Three-phase Converter FVC series
User’s manual

Release 18, November 2009
Firmware version: V1.01

Attention
This manual provides all the necessary information regarding the mode of operation of FVC series converters. For the correct use of this specific equipment it is recommended to refer to the characteristics data sheet of the converter, which is an integral part of this manual.
Converter series FVC

The converter FVC series are static AC/AC three-phase devices with double conversion and IGBT technology under microprocessor control. They supply the load with variable voltage and frequency at the set value regardless of impedance value and mains fluctuations.

The information about voltage and current supplied is shown by means of 7 segments displays.

They can be controlled by external signals.

They are equipped with RS485 serial interface.

They can have two output scales so to supply the maximum power at two different full-scales.

Product presentation

According to the output power, the equipment can be assembled in:
- table rack
- recessed rack
- metal cabinet

Control interface

![Control interface image]

commands and connections

<table>
<thead>
<tr>
<th>Command/Connection</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voltage setting command and visualization</td>
<td>on front panel</td>
</tr>
<tr>
<td>Frequency setting command and visualization</td>
<td>on front panel</td>
</tr>
<tr>
<td>Logical command for output-on:</td>
<td>on front panel</td>
</tr>
<tr>
<td>Selection for local/remote commands:</td>
<td>from RS485 serial interface</td>
</tr>
<tr>
<td>Line breaker:</td>
<td>on front panel</td>
</tr>
<tr>
<td>RS485 serial interface:</td>
<td>on front panel</td>
</tr>
<tr>
<td>Mains supply:</td>
<td>from cable on the back side (rack version)</td>
</tr>
<tr>
<td></td>
<td>on terminal blocks inside the cabinet (metal cabinet version)</td>
</tr>
<tr>
<td>Outputs:</td>
<td>on front panel</td>
</tr>
<tr>
<td>Emergency input:</td>
<td>on front panel</td>
</tr>
<tr>
<td>Auxiliary inputs/outputs</td>
<td>on front panel</td>
</tr>
</tbody>
</table>
Introduction

Thank you for choosing our product. We invite you to read this manual thoroughly because here you can find the technical characteristics and all the necessary information for using this equipment correctly.

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This guide provides specific information related only to the mentioned products. No part of this manual may be reproduced in any form or by any means without our written consent.

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This technical document version voids and replaces all previous versions.

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1. Preface

1.1 How to use and understand the instructions provided in this manual

In this manual you can find also functions that might not be present on the equipment you have purchased; nevertheless proper information will tell you about eventual limitations. This solution has been chosen for clarity and to better evaluate the functional characteristics available on all our products.

1.2 Safety instructions

The following notes or graphic symbols list a series of instructions essential for the correct use of the equipments. Such information could be found, in graphic form, also on the equipment or used in the manual to focus the attention on the specific issue. It is highly recommended to read such instructions carefully before equipment installation.

- Do not install the Equipment in environments with temperatures different from those allowed.

- Do not expose the Equipment to direct sun light.

  Do not pour any kind of liquids on the Equipment.
  In case of fire, use foam, CO2 or dry chemicals fire-extinguishers.
Attention

The lightning symbol within a triangle is a warning symbol that indicates the presence of “dangerous voltages” inside the equipment with risk of electric shock.

The exclamation mark within a triangle is a caution symbol that indicates the presence of important additional information for the correct use of the equipment.

The empty triangle it’s a caution symbol that indicates a danger of equipment damage if improperly used.

The text that follows this symbol gives information, recommendations or other particular instructions for the correct operation of the equipment.

The text that follows this symbol gives information, recommendations or other particular instructions in order to avoid danger and/or injury to personnel.

