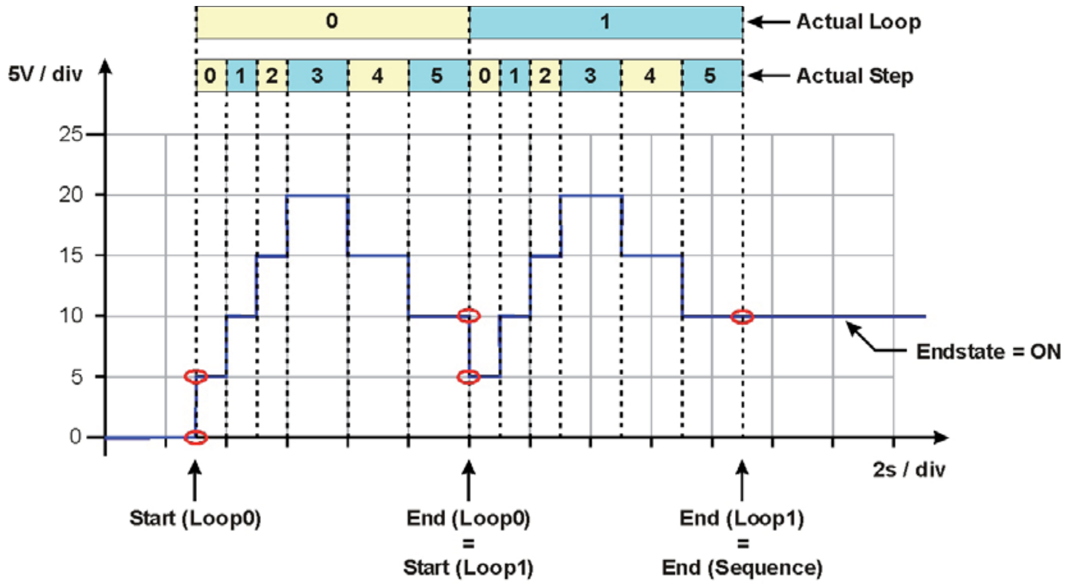
3. Description of Function

VE3PUID digitally programmable (FW: 01.02.xx)

NOTE: The "SAVE" functionality also saves the sequence settings to EEPROM.

NOTE: The sequence stops, the device output is deactivated and the current values of step, step time and loop are reset if the device is switched off. If the sequence is restarted, the system consequently starts again from the beginning. Interrupting and continuing are not possible.

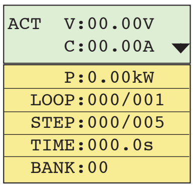
An example of a sequence is shown below. The settings with which the device must be programmed for this sequence are also shown. Note that only the voltage setpoints relevant to the sequence have been listed for the memory banks. All settings of the memory banks can be freely programmed of course:



Configuration of the Sequence:	- Configuration:	AUTO (END-ON)	
	- Loop number:	2	
	- Step number:	6	
Setting the banks:	- Bank 0:	Vset = 5V	
	- Bank 1:	Vset = 10V	
	- Bank 2:	Vset = 15V	
	- Bank 3:	Vset = 20V	
Configuration of the Steps:	- Step 0:	Bank = 0	Time = 1s
	- Step 1:	Bank = 1	Time = 1s
	- Step 2:	Bank = 2	Time = 1s
	- Step 3:	Bank = 3	Time = 2s
	- Step 4:	Bank = 2	Time = 2s
	- Step 5:	Bank = 1	Time = 2s

The diagram below shows the additional information shown on the "ACT" display at STATUS level in Sequence mode:

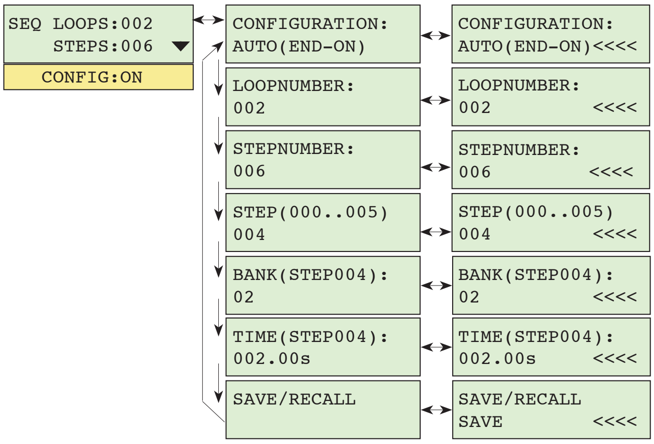
Line 1..3:	current actual values of voltage, current and power	
Line 4:	current loop status	(current loop / last loop)
Line 5:	current step status	(current step / last step)
Line 6:	current dwell time of step	
Line 7:	memory bank currently used.	



The sequence is configured in "SEQ" operating mode.

The starting point is the "SEQ" display at STATUS level. After a switch to SELECT level, the corresponding value can be selected and then edited at EDIT level. New values set are adopted only when "ENTER" is pressed.

Note that the current step is set under "STEP". This is necessary in order to make the "BANK" and "TIME" settings assigned to the step.



3. Description of Function

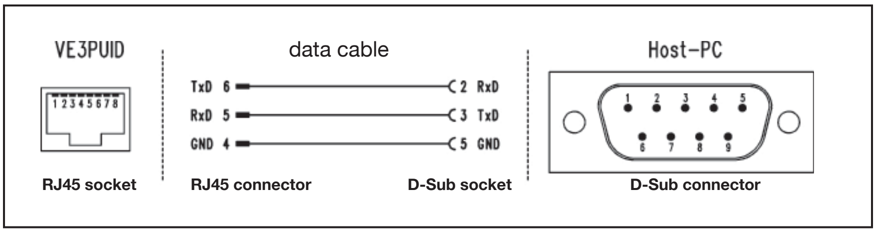
VE3PUID digitally programmable (FW: 01.02.xx)

3.4 Remote Control via RS232

3.4.1 Connection and Configuration

The device can be controlled remotely from a PC via the RS232 interface. A data cable consisting of the transmit line (TxD), the receive line (RxD) and the GND connection must be connected for this purpose. No handshake signals are used.

It is advisable to use a shielded, twisted-pair cable as the data cable. The pin assignment is shown below.

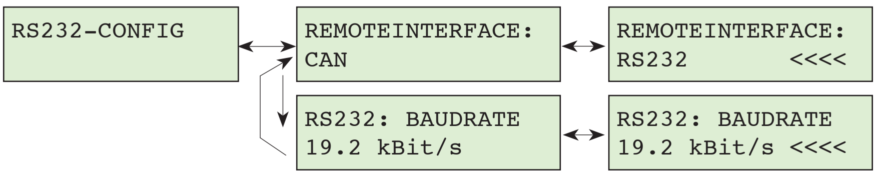


Data is transferred serially and bit-by-bit, whereby the transfer rate can be set optionally to 1200, 2400, 4800, 9600 or 19200 bit/s. 19200 bit/s is set in the condition as delivered.

A data byte is transferred by sending the eight data bits one after the other, each framed by one start bit and one stop bit. A parity bit is not used. Consequently, ten data bits must be transferred per data byte. The adjacent transfer times per databyte result, dependent on transfer rate.

Bit/s	µs/Bit	ms/Byte
1200	833.3	8.3
2400	416.7	4.17
4800	208.3	2.08
9600	104.2	1.04
19200	52.1	0.52

The active RS232 interface is set in "CONFIG" mode.
The starting point is the "RS232-CONFIG" display at Status level. After a switch to Select level, the required transfer rate and the active interface can be set in the EDIT level.
The new value is active after pressing the ENTER key.



NOTE: The required interface is selected with "REMOTEINTERFACE". Only one interface may be used at any one time.

NOTE: The controller must be restarted in order to accept new settings for the selected interface. This can be done by pressing the "RESET" button. A new start is performed automatically if a new interface has been selected with "REMOTEINTERFACE".

3.4.2 Syntax

Corresponding statements must be sent to the device in order to allow you to make settings on the device or read out settings from the device via the RS232 interface. These statements are character strings in ASCII format. A specific command set has been developed for this, and the statements in it essentially consist of the abbreviations of the corresponding English terms (e.g. *SV* - Set Voltage). The letters used may be upper case, lower case or mixed.

Certain statements have been combined to form groups. These contain a corresponding prefix followed by a **colon** *(ASCII:124 - <:>)*. For instance, *"LIM:"* is prefixed in the case of statements on limit values. On a general basis, statements may either be queries or commands.

A query prompts the device to return the corresponding status values or settings after a validity check. Queries are identified by a **question mark** *(ASCII:63 - <?>)* following the statement. Queries may be made in any device operating mode, i.e. also in Local mode.
A command makes settings on the device. However, this is possible only if the device is in Remote mode. Also note that certain commands may be made only in certain operating modes.

A command may contain parameters. It then consists of a statement block and a parameter block. The blocks are separated by a **space** *(ASCII:32 - <SP>)*.

Parameters are transferred only in numeric form. The parameters may be integers or decimal numbers, and a **period** *(ASCII:46 - <.>)* is used as the decimal separator. Negative values and values in exponential notation are not permitted.

A maximum of 5 digits may be used for integers or for the integer part of a decimal number. The same applies to the fraction part of a decimal number. In the case of decimal numbers less than one, the zero in front of the decimal separator may be omitted.

If several parameters are transferred, each individual parameter may have only one digit, i.e. it may assume only a value from 0 to 9. They are separated by **underscores** *(ASCII:95 - <_>)*.

A statement must be terminated in defined manner so that the end of the statement is recognised correctly. Either **Carriage Return** *(ASCII:13 - <CR>)* or **Line Feed** *(ASCII:10 - <LF>)* may be used as the end character for this.

The device always responds after it has received a statement: with the corresponding value in the case of a successful query or with "OK" in the case of an accepted command. If an error has occurred within a statement *(e.g. invalid character)*, a code for communication error "CER" is sent with an error number. A device response is terminated with **Line Feed** *(ASCII:10 - <LF>)*.

The codes for communication errors are listed below:

Error code	Expression	Description
CER01	Syntax-Error	Syntax error *(e.g. invalid character, too many characters etc.)*
CER02	Instruction-Error	Invalid statement
CER03	Mode-Error	Incorrect operating mode
CER04	Parameter-Error	Missing parameters, too many parameters or wrong parameter type
CER05	Range-Error	Setting outside of valid limits
CER06	Enable-Error	Device has no Enable *(e.g. has not been reset since error)*
CER07	Off-Error	Command may be executed only with device switched off.

3.4.3 Statements

3.4.3.1 Overview

NOTE: A poll or command is identified with "✓" in the tables below if implemented. By contrast, identification "---" means that the corresponding functionality has not been implemented. In the "Parameter" column, "---" also indicates that a command is used without parameter. The letters "L" (Local) and "R" (Remote) indicate the operator control mode in which the corresponding command is accepted by the device.

Identification					
Statement	**Description**		**Query**	**Command**	**Parameter**
`ID:TYP`	Unit type	*(TYPe)*	✓	---	---
`ID:AN`	Article number	*(Article Number)*	✓	---	---
`ID:SN`	Serial number	*(Serial Number)*	✓	---	---
`ID:FW`	Firmware	*(FirmWare)*	✓	---	---
`ID:XV`	max. Output voltage	*(maX. Voltage)*	✓	---	---
`ID:XC`	max. Output current	*(maX. Current)*	✓	---	---
`ID:XP`	max. Output power	*(maX. Power)*	✓	---	---

Device-Control					
Statement	**Description**		**Query**	**Command**	**Parameter**
`DEV:MOD`	Mode	*(MODe)*	✓	✓ (R/L)	2
`DEV:SAV`	Store settings	*(SAVe)*	---	✓ (R/L)	0
`DEV:RCL`	Restore settings	*(ReCaLl)*	---	✓ (R/L)	0
`DEV:LCK`	Key log	*(LoCK)*	✓	✓ (R/L)	1
`DEV:STA`	Status word	*(STAte)*	✓	---	---
`DEV:ERR`	Error word	(ERRor)	✓	---	---
`DEV:FLG`	Flag word	(FLaG)	✓	---	---
`DEV:CFM`	Confirm error	(ConFirM)	---	✓ (R/L)	0
`DEV:RST`	Reset controller	(ReSeT)	---	✓ (R/L)	0

Output-Control					
Statement	**Description**		**Query**	**Command**	**Parameter**
`OUT`	Activate output		✓	✓ (R)	1
`SB`	Memory bank	*(Set Bank)*	✓	✓ (R)	1
`SV`	Set value voltage	*(Set Voltage)*	✓	✓ (R)	1
`SC`	Set value current	*(Set Current)*	✓	✓ (R)	1
`AV`	Actual value voltage	*(Actual Voltage)*	✓	---	---
`AC`	Actual value current	*(Actual Current)*	✓	---	---
`AP`	Actual value power	*(Actual Power)*	✓	---	---

3. Description of Function

VE3PUID   digitally programmable   (FW: 01.02.xx)

Limit-Control					
Statement	**Description**		**Query**	**Command**	**Parameter**
`LIM:CFG`	Configuration	(ConFiGuration)	✓	✓ (R)	3
`LIM:VH`	Upper voltage limit	(Voltage High)	✓	✓ (R)	1
`LIM:VL`	Lower voltage limit	(Voltage Low)	✓	✓ (R)	1
`LIM:CH`	Upper current limit	(Current High)	✓	✓ (R)	1
`LIM:CL`	Lower current limit	(Current Low)	✓	✓ (R)	1

Protection-Control					
Statement	**Description**		**Query**	**Command**	**Parameter**
`PRT:CFG`	Configuration	*(ConFiGuration)*	✓	✓ (R)	3
`PRT:VH`	Upper voltage monitoring value	*(Voltage High)*	✓	✓ (R)	1
`PRT:VL`	Lower voltage monitoring value	*(Voltage Low)*	✓	✓ (R)	1
`PRT:VDL`	Delay time voltage monitoring	*(Voltage DeLay)*	✓	✓ (R)	1
`PRT:CH`	Upper current monitoring value	*(Current High)*	✓	✓ (R)	1
`PRT:CL`	Lower current monitoring value	*(Current Low)*	✓	✓ (R)	1
`PRT:CDL`	Delay time current monitoring	*(Current DeLay)*	✓	✓ (R)	1
`PRT:PH`	Upper power monitoring value	*(Power High)*	✓	✓ (R)	1
`PRT:PL`	Lower power monitoring value	*(Power Low)*	✓	✓ (R)	1
`PRT:PDL`	Delay time power monitoring	*(Power DeLay)*	✓	✓ (R)	1

Sequence-Control					
Statement	**Description**		**Query**	**Command**	**Parameter**
`Q:CFG`	Config. (MAN/AUTO-OFF/AUTO-ON)	*(ConFiGuration)*	✓	✓ (R)	1
`Q:SLN`	Set: Loop number	*(Set Loop Number)*	✓	✓ (R)	1
`Q:SSN`	Set: Step number per loop	*(Set Step Number)*	✓	✓ (R)	1
`Q:SSB`	Set: Step bank	*(Set Step Bank)*	✓	✓ (R)	1
`Q:SST`	Set: Step time	*(Set Step Time)*	✓	✓ (R)	1
`Q:AL`	Act: Actual loop	*(Actual Loop)*	✓	---	---
`Q:AS`	Act: Actual step	*(Actual Step)*	✓	✓ (R)	1
`Q:AST`	Act: Actual step time	*(Actual Step Time)*	✓	---	---
`Q:RS`	Restart of the sequence	*(ReStart)*	---	✓ (R)	0

3.4.3.2 Description

3.4.3.2.1 Identification

The statements of this group serve the purpose of device identification. They are solely queries that can be made in any control mode.

