SEMIKRON
innovation+service

MP400T

Three-phase thyristor gate control module, microprocessor-controlled, with two programmable feedback signals

- 150 to 440Vac (between lines) (±20%), 20-400 Hz power supply, self-adjustable (switched power supply)
- Trouble-free operation under inductive loads
- Digital phase control through keyboard or by means of external 0-5V, 0-10V, 0-20mA or 4-20mA signals
- 4-digit display (0 to 1,000)
- Rise and fall ramps programmable independently by an optional threshold.
- Final ramp output to control a bypass contactor
- Current **regulation** or **limitation** function with two current transformer or Hall-effect sensor inputs.
- Voltage **regulation** or **limitation** function with a voltage transformer input
- The P and I values for both feedback signals can be programmed
- 4 kV galvanic isolation
- Phase failure detection with (programmable) stop and correct phase sequence with alarm
- Thyristor failure detection
- Overtemperature protection with stop by means of a temperature switch and/or a thermoresistor (0 to 150° C) with temperature indication on the display
- External disable input
- Remote control option from a PC through RS485 (up to 31 units can be controlled)
- An additional display can be mounted on the cabinet front panel

TECHNICAL DATA

Power supply voltage		150 to 440V ±20%
		20 to 400 Hz ±10%
Power consumption		22 VA max.
Input voltages	INHI-IN, TERMO	4 - 24 Vdc
	0-5 V IN	0 - 5 Vdc (15 Vdc max.)
	0-10 V IN	0 - 10 Vdc (15 Vdc max.)
Input signals	+5V OUT	5 Vdc 10 mA max.
	+12V	12 Vdc 10 mA max.
	-12V	-12 Vdc 10 mA max.
	LINT, FRAMP, INHI-O	Open-collector
		30 Vdc max., 50 mA max.
Voltage feedback		6 V_{rms} (Default value) Input impedance 27 kΩ
Current feedback		2×4 V_{rms} (Default value) Input impedance 17 kΩ
Temperature indication		0 – 150ºC (between 10 and 140ºC error=2%)
Trigger current		300 mA @ V_{GT} = 5V
Operation temperature		0 – 60ºC
Humidity level		10 - 95% without condensation
Power-on		1 second
Weight		1 kg

1. Installation

This section explains the meaning of each of the printed circuit board terminals, but not the features of the signals found on those PCBs. The physical terminal layout on the PCB is shown in the Figura 1on page 27/35 an Figura 2 on page 29/35.

1.1. Power supply (inputs)

R: R phase connection to the three-phase mains.
S: S phase connection to the three-phase mains.
T: T phase connection to the three-phase mains.

1.2. Thyristor driving (outputs)(see pages /35, /35 and 31/35)

K1,G1: Thyristor 1 cathode and gate, respectively.
K2,G2: Thyristor 2 cathode and gate, respectively.
K3,G3: Thyristor 3 cathode and gate, respectively.
K4,G4: Thyristor 4 cathode and gate, respectively.
K5,G5: Thyristor 5 cathode and gate, respectively.
K6,G6: Thyristor 6 cathode and gate, respectively.

1.3. Feedbacks (inputs)

Up to two feedback types can be used:

VOLT,GND: Between VOLT (15) and GND (7) terminals, the voltage feedback used (the voltage transformer secondary signal, the tachogenerator signal, etc.) should be connected.

INT1+,INT1-: Between the INT1+ (10) and INT1- (11) terminals, the secondary of one of the two possible current transformers used should be connected.

INT2+,INT2-: Between the INT2+ (12) y INT2- (13) terminals, the secondary of the other of the two possible current transformers used should be connected.

To inputs for transformers are included to measure the current in two phases and therefore be sure that the maximum current is measured, only one transformer is necessary if one is sure that current by all the phases is the same.

1.4. Alarms (inputs)

INHI_IN: The INPUT DISABLE alarm switch (NO contact) will be connected here. Connection will be made between the INHI_IN (5) terminal and a voltage between signal +5V(19) and +12V (20).