A proper disposal of the shipment packing is recommended.
1.3 *Compliance declaration*

MANUFACTURER DECLARATION OF CONFORMITY

The Zenone Elettronica Converter:

FVC

are herewith confirmed to comply with the requirements set out in the Council Directive on the Approximation of the Law of Member States relating to:


- **EN 61000-6-1 - CEI EN 61000-6-1 (2° ed. 2007-10) Electromagnetic compatibility (EMC) - Part 6-1: Generic standards - Immunity for residential, commercial and light-industrial environments***

- **EN 61000-6-3 - CEI EN 61000-6-3 (2° ed. 2007-11) Electromagnetic compatibility (EMC) - Part 6-3: Generic standards - Emission standard for residential, commercial and light-industrial environments***

EN 61326-1 :2006

Electrical equipment for measurement, control and laboratory use - EMC requirements - Part 1: General requirements

- **Low Voltage Equipment Directive (2006/95/EEC) and EN61010-1 (“Safety of Electrical Measuring Apparatus”)**

Mirabella 01-10-2009

Zenone Elettronica S.r.l.

Luigi Zenone

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1.4 Identification label

Each equipment is identified by the following label. We invite you to consider the data shown in it as indispensable for the product traceability, and to communicate them for eventual request for support.
2. Preliminary operations

2.1 Working environment

The converter is designed for indoor use.

❄️ + 5 °C  ☀️ + 40 °C

Place the device on a suitable support or on a plane surface for good stability. Be sure that proper ventilation is allowed and no objects obstruct the ventilation openings.

2.2 Precautions

Operate the equipment at its rated mains voltage, on earthed outlet only. Fasten suitable cables or bars of adequate section on the output bolts, calculated on the bases of the equipment functional characteristics.

⚠️ WARNING: Power connections can generate high temperature spots, that could cause burnings.

⚠️ WARNING: All standard converters are delivered with output FLOATING, not connected to any potential (unless otherwise specified); at the moment of installation MUST BE CONNECTED TO GND OR TO ANY OTHER POTENTIAL. Maximum allowed voltage on the output bolts, when not connected to earth, is 300VAC.
2.3 Equipment operation

Connect the equipment to the power mains, *it is recommended to follow the instructions given on the equipment (or in the attached sheet) regarding voltage, frequency and earth connection*, then turn on the power switch, which could be located on the back panel or by the cabinet side depending on the type of equipment. In some models the power-on command can be part of an external power supply frame. In some cases the integrated console, keyboard/display, can be connected to the cabinet by means of an external cable. At system power-on a self-diagnostic routine tests the most important equipment functionalities and detects eventual faults. In case of failures or malfunctions, we must be informed in advance before sending the equipment to our laboratories.
3. Auxiliary Inputs / Outputs

3.1.1 Inputs
The FVC converters have some inputs for remote control

<table>
<thead>
<tr>
<th>function</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emergency</td>
<td>Voltage-free NC contact, its opening causes the immediate disengagement of the line breaker disconnecting the equipment from the mains</td>
</tr>
<tr>
<td>on - off</td>
<td>Voltage-free NO contact, allows to start the converter from remote control</td>
</tr>
<tr>
<td>Voltage command</td>
<td>Analog input 0 ÷ 10V, remote command for the output voltage 0 ÷ 100%</td>
</tr>
<tr>
<td>Frequency command</td>
<td>Analog input 0 ÷ 10V, remote command for the output frequency 0 ÷ 100%</td>
</tr>
</tbody>
</table>

3.1.2 Outputs
The FVC converters have some outputs for remote signaling

<table>
<thead>
<tr>
<th>function</th>
<th>description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Converter running</td>
<td>PNP digital output, it signals that the converter is running Max 30V 0,5A</td>
</tr>
<tr>
<td>Alarm</td>
<td>PNP digital output, it signals a fault Max 30V 0,5A</td>
</tr>
</tbody>
</table>

3.2 Communication port
The converter is equipped with a RS484 communication port which allows to connect a PC or other system for parameters setting, for the alarm register reading and for remote control.

The Baud Rate is the transfer speed and is set at 9600.
4. Converter operation

4.1 Starting the output of power

After the preliminary operations, connecting the equipment to the mains and to an eventual load, are done it’s possible to turn on the converter acting on the main switch.