ID:TYP This statement allows you to query the device type.
Format of the response: *Device designation Nominal voltage.Nominal current.*
For example: `ID:TYP?` *<LF>* => `VE3PUID` *<SP>* `30.125` *<LF>*

ID:AN This statement allows you to query the article number of the device
Format of the response: *Article number.Version number*
For example: `ID:AN?` *<LF>* => `58000002.00` *<LF>*

ID:SN This statement allows you to query the series number of the device.
For example: `ID:AN?` *<LF>* => `12345678` *<LF>*

ID:FW This statement allows you to query the firmware status.
Format of the response: *Main version number.Secondary version number.Build number*
For example: `ID:FW?` *<LF>* => `01.02.00` *<LF>*

ID:DAT The calibration date of the device is polled with this instruction.
Format of the response: *Year/Month/Day*
For example: `ID:DAT?` *<LF>* => `2006/06/30` *<LF>*

ID:XV This statement queries the device's maximum output voltage (in volt).
For example: `ID:XV?` *<LF>* => `30.000` *<LF>*

ID:XC This statement queries the device's maximum output current (in ampere).
For example: `ID:XC?` *<LF>* => `125.000` *<LF>*

ID:XP This statement queries the device's maximum output power (in kilowatts).
For example: `ID:XP?` *<LF>* => `3000` *<LF>*

3.4.3.2.2 Device-Control

The statements of this group serve the purpose of device monitoring. Both queries and commands may be made in this control mode.

DEV:MOD This statement presets or reads out operating mode and control mode of the device. It contains two parameters, whereby the first is the operating mode and the second is the control mode. The device must be in STANDBY in order to allow its operating mode to be changed. Otherwise, a communication error message will be issued.

Values:	Operation mode:	0	CONFIGURATION
		1	STANDARD
		2	LAB
		3	SEQUENCE
	Control mode:	0	LOCAL
		1	REMOTE

For example:	`DEV:MOD?` *<LF>*	=>	`0_1` *<LF>*	*(actual mode: CFG ; REM)*
	`DEV:MOD` *<SP>* `1_1` *<LF>*	=>	`CER07` *<LF>*	*(unit is not in STANDBY)*
	`DEV:MOD` *<SP>* `1_1` *<LF>*	=>	`OK` *<LF>*	*(new mode: STD ; REM)*

DEV:SAV No settings are saved automatically in control mode "REMOTE". This applies both to the settings of the device output and to the values of the device configuration. This command prompts the device to save all settings.

For example: `DEV:SAV` *<LF>* => `OK` *<LF>*

DEV:RCL This command prompts the device to recall all settings from memory.

For example: `DEV:RCL` *<LF>* => `OK` *<LF>*

DEV:LCK This statement allows you to disable or enable the buttons on the device's operating panel

Values:	0	UNLOCKED
	1	LOCKED

For example:	`DEV:LCK?` *<LF>*	=>	`0` *<LF>*	*(actual status: UNLOCKED)*
	`DEV:LCK` *<SP>* `1` *<LF>*	=>	`OK` *<LF>*	*(new status: LOCKED)*

3. Description of Function

VE3PUID digitally programmable (FW: 01.02.xx)

`DEV:STA` This query allows you to determine the device status. The return value is a 16-bit word representing the device status. It is returned as a decimal number computed from the significance of the individual bits:

Bit number	Significance			
0	1	Output of the unit	*(0 = STANDBY*	*; 1 = ON)*
1	2	Common fault	*(0 = no error*	*; 1 = error)*
2	4	Sliding switch	*(0 = STANDBY*	*; 1 = ON)*
3	8	ENABLE (signal connector)	*(0 = STANDBY*	*; 1 = ON)*
4	16	Voltage control	*(0 = inactive*	*; 1 = active)*
5	32	Current control	*(0 = inactive*	*; 1 = active)*
6	64	Power limiting	*(0 = inactive*	*; 1 = active)*
7	128	Lock	*(0 = inactive*	*; 1 = active)*
8	256	Reserve		
9	512	Reserve		
10	1024	Reserve		
11	2048	Reserve		
12	4096	Reserve		
13	8192	Reserve		
14	16384	Reserve		
15	32768	Reserve		

For example: `DEV:STA?` => *157<LF>* *(1001 1101)*

(Output of the unit = ON ;
Common fault = no error;
Sliding switch = ON;
ENABLE = ON)
Voltage control = active;
Lock = active)

`DEV:ERR` This prompt allows you to query the device's error status. The return value is a 16-bit word returned as a decimal number. The error status can be computed from the significance of the individual bits:

Bit number	Significance			
0	1	Common fault	*(0 = no error*	*; 1 = error)*
1	2	Overtemperature	*(0 = inactive*	*; 1 = active)*
2	4	Overvoltage protection	*(0 = inactive*	*; 1 = active)*
3	8	Power Fail Signal	*(0 = inactive*	*; 1 = active)*
4	16	Voltage Fail	*(0 = inactive*	*; 1 = active)*
5	32	V-Protection: High-Error	*(0 = inactive*	*; 1 = active)*
6	64	V-Protection: Low-Error	*(0 = inactive*	*; 1 = active)*
7	128	C-Protection: High-Error	*(0 = inactive*	*; 1 = active)*
8	256	C-Protection: Low-Error	*(0 = inactive*	*; 1 = active)*
9	512	P-Protection: High-Error	*(0 = inactive*	*; 1 = active)*
10	1024	P-Protection: Low-Error	*(0 = inactive*	*; 1 = active)*
11	2048	Reserve		
12	4096	Reserve		
13	8192	Reserve		
14	16384	Reserve		
15	32768	Reserve		

For example: `DEV:ERR?` => *3<LF>* *(11)*

(Common fault = ON ;
Overtemperature = active)

DEV:FLG This query allows you to query the flags of the device. The return value is a 16-bit word that is returned as a decimal number.

Bit number:	Significance:				
0	1	VLim:	High - Flag	*(0 = inactive*	*; 1 = active)*
1	2	VLim:	Low - Flag	*(0 = inactive*	*; 1 = active)*
2	4	CLim:	High - Flag	*(0 = inactive*	*; 1 = active)*
3	8	CLim:	Low - Flag	*(0 = inactive*	*; 1 = active)*
4	16	PLim:	High - Flag	*(0 = inactive*	*; 1 = active)*
5	32	PLim:	Low - Flag	*(0 = inactive*	*; 1 = active)*
6	64	VPrt:	High - Flag	*(0 = inactive*	*; 1 = active)*
7	128	VPrt:	Low - Flag	*(0 = inactive*	*; 1 = active)*
8	256	CPrt:	High - Flag	*(0 = inactive*	*; 1 = active)*
9	512	CPrt:	Low - Flag	*(0 = inactive*	*; 1 = active)*
10	1024	PPrt:	High - Flag	*(0 = inactive*	*; 1 = active)*
11	2048	PPrt:	Low - Flag	*(0 = inactive*	*; 1 = active)*
12	4096	Reserve			
13	8192	Reserve			
14	16384	Reserve			
15	32768	Reserve			

For example: *`DEV:FLG?`* => *6<LF>* *`(1010)`* *(VLim-Low-Flag = ON ; CLim-Low-Flag = ON)*

DEV:CFM This command allows you to reset a pending error provided the cause has been eliminated.

For example: `DEV:CFM` => `OK`*<LF>*

DEV:RST This command allows you to restart the device. The controller is restarted and the settings are read in from memory. Settings that have not yet been saved are lost.

For example: `DEV:RST` => `OK`*<LF>*

3.4.3.2.3 Output-Control

The statements of this group serve to monitor the device output. The queries can be made in any control mode. Commands are accepted only in "R", whereby the device may not be in Configuration mode either.

OUT

This command switches the device output on and off (STANDBY). Enable must have been issued for switch-on (slide switch to ON; ENABLE to ON; no error). It is also possible to query status of the device output.

Values:
- 0 STANDBY
- 1 ON

For example:	`OUT?` *<LF>*	=>	`0` *<LF>*	*(actual status: STANDBY)*
	`OUT` *<SP>* `1` *<LF>*	=>	`CER06` *<LF>*	*(no issue)*
	`OUT` *<SP>* `1` *<LF>*	=>	`OK` *<LF>*	*(new status: ON)*

SB

This statement allows you to set or read out the active memory bank. While read-out is possible in every operating mode, it may be changed in "SEQ" operating mode only if the device is switched off. The memory bank is preset via the sequence in ON state.

Value range: 0 ... 29

For example:	`SB?` *<LF>*	=>	`0` *<LF>*	*(memory bank 0 active)*
	`SB` *<SP>* `1` *<LF>*	=>	`CER03` *<LF>*	*(incorrect operating mode)*
	`SB` *<SP>* `1` *<LF>*	=>	`OK` *<LF>*	*(new memory bank: 1)*

SV

This statement allows you to set or read out the voltage setpoint.

For example:	`SV?` *<LF>*	=>	`30` *<LF>*	*(actual value: 30V)*
	`SV` *<SP>* `1` *<LF>*	=>	`OK` *<LF>*	*(new value: 1V)*

SC

This statement allows you to set or read out the current setpoint.

For example:	`SC?` *<LF>*	=>	`125` *<LF>*	*(actual value: 125A)*
	`SC` *<SP>* `20` *<LF>*	=>	`OK` *<LF>*	*(new value: 20A)*

AV

This query allows you to read out the actual voltage value from the device output.

For example:	`AV?` *<LF>*	=>	`20.500` *<LF>*	*(V_{actual} = 20.5V)*

AC

This query allows you to read out the actual current value from the device output.

For example:	`AC?` *<LF>*	=>	`100.200` *<LF>*	*(I_{actual} = 100.2A)*

AP

This query allows you to read out the actual power value from the device output.

For example:	`AP?` *<LF>*	=>	`2.054` *<LF>*	*(P_{actual} = 2.054kW)*

3.4.3.2.4 Limit-Control

The statements of this group allow you to set and configure the setpoint limits. The queries can be made in any control mode. Commands are accepted only in "REMOTE", whereby the device may not be in Configuration mode either.

LIM:CFG The statement serves the purpose of limit configuration, i.e. it is used to define or read out the response behaviour of the individual limit values. The statement contains three parameters (VLIM, CLIM, PLIM*) that may assume the following values:

Values:	0	OFF	(inactive)
	1	LOW ACTIVE	(lower setpoint limit active)
	2	HIGH ACTIVE	(upper setpoint limit active)
	3	BOTH ACTIVE	(both setpoint limits active)

For example:	LIM:CFG? *<LF>*	=>	0_0_0 *<LF>*	*(Cfg. VLIM : OFF Cfg. CLIM : OFF Cfg. PLIM : OFF)*
	LIM:CFG *<SP>* 1_4_0 *<LF>*	=>	CER05 *<LF>*	*(incorrect value range)*
	LIM:CFG *<SP>* 1_2_0 *<LF>*	=>	OK *<LF>*	*(Cfg. VLIM : LOW ACTIVE Cfg. CLIM : HIGH ACTIVE Cfg. PLIM : OFF)*

* For standard devices the value for PLIM is "0".

LIM:VH This statement allows you to set or read out the upper voltage limit value.

For example:	LIM:VH? *<LF>*	=>	30 *<LF>*	*(actual value: 30V)*
	LIM:VH *<SP>* 20 *<LF>*	=>	CER03 *<LF>*	*(incorrect operating mode)*
	LIM:VH *<SP>* 20 *<LF>*	=>	OK *<LF>*	*(new value: 20V)*

LIM:VL This statement allows you to set or read out the lower voltage limit value.

For example:	LIM:VL? *<LF>*	=>	0 *<LF>*	*(actual value: 0V)*
	LIM:VL *<SP>* 1 *<LF>*	=>	OK *<LF>*	*(new value: 1V)*

LIM:CH This statement allows you to set or read out the upper current limit value.

For example:	LIM:CH? *<LF>*	=>	125 *<LF>*	*(actual value: 125A)*
	LIM:CH *<SP>* 100 *<LF>*	=>	OK *<LF>*	*(new value: 100A)*

LIM:CL This statement allows you to set or read out the lower current limit value.

For example:	LIM:CL? *<LF>*	=>	0 *<LF>*	*(actual value: 0A)*
	LIM:CL *<SP>* 5 *<LF>*	=>	OK *<LF>*	*(new value: 5A)*

3.4.3.2.5 Protection-Control

The statements of this group allow you to set and configure the actual value monitoring functions. The queries can be made in any control mode. Commands are accepted only in "REMOTE", whereby the device may not be in Configuration mode either.

PRT:CFG The statement serves the purpose of Protection Configuration, i.e. it is used to define or read out the response behaviour of the individual monitoring values. The statement contains three parameters (VPRT, CPRT, PPRT) that may assume the following values:

Values:	0	OFF	(inactive)
	1	LOW ACTIVE	(lower monitoring value active)
	2	HIGH ACTIVE	(upper monitoring value active)
	3	BOTH ACTIVE	(both monitoring values active)

For example: `PRT:CFG?` <LF>	=>	`0_0_0` <LF>	*(Cfg. VPRT : OFF Cfg. CPRT : OFF Cfg. PPRT : OFF)*
`PRT:CFG` <SP> `1_4_0` <LF>	=>	`CER05` <LF>	*(incorrect value range)*
`PRT:CFG` <SP> `1_2_3` <LF>	=>	`OK` <LF>	*(Cfg. VPRT : LOW ACTIVE Cfg. CPRT : HIGH ACTIVE Cfg. PPRT : OFF)*

PRT:VH This statement allows you to set or read out the upper voltage monitoring value.

For example: `PRT:VH?` <LF>	=>	`30` <LF>	*(actual value: 30V)*
`PRT:VH` <SP> `20` <LF>	=>	`CER03` <LF>	*(incorrect operating mode)*
`PRT:VH` <SP> `20` <LF>	=>	`OK` <LF>	*(new value: 20V)*

PRT:VL This statement allows you to set or read out the lower voltage monitoring value.

For example: `PRT:VL?` <LF>	=>	`0` <LF>	*(actual value: 0V)*
`PRT:VH` <SP> `1` <LF>	=>	`CER03` <LF>	*(incorrect operating mode)*
`PRT:VL` <SP> `1` <LF>	=>	`OK` <LF>	*(new value: 1V)*

PRT:VDL This statement allows you to set or read out the delay time for voltage monitoring. The adjustment range is 0.1 ... 600s.

For example: `PRT:VDL?` <LF>	=>	`0.1` <LF>	*(actual value: 0.1s)*
`PRT:VDL` <SP> `1` <LF>	=>	`CER03` <LF>	*(incorrect operating mode)*
`PRT:VDL` <SP> `1` <LF>	=>	`OK` <LF>	*(new value: 1s)*

PRT:CH This statement allows you to set or read out the upper current monitoring value.

For example: `PRT:CH?` <LF>	=>	`125` <LF>	*(actual value: 125A)*
`PRT:CH` <SP> `100` <LF>	=>	`CER03` <LF>	*(incorrect operating mode)*
`PRT:CH` <SP> `100` <LF>	=>	`OK` <LF>	*(new value: 100A)*

PRT:CL This statement allows you to set or read out the lower current monitoring value.

For example: `PRT:CL?` <LF>	=>	`0` <LF>	*(actual value: 0A)*
`PRT:CL` <SP> `5` <LF>	=>	`CER03` <LF>	*(incorrect operating mode)*
`PRT:CL` <SP> `5` <LF>	=>	`OK` <LF>	*(new value: 5A)*

PRT:CDL This statement allows you to set or read out the delay time for current monitoring. The adjustment range is 0.1 ... 600s.

For example:	PRT:CDL? <LF>	=>	0.1 <LF>	*(actual value: 0.1s)*
	PRT:CDL <SP> 1 <LF>	=>	CER03 <LF>	*(incorrect operating mode)*
	PRT:CDL <SP> 1 <LF>	=>	OK <LF>	*(new value: 1s)*

PRT:PH This statement allows you to set or read out the upper power monitoring value.

For example:	PRT:PH? <LF>	=>	3 <LF>	*(actual value: 3kW)*
	PRT:PH <SP> 2.2 <LF>	=>	CER03 <LF>	*(incorrect operating mode)*
	PRT:PH <SP> 2.2 <LF>	=>	OK <LF>	*(new value: 2.2kW)*

PRT:PL This statement allows you to set or read out the lower power monitoring value.

For example:	PRT:PL? <LF>	=>	0 <LF>	*(actual value: 0kW)*
	PRT:PL <SP> 1 <LF>	=>	CER03 <LF>	*(incorrect operating mode)*
	PRT:PL <SP> 1 <LF>	=>	OK <LF>	*(new value: 1kW)*

PRT:PDL This statement allows you to set or read out the delay time for power monitoring. The adjustment range is 0.1 ... 600s.