TERMO: The TEMPERATURE SWITCH alarm switch (NC contact) will be connected here. Connection will be made between TERMO (4) and a voltage between +5V and +12V (20).

IN_TEMPE: The temperature sensor will be connected here. It will allow the OVERTEMPERATURE alarm to be controlled. Connection will be made between IN_TEMPE (6) terminal and GND (7) terminal.

1.5. Control signal (input)

The control signal used to display the setpoint (or the voltage or current setting) can be injected from two positions: only one of the positions can be connected at the same time.

Control by voltage:

Position A: the signal is injected between **IN 0..5** input and GND (7). The signal can have any value between +5V y GND.

Position B: the signal can be injected between the **IN 0..10** input and GND (7). The signal can have any value between +10V and GND.

Others voltage control:

If your signal has values between Vin and Vend then:

$$R32 = \frac{(33.2 \cdot V_{inic})}{12 - V_{inic}} \ k\Omega \qquad \left\{ \begin{array}{l} V_{inic} = \dfrac{V_{in}}{i} \\[2ex] i = \left\{ \begin{array}{l} 1 \text{ input 0-5v} \\ 2 \text{ input 0-10V} \end{array} \right. \end{array} \right.$$

and

$$R27 = R28 = \frac{476.56}{(V_{end} - V_{inic})} k\Omega$$

Control by current:

4-20mA:

With J19 not connected, put a 316R-1% resistor in parallel with 0-5V input.

0-20mA:

With J19 connected, put a 249R-1% resistor in parallel with 0-5V input.

1.6. Open-collector outputs (outputs)

There are three outputs (all of them in open-collector) where a LED can be connected to display the current system operation status (please see figure below).

LINT (1): when this output is active, it means **the MP400T is performing a regulation or a limitation**.

FRAMP (2): when this output is active, it means **the programmed ramp end point has been reached**.

INHI_OUT (3): when this output is active, it means that **an alarm is active** (input disable, temperature switch off and/or overtemperature, ...).
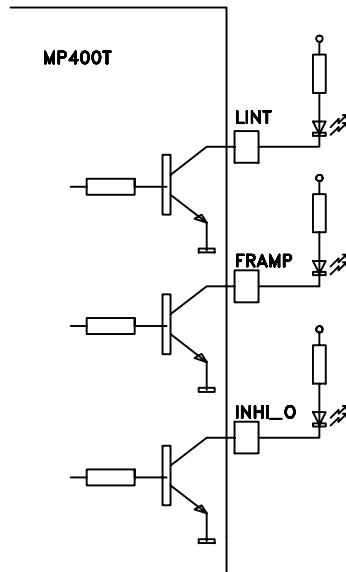
1.7. Switches (inputs)

Two inputs are available to which two switches are connected. One of the two switch terminals must always be connected to a voltage between +5V and +12V.

Start/Stop (14): it allows the equipment to be started and stopped (it starts a stops with ramp).

Pote/Key (18): According to the switch setting, the control signal value or the value keyed in for the '**setpoint**' parameter or entered from the personal computer (if a REMOTE control is performed) is considered. **Please see sections 2.8 and 3.1.1**.

1.8. PC connection (inputs/outputs)

RS485+,RS485-: Communication is performed by connecting the personal computer to the R485+ (17) and RS485- (16) terminals using an RS232-RS485 interface converter. Appendix A shows a brief description of the MP400T management program operation from a personal computer.

1.9. Auxiliary power supply signals (outputs)

+12V (20): +12 volt signal, DC, 10mA
-12V (21): -12 volt signal, DC, 10mA
+5V (19): +5 volt signal, DC, 10mA.

2. Signal features

2.1. R,S,T power supply

Minimum voltage:	150 V_{AC} -20%
Maximum voltage:	440 V_{AC} +20%
Mains frequency:	20Hz-400Hz. +/- 10%.