Note: the main switch will not activate if the emergency circuit is open or the emergency push-button is pressed.

Once the equipment is turned on it’s possible to start the output of power in the following ways:

- Pressing the on-off push-button on the front panel
- With command from serial port; entering the appropriate string.
- Activating the appropriate digital input.

Under these conditions the converter will take immediately the voltage and frequency set.

4.2 Setting voltage and frequency

The setting of voltage and frequency output can be done:

- by means of the potentiometers on the front panel
- by means of analog signal 0 ÷ 10V
- from serial port

4.3 Scale selection

The FVC converters can have one or two output scales in order to supply the maximum power with different full-scales. The scale selection must be done with the appropriate selector in stand-by mode.

An eventual change of scale, while the output is on, will take place only after the converter is switched “off”

4.3 Display of set values

In stand-by it’s possible to visualize on the displays the voltage and frequency values simply pressing the “F1” push-button

“F1” pressed = visualization of voltage and frequency entered
“F1” released = off
4.4 Command type selection

The selection of the command type:
- front panel
- analog or digital inputs
- serial port

can be done via serial communication by means of “FVC Manager” software (look at paragraph 12).

4.5 Measurements display

While the output is on the converter shows on the displays the concatenated output voltage between the phases L1-L2 and the current on phase L1. Pressing “F1” it’s possible to visualize in sequence:
- FREQ = output frequency
- F1 V = voltage L1-L2
- F1 A = current L1
- F2 V = voltage L2-L3
- F2 A = current L2
- F3 V = voltage L3-L1
- F3 A = current L3

If no keys are pressed within 3 seconds the displays will show the initial condition.

4.5 Change of scale

The FVC converters can have two voltage scales, this allows to supply the maximum of energy even with lower output voltages. The change of scale is done with appropriate selector on the front panel and has effect only with the equipment in stand-by.

5 Maintenance instructions

- Check periodically the air vents, clean them or change the filter (if present);
- Check and tighten periodically the bolts of the connections between the power outputs and the external circuit under test (in case of high currents).
6. External connections

6.1 DB15 I/O connections

The I/O section of the interface connector is made of:

- 2 Inputs “PNP” type at 24V (Pin 1 and 2)
- 2 outputs “PNP” type at 24V (Pin 11 and 12)
- 1 “Emergency” input (pin 3)
- 1 24V supply output limited at 100 mA max
- 2 Pins assigned for a 24V supply (4=GND e 10=VCC).
The inputs have the following function:
- Input 1: Allows to START and to STOP the output supply
- Input 2: Not used
- Input “Emergency”: normally closed to the common of 24V. When opened causes the disengagement of the line breaker.

The outputs have the following function:
- Output 1: Active when the power output is on.
- Output 2: Active in case of fault.

6.2 DB15 RS485 connection

RS485 section

The RS485 section of the interface connector is made up of pin “A” and “B” of the RS485 interface and of a Ground pin. For a proper functioning of the serial communication it’s suggested to insert in a point of the line two resistances of 1Kohm connected as in the diagram.
6.3 *DB15 analog connections*

The Analog section of the interface connector is made of pin:
- AIN1_P and AIN1_N of the Analog input 1 (Pin 14 and 7)
- AIN2_P and AIN2_N of the Analog input 2 (Pin 15 and 8)
- Reference ground GND (Pin 6)

They are two balanced inputs that can take a maximum voltage of +/- 10V with respect to GND.
Their function, when enabled by appropriate command via RS485, is to set the Voltage (Input 1) and the frequency (Input 2).
7. Error and faults signaling:

The converters are equipped with self-diagnosis routine; in case of anomalous event the power output is stopped and an error message is displayed.