For example:	PRT:PDL? <LF>	=>	0.1 <LF>	*(actual value: 0.1s)*
	PRT:PDL <SP> 1 <LF>	=>	CER03 <LF>	*(incorrect operating mode)*
	PRT:PDL <SP> 1 <LF>	=>	OK <LF>	*(new value: 1s)*

3.4.3.2.6 Sequence-Control

The instructions of this group serve to set and poll the status of sequences. Polling can be performed in any operator control mode. Commands are accepted only in "REMOTE".

Q:CFG The operating mode of this sequence can be configured with this instruction. The device must be switched off to change the value. It is also possible to poll the setting value.

Values:	0	MANUAL	(manual operation)
	1	AUTO (END-OFF)	(automatic operation, off at the end of sequence)
	2	AUTO (END-ON)	(automatic operation, on at the end of sequence)

For example :	Q:CFG? <LF>	=>	0 <LF>	*(actual value: MANUAL)*
	Q:CFG 1 <LF>	=>	CER07 <LF>	*(power supply is not switched off)*
	Q:CFG 1 <LF>	=>	<LF>	*(new value: AUTO END-OFF)*

Q:SLN The number of loop passes can be set or read out with this instruction. The device must be switched off to change a value in Automatic mode.

Value range: 0 ... 255 (0 = endless)

For example:	Q:SLN? <LF>	=>	0 <LF>	*(actual value: endless loop)*
	Q:SLN <SP> 1000 <LF>	=>	CER05 <LF>	*(incorrect value)*
	Q:SLN <SP> 2 <LF>	=>	OK <LF>	*(new value: 2 loops)*

Q:SSN The number of steps per loop pass can be set or read out with this instruction. The device must be switched off to change a value in Automatic mode.

Value range: 1 ... 100

For example:	Q:SSN? <LF>	=>	100 <LF>	*(actual value: 100 steps)*
	Q:SSN <SP> 6 <LF>	=>	CER03 <LF>	*(incorrect control mode)*
	Q:SSN <SP> 6 <LF>	=>	OK <LF>	*(actual value: 6 steps)*

3. Description of Function

VE3PUID digitally programmable (FW: 01.02.xx)

Q:SSB This instruction allows you to define or read out the memory bank for the currently selected step. The device must be switched off to change a value in Automatic mode.

Value range: 0 ... 29

For example:	Q:SSB? *<LF>*	=>	0 *<LF>*	*(actual value: bank 0)*
	Q:SSB *<SP>* 30 *<LF>*	=>	CER05 *<LF>*	*(incorrect value)*
	Q:SSB *<SP>* 3 *<LF>*	=>	OK *<LF>*	*(new value: bank 3)*

Q:SST This instruction allows you to define or read out the dwell time for the currently selected step. The device must be switched off to change a value in Automatic mode.

Value range: 0.01 ... 600.00s

For example:	Q:SST? *<LF>*	=>	0.5 *<LF>*	*(actual value: 0.5s)*
	Q:SST *<SP>* 601 *<LF>*	=>	CER05 *<LF>*	*(incorrect value)*
	Q:SST *<SP>* 1 *<LF>*	=>	OK *<LF>*	*(new value: 1s)*

Q:AL The current loop is polled with this instruction.

For example:	Q:AL? *<LF>*	=>	0 *<LF>*	*(actual loop: 0)*

Q:AS The current steps of the sequence are set or polled with this instruction. The device must be switched off to change a value in Automatic mode.

Value range: 0 ... number of steps - 1

For example:	Q:AS? *<LF>*	=>	1 *<LF>*	*(actual step: 1)*
	Q:AS 7 *<LF>*	=>	CER05 *<LF>*	*(incorrect value)*
	Q:AS 2 *<LF>*	=>	OK *<LF>*	*(actual step: 2)*

Q:AST The dwell time of the current step elapsed is polled with this instruction.

For example:	Q:AST? *<LF>*	=>	1.200 *<LF>*	*(actual step time: 1.2s)*

Q:RS A sequence can be restarted with this command. This is possible during the sequence run or if a sequence configured as "AUTO (END-ON)" is complete. The advantage of this function is that the sequence restart can be performed without having to specially switch off the device.

For example:	Q:RS *<LF>*	=>	OK *<LF>*

3.4.4 General Information on Remote Control via RS232

Certain information on remote control via the RS232 interface is provided below. This is intended to familiarise the user a little with the behaviour of the device and provide assistance:

- Transmission of an instruction and processing thereof by the device are subdivided into the following phases:

  Reception of the instruction string:

  The user sends the instruction string to the device and the string is written, byte by byte, into the receive buffer. The instruction string is completed with the termination character. The transfer time required for this depends on the string length and the baud rate used.

  Evaluation and processing:

  A syntax check of the character string is first conducted in the receive buffer. The instruction type is then determined. If the instruction is a poll function, the corresponding value is transferred to the send buffer. In the event of a command, the parameters also transferred are checked and accepted. If an error has occurred, the corresponding error code is transferred to the transmit buffer. The time required for this phase is dependent on the instruction and instruction type and amounts to approx. 4...16ms.

  Sending the device response:

  The device returns the prepared data from the send buffer to the user. The transfer time required for this is dependent on the string length and the baud rate used.

  NOTE: Transfer times can be calculated on the basis of the string length and the table for the transfer times per data byte in Chapter "Connection and configuration of the RS232 interface".

- If the termination character of an instruction has been received, reception is barred for further messages. The next instruction may not be received by the device until after the device response. Otherwise, a communication error is signalled.
- In principle, any number of characters may be received after reception of the first character of an instruction through to the termination character. The plausibility check is not performed until the termination character is received, and the Enable signal is then issued for the next instruction. Consequently, it may certainly be practical to send a "dummy instruction" consisting only of the termination character to the device so as to initialise the receive buffer.
- Many settings, if changed, result in adaptation of another setting. For example, the voltage setpoint is adapted to a limit if the limit has been activated and the setpoint lay outside the defined range. This adaptation occurs after a time delay, for technical reasons, so that the updated value is not available until after approx. 100ms.
- The functions for reception of instructions via the RS232 interface have a very high priority for technical reasons. Commands should also be detected and accepted as soon as possible. For this reason, programmed times (protection delay times and sequence times) may be falsified as the result of instructions via the RS232 interface. In the worst case, this may result in a time delay of approx. 3ms per instruction. It can be seen that the total error is dependent on the updating rate and the communication density. Consequently, no generally valid statement on the deviations can be made easily. It is advisable to update values via the interface no more quickly than every 100ms.
- After commands "DEV:SAV" and "DEV:RCL" have been received, signal "OK" is returned. This is done immediately on reception of the commands and not after termination of the corresponding function. The save process is complete after approx. 3 seconds, and retrieving the settings takes approx. 1s.

3.5 Remote Control via CAN

NOTE: What is said below assumes that the reader has a basic knowledge of CAN and CANopen.

3.5.1 Overview

• **CANopen-Functionality**	according to "CiA Draft Standard 301, Version 4.02" (CANopen - Application Layer and Communication Profile
Type of device	- CANopen Slave
Functions supported	- Bootup - NMT - SYNC-Consumer - Emergency Object - Heartbeat-Producer - SDO Communication (Expedited, Segmented) - PDO Communication - STORE / RESTORE
Functions not supported	- SYNC-Producer - Heartbeat-Consumer - SDO Block Transfer - PDO Inhibit Time - LSS - Node Guarding - Time Stamp
Frame format used	- Standard format (11-Bit Identifier)
Node address	- adjustable via menu (adjustment range: 1...127)
Service data	- 1 Transmit / 1 Receive SDO
Process data	- fixed PDO Mapping - 4 Transmit / 3 Receive PDOs
Communication parameter	- Changes are saved only to RAM and not saved to non-volatile memory
Remote-Frames	- according to "CiA Application Note 802" will be not supported
• **Bus connection**	according to ISO 11898-2 (Road vehicles CAN Part 2: High speed medium access unit)
Baud rates	- 10, 20, 50, 125, 250, 500, 800, 1000 kBit/s
• **Visualization**	according to "CiA Draft Recommendation 303-3, Version 1.0" (CANopen - Additional specification Part 3: Indicator specification)

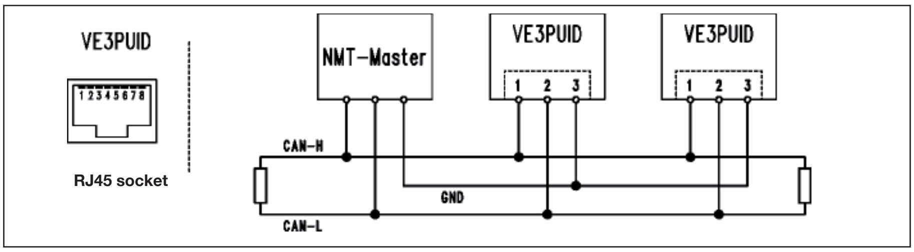
RUN-LED	- CAN-Interface inactive	off
	- Stopped	flashing (200ms / 1000ms)
	- Pre-Operational	flashing (200ms / 200ms)
	- Operational	on
ERROR-LED	- no error	off
	- error active/passive	flashing (200ms / 1000ms)
	- bus off	on

NOTE: The terms "Receive", "Transmit", "Download" and "Upload", used below in conjunction with CANopen services, must always be considered from the point of view of the power supply unit. Receive and Download services are used to receive data from the power supply unit, and Transmit and Upload services are used by the power supply unit to transmit data.

3.5.2 Connection and Configuration

The power supply unit features a CAN interface for coupling to a CAN Highspeed Network in accordance with ISO 11898-2 and can be connected to such a CAN Highspeed Network via a suitable connection cable.

The adjacent illustration shows the pin assignment of the connector used for this and a schematic overview of the structure of the CAN network.



NOTE: When setting up the bus, ensure that the power supply unit has an electrically isolated interface. The GND signal should consequently be co-routed in the CAN cable. The devices (bus nodes) connected to the bus then have a standard reference potential. A shielded cable is recommended as data cable. The CAN-H and CAN-L signals should be routed through twisted-pair cables. The GND signal can be applied to shield. Special cable types for CAN are available from most cable manufacturers. The ends of the bus must also be terminated with 120Ω. This must be done by the user. The power supply unit itself does not have a terminating resistor. The CAN network may not branch either. Exceptions are short stub lines to the bus nodes that should not exceed a length of 30cm. In addition, when designing the network, note that the maximum extent of the network will depend on the transfer rate used. The table below shows the recommended maximum line lengths for the various bit rates, recommended in accordance with CiA DS 102:

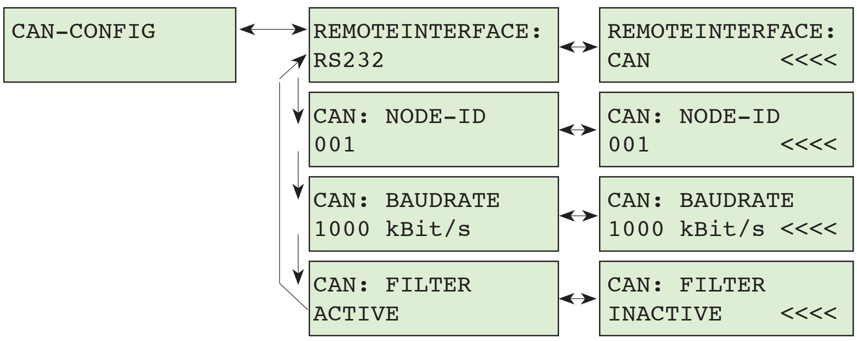
Bit rate / kBit/s	max. length of line /m
10	5000
20	2500
50	1000
125	500

Bit rate / kBit/s	max. length of line /m
250	250
500	100
800	50
1000	25

The power supply unit must be configured in order to allow it to operate on the bus. This involves firstly setting the node address (Node ID). The setting range for this is 1...127. Address 0 is reserved for network management. Each node address may be assigned only once. In addition, the power supply unit must be set to the transfer rate of the bus. Speeds of 10 or 1000kbit/s can be set. One other programming option with respect to the CAN interface is the acceptance filter. This allows you to enhance message reception and performance. Please refer to the corresponding Chapter for a precise description.

The CAN interface is set in "CONFIG" operating mode.

The starting point is the "CAN-CONFIG" display at Status level. After a switch to Select level, you can select the required parameter and then edit it at Edit level. A newly set value is not accepted until confirmation with the "ENTER" key.



NOTE: The required interface can be selected with "REMOTEINTERFACE". Only one interface can be used at any one time.

NOTE: The controller must be restarted in order to allow you to accept new settings in respect of the selected interface. This can be done by pressing the "RESET" button. A restart is performed automatically if you have selected a new interface with "REMOTEINTERFACE".

3.5.3 Predefined Connection Set

The Predefined Connection Set has been specified in CANopen in order to implement simple configuration of bus users. For a network with one Master and 127 Slaves, it supplies the basic assignment in respect of services and bus nodes. The 11-bit identifier is split into a 4-bit function code and a 7-bit node address (Node ID) using the CAN Standard Frame Format. The function code defines the service and its priority. The node address is used to assign the message to a bus user. Messages may consequently be sent only by one single user at any one time. The resultant ID ranges and the data directions of the services are shown below for the various services:

Service		ID (bin)		ID (dec)	ID (hex)	from the Device	to the Device
		Function	Node				
NMT		0000	0000000	0	000		✓
SYNC		0001	0000000	128	080		✓
EMCY		0001	xxxxxxx	129...255	081...0FF	✓	
PDO1	Tx	0011	xxxxxxx	385...511	181...1FF	✓	
	Rx	0100	xxxxxxx	513...639	201...27F		✓
PDO2	Tx	0101	xxxxxxx	641...767	281...2FF	✓	
	Rx	0110	xxxxxxx	769...895	301...37F		✓
PDO3	Tx	0111	xxxxxxx	897...1023	381...3FF	✓	
	Rx	1000	xxxxxxx	1025...1151	401...47F		✓
PDO4	Tx	1001	xxxxxxx	1153...1279	481...4FF	✓	
	Rx	1010	xxxxxxx	1281...1407	501...57F		✓
SDO	Tx	1011	xxxxxxx	1409...1535	581...5FF	✓	
	Rx	1100	xxxxxxx	1537...1663	601...67F		✓
BOOTUP/HEARTBEAT		1110	xxxxxxx	1793...1919	701...77F	✓	

3.5.4 States

Various states that a network node may assume in respect of communication have been specified in CANopen. The stage transitions are implemented by the corresponding events with an internal state machine. A distinction is made between the following states:

Initialisation This phase is run through after Power-Up or after a Reset. The device and communication parameters are initialised. The power supply unit is not integrated in the communication process during this phase. It is transitioned automatically to "Pre-Operational" state after completion of the initialisation process.

Pre-Operational This state is used to program the power supply unit. The user has access to the object directory via the SDO services. This allows application-specific settings, such as the Heartbeat Time, to be made. PDO services are not processed.

Operational The power supply unit is fully integrated in the network. In this state, the process data can also be exchanged via the PDO services.

Stopped The power supply unit is disconnected from network operation in this state. Access is provided only via the NMT services.

The table below provides an overview of what communication services are allowed in what state:

	Initialisation	Pre-Operational	Operational	Stopped
NMT		✓	✓	✓
SYNC		✓	✓	
EMCY		✓	✓	
PDO			✓	
SDO		✓	✓	
Bootup	✓			
Heartbeat		✓	✓	✓

NOTE: The power supply unit is automatically in "Pre-Operational" state after Power-Up.

3.5.5 Communication Services

3.5.5.1 Network Management (NMT)

CANopen network management is designed as a Master/Slave system. The Master has the option of changing the state of the Slaves with the NMT message. The NMT messages are not confirmed by the Slaves.

An NMT message is sent with identifier "0" and consequently has highest priority in the network. It contains two data bytes, whereby data byte 0 contains the command code and data byte 1 contains the node address. The possible values that the command code may assume are listed below:

01h (1d)	Start Remote Node	(Switch to "Operational" state)
02h (2d)	Stop Remote Node	(Switch to "Stopped" state)
80h (128d)	Enter Pre-Operational State	(Switch to "Pre-Operational" state)
81h (129d)	Reset Node	
82h (130d)	Reset Communication	

NOTE: The command applies to all bus nodes if "0" is entered as the node address. This allows the entire network to be started with one single command for example.