2.2. Current feedback

The effective value of the current transformer secondary signal when in full-scale operation (setpoint = 99.9%) should be such that the following relationship applies:

If $V_{irel} > 2.25V$ then

$$R119 \quad and/or \quad R125 = \frac{(10 \cdot V_{irel} - 22.5)}{2.25}$$

If $V_{irel} < 2.25V$ then

$$R119 \quad and/or \quad R125 = 0 \quad and \quad R118 \quad and/or \quad R124 = \infty$$

$$R116 = R117 \quad and/or \quad R122 = R123 = \frac{225.6}{V_{rel}}$$

Being results always in kΩ
(Being V_{irel} the transformer secondary signal (default value=4V))
For this purpose, both resistors have been left with default values (R119=R125=7k68), and their value can be changed as per the previous relationship.

If you want to use Shunt you must made the feedback by this input and jumpers 22 and 25 must not be connected. In this case the resistors will be:

- $R119 \quad and/or \quad R125 = 0$
- $R118 \quad and/or \quad R124 = \infty$
- $R114 = R115 = 4k7 \quad and/or \quad R120 = R121 = 4k7$
- $R116 = R117 = \dfrac{23.5}{V_{irel}} \quad and/or \quad R122 = R123 = \dfrac{23.5}{V_{irel}}$

(Being V_{irel} the shunt signal in volts.)

2.3. Voltage feedback

The effective value of the voltage transformer secondary signal when in full-scale operation (setpoint = 99.9%) should be such that the following relationship applies:

If $V_{vrel} > 2.25V$ then $R43 = \dfrac{(10 \cdot V_{Vrel} - 22.5)}{2.25}$ (kΩ)

If $V_{vrel} < 2.25V$ then R43=0 R44=∞ and $R_{46} = R_{47} = \dfrac{225.6}{V_{vrel}}$ (kΩ)

(Being V_{irel} the transformer secondary signal (default value=6V))
For this purpose, R_{43} has been left with the preset value (R43=16k5), and its value can be changed as per the previous relationship.

2.4. Alarms

INHI_IN: Its value can be an open-circuit or a voltage between +5V and +12V.
  If INHI_IN is open, the alarm is off.
  If INHI_IN is a voltage between +5V and +12V, the alarm is active.

TERMO: Its value can be an open-circuit or a voltage between +5V and +12V.
  If TERMO is open, the alarm is active.
  If TERMO is a voltage between +5V and +12V, the alarm is off.

IN_TEMPE: The temperature sensor resistive value will give us the operation temperature value. The MP400T unit is adjusted to operate with the semiconductor PTC sensor for a 0 to 150°C operation temperature range.

2.5. Control signal

This is a direct-current voltage from 0 volt to 5 volt (if injected in **0..5** terminal) or from 0 volt to 10 volt (if injected in terminal **0..10**).

2.6. Open collector outputs

The electrical diagram for each of the LINT, FRAMP and INHI_O outputs is shown in the figure in section 1.6. Therefore, to use those signals, a LED diode with a current limiting series resistor should be connected to each of the terminals mentioned above.

2.7. PC connection

This is a differential input corresponding to a signal according to RS485 standard.

2.8. Switches

These must be supplied with a voltage between +5V and +12V, for which the PCB auxiliary power supply outputs should be used.

The switches are identified as:

1. Start/Stop: If the '**start**' parameter has been set to **0** (AUTOMATIC, see section 3.2.4), the MP400T unit will not start controlling the load until the switch is short-circuited. If the switch is open, the system will stop.

2. Pote/Key: If the switch is short-circuited, the setpoint is determined by the submenu 3 setting (please see section 3.2.9). If the switch is in open circuit, the setpoint is determined by the potentiometer of the input signal.

3. Operation

This section explains the following:

1. The steps to be followed to control the MP400T while the system is operating normally.

2.   The steps to be followed to program each of the user-configurable system parameters as well as their default setting.

3.   The meaning of the alarm messages.

## 3.1.   MP400T control during normal operation

This section explains the steps to be followed to control the system connected to the MP400T.