<table>
<thead>
<tr>
<th>Signal</th>
<th>Cause</th>
<th>Remedy</th>
</tr>
</thead>
<tbody>
<tr>
<td>DSP X FAIL</td>
<td>Communication error between the central processor and the DSP shown by nr. X</td>
<td>Shut off and turn on the equipment; if the error remains contact the assistance</td>
</tr>
<tr>
<td>FAIL</td>
<td>Generic error</td>
<td>Connect a PC to the equipment and by means of the software “GesPWM” check the table below</td>
</tr>
</tbody>
</table>

By means of the software GesPWM it’s possible to visualize the following table:

<table>
<thead>
<tr>
<th>Signal</th>
<th>Cause</th>
<th>Remedy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature</td>
<td>Very high temperature of the heat-sink</td>
<td>Shut off the equipment and wait a few minutes. If the phenomenon repeats check the air vents and make sure the fans work properly.</td>
</tr>
<tr>
<td>Under-voltage</td>
<td>Supply voltage to low &lt;350V</td>
<td>Check the mains and the presence of all three phases.</td>
</tr>
<tr>
<td>Over-voltage</td>
<td>Supply voltage to high &gt;460V</td>
<td>Check the mains voltage.</td>
</tr>
<tr>
<td>Current limit</td>
<td>Maximum allowed current exceeded</td>
<td>Check the load or the parameters settings.</td>
</tr>
<tr>
<td>NTC error</td>
<td>Fault in the temperature measurement circuit</td>
<td>Contact the assistance.</td>
</tr>
<tr>
<td>Fault</td>
<td>IGBT failure</td>
<td>Contact the assistance.</td>
</tr>
<tr>
<td>Precharge</td>
<td>Malfunction of the precharge capacitors circuit</td>
<td>Check the precharge relay.</td>
</tr>
</tbody>
</table>

If the fault persists, contact the assistance.
8 Converter diagram

![Converter diagram](image-url)
9 Control scheme

The FVC converter has two control units, one for regulation and one for central management, both are externally accessible and modifiable through the appropriate programs:

- Control and regulation unit by means of “GesPWM” software
- Central management unit by means of “FVC Manager” software

10 Control and regulation unit

The converter is equipped with a sophisticated digital control system, which has to keep the voltage and/or the current output constant regardless of load change and mains variations.

The regulation is based on two PID algorithms in sequence and named:

“Inner loop” with feedback current taken at the output,
“Outer loop” with feedback voltage taken at the output.

The following figure shows the principle of operation

10.1 Control system block diagram

The control loops are pre-adjusted in production to have a good compromise between speed and stability over most loads, in some cases it is necessary to change some parameters for the following reasons:

- Oscillations due to a load too reactive
- To enhance the generator dynamic performance
- To adapt the generator to the load
10.2 Control system description

The control system is based on two PID loops in sequence, named “Inner loop and Outer loop”.

The inner loop is the fastest and will adjust the current in the load. It takes as input the reference of the outer loop.

The outer loop regulates the output voltage, reacts more slowly and it provides the value of current to the inner loop. It takes as input the main reference and the feedback comes from the output voltage of the converter.
10.3 Parameters definition and function

**Kp:** range 0 ÷ 10000
It’s the proportional gain of the regulation loop (it causes the output to change according to the input error).

**Ti:** range $dt$ ÷ 32000µS; 0 = integral disabled
It’s the integration time of the regulation loop in microseconds, can be applied directly or multiplied by the parameter Kp (causes the output to change with a speed proportional to the error, sets the regulation point canceling the offset).

**Td:** range $dt$ ÷ 32000µS; 0 = derivative disabled
It’s the derivative time of the regulation loop in microseconds, can be applied directly or multiplied by the parameter Kp (causes the output to change proportionally to the rate of change of the input, reduces the system response time).