NOTE: An initialisation procedure is required for resetting the communication parameters. Consequently, "Reset Communication" also results in a restart (Reset) of the controller

3.5.5.2 Synchronisation Object (SYNC)

In the case of specific applications, it may be necessary to coordinate the run times of certain applications and consequently obtain a shared timebase. The synchronisation object (SYNC) is intended for this. It is used in conjunction with the process data objects (PDOs) that have been set for synchronous mode. It can be used to query the device data (Transmit PDOs) and to accept new data (Receive PDOs).

The SYNC object is a message without data bytes. By default, identifier "80h" is used, signifying a higher priority. However, the user has the option of defining a new ID via object 1005h. This allows the user to activate individual device groups with various SYNC objects.

NOTE: The power supply unit is simply a SYNC consumer, i.e. it can simply receive a SYNC object and respond to it depending on its configuration. It is not possible to operate the power supply unit as SYNC producer, i.e. as a sender of SYNC objects.

3.5.5.3 Emergency (EMCY)

An Emergency message is a message signalling an error and sent independently by the power supply unit. A distinction is made between application errors (device-specific) and communication errors.

By default, "80h + Node" is used as the identifier for the Emergency message. This signifies a high priority. However, the user has the option of defining a different, new ID via object 1014h.

The Emergency message contains 8 data bytes. Byte 0 and byte 1 contain an error code. Byte 2 indicates the content of object 1001h. Bytes 3...7 are intended for manufacturer-specific information.

The implemented error codes that can be sent are listed below:

0000h	Error has been reset, no error now pending	
1000h	Assignment:	Common device error
3120h	Assignment:	Lower limit of input voltage undershot (PFS)
8110h	Communication:	CAN-Overflow - Message has been lost
8150h	Communication:	COB-ID crash
8210h	Communication:	incorrect PDO-length

NOTE: The error status of the device represented in object 2021h is also sent in bytes 3..7 in the case of general device error.

3.5.5.4 Process Data Objects (PDOs)

Process data objects (PDOs) serve to transfer real-time data. The data should be sent in this case without appreciable overhead wherever possible. This is why only pure useful data is sent and no protocol-specific data. The max. 8 data bytes can be utilised to the full for process data. It is necessary to redefine what data is sent via what channel. No confirmation signal is used either since this would result in a substantial reduction in bus bandwidth.

NOTE: Data transfer via PDOs is not possible until the device is in "Operational" state.

NOTE: Since PDO messages are not confirmed, the user should monitor whether data to the power supply unit actually has been accepted by the power supply unit. If, for instance, the output is switched off, you should check whether the output has actually been switched off. This prevents unintended states of the power supply unit.

The user has available 3 Receive PDOs (RPDOs) for sending data to the power supply unit and 4 Transmit PDOs (TPDOs) for reception of data from the power supply unit. Communication via the PDOs must be configured accordingly in order for it to function correctly. This requires assignment of the PDO data to the object directory (PDO mapping) on the one hand and definition of the transfer parameters on the other.

Receive PDOs (Data to the Power Supply)

Mapping is performed with objects 1600h...1602h for the RPDOs and with objects 1A00h...1A03h for the TPDOs. Fixed mapping is used, i.e. the assignment to the object directory is a permanent assignment and cannot be changed by the user. PDO mapping of the power supply unit is explained below:

Receive PDOs (Data to the Power Supply)						
Name	**Byte**	**Object**	**Index**	**Sub**	**Value range**	**Note**
RPDO1	0	OUT	2000h	01h	0...1	OFF/ON
	1	SETBANK	2001h	01h	0...29	Memory bank
	2..7	---	---	---	---	---
RPDO2	0..3	VSET	2202h	01h	0...Vmax	Vset in mV
	4..7	---	---	---	---	---
RPDO3	0..3	ISET	2402h	01h	0...Imax	Iset in mA
	4..7	---	---	---	---	---

NOTE: Data transfer is performed in "Little Endian Format" (least significant byte first).

The transfer parameters for the RPDOs are defined with the objects 1400h...1402h. The identifier for the corresponding PDO channel is defined in subindex 1 in each case. A 32-bit-coded value is entered for this, and its breakdown is described below:

31	*30*	*29*	*28 ... 11*	*10 ... 0*
X	1	0	000000000000000000	XXXXXXXXX
active	*no RTR*	*STD*	*reserved for EXT-ID*	*STD-ID*

The most significant bit 31 defines whether the PDO is active (1=inactive; 0=active). Optionally, using bit 30, it is possible to define whether Remote Frames are allowed for the PDO (not allowed, consequently bit 30=1). Optionally, bit 29 can be used to select the CAN frame format (default format with 11-bit IDs used, consequently bit 29=0). Bits 0...10 define the actual identifier.

In respect of transfer mode, CANopen distinguishes between synchronous and asynchronous RPDOs. In the case of synchronous RPDOs, the SYNC object is used as the trigger signal for data acceptance, so to speak, i.e. the data is accepted with the next SYNC object. In the case of asynchronous RPDOs, the data is accepted directly.

The RPDO transfer mode is configured in sub-index 2 of the aforesaid objects. An PRDO is configured as synchronous with values 0...240 and is configured as asynchronous with values 254 and 255.

Transmit-PDOs (Data from Power Supply)

Mapping for the TPDOs is performed with objects 1A00h...1A03h. Fixed mapping is used, i.e. there is a fixed assignment to the object directory, and this cannot be changed by the user. The assignment is outlined below:

Transmit PDOs (Data from Power Supply)						
Name	**Byte**	**Object**	**Index**	**Sub**	**Value range**	**Note**
TPDO1	0..1	DEV_STATE	2020h	01h	0...FFFFh	Status word (bit-coded)
	2..3	DEV_ERROR	2021h	01h	0...FFFFh	Error word (bit-coded)
	4..5	DEV_FLAG	2023h	01h	0...FFFFh	Flag word (bit-coded)
	6..7	---	---	---	---	---
TPDO2	0..3	VACT	2201h	01h	0...1.05*Vmax	Vact in mV
	4..7	VSET	2202h	01h	0...Vmax	Vset in mV
TPDO3	0..3	IACT	2401h	01h	0...1.05*Imax	Iact in mA
	4..7	ISET	2402h	01h	0...Imax	Iset in mA
TPDO4	0..3	PACT	2601h	01h	0...1.05*Pmax	Pact in 100mW
	4..7	---	---	---	---	---

NOTE: Data transfer is performed in "Little Endian Format" (least significant byte first).

The transfer parameters for the TPDOs are defined with objects 1800h...1803h. Here as well, the identifier for the corresponding PDO channel is defined in sub-index 1. The format of this 32 bit-coded value is identical to that of the RPDOs (see above).

A distinction is made between synchronous and asynchronous TPDOs for the transfer mode. Synchronous TPDOs are used together with the SYNC object with which data output is initiated. Data output via asynchronous TPDOs is performed on the basis of the selectable "Event Time".

The TPDO transfer mode is configured in sub-index 2 of the aforesaid objects. The TPDO is configured as synchronous TPDO with values 0...240. This defines the number of SYNCs after which the TPDO is transmitted. Values 0 and 1 are handled equally, i.e. transmission occurs after the next SYNC. Configuration as asynchronous TPDO is performed with values 254 and 255. The TPDO is then transmitted after the "Event-Time" set in sub-index 5. The value of this event time is entered in milliseconds. If a 0 is entered, the TPDO is inactive. The optional transfer modes 252 and 253 are not supported owing to the problems relating to Remote Frames (see "CiA Application Note 802").

NOTE: You are advised to deactivate PDOs not used so as to reduce data traffic on the bus. This can be done by setting bit 31 when defining the identifier. This can also be done in the case of TPDOs by configuring the TPDO as asynchronous and setting the Event-Time to "0".

NOTE: The extensive configuration options of the PDOs allow a high level of flexibility but do pose the risk of an unexpected response on the part of the power supply unit. Consequently, great care should be taken when planning communication.

3.5.5.5 Service Data Objects (SDO)

Service data objects (SDOs) serve the purpose of read or write access to the object directory and, consequently, access to internal device data. They are primarily intended for configuration of the power supply unit. Consequently, the focus is not on the real-time behaviour, thus allowing a certain level of overhead. SDOs are also intended for transferring large quantities of data. A data package is then distributed over several messages.

CANopen foresees the three SDO transfer modes "Expedited", "Segmented" and "Block". SDO block transfer has not been implemented on the power supply unit. Expedited Transfer will be explained in greater detail below. This transfer mode also allows all objects of the object directory to be controlled, apart from objects 1008h (device name), 1009h (hardware version) and 10Ah (firmware version). Consequently, we shall not discuss Segmented Transfer in further detail at this point. You can read up on it in the CANopen Specification "CiA Draft Standard 301, Version 4.02".

Data exchange via SDOs is based on a "Client-Server" communication model and is basically split into the three phases "Initiation", "Data exchange" and "Termination". The data is already exchanged in the initialisation phase with Expedited Transfer. The two other phases do not apply.

For each power supply unit, SDO transfer is performed with two identifiers that are permanently assigned via the "Predefined Connection Set" and that cannot be changed. A request is sent to the Server (the power supply unit) from the Client (generally the Network Master) via the SDO-Rx ID. This request initiates either transmission of the required data (upload) or reception of data (download). The Server then sends its confirmation (including the data in the case of upload) via the SDO-Tx ID to the Client. If an error occurs during transfer, transfer is aborted with an "Abort" message. This may be issued either by the Client or by the Server.

An SDO message is always sent with 8 data bytes. It is obvious that not all 8 data bytes can be used for the useful data and that it is necessary to integrate protocol information. Data byte 0 contains the function code of the message. This defines the transfer mode, transfer direction and number of data bytes. Data byte 1 and 2 contain the index of the object that is to be accessed. Data byte 3 contains the subindex. Data bytes 4...7 are available for the useful data.

NOTE: Object index and data bytes are entered in "Little Endian Format" (least significant byte first).

The various Client and Server function codes for Expedited Transfer are listed below:

Upload:	Client-Request (data request):	`40h`	(initiate upload request)
	Server-Confirmation (data broadcast):	`4Fh`	(initiate upload response / 1Byte / expedited)
		`4Bh`	(initiate upload response / 2Byte / expedited)
		`47h`	(initiate upload response / 3Byte / expedited)
		`43h`	(initiate upload response / 4Byte / expedited)
Download:	Client-Request (data broadcast):	`2Fh`	(initiate download request / 1Byte / expedited)
		`2Bh`	(initiate download request / 2Byte / expedited)
		`27h`	(initiate download request / 3Byte / expedited)
		`23h`	(initiate download request / 4Byte / expedited)
	Server-Confirmation (receipt):	`60h`	(initiate download response)

An Abort message also has the above-described format. "80h" is entered as the function code. An SDO-specific 32-bit error code that is listed below is sent with the data bytes (bytes 4...7):

`0503 0000h`	Toggle-Bit has not change (at Segmented Transfer)
`0504 0000h`	SDO Time-Out
`0504 0001h`	Client-/Server-Command unnown
`0504 0005h`	not enough memory
`0601 0000h`	Access: Object access not supported
`0601 0001h`	Access: Read access to Write-Only Object
`0601 0002h`	Access: Write access to Read-Only Object
`0602 0000h`	Object not present

3. Description of Function

VE3PUID digitally programmable (FW: 01.02.xx)

0604 0041h	PDO-Mapping: Object can not be mapped
0604 0042h	PDO-Mapping: Number and length of the object incorrect
0604 0043h	General parameter incompatibility
0604 0047h	General internal device incompatibility
0606 0000h	No access owing to hardware errors
0607 0010h	Invalid type of data, invalid parameter length
0607 0012h	Invalid type of data, exeeded parameter length
0607 0013h	Invalid type of data, too short parameter length
0609 0011h	Subindex not present
0609 0030h	Parameter: exeeded value range
0609 0031h	Parameter: Value too high
0609 0032h	Parameter: Value too low
0609 0036h	Parameter: Maximum value falls below minimum value
0800 0000h	Common error
0800 0020h	Data cannot be transferred or saved
0800 0021h	Data cannot be transferred or saved owing to local operating mode
0800 0022h	Data cannot be transferred or saved owing to current operating status
0800 0023h	No object index available

Various examples of SDO data transfer with a device (Node ID: 1) are shown below:

1.) 1.) Read-out of the current memory bank (Index: 2001 / Subindex: 1 / 1 Data byte)

		DB0	DB1	DB2	DB3	DB4	DB5	DB6	DB7	
Client: (request)	601h	40h	01h	20h	01h	00h	00h	00h	00h	
	ID (SDO-Rx)	*Cmd*	*Index*		*Sub*	*Data*				

		DB0	DB1	DB2	DB3	DB4	DB5	DB6	DB7	
Server: (response)	581h	4Fh	01h	20h	01h	1Dh	00h	00h	00h	Memory bank 29
	ID (SDO-Tx)	*Cmd*	*Index*		*Sub*	*Data*				

2.) Vset change to 10V (Index: 2202 / Subindex: 1 / 4 Data bytes)

		DB0	DB1	DB2	DB3	DB4	DB5	DB6	DB7	
Client: (request)	601h	23h	02h	22h	01h	10h	27h	00h	00h	
	ID (SDO-Rx)	*Cmd*	*Index*		*Sub*	*Data*				

		DB0	DB1	DB2	DB3	DB4	DB5	DB6	DB7	
Server: (response)	581h	60h	02h	22h	01h	00h	00h	00h	00h	10000 = 2710h
	ID (SDO-Tx)	*Cmd*	*Index*		*Sub*	*Data*				

3.) Switch on output (Index: 2000 / Subindex: 1 / 1 Data byte)

		DB0	DB1	DB2	DB3	DB4	DB5	DB6	DB7	
Client: (request)	601h	2Fh	00h	20h	01h	01h	00h	00h	00h	
	ID (SDO-Rx)	*Cmd*	*Index*		*Sub*	*Data*				

		DB0	DB1	DB2	DB3	DB4	DB5	DB6	DB7	
Server: (response)	581h	80h	00h	20h	01h	22h	00h	00h	08h	Abort (0800 0022h)
	ID (SDO-Tx)	*Cmd*	*Index*		*Sub*	*Data*				

NOTE: Response times to downloads or uploads are not specified and also depend on the bus load.

NOTE: As mentioned above, SDO messages are always sent with 8 data bytes. Consequently, excess data bytes are also sent in the case of messages with less than 4 bytes useful data. These excess data bytes are not necessarily set to "0", i.e. the user must ensure that the correct data bytes are evaluated in the case of an SDO message.

3.5.5.6 Bootup/Heartbeat

On termination of the initialisation phase, the device transitions to Pre-Operational status. With this state transition, the device sends a so-called "Bootup" message signalling its presence on the bus.

The Heartbeat is a service for device monitoring. The device cyclically sends a sign-of-life message that can be evaluated by one or more bus users. The message contains the device state described in Chapter "States" in respect of CAN communication.

The Heartbeat Time is configured in object 1017h. The time between two Heartbeat messages in milliseconds (min. 10ms) is set. If value zero is entered, Heartbeat is inactive.

The Bootup and Heartbeat messages are sent with identifier "700h + Node" and contain one data byte. This data byte represents the device state with the following values:

`00h (0d)`	Bootup
`04h (4d)`	Stopped
`05h (5d)`	Operational
`7Fh (127d)`	Pre-Operational

NOTE: The device is only a Heartbeat Producer, i.e. it is only able to produce Heartbeats. It is not possible to monitor the Heartbeats of other devices with the device (Heartbeat-Consumer).

3.5.5.7 Store/Restore

Configuring the communication parameters of users in a CANopen network is frequently very complex. It is consequently desirable to save the settings to non-volatile memory or restore them from this memory. This option is provided with objects 1010h and 1011h:

Save:

Object 1010h serves to save the CANopen communication parameters, i.e. the editable objects from area 1000h ... 1FFFh are saved to EEPROM. The CAN interface is initialised accordingly in this way if the device is restarted.