After powering on the MP400T unit or after pressing the RESET (that is with the system in STOP) key, the display will show the following message for a second:
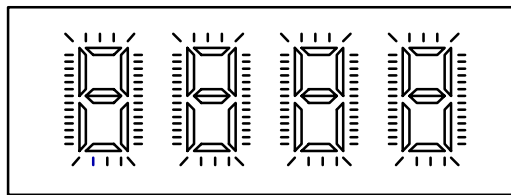
1

Then, if the parameter setting is '**control=LOCAL**' (please see section 3.2.3), the unit will display the following messages:
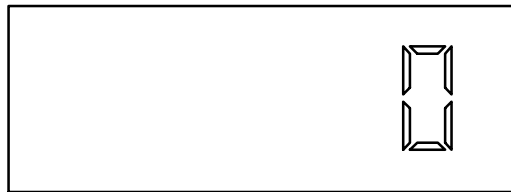
2

If the parameter setting is '**control=REMOTE**' (please see section 3.2.3), the unit will display the parameter setting '**address**', and will remain in this position until the DEFAULT key is pressed for more than 5 seconds. In the meanwhile, control of the unit will be performed from the personal computer.

If the parameter setting is '**control=LOCAL**', the '**start**' parameter setting will be considered (please see section 3.2.4).

A.   If '**start=MANUAL**', three actions can be performed:

1. All variables can be programmed to their default setting.
    This is performed by pressing the DEFAULT key for more than 5 seconds. The default parameter settings are given in section 3.2. Releasing the DEFAULT key changes to any of the actions described in item A.

2. Proceed to the customised parameter setup.
    For this purpose, press the ENTER key for more than 5 seconds. To continue the process, proceed with section 3.2.

3. Start normal operation to control the load connected to the MP400T unit.
    For this purpose, press the UP and ENTER keys simultaneously. Then, the setpoint being used by the system will be displayed. To stop the system press the DOWN and ENTER keys simultaneously.

B. If, on the contrary, the parameter setting is '**start=AUTOMATIC**', the **Start/Stop** switch setting should be considered. This setting will either stop or start the system (please see section 2.8).

Whenever the system is stopped, the actions described in item A can be carried out.

Once the MP400T unit starts normal operation, the setpoint being used by the system is displayed.

The first step carried out by the MP400T is the execution of the **starting peak** for the programmed **time**. Then the **rise ramp** also for a programmed **time**. The user cannot start to control the system from the MP400T until the rise ramp is not finished.

When finishing the rise ramp two options are available:

3.1.01. To sequentially display each of the four parameters enabled for display. The sequential display of each parameter is effected by pressing ENTER.

A. Setpoint.
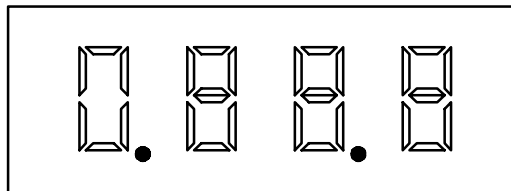
3

B. System operation temperature value.
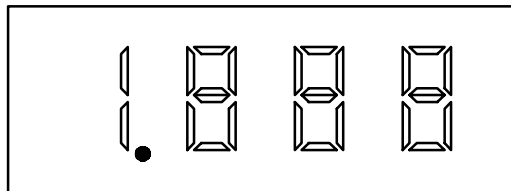
3

C. Load current value in %.
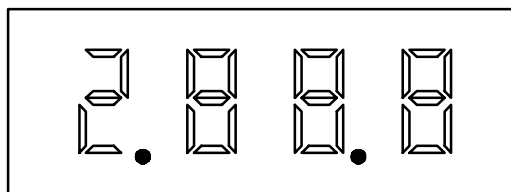
4

D. Terminal voltage at the load connected to the MP400T.
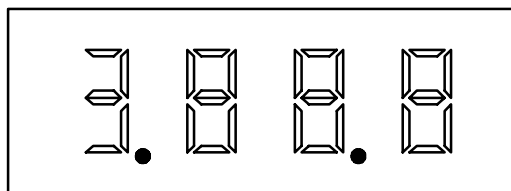
5

E. If any alarm is active, the appropriate alarm code will be displayed. (Please see section 3.3).

3.1.02. Changing the **setpoint**.

The setpoint can be changed in two ways:

1. Using the keyboard.
2. Using the potentiometer.

The method used will depend on the **Pote/Key** switch setting.