**dt** machine cycle time can not be modified.

Positive integral limitation: range 0 ÷ 100%
It’s the maximum value the integral variable can take

Negative integral limitation: range 0 ÷ 100%
It’s the minimum value the integral variable can take
Positive derivative limitation: range 0 ÷ 100%
It’s the maximum value the derivative variable can take

Negative derivative limitation: range 0 ÷ 100%
It’s the minimum value the derivative variable can take

**Z.T.R. block**
The Z.T.R. block ensure the correction of the waveform during the crossing of the zero (correction of dead time) by adding an additional gain when the current crosses zero. The adjusting of this block is made with sine wave or triangular wave.

**Z.T.R. gain** range 0 ÷ 100
Represents the additional gain during the zero crossing by the current.

**Z.T.R. amplitude** range 0 ÷ 100
Represents the maximum correction value, previously calculated, that can applied to the modulator.

### 10.4 Procedure for adjusting the control system

The following section provides only a guideline for adjusting the PID regulation loops as in many cases does not apply a clear rule and adjustments are made based on personal experiences.

Note: Eventual parameters modifications must be done by specialized personnel only because these modifications could cause malfunctions and/or converter damages.

Note: Before making any change to the regulation parameters it’s advisable to take note of the existing parameters so to restore the initial setup.

In most cases, in particular when the equipment must be adapted to the load, it’s sufficient to make slight changes to some parameters following simple rules:

- In case of severe capacitive load, reduce the $Kp$ coefficients and increase the integration time $Ti$.

- In case of severe inductive load, increase the $Kp$ coefficients and reduce the integration time $Ti$. 
10.5 Technique for adjusting the loops

The adjusting of PID loops must be done in two phases, first the inner one and then the external one.

In order to adjust and verify the dynamic performances, it’s better to have a dynamic load at the output so to visualize the voltage variations with respect to the load variations.

Under these conditions adjust first the inner loop $K_p$, $T_I$ and $T_d$ parameters until the maximum performances are obtained. Once the inner loop has been adjusted, the parameters $K_p$, $T_I$ and $T_d$ of the external loop can be adjusted so to optimize the global performance.
Step function response varying $K_p$ with $T_i$ constant

Step function response varying $T_i$ with $K_p$ constant
Step function response with Kp too high

Step function response with Kp and Ti too small
11 GesPWM software

The “GesPWM” software is compatible with WINDOWS XP systems and allows to set up some important parameters of the converter; it must be installed on a suitable PC and executed.

Such software is designed to set up the parameters of different equipment types we produce, therefore it’s possible that are displayed some parameters that have no function for this specific converter.

11.1 Connecting the equipment to the PC

The converter must be connected to the PC through the serial port of the console by means of the specific cable.

After the connection has been done and the program GesPWM is executed, the following mask will appear:

![GesPWM mask](image)

By means of the menu “Set” it’s possible to select the parameters for the serial link: PC port and baud-rate. **In this case the baud-rate must be 9600**

In position “2” must be set:
• Indirizzo Macchina (machine address): Equipment serial address (DEFAULT case 1)
• Indirizzo DSP (DSP address): indirizzo seriale del modulo di potenza (in this case 1)

Once the parameters have been set-up as shown above, push the button “3” to start the connection.
In this situation the mask will appear as shown above and it’s possible:
• By means of the button “4” to display the machine state with the readings of AC mains voltage, DC BUS voltage, temperature of heat sink and the state of the alarms.
  With the RESET button it’s possible to reset some stored alarms.
• By means of the button “Parametri PWM” to step into the next mask where the PWM parameters are shown and could eventually be changed.

The regulation parameters for this type of equipment are those shown with “1”, the others must not be changed.
The sampling timing “dt” is shown at point “2”.
In order to change any parameter just overwrite it and push ENTER on the keyboard.
The button “REFRESH” provides an over-reading of the parameters stored in the memory module.
12 FVC Manager software

The “FVC Manager” software allows full control of FVC series voltage sources. The “FVC Manager” can manage up to 32 FVC generators.