Saving is initiated with an SDO transfer (download request). The user sends a send request for object 1010h to the device, whereby sub-index 1 or 2 can be used. This send request sends ASCII code "save". If this code is received correctly by the device, a confirmation message is returned and saving is started. The SDO transfer for this functionality is outlined below:

SDO-Download (Index: 1010h ; Subindex: 1 ; 4 Data bytes)

Client:
(request)

	DB0	*DB1*	*DB2*	*DB3*	*DB4*	*DB5*	*DB6*	*DB7*	
601h	**23h**	**10h**	**10h**	**01h**	**73h**	**61h**	**76h**	**65h**	"s","a","v","e"
ID (SDO-Rx)	*Cmd*	*Index*		*Sub*	*Data*				

Server:
(response)

	DB0	*DB1*	*DB2*	*DB3*	*DB4*	*DB5*	*DB6*	*DB7*
581h	**60h**	**10h**	**10h**	**01h**	00h	00h	00h	00h
ID (SDO-Tx)	*Cmd*	*Index*		*Sub*	*Data*			

Restore:

Object 1011h is used to retrieve the CANopen communication parameters, i.e. to reset to the factory default settings. This function saves the basic settings of the editable objects from area 1000h ... 1FFFh to EEPROM. These settings are not activated until after a restart since this is the only way of initialising the CAN interface with the new settings.

The CANopen communication parameters are also retrieved with an SDO transfer (download request). The user sends a send request for object 1011h to the device. Here as well, sub-index 1 or 2 can be used. This send request sends ASCII code "load". If the device receives the code correctly, a confirmation message is sent and saving of the basic settings to EEPROM is started. The SDO transfer for this functionality is outlined below:

SDO-Download (Index: 1011h ; Subindex: 2 ; 4 Data bytes)

Client:
(request)

	DB0	DB1	DB2	DB3	DB4	DB5	DB6	DB7
601h	23h	11h	10h	02h	6Ch	6Fh	61h	64h
ID (SDO-Rx)	Cmd	Index		Sub	Data			

"l","o","a","d"

Server:
(response)

	DB0	DB1	DB2	DB3	DB4	DB5	DB6	DB7
581h	60h	11h	10h	02h	00h	00h	00h	00h
ID (SDO-Tx)	Cmd	Index		Sub	Data			

NOTE: If the mains unit receives an incorrect code with one of these functions, the response is an SDO Abort message with error code "0800 0020" (unable to transfer data).

NOTE: The basic settings of the CANopen communication parameters are shown in the tables further to the overview of the object directory.

NOTE: Store and Restore relate solely to the CANopen communication parameters. No other settings are saved or retrieved with these functions.

3.5.6 Object Directory

Abbreviations used:

access modes:
- RO Read Only
- WO Write Only
- RW Read / Write

Data types:
- U08 unsigned 8-Bit number (unsigned char)
- U16 unsigned 16-Bit number (unsigned int)
- U32 unsigned 32-Bit number (unsigned long)
- String character string

Structure of the object directory:
- 1000h ... 1FFFh communication profile
- 2000h ... 5FFFh manufacturer-specific area
- 6000h ... 9FFFh standardised device profiles (not used)

3.5.6.1 Communication Profile (Overview)

NOTE: The objects from the communication profile relevant to operation of the device have already been explained in the previous chapters. A detailed description of the other objects was intentionally omitted. You can read up on this information in the CANopen Specification "CiA Draft Standard 301, Version 4.02".

NOTE: The basic settings of the editable communication objects (access: RW) that are loaded in the case of factory default settings or when the CAN communication parameters are restored via object 1011h are entered in column "Default".

Communication profile: common						
Index	**Sub**	**Name**	**Access**	**Type**	**Default**	**Note**
1000h	0	device type	RO	U32	0	no device profile
1001h	0	error register	RO	U08	0	last error
1002h	0	manufacturer status	RO	U32	0	Status- and error word of the unit
1003h	0	number of errors	RO	U08	0	Number of errors
	1	error 1	RO	U32	0	
	2	error 2	RO	U32	0	
	3	error 3	RO	U32	0	
	4	error 4	RO	U32	0	
1005h	0	SYNC-ID	RW	U32	80h	
1008h	0	device name	RO	string		e.g. „VE3PUID 30.125“
1009h	0	hardware version	RO	string		e.g. „58200002.00“
100Ah	0	firmware version	RO	string		e.g. „01.00.00“
1010h	0	number of entries	RO	U08		Parameter store:
	1	save comm.-param.	RW	U32		Communication parameter
	2	save comm.-param.	RW	U32		Communication parameter
1011h	0	number of entries	RO	U08		Param. recover:
	1	restore comm.-param.	RW	U32		Communication parameter
	2	restore comm.-param.	RW	U32		Communication parameter
1014h	0	EMCY-ID	RW	U32	80h + Node	
1017h	0	heartbeat time	RW	U16	0	in ms (min. 10ms)
1018h	0	number of entries	RO	U08	4	
	1	vendor ID	RO	U32	214h	
	2	product code	RO	U32		
	3	revision number	RO	U32		internal CAN-Revision
	4	serial number	RO	U32		

EMC + Safety tested

Communication profile: Receive PDO Communication Parameter						
Index	**Sub**	**Name**	**Access**	**Type**	**Default**	**Note**
1400h	0	number of entries	RO	U08	2	RPDO1:
	1	COB-ID	RW	U32	40000200h + Node	Identfier
	2	transmission type	RW	U08	255	query of data at once
1401h	0	number of entries	RO	U08	2	RPDO2:
	1	COB-ID	RW	U32	40000300h + Node	Identfier
	2	transmission type	RW	U08	255	query of data at once
1402h	0	number of entries	RO	U08	2	RPDO3:
	1	COB-ID	RW	U32	40000400h + Node	Identfier
	2	transmission type	RW	U08	255	query of data at once

Communication profile: Receive PDO Mapping Parameter						
Index	**Sub**	**Name**	**Access**	**Type**	**Default**	**Note**
1600h	0	number of objects	RO	U08	2	RPDO1: number
	1	mapping of object 1	RO	U32	20000108h	Object1: OUT
	2	mapping of object 2	RO	U32	20010108h	Object2: SETBANK
1601h	0	number of objects	RO	U08	1	RPDO2: number
	1	mapping of object 1	RO	U32	22020120h	Object1: Vset
1602h	0	number of objects	RO	U08	1	RPDO3: number
	1	mapping of object 1	RO	U32	24020120h	Object1: Cset

Communication profile: Transmit PDO Communication Parameter						
Index	**Sub**	**Name**	**Access**	**Type**	**Default**	**Note**
1800h	0	number of entries	RO	U08	3	TPDO1:
	1	COB-ID	RW	U32	40000180h + Node	Identfier
	2	transmission type	RW	U08	1	Sending with each SYNC
	5	event timer	RW	U16	0	Sending cycle (in ms)
1801h	0	number of entries	RO	U08	3	TPDO2:
	1	COB-ID	RW	U32	40000280h + Node	Identfier
	2	transmission type	RW	U08	1	Sending with each SYNC
	5	event timer	RW	U16	0	Sending cycle (in ms)
1802h	0	number of entries	RO	U08	3	TPDO3:
	1	COB-ID	RW	U32	40000380h + Node	Identfier
	2	transmission type	RW	U08	1	Sending with each SYNC
	5	event timer	RW	U16	0	Sending cycle (in ms)
1803h	0	number of entries	RO	U08	3	TPDO4:
	1	COB-ID	RW	U32	40000480h + Node	Identfier
	2	transmission type	RW	U08	1	Sending with each SYNC
	5	event timer	RW	U16	0	Sending cycle (in ms)

Communication profile: Transmit PDO Mapping Parameter						
Index	Sub	Name	Access	Type	Default	Note
1A00h	0	number of objects	RO	U08	3	TPDO1: number
	1	mapping of object 1	RO	U16	20200110h	object1: STATE
	2	mapping of object 2	RO	U16	20210110h	Object2: ERROR
	3	mapping of object 3	RO	U16	20230110h	Object2: FLAGS
1A01h	0	number of objects	RO	U08	2	TPDO1: number
	1	mapping of object 1	RO	U32	22010120h	object1: Vact
	2	mapping of object 2	RO	U32	22020120h	Object2: Vset
1A02h	0	number of objects	RO	U08	2	TPDO1: number
	1	mapping of object 1	RO	U32	24010120h	object1: Cact
	2	mapping of object 2	RO	U32	24020120h	Object2: Cset
1A03h	0	number of objects	RO	U08	1	TPDO1: number
	1	mapping of object 1	RO	U32	26010120h	Object1: Pact

3.5.6.2 Manufacturer-specific Area (Overview)

NOTE: Value "1" is always entered in sub-index 0 (number of sub-indices used) on the objects in the manufacturer-specific area. Only sub-index 1 is shown in the tables in order to maintain clarity. Only this sub-index is used for value transfer or polling. The permitted value ranges for the objects are entered in columns "Values".

Manufacturer-specific area : Common						
Index	Sub	Name	Access	Type	Values	Note
2000h	1	OUT	RW	U08	0..1	Off/On
2001h	1	SETBANK	RW	U08	0..29	0...29
2010h	1	Operation Mode	RW	U08	0..1	Config/Standard
2011h	1	Control Mode	RW	U08	0..1	Local/Remote
2012h	1	Lock	RW	U08	0..1	Unlock/Lock
2020h	1	Device State	RO	U16	0..65535	bit-coded
2021h	1	Fail State	RO	U16	0..65535	bit-coded
2022h	1	Fail Confirm	WO	U08	0	
2023h	1	Flag State	RO	U16	0..65535	bit-coded
2030h	1	Save Values	WO	U08	0	
2031h	1	Recall Values	WO	U08	0	

Manufacturer-specific area : Sequence						
Index	Sub	Name	Access	Type	Values	Note
2100h	1	Restart Sequence	WO	U08	1	
2101h	1	Configuration	RW	U08	0..2	Man/Auto-OFF/Auto-On
2110h	1	Act Loop	RO	U08	0..254	
2111h	1	Act Step	RW	U08	0..99	
2112h	1	Act Step Time	RO	U32	1..600000	in 1ms (min. 10ms)
2120h	1	Set Loop Number	RW	U08	0..255	0 = infinite
2121h	1	Set Step Number	RW	U08	1..100	
2122h	1	Set Step Time	RW	U32	1..600000	in 1ms (min. 10ms)
2123h	1	Set Step Bank	RW	U08	0..29	

3. Description of Function

VE3PUID digitally programmable (FW: 01.02.xx)

EMC + Safety tested

Manufacturer-specific area : Voltage						
Index	**Sub**	**Name**	**Access**	**Type**	**Values**	**Note**
2200h	1	Vmax	RO	U32	Vmax	in mV (depending on type)
2201h	1	Vact	RO	U32	0..1.05*Vmax	in mV (depending on type)
2202h	1	Vset	RW	U32	0..Vmax	in mV (depending on type)
2210h	1	VLim: Configuration	RW	U08	0..3	Off/Low/High/Both
2211h	1	VLim: High Value	RW	U32	0..Vmax	in mV (depending on type)
2212h	1	VLim: Low Value	RW	U32	0..Vmax	in mV (depending on type)
2220h	1	VPrt: Configuration	RW	U08	0..3	Off/Low/High/Both
2221h	1	VPrt: High Value	RW	U32	0..1.05*Vmax	in mV (depending on type)
2222h	1	VPrt: Low Value	RW	U32	0..1.05*Vmax	in mV (depending on type)
2223h	1	VPrt: Delaytime	RW	U32	1..600000	in 1ms (min. 10ms)

Manufacturer-specific area : Current						
Index	**Sub**	**Name**	**Access**	**Type**	**Values**	**Note**
2400h	1	Cmax	RO	U32	Cmax	in mA (depending on type)
2401h	1	Cact	RO	U32	0..1.05*Cmax	in mA (depending on type)
2402h	1	Cset	RW	U32	0..Cmax	in mA (depending on type)
2410h	1	CLim: Configuration	RW	U08	0..3	Off/Low/High/Both
2411h	1	CLim: High Value	RW	U32	0..Cmax	in mA (depending on type)
2412h	1	CLim: Low Value	RW	U32	0..Cmax	in mA (depending on type)
2420h	1	CPrt: Configuration	RW	U08	0..3	Off/Low/High/Both
2421h	1	CPrt: High Value	RW	U32	0..1.05*Cmax	in mA (depending on type)
2422h	1	CPrt: Low Value	RW	U32	0..1.05*Cmax	in mA (depending on type)
2423h	1	CPrt: Delaytime	RW	U32	1..600000	in 1ms (min. 10ms)

Manufacturer-specific area : Power						
Index	**Sub**	**Name**	**Access**	**Type**	**Values**	**Note**
2600h	1	Pmax	RO	U32	3000000	in 1mW
2601h	1	Pact	RO	U32	0..3150000	in 1mW
2620h	1	PPrt: Configuration	RW	U08	0..3	Off/Low/High/Both
2621h	1	PPrt: High Value	RW	U32	0..3150000	in 1mW
2622h	1	PPrt: Low Value	RW	U32	0..3150000	in 1mW
2623h	1	PPrt: Delaytime	RW	U32	1..600000	in 1ms (min. 10ms)

3.5.6.3 Manufacturer-specific Area (Description)

COMMON

2000h Sub1 OUT **Access: RW** **Type: U08** **PDO-Access: Yes**

The output of the power supply unit can be switched on and off via this object. The Enable signal must have been issued (slide switch set to ON, ENABLE to ON and no error) for switch-on. It is also possible to query the status of the device output via this object.

Values:	0	STANDBY
	1	ON

2001h Sub1 SETBANK **Access: RW** **Type: U08** **PDO-Access: Yes**

This object allows you to set or read out the memory bank.

Value range: 0 ... 29

2010h Sub1 OPERATION MODE **Access: RW** **Type: U08** **PDO-Access: No**

This object is used to preset or read out the operating mode of the device. It may be changed only if the power supply unit is in STANDBY. Otherwise, SDO communication will be aborted with an abort code 08000022h.

Values:	0	CONFIGURATION
	1	STANDARD
	2	LAB
	3	SEQUENCE

2011h Sub1 CONTROL MODE **Access: RW** **Type: U08** **PDO-Access: No**

This object is used to preset or read out the control mode of the power supply unit.

Values:	0	LOCAL
	1	REMOTE

2012h Sub1 LOCK **Access: RW** **Type: U08** **PDO-Access: No**

This object allows you to disable or enable the buttons of the device's control panel. It can also be used to read out the current status of the Button Lock function.

Values:	0	UNLOCKED
	1	LOCKED

2020h Sub1 DEVICE STATE **Access: RO** **Type: U16** **PDO-Access: Yes**

This object allows you to determine the device status. The return value is a 16-bit word that is returned as a decimal number. The device status results from the significance of the individual bits:

Bit:	0	Significance:	1	Output of the Unit	(0 = STANDBY	; 1 = ON)
	1		2	Common Fault	(0 = no error	; 1 = error)
	2		4	Sliding Switch	(0 = STANDBY	; 1 = ON)
	3		8	ENABLE (signal connector)	(0 = STANDBY	; 1 = ON)
	4		16	Voltage Control	(0 = inactive	; 1 = active)
	5		32	Current Control	(0 = inactive	; 1 = active)
	6		64	Power Limiting	(0 = inactive	; 1 = active)
	7		128	Lock	(0 = inactive	; 1 = active)
	8		256	Reserve		
	9		512	Reserve		
	10		1024	Reserve		
	11		2048	Reserve		
	12		4096	Reserve		
	13		8192	Reserve		
	14		16384	Reserve		
	15		32768	Reserve		

2021h Sub1 FAIL STATE **Access: RO** **Type: U16** **PDO-Access: Yes**

This object allows you to determine the error status. The return value is a 16-bit word that is returned as a decimal number. The device status results from the significance of the individual bits:

Bit:		Significance:			
Bit:	0	Significance:	1	Common Fault	(0 = no error ; 1 = error)
	1		2	Overtemperature	(0 = inactive ; 1 = active)
	2		4	Overvoltage Protection	(0 = inactive ; 1 = active)
	3		8	Power Fail Signal	(0 = inactive ; 1 = active)
	4		16	Voltage Fail	(0 = inactive ; 1 = active)
	5		32	V-Protection: High-Error	(0 = inactive ; 1 = active)
	6		64	V-Protection: Low-Error	(0 = inactive ; 1 = active)
	7		128	C-Protection: High-Error	(0 = inactive ; 1 = active)
	8		256	C-Protection: Low-Error	(0 = inactive ; 1 = active)
	9		512	P-Protection: High-Error	(0 = inactive ; 1 = active)
	10		1024	P-Protection: Low-Error	(0 = inactive ; 1 = active)
	11		2048	Reserve	
	12		4096	Reserve	
	13		8192	Reserve	
	14		16384	Reserve	
	15		32768	Reserve	

2022h Sub1 FAIL CONFIRM **Access: WO** **Type: U08** **PDO-Access: No**

This object allows you to reset a pending error provided the cause has been eliminated.