12.1 Software installation

The “FVC manager” software is compatible with Windows XP and supplied in a compressed package. For the installation, just click over the proper icon and accept the license agreement terms. The “FVC Manager” program is supplied with a free license for ZENONE ELETTRONICA equipment users and its disclosure is forbidden.

Note: ZENONE ELETTRONICA disclaims any liability for incompatibilities or conflicts with other software and operating systems.

12.2 Presentation

When opened, the program shows the following mask:
12.3 Preliminary operations

The first things to do in the initial mask is to enter the “COM” number on which the converter or the converters are connected. Click on “porta COM” and select the appropriate address, if not present click on “refresh”. The “Baud Rate” for this equipment must be 9600. The Timeout is the maximum waiting time for the acknowledgment by the load that a program command has been accepted. After which a serial communication error is generated. Once these operations are finished, the serial communication can be activated pressing the proper button (the green light means activation ok); eventual communication errors can be reset with the appropriate button.

12.4 Identification of FVC connected

At this point the program must identify the converters. Write in the window at the bottom left the starting address for the search and click on “Cerca”. In this way the program will begin the identification of all converters connected and list them in the window. Once all converters are recognized it’s possible to stop the search with the button “Stop” otherwise automatically goes up to 32.

12.5 Address change

In the section at the top right it’s possible to change the address to the single converter selecting it in the window, assign the new address and click on “applica”. Warning: do not assign the same address to more equipments. The acquisition of the new address will take place immediately after sending the command for which the identification of the converters must be repeated.

12.6 Test applications

The program can run 32 applications of command. To run a command application select the converter in the appropriate window and click on “lancia”.

12.7 Command mask

After selecting the converter it’s possible to run the application command. The program first reads the settings of the selected converter and then displays the mask shown below: the top row shows the name of the converter, the serial number and his serial address.
Above right it is possible to set the command sources:

“Sorgente riferimento” (source reference):
- da pannello (front panel potentiometer)
- analogico (analog input 1; 0÷10V)
- seriale (serial interface)

“Sorgente Start” (Start source):
- pannello/seriale (front panel/serial interface)
- ingresso digitale (digital input)

Note: In order to control the converters with the software you need to set:

“Sorgente riferimento”: seriale (serial interface)
“Sorgente Start”: pannello/seriale

bottom left, you can set the FVC voltage and frequency outputs:
- With digital potentiometer.
- By entering the number expressed in% in the box under the potentiometer.
- Using increment and decrement arrows keys placed under the potentiometer.

Once the value is set click on the button “scrivi” to transfer it to the converter. If the box “Scrivere automatica” is selected, each modification of the reference will be automatically written in the converter.

With the Start and Stop buttons it’s possible start and/or stop the supply of energy.
Under the voltage command (Tensione) it’s possible to change the output scale in the appropriate box and confirming it with the command “srivi”.

The displays in the top left show RMS voltages and currents on the three phases.
13 Communication protocol V1.1

It’s possible to communicate with the device (send commands and get replies) by means of the RS485 serial interface, according to a half-duplex communication protocol.

The settings of the communication port is:

- **Device address**: from 1 to 32 (assigned with appropriate software)
- **Baud-rate**: 9600 b/s
- **Number of bits**: 8
- **Stop bit**: 1
- **Parity**: None

Each command and each reply are preceded by a start (STX) and the address (IND) of the device we intend to communicate with, followed by a stop (ETX) and a checksum (CKSUM) for the data correctness verification.