Value: 0

2023h Sub1 FLAG STATE **Access: RO** **Type: U16** **PDO-Access: Yes**

This object allows you to query the flags of the power supply unit. The return value is a 16-bit word that is returned as a decimal number:

Bit:	0	Significance:	1	VLim:	High - Flag	(0 = inactive ; 1 = active)
	1		2	VLim:	Low - Flag	(0 = inactive ; 1 = active)
	2		4	CLim:	High - Flag	(0 = inactive ; 1 = active)
	3		8	CLim:	Low - Flag	(0 = inactive ; 1 = active)
	4		16	PLim:	High - Flag	(0 = inactive ; 1 = active)
	5		32	PLim:	Low - Flag	(0 = inactive ; 1 = active)
	6		64	VPrt:	High - Flag	(0 = inactive ; 1 = active)
	7		128	VPrt:	Low - Flag	(0 = inactive ; 1 = active)
	8		256	CPrt:	High - Flag	(0 = inactive ; 1 = active)
	9		512	CPrt:	Low - Flag	(0 = inactive ; 1 = active)
	10		1024	PPrt:	High - Flag	(0 = inactive ; 1 = active)
	11		2048	PPrt:	Low - Flag	(0 = inactive ; 1 = active)
	12		4096	Reserve		
	13		8192	Reserve		
	14		16384	Reserve		
	15		32768	Reserve		

2030h Sub1 SAVE VALUES **Access: WO** **Type: U08** **PDO-Access: No**

No settings are saved automatically in control mode "REMOTE". This applies both to the settings of the device output and to the values of the device configuration. The settings can be saved to non-volatile memory (EEPROM) with this object. This covers the memory banks, the settings for device configuration and those of the sequences. The CANopen communication parameters are not saved either. They can be saved with object 1010h.

Value: 0

2031h Sub1 RECALL VALUES **Access: WO** **Type: U08** **PDO-Access: No**

The device is prompted to retrieve all settings from non-volatile memory with this object. The values in RAM are consequently lost. The CANopen communication parameters are not affected by this.

Value: 0

SEQUENCE:

2100h Sub1 SEQ: RESTART **Access: WO** **Type: U08** **PDO-Access: No**

A sequence can be restarted with this object. This is possible during the sequence run or if a sequence configured as "AUTO (END-ON)" is complete. The advantage of this function is that the sequence can be restarted without having to specially switch the device off.

Value: 1

2101h Sub1 SEQ: CONFIGURATION **Access: RW** **Type: U08** **PDO-Access: No**

The operating mode of the sequence can be configured with this object. The device must be switched off to change a value. It is also possible to poll the setting.

Value range:	0	MANUAL	(manual operation)
	1	AUTO (END-OFF)	(automatic operation, off at end of sequence)
	2	AUTO (END-ON)	(automatic operation, on at end of sequence)

2110h Sub1 SEQ: ACTUAL LOOP **Access: RO** **Type: U08** **PDO-Access: No**

The current loop is polled with this object.

Value range: 0 ... 254

2111h Sub1 SEQ: ACTUAL STEP **Access: RW** **Type: U08** **PDO-Access: No**

The current step of the sequence is set or polled with this object. The device must be switched off to change a value in Automatic mode.

Value range: 0 ... (STEPNUMBER-1)

2112h Sub1 SEQ: ACTUAL STEP TIME **Access: RO** **Type: U32** **PDO-Access: No**

The dwell time elapsed in the current step is polled with this object.

Value range: 0 ... 600000 (in ms)

2120h Sub1 SEQ: SET LOOP NUMBER **Access: RW** **Type: U08** **PDO-Access: No**

The number of loop passes can be set or read out with this object. The device must be switched off to change a value in Automatic mode.

Value range:	0	INFINITE (endless loop)
	1 ... 255	

2121h Sub1 SEQ: SET STEP NUMBER **Access: RW** **Type: U08** **PDO-Access: No**

The number of steps per loop pass can be set or read out with this object. The device must be switched off to change a value in Automatic mode.

Value range: 1 ... 100

2122h Sub1 SEQ: SET STEP TIME **Access: RW** **Type: U32** **PDO-Access: No**

The dwell time for the currently selected step can be defined or read out with this object. The device must be switched off to change a value in Automatic mode.

Value range: 10 ... 600000 (in ms)

2123h Sub1 SEQ: SET STEP BANK **Access: RW** **Type: U08** **PDO-Access: No**

The memory bank for the currently selected step can be defined or read out with this object. The device must be switched off to change a value in Automatic mode.

Value range: 0 ... 29

3. Description of Function

VE3PUID digitally programmable (FW: 01.02.xx)

VOLTAGE:

2200h Sub1 VMAX **Access: RO** **Type: U32** **PDO-Access: No**

This object allows you to query the maximum output voltage (in mV) of the power supply unit.

Value: Vmax (depending on type)

2201h Sub1 VACT **Access: RO** **Type: U32** **PDO-Access: Yes**

This object allows you to query the actual voltage value (in mV) of the device output.

Value range: 0 ... 1.05 x Vmax (depending on type)

2202h Sub1 VSET **Access: RW** **Type: U32** **PDO-Access: Yes**

This object allows you to set or read out the voltage setpoint (in mV) of the device.

Value range: 0 ... Vmax (depending on type)

2210h Sub1 VLIM - CONFIG **Access: RW** **Type: U08** **PDO-Access: No**

This object is used for configuration of the voltage limits, i.e. it is used to define or read out the response behaviour of the individual voltage limit values.

Values:	0	OFF	(inactive)
	1	LOW ACTIVE	(lower voltage limit value active)
	2	HIGH ACTIVE	(upper voltage limit value active)
	3	BOTH ACTIVE	(both voltage limit values active)

2211h Sub1 VLIM - HIGH VALUE **Access: RW** **Type: U32** **PDO-Access: No**

This object allows you to set or read out the upper voltage limit value (in mV).

Value range: 0 ... Vmax (depending on type)

2212h Sub1 VLIM - LOW VALUE **Access: RW** **Type: U32** **PDO-Access: No**

This object allows you to set or read out the lower voltage limit value (in mV).

Value range: 0 ... Vmax (depending on type)

2220h Sub1 VPRT - CONFIG **Access: RW** **Type: U08** **PDO-Access: No**

This object is used for configuration of the voltage monitoring value, i.e. it is used to define or read out the response behaviour of the individual voltage monitoring values.

Values:	0	OFF	(inactive)
	1	LOW ACTIVE	(lower voltage monitoring value active)
	2	HIGH ACTIVE	(upper voltage monitoring value active)
	3	BOTH ACTIVE	(both voltage monitoring value active)

2221h Sub1 VPRT - HIGH VALUE **Access: RW** **Type: U32** **PDO-Access: No**

This object allows you to set or read out the upper voltage monitoring value (in mV).

Value range: 0 ... 1.05 x Vmax (depending on type)

2222h Sub1 VPRT - LOW VALUE **Access: RW** **Type: U32** **PDO-Access: No**

This object allows you to set or read out the lower voltage monitoring value (in mV).

Value range: 0 ... 1.05 x Vmax (depending on type)

2223h Sub1 VPRT - DELAY **Access: RW** **Type: U32** **PDO-Access: No**

This object allows you to set or read out the delay time (in 1 ms) for voltage monitoring.

Value range: 1... 600000

CURRENT:

2400h Sub1 CMAX **Access: RO** **Type: U32** **PDO-Access: No**

This object allows you to query the maximum output current (in mA) of the power supply unit.

Value: Cmax (depending on type)

2401h Sub1 CACT **Access: RO** **Type: U32** **PDO-Access: Yes**

This object allows you to query the actual current value (in mA) of the device output.

Value range: 0 ... 1.05 x Cmax (depending on type)

2402h Sub1 CSET **Access: RW** **Type: U32** **PDO-Access: Yes**

This object allows you to set or read out the current setpoint (in mA) of the device.

Value range: 0 ... Cmax (depending on type)

2410h Sub1 CLIM - CONFIG **Access: RW** **Type: U08** **PDO-Access: No**

This object is used for configuration of the current limits, i.e. it is used to define or read out the response behaviour of the individual current limit values.

Values:	0	OFF	(inactive)
	1	LOW ACTIVE	(lower current limit value active)
	2	HIGH ACTIVE	(upper current limit value active)
	3	BOTH ACTIVE	(both current limit values active)

2411h Sub1 CLIM - HIGH VALUE **Access: RW** **Type: U32** **PDO-Access: No**

This object allows you to set or read out the upper current limit value (in mA).

Value range: 0 ... Cmax (depending on type)

2412h Sub1 CLIM - LOW VALUE **Access: RW** **Type: U32** **PDO-Access: No**

This object allows you to set or read out the lower current limit value (in mA).

Value range: 0 ... Cmax (depending on type)

2420h Sub1 CPRT - CONFIG **Access: RW** **Type: U08** **PDO-Access: No**

This object is used for configuration of the current monitoring value, i.e. it is used to define or read out the response behaviour of the individual current monitoring values.

Values:	0	OFF	(inactive)
	1	LOW ACTIVE	(lower current monitoring value active)
	2	HIGH ACTIVE	(upper current monitoring value active)
	3	BOTH ACTIVE	(both current monitoring values active)

2421h Sub1 CPRT - HIGH VALUE **Access: RW** **Type: U32** **PDO-Access: No**

This object allows you to set or read out the upper current monitoring value (in mA).

Value range: 0 ... 1.05 x Cmax (depending on type)

2422h Sub1 CPRT - LOW VALUE **Access: RW** **Type: U32** **PDO-Access: No**

This object allows you to set or read out the lower current monitoring value (in mA).

Value range: 0 ... 1.05 x Cmax (depending on type)

2423h Sub1 CPRT - DELAY **Access: RW** **Type: U32** **PDO-Access: No**

This object allows you to set or read out the delay time (in 1ms) for current monitoring.

Value range: 1... 600000

POWER:

2600h Sub1 PMAX **Access: RO** **Type: U32** **PDO-Access: No**

This object allows you to query the maximum output power (in 1mW) of the power supply unit.

Value: 3000000 (=3kW)

2601h Sub1 PACT **Access: RO** **Type: U32** **PDO-Access: Yes**

This object allows you to query the actual power value (in 1mW) of the device output.

Value range: 0 ... 3150000

2620h Sub1 PPRT - CONFIG **Access: RW** **Type: U08** **PDO-Access: No**

This object is used for configuration of the power monitoring values, i.e. it is used to define or read out the response behaviour of the individual power monitoring values.

Values:	0	OFF	(inactive)
	1	LOW ACTIVE	(lower power monitoring value active)
	2	HIGH ACTIVE	(upper power monitoring value active)
	3	BOTH ACTIVE	(both power monitoring values active)

2621h Sub1 PPRT - HIGH VALUE **Access: RW** **Type: U32** **PDO-Access: No**

This object allows you to set or read out the upper power monitoring value (in 1mW).

Value range: 0 ... 3150000

2622h Sub1 PPRT - LOW VALUE **Access: RW** **Type: U32** **PDO-Access: No**

This object allows you to set or read out the lower power monitoring value (in 1mW).

Value range: 0 ... 3150000

2623h Sub1 PPRT - DELAY **Access: RW** **Type: U16** **PDO-Access: No**

This object allows you to set or read out the delay time (in 1ms) for voltage monitoring.

Value range: 1... 600000

3.5.7 Message Filtering

A bus user must receive all messages from the bus and filter off the messages destined for it via a suitable selection procedure. This selection procedure is software-based on the power supply unit owing to the CAN hardware used. High bus load consequently also means a high load on the microcontroller. If, for instance, a SYNC object appears on the bus, this is a particularly problematic time. All synchronous TPDOs are now transmitted. Even though these messages are destined for the Network Master and not for the power supply unit, its microcontroller is loaded substantially. If the microcontroller then does not acquire all messages fast enough, this involves the risk of messages possibly being lost.

The acceptance filter implemented in the device remedies this situation. This acceptance filter allows restricted message filtering by the CAN hardware. The acceptance filter provides two masks. These two masks allow only messages with ID "0" and the set Node ID. Using the "Predefined Connection Set", the power supply unit receives only the generally valid messages (NMT, SYNC) and the Receive messages of the set Node ID (RPDOs and RSDOs). All other messages are ignored.

The acceptance filter does, however, afford the disadvantage that the IDs for SYNC, EMCY and the RPDOs can no longer be freely assigned. The IDs for a device with Node ID "15" that are accepted by the power supply unit with acceptance filtering active are listed below. This section also shows you which IDs are available for free assignment:

Nr	Function	Node	ID(dec)	ID(hex)	Assignment
1	0000	0000000	0	000h	NMT
2	0001	0000000	128	080h	SYNC
3	0010	0000000	256	100h	***free***
4	0011	0000000	384	180h	***free***
5	0100	0000000	512	200h	***free***
6	0101	0000000	640	280h	***free***
7	0110	0000000	768	300h	***free***
8	0111	0000000	896	380h	***free***
9	1000	0000000	1024	400h	***free***
10	1001	0000000	1152	480h	***free***
11	1010	0000000	1280	500h	***free***
12	1011	0000000	1408	580h	***free***
13	1100	0000000	1536	600h	***free***
14	1101	0000000	1664	680h	***free***
15	1110	0000000	1792	700h	***free***
16	1111	0000000	1920	780h	***free***
17	0000	0001111	15	00Fh	***free***
18	0001	0001111	143	08Fh	EMCY
19	0010	0001111	271	10Fh	***free***
20	0011	0001111	399	18Fh	TPDO 1
21	0100	0001111	527	20Fh	RPDO 1
22	0101	0001111	655	28Fh	TPDO 2
23	0110	0001111	783	30Fh	RPDO 2
24	0111	0001111	911	38Fh	TPDO 3
25	1000	0001111	1039	40Fh	RPDO 3
26	1001	0001111	1167	48Fh	TPDO 4
27	1010	0001111	1295	50Fh	RPDO 4
28	1011	0001111	1423	58Fh	TSDO
29	1100	0001111	1551	60Fh	RSDO
30	1101	0001111	1679	68Fh	***free***
31	1110	0001111	1807	70Fh	BOOTUP/HEARTBEAT
32	1111	0001111	1935	78Fh	***free***

4. Mechanics, Environmental, Safety

VE3PUID digitally programmable (FW: 01.02.xx)

4.1 Mechanics

The primary switched power supplies of the **energy 3000** series are available either as installation units or as 19" versions.
The sturdy mechanical structure is of aluminium.
Extruded profiles developed in-house for cooling brackets and corner profiles form the basis for the finely tuned balance between mechanical sturdiness, protection against electromagnetic interference and optimal heat dissipation. The cooling is attained through temperature-controlled fan operation.

Enclosure rating:
IP 30 according to
EN 60529/IEC 529
when built-in, at the front panel

Mechanical maximum stress:
Vibrations:
0.15mm double amplitude
or 2g at 5 - 500Hz
according to DIN 40046
(same values in transport packaging)

Shock:
10g; duration 11ms
according to DIN 40046
in transport packaging
10g, duration 18ms.

4.2 Environmental

4.2.1 Environmental

Operating temperature range:
see data sheet.

Storage temperature:
see data sheet.

Humidity: 95% ,
without condensation.

4.2.2 RoHS EU Directive 2011/65/EU

The reduction of hazardous substances in electrical and electronic equipment is an important contribution to the protection of the environment and deserves the strongest possible support from all of us.
All Kniel products/power supplies delivered after 15 January 2006 comply with EU Directive 2011/65/EU except for some customer specific products. Products not compliant with said directive are noted as such in the delivery documents.

4.2.3 WEEE EU Directive 2012/19/EU

Directive 2012/19/EU particularly applies to short-lived consumer goods for the mass market. Kniel products are generally used as capital goods over periods of many years or even decades. Therefore our products do not belong to the intended target group of the directive. Additionally said directive focusses on complete units or systems and thus does not cover our products. None of our products can be classified into one of the categories mentioned in said directive. Hence, Kniel does not plan to provide statistical information about when our products were placed on the market. We do not offer cost-free return of our products.