<table>
<thead>
<tr>
<th>STX</th>
<th>IND</th>
<th>Command or reply</th>
<th>ETX</th>
<th>CKSUM</th>
</tr>
</thead>
<tbody>
<tr>
<td>STX</td>
<td>=</td>
<td>Start character, Hexadecimal value 0x02</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IND</td>
<td>=</td>
<td>Device address, added to the hexadecimal value 0x80 (ex. Address 1 = character 0x81)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ETX</td>
<td>=</td>
<td>Stop character, Hexadecimal value 0x03</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CKSUM</td>
<td>=</td>
<td>Control checksum, it’s a character sum of all characters of the command, Inclusive of STX and ETX characters, module 256.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Each command that carries a parameter receives a reply with a result character (ESI) that can have the following values:

- “0” = Command executed.
- “1” = Command not executed.
General information commands and device options

Device serial number request

<table>
<thead>
<tr>
<th>Command</th>
<th>Reply</th>
</tr>
</thead>
<tbody>
<tr>
<td>0x10 &quot;S&quot;</td>
<td>0x10 &quot;S&quot;</td>
</tr>
</tbody>
</table>

Device firmware version request

<table>
<thead>
<tr>
<th>Command</th>
<th>Reply</th>
</tr>
</thead>
<tbody>
<tr>
<td>0x10 &quot;F&quot;</td>
<td>0x10 &quot;F&quot;</td>
</tr>
</tbody>
</table>

Device name request

<table>
<thead>
<tr>
<th>Command</th>
<th>Reply</th>
</tr>
</thead>
<tbody>
<tr>
<td>0x10 &quot;N&quot;</td>
<td>0x10 &quot;N&quot;</td>
</tr>
</tbody>
</table>

Request and setting device setup mode

<table>
<thead>
<tr>
<th>Command</th>
<th>Reply</th>
</tr>
</thead>
<tbody>
<tr>
<td>0x10 &quot;M&quot;</td>
<td>0x10 &quot;M&quot;</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Command</th>
<th>Reply</th>
</tr>
</thead>
<tbody>
<tr>
<td>0x11 &quot;M&quot; &quot;M&quot;</td>
<td>0x11 &quot;M&quot; ESI</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Setup mode setting</th>
<th>Reply</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;0&quot;</td>
<td>Setup and start from panel</td>
</tr>
<tr>
<td>&quot;4&quot;</td>
<td></td>
</tr>
<tr>
<td>&quot;2&quot;</td>
<td></td>
</tr>
<tr>
<td>&quot;4&quot;</td>
<td>Setup and external start</td>
</tr>
</tbody>
</table>

**Note:** In case of remote mode (look at appropriate command 0x15 “M”), this command has effect only for the start.
Commands for test main setup

Request and sending voltage value

<table>
<thead>
<tr>
<th>Command</th>
<th>Reply if IDX ok</th>
</tr>
</thead>
<tbody>
<tr>
<td>0x12 &quot;M&quot; IDX</td>
<td>0x12 &quot;M&quot; IDX UMIS Voltage value*</td>
</tr>
</tbody>
</table>

Reply if IDX not ok

<table>
<thead>
<tr>
<th>Command</th>
<th>Reply</th>
</tr>
</thead>
<tbody>
<tr>
<td>0x12 &quot;M&quot; ESI</td>
<td></td>
</tr>
</tbody>
</table>

IDX = 0x81 (Fixed value)

UMIS = “1” (Fixed value)

* For the allowed ranges refer to equipment specifications

Request and sending frequency value

<table>
<thead>
<tr>
<th>Command</th>
<th>Reply</th>
</tr>
</thead>
<tbody>
<tr>
<td>0x12 &quot;F&quot;</td>
<td>0x12 &quot;F&quot; Frequency in hundredths of Hz</td>
</tr>
</tbody>
</table>

Command

<table>
<thead>
<tr>
<th>Command</th>
<th>Reply</th>
</tr>
</thead>
<tbody>
<tr>
<td>0x13 &quot;F&quot;</td>
<td>0x13 &quot;F&quot; ESI</td>
</tr>
</tbody>
</table>

Frequency in hundredths of Hz
Request and sending scales

<table>
<thead>
<tr>
<th>Command</th>
<th>Reply</th>
</tr>
</thead>
<tbody>
<tr>
<td>0x12 &quot;W&quot;</td>
<td>0x12 &quot;W&quot; Scale</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Command</th>
<th>Reply</th>
</tr>
</thead>
<tbody>
<tr>
<td>0x13 &quot;W&quot; Scale</td>
<td>0x13 &quot;W&quot; ESI</td>
</tr>
</tbody>
</table>