4.3 Electrical Safety

Kniel power supplies are designed to cover a broad range of applications. The power supplies are built according to **EN 60950 / IEC 950** for safety of data processing equipment, including electrical office machines, in order that the conventional regulations applicable to different fields of application are observed.

4.3.1 Important Electrical Safety Features

The output circuit is electrically isolated from the input circuit.
Electrical isolation between primary circuit and secondary circuit is achieved by adequate air gaps and creepage distances.
The signal outputs and inputs (interface connection X3) must be considered as a separate SELV circuit.

Every unit is subject to a high-voltage test to ensure that safe electrical isolation is actually provided.

Note

On no account do we recommend a repeat test by the customer according to EN 60950/IEC 950 since this could damage semiconductors and insulation and an internal active high voltage limitation will limit the proof voltage. If a further high-voltage test on each unit is mandatory, the test conditions must be coordinated with Kniel. Otherwise, we are unable to accept warranty.

4.3.2 SELV

Kniel power supplies with an output voltage of max. 55Vdc comply with the requirements of SELV circuits.
SELV circuits must have a safe electrical isolation from the mains.

Test voltages (proof voltages)

for all output voltages:

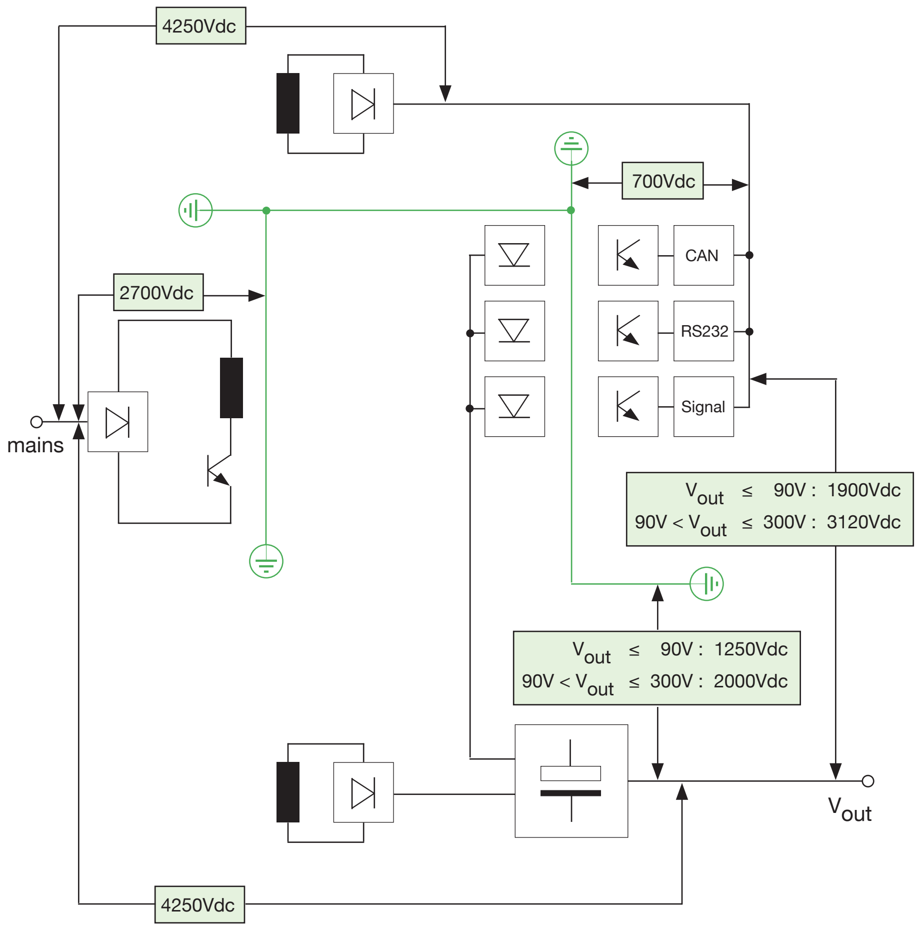
primary	-	SELV Signals	4250 Vdc
SELV Signals	-	PE	700 Vdc

for units with $V_O \leq 90V$:

primary	-	secondary	4250 Vdc
primary	-	PE	2700 Vdc
secondary	-	PE	1250 Vdc
SELV Signals	-	secondary	1900 Vdc

for units with $90V < V_O \leq 300V$:

primary	-	secondary	4250 Vdc
primary	-	PE	2700 Vdc
secondary	-	PE	2000 Vdc
SELV Signals	-	secondary	3120 Vdc



4.3.3 Definition of the Ambient Conditions According to EN 60950/IEC 950

Pollution Severity II
Only non-conductive pollution occurs. Temporary conductivity as the result of condensation must be anticipated occasionally.

Overvoltage Category II
Equipment of overvoltage category II is intended for use in installations or parts thereof in which lightning over-voltage does not need to be taken into con-sideration. This includes, for in-stance, domestic electrical appliances. Overvoltages resulting from switching operations must be taken into consi-deration.

4.3.4 Definition of the Safety Class

Kniel primary switched power supplies are constructed according to safety class I. With this safety class, all expo-sed parts must be connected to the PE wire with low resistance. Each unit is tested before delivery.

Leakage Current

The maximum permitted leakage cur-rent of permanently installed equipment is 3.5mA. Kniel power supplies of this series do not exceed this value between 45 and 66Hz frequency of the mains.

More Tests

A fire resistance test, an overload test and a test of mechanical load capability are also conducted according to EN 60950/IEC 950.
A test designated "operation not as intended and incorrect operation" is conducted in order to allow us to as-sess the risks and dangers if the unit is operated not as intended.

4. Mechanics, Environmental, Safety

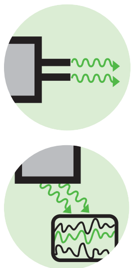
VE3PUID digitally programmable (FW: 01.02.xx)

EMC + Safety tested

4.4 EMC

The switched mode power supplies fully comply with the legal requirements for emitted interference according to EN 55022/55011 as well as the interference immunity according to EN/IEC 61000-6-2.
To fully serve this wide application area the regulations for the domestic and commercial sectors apply for emitted interference, and the regulations for the industrial sector apply for the interference immunity. This means in each case, that a more stringent limit value is valid.

4.4.1 Emitted Interference According to EN 55022/55011 (emission)



In primary switched power supplies radiated noise is generated by high-frequency, periodic switching operations. The higher the switching frequencies and the steeper the rising or falling edges of current and voltage are, the higher will be the high-frequency share of the noise spectrum.
The noise spectrum is considered over a bandwidth of 150KHz to 1 000MHz.
Up to 30MHz the interference voltage is measured and evaluated on lines, either as an average measurement*1 or as a quasi-peak measurement*2.
In the higher frequency band between 30MHz and 1 000MHz, the radiated interference fields are recorded at 10m distance.
The permitted limit values are intended to prevent neighboring electronic equipment being affected by interference. Corresponding limit values are stipulated in EN 55022.
Limit curve B must be observed if the primary switched power supplies are used on residential or commercial premises or in public facilities. See figure 4 and figure 5.
The limiting values for industrial applications are defined in EN 55011.

Figure 4
Limit value class
150KHz to 30MHz

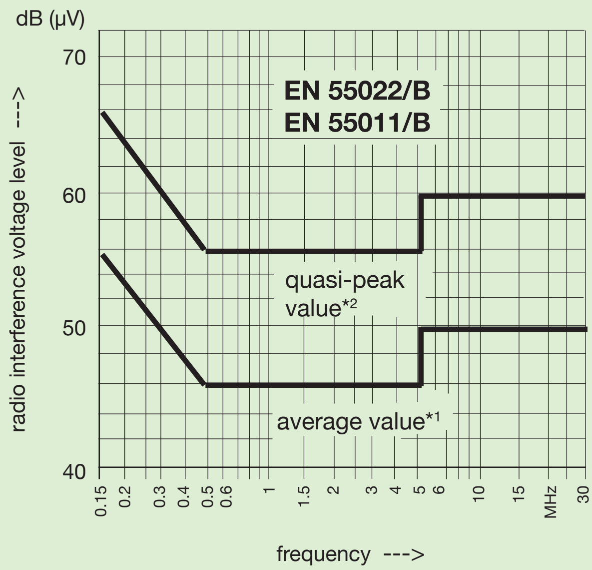
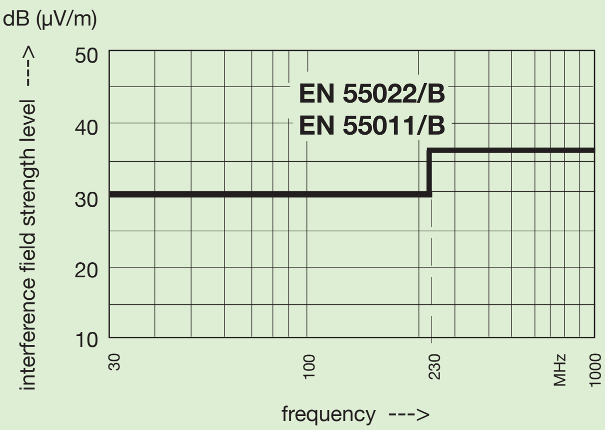


Figure 5
Limit value class
30MHz to 1 000MHz



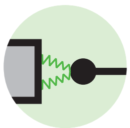
*1 = The average value is the arithmetic mean value of a signal.

*2 = In the case of a quasi-peak measurement, the peak value of noise voltage is evaluated in conjunction with the pulse frequency.

4.4.2 Interference Immunity According to EN/IEC 61000-6-2

The immunity to electromagnetic interference, as occurs in practice as the result of static discharges, switching operations on inductive circuits and capacitors, as the result of lightning strike and as the result of high-frequency irridiation is verified by a series of tests.
The limit values according to EN/IEC 61000-6-2 (industrial application) apply for Kniel primary switched power supplies.

4.4.3 ESD - Immunity to Electrostatic Discharge According to EN/IEC 61000-4-2

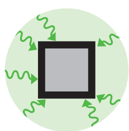


This test verifies the immunity to electrostatic discharge as may occur from the operator's body when touching the equipment. Static discharges as can arise between different objects are also covered with this test.
The required test voltage (proof voltage) is:

8kV - discharge in air
4kV - contact discharge.

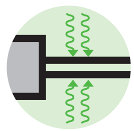
Evaluation criterion B.
Kniel primary switched power supplies meet evaluation criterion A.

4.4.4 Immunity to Electromagnetic Fields According to EN/IEC 61000-4-3



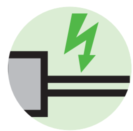
Electromagnetic fields are generated by radio-telephonic equipment, radio broadcasting stations, TV stations and other industrial electromagnetic interference sources. The aim of this standard is to ensure immunity of equipment. The test covers the frequency band from 80MHz to 1 000MHz with a field strength of 10V/m.
The measurement is carried out in a booth.
No limit values or maximum permissible deviations are stipulated in the standard.
The output voltage may not deviate more than 2% from the value set during this test.

4.4.5 Fast Electrical Transients Burst Test According to EN/IEC 61000-4-4



Fast transient bursts occur during switching operations, e.g. disconnecting inductive loads and bounce of relay contacts, in all electrical power supply systems.
The burst test is intended to guarantee that the function of electrical equipment is not impaired on a sustained basis as the result of these extremely brief voltage peaks.
The standard demands:
Evaluation criterion B.
Kniel primary switched power supplies meet evaluation criterion A.

4.4.6 Immunity to Surge Voltages According to EN/IEC 61000-4-5



This type of surge voltage occurs in supply systems as the result of switching large inductive circuits or capacitor banks, as the result of short-circuits in the system or as the result of lightning strike.

The standard demands:

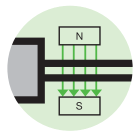
2kV	L1 / N	-->	SL
1kV	L1	-->	N.

Evaluation criterion B is met.

4.4.7 Immunity to Conducted Interference Induced by High-Frequency Fields According to EN/IEC 61000-4-6

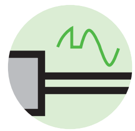
In the frequency band 150kHz to 80MHz, the equipment is subject to modulated fields which induce noise voltages of 10V in the supply lead.
No limit values or maximum permissible deviations are stipulated in the standard.
The output voltage may not deviate more than 2% from the value set during this test.

4.4.8 Magnetic Field with Energy Frequency According to EN/IEC 61000-4-8



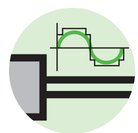
In the frequency range between 50Hz and 60Hz the device is applied with 30A/m. There must be no interference.
Kniel primary switched power supplies meet evaluation criterion A.

4.4.9 Collapse of Voltage and/or Voltage Interruptions According to EN/IEC 61000-4-11



The requirements demanded by EN/IEC 61000-4-11 for collapse of voltage and/or voltage interruptions are fully met.

4.4.10 Limits for Harmonic Current Emissions According to EN/IEC 61000-3-2



The requirements demanded by EN/IEC 61000-3-2 for harmonic current emissions are fully met.

Note

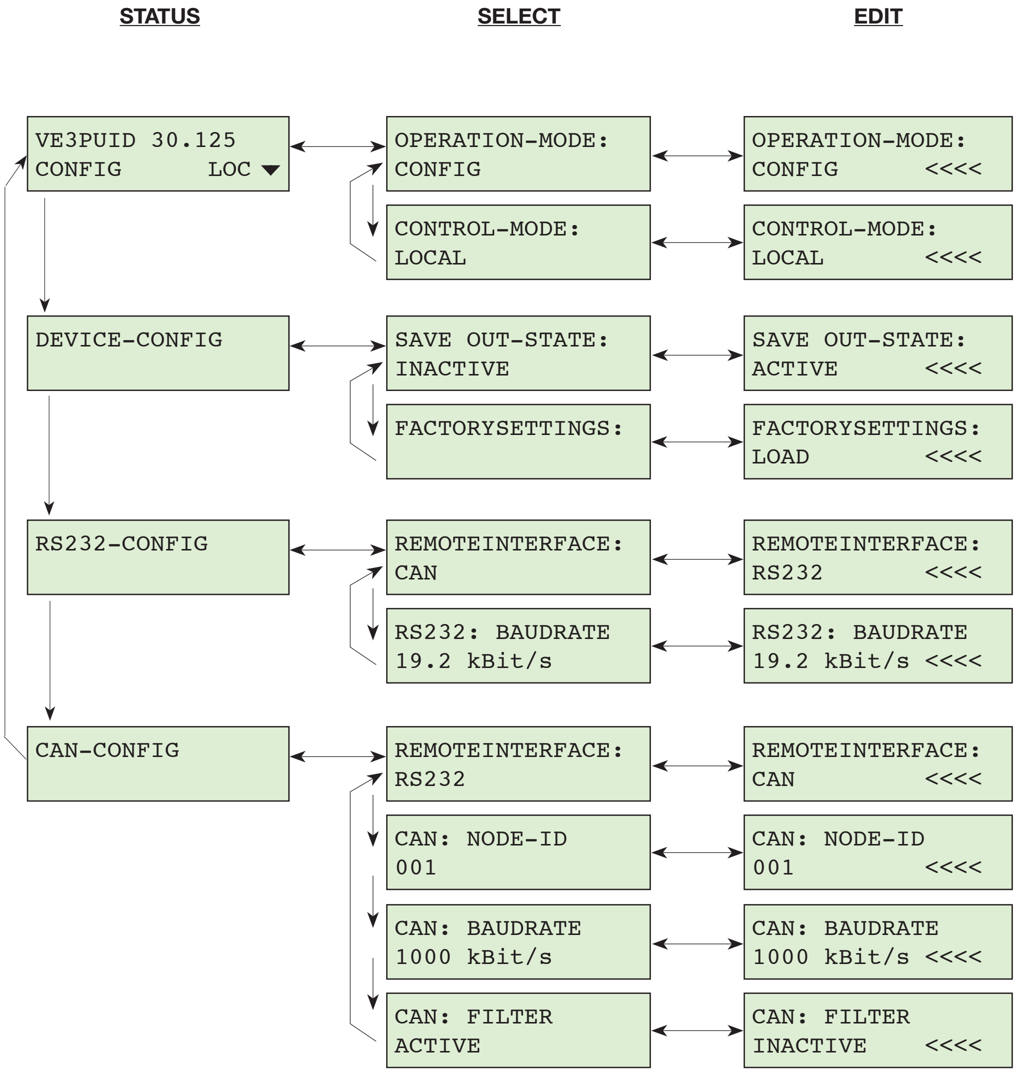
Compliance with the specified standards applies only to the Kniel power supplies.
If the power supply is integrated in an overall system, it is the user's obligation that the complete system meets the applicable standards.
Kniel is unable to assume warranty for this owing to the wide variety of applications.
Please consult Kniel regarding test conditions if the interference immunity tests are to be repeated.