“Scala”: Can take values “1” or “2”.
Commands for reading the running test values

Reading the converter state

<table>
<thead>
<tr>
<th>Command</th>
<th>Reply</th>
</tr>
</thead>
<tbody>
<tr>
<td>0x14 &quot;E&quot;</td>
<td>0x14 &quot;E&quot; State or result of converter</td>
</tr>
</tbody>
</table>

Test state:

- "0" Halt
- "1" Running
- "2"
- "3"
- "4"
- "5"
- "6" Fail (failure or malfunction)
- "7"
- "A"

Reading the actual main value

<table>
<thead>
<tr>
<th>Command</th>
<th>Reply</th>
</tr>
</thead>
<tbody>
<tr>
<td>0x14 &quot;M&quot; FA</td>
<td>0x14 &quot;M&quot; UMIS Actual value</td>
</tr>
</tbody>
</table>

FA Necessary in the three-phases devices.
Select the phase to read ("1","2","3"), if omitted it means "1"

UMIS

- "0" Millivolt
- "1" Volt
Reading the actual secondary value

<table>
<thead>
<tr>
<th>Command</th>
<th>Reply</th>
</tr>
</thead>
<tbody>
<tr>
<td>0x14 “S”</td>
<td>FA UMIS Actual value</td>
</tr>
</tbody>
</table>

FA Necessary in the three-phases devices. Select the phase to read (“1”, “2”, “3”), if omitted it means “1”

UMIS

| “0”     | Milliampere                |
| “1”     | Ampere                     |

Reading the remote connection state

<table>
<thead>
<tr>
<th>Command</th>
<th>Reply</th>
</tr>
</thead>
<tbody>
<tr>
<td>0x14 “L”</td>
<td>Connection state</td>
</tr>
</tbody>
</table>

Connection state:

| “L”     | Not ACTIVE                 |
| “R”     | Active                     |

Test Start and Stop commands

Enables remote mode

<table>
<thead>
<tr>
<th>Command</th>
<th>Reply</th>
</tr>
</thead>
<tbody>
<tr>
<td>0x15 “M”</td>
<td>Mode ESI</td>
</tr>
</tbody>
</table>

Remote mode:

| “L”     | Not active                 |
| “R”     | Active                     |

In “Remote” mode the output values are defined via SERIAL link. The start can be given from SERIAL link or from PANEL/EXTERNAL according to the appropriate command (0x11 “M”).
Test start

<table>
<thead>
<tr>
<th>Command</th>
<th>Reply</th>
</tr>
</thead>
<tbody>
<tr>
<td>0x15 &quot;R&quot;</td>
<td>0x15 &quot;R&quot; ESI</td>
</tr>
</tbody>
</table>

**Note:** It’s possible to start the test only if in remote mode and the start from selected PANEL/EXTERNAL. The positive result of the command means that it was accepted but, in order to be sure the start has taken place, it’s necessary to read the device state (Command 14E).

Test stop

<table>
<thead>
<tr>
<th>Command</th>
<th>Reply</th>
</tr>
</thead>
<tbody>
<tr>
<td>0x15 &quot;S&quot;</td>
<td>0x15 &quot;S&quot; ESI</td>
</tr>
</tbody>
</table>

**Note:** It’s possible to stop the test only if in remote mode and stop from selected PANEL/EXTERNAL. The positive result of the command means that it was accepted but, in order to be sure the stop has taken place, it’s necessary to read the device state (Command 14E).

Address assignment

<table>
<thead>
<tr>
<th>Command</th>
<th>Reply</th>
</tr>
</thead>
<tbody>
<tr>
<td>0x15 &quot;A&quot; IND</td>
<td>0x15 &quot;A&quot; ESI</td>
</tr>
</tbody>
</table>