Explanation: evaluation criterion

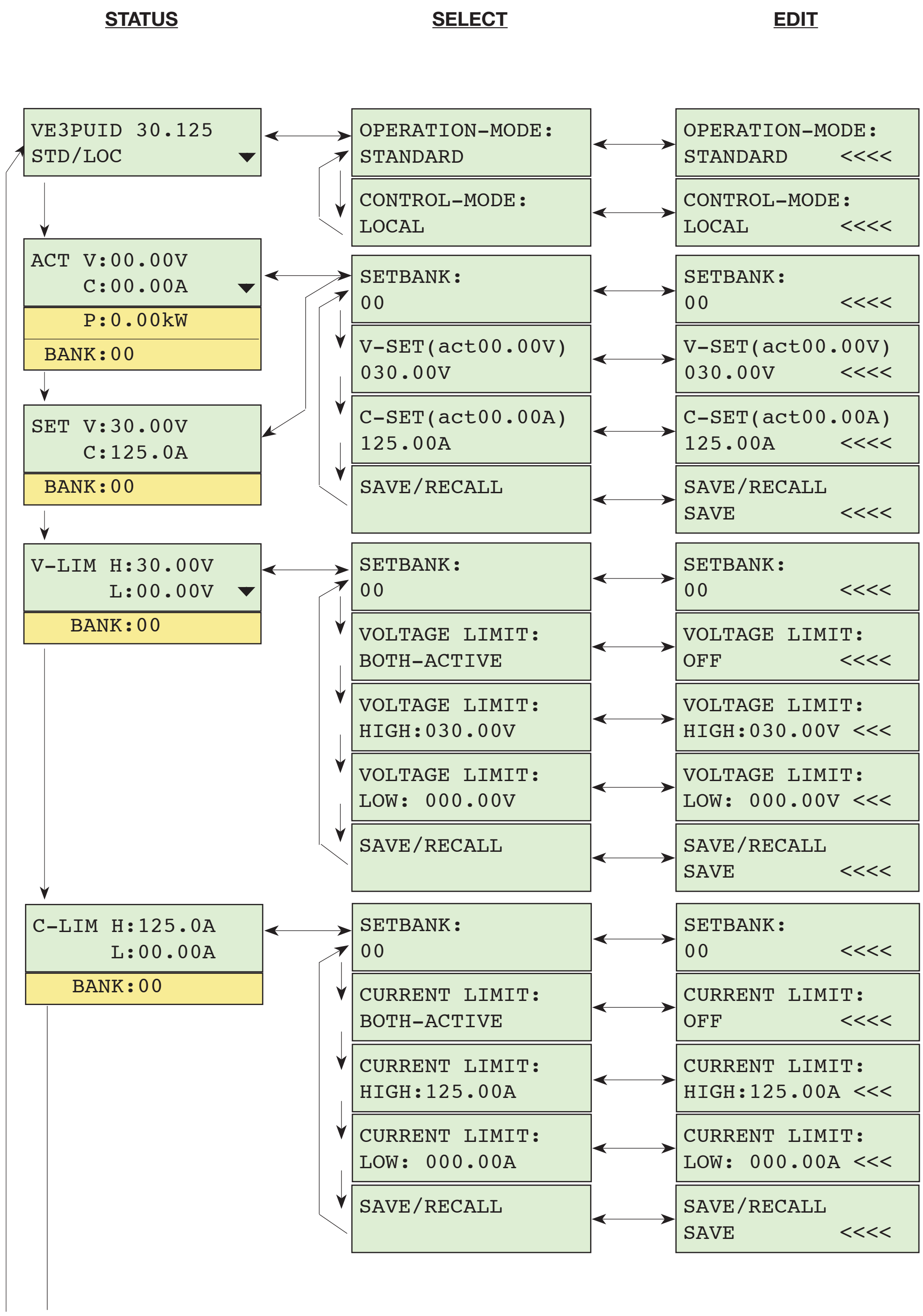
A : In this test the function may not be influenced in any way.

B : Partial loss of power or function. After completing the test the unit must operate within its specification again.

A.1 Menu Structure for Operating Mode "Config"



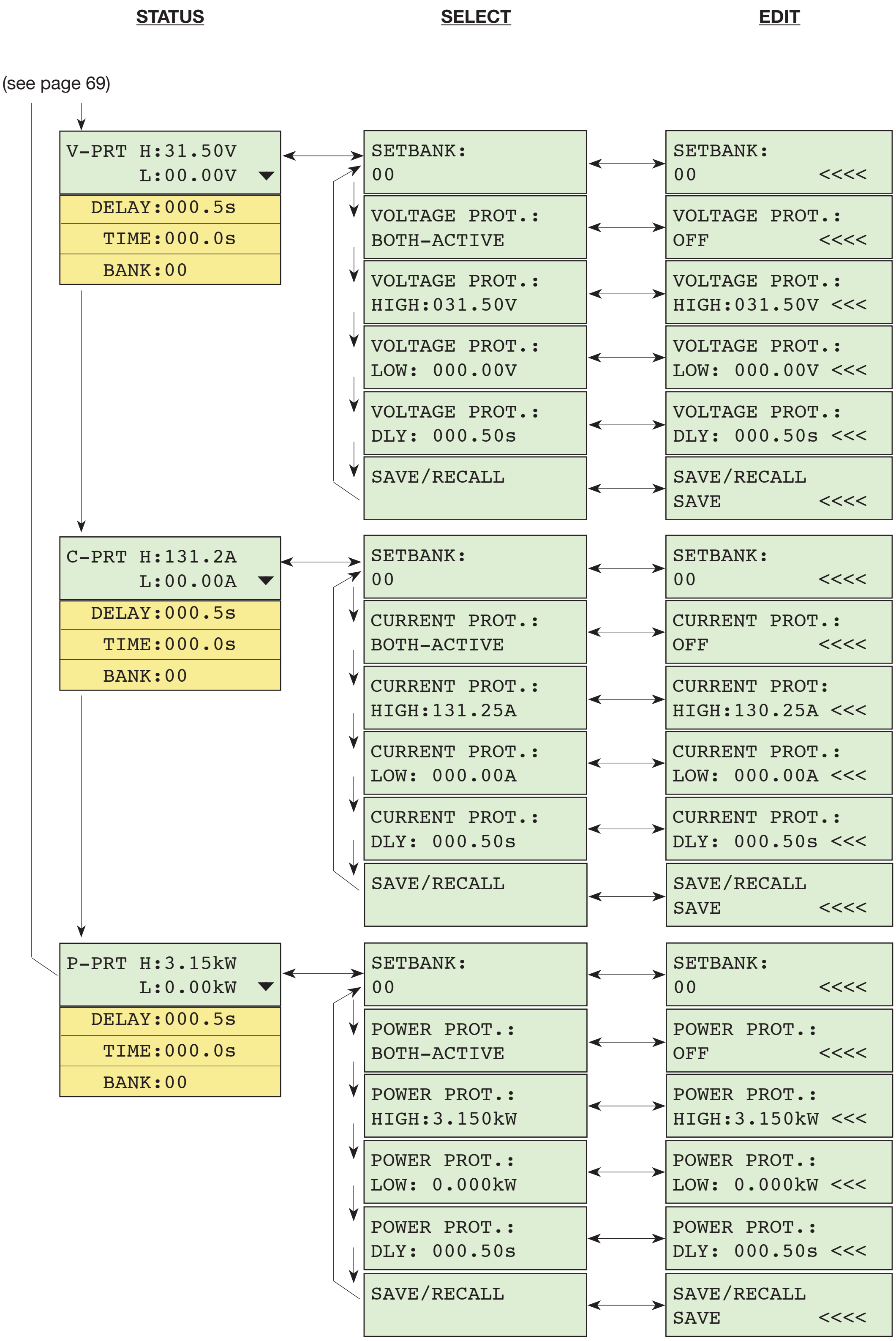
A.2 Menu Structure for Operating Mode "Standard" and "LAB"



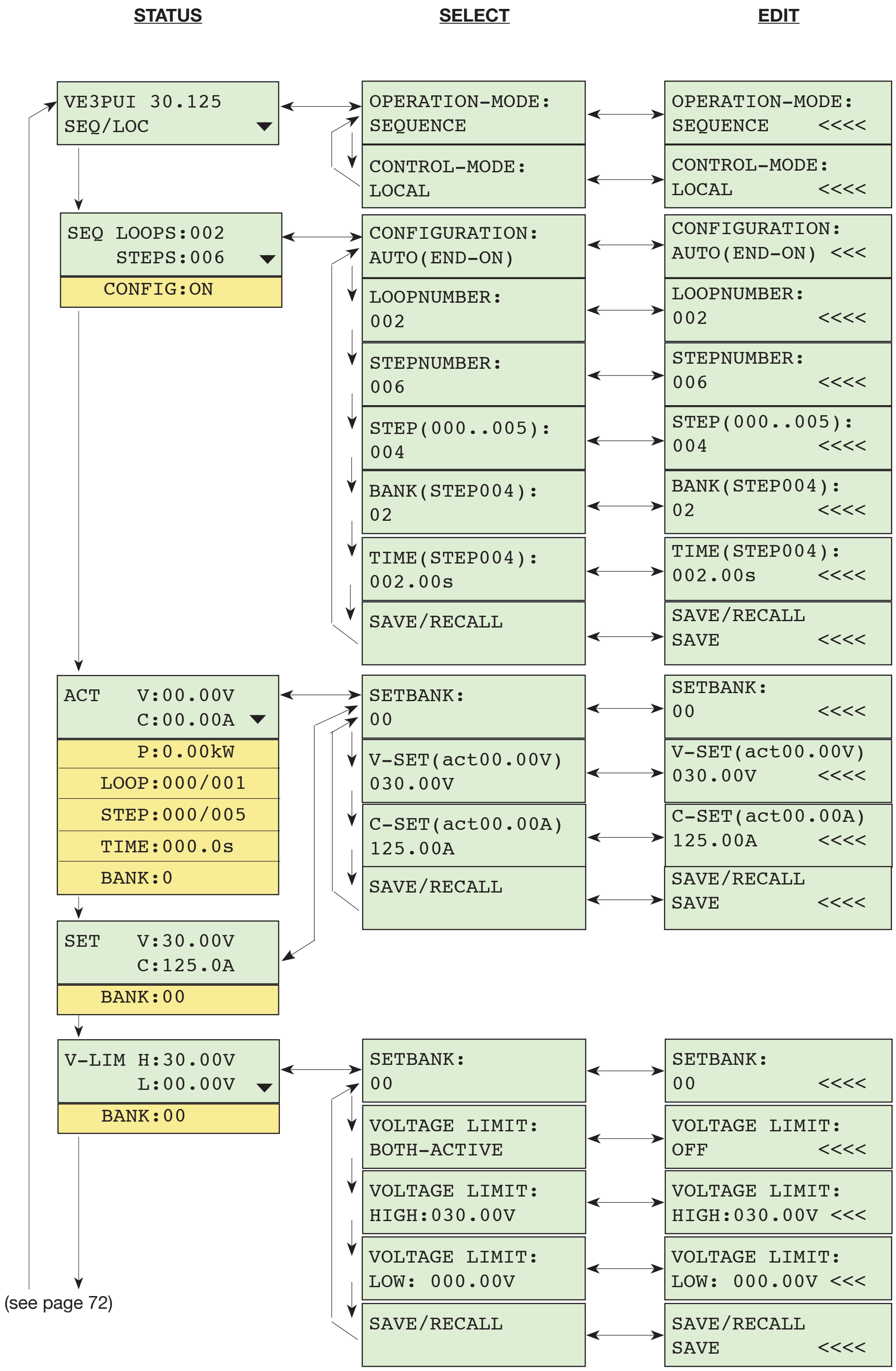
(see page 70)

Annex

VE3PUID digitally programmable (FW: 01.02.xx)

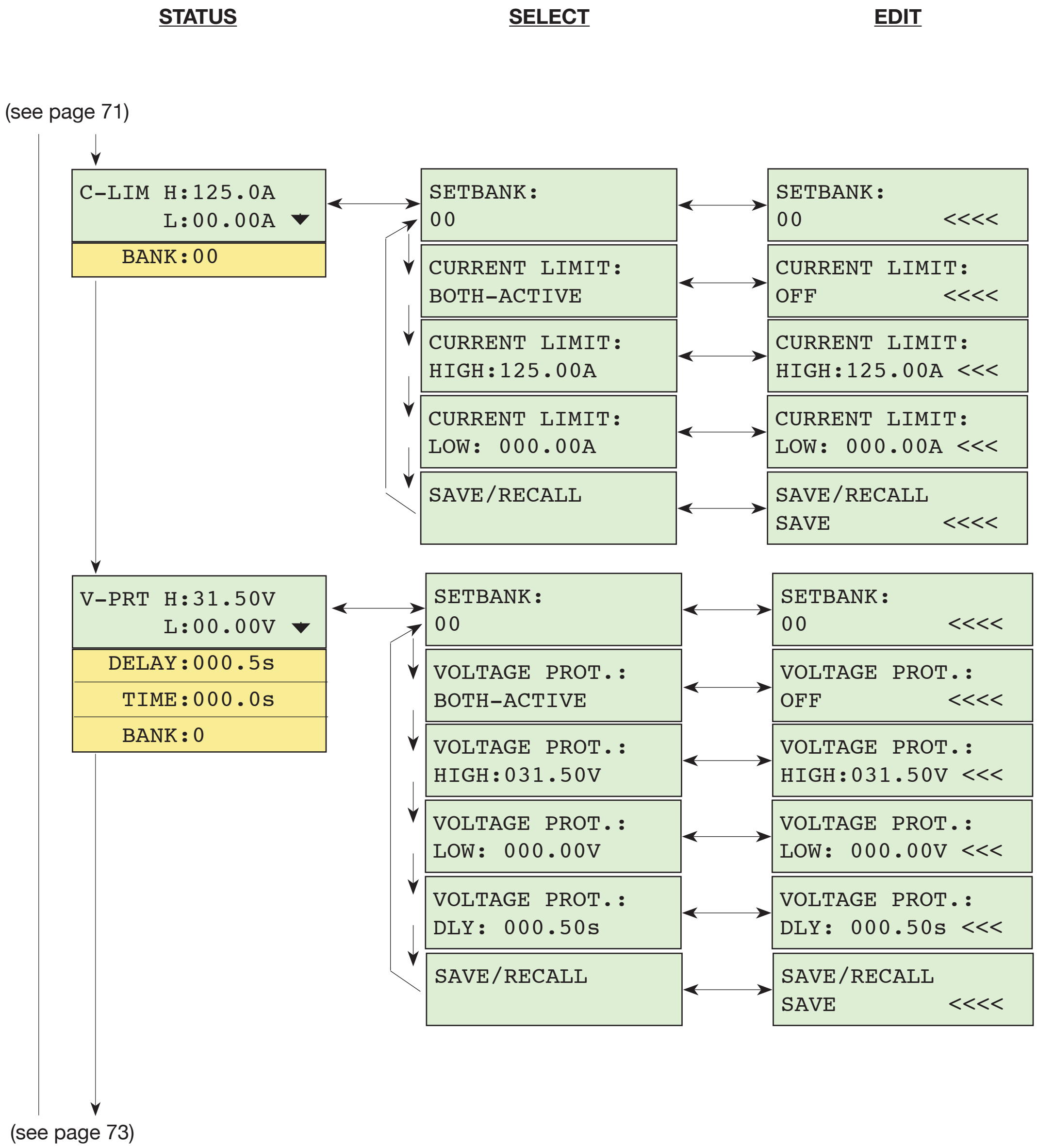


A.3 Menu Structure for Operating Mode "Sequence"



Annex

VE3PUID digitally programmable (FW: 01.02.xx)



Annex

VE3PUID digitally programmable (FW: 01.02.xx)