3.1.1   Changing the setpoint through the keyboard

The Pote/Key switch must be closed (that is in KEY).

Press the ENTER key for more than two seconds. Then, the programming mode during normal operation is selected.

After pressing ENTER for more than two seconds, the current setpoint value is displayed with the leftmost digit blinking. To know that we are in programming mode, this digit blinks.

The setpoint value can be changed by using the UP or DOWN keys. Each time the UP key is pressed, the setting is increased 0.1% and pressing the DOWN key decreases the setting value 0.1% (rightmost digit). Also, if one of the two keys is pressed and held for more than two seconds, this increase or decrease will occur rapidly.

If the ENTER key is pressed again, the programming mode is again released.

3.1.2   Changing de setpoint using the control signal

The Pote/Key switch should be open (that is in POTE).

The setpoint value is determined by the voltage at the IN-0..5 or IN-0..10 terminal (please see 1.5) to GND.

3.2.   Programming

The programming activity refers to those steps to be followed to change the configurable parameter data of the system. This modification must be made with the system stopped (STOP). These parameters, their meaning and what they look like exactly on the display when they are programmed are explained below. The order coincides with the order of the appearance on the display of the MP400T unit.

NOTE: To start the programming activity the ENTER key must be pressed for more than 5 seconds. In each menu position one (or a maximum of two) leftmost digit with a decimal point indicating the parameter index is about to be modified will appear. The rest of the digits can be changed until the desired value is reached. Only one digit will be active at a time. This digit can be distinguished because it is blinking. Pressing the UP key increases its value and pressing de DOWN key decreases its value. Pressing the ENTER key enables the setting. Once the ENTER key is pressed, the active digit is no longer active (it stops blinking) and the next one becomes the active one (the one immediately to the right). If this digit were the last parameter that can be changed, pressing the ENTER key moves directly to the next menu item and so on until the last parameter is reached. When the parameters had been modified they will be saved and they are not going to be losed when the equipment was witched off.

3.2.1 User password: It consists of a four-figure number which allows the user to enter the parameter setup menu. The password data can be a number between '**0000**' and '**9999**'.
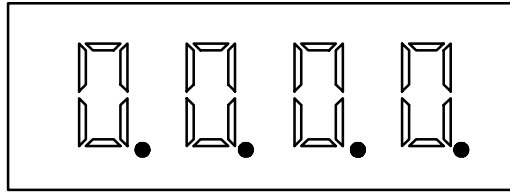
7

The user has three attempts to enter the correct password. If after the third attempt, the entered number is not correct, the display will have the appearance of the figure below and the M400T unit will remain in this situation until a reset is carried out.

8
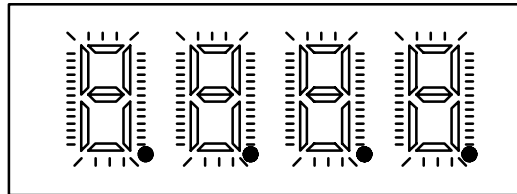
Default setting: '**0000**'

3.2.2 Changing the password: Once a correct password has been entered, it can be changed at any time. To do so, press and hold ENTER for more than 5 seconds. If you don't hold the key for at least this time, the menu will skip to the next item ('**control**'). After this time elapses, the leftmost digit will start blinking and will enable entering the new password.
Press the UP or Down key to change the digit.
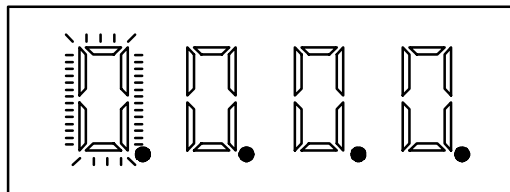
9

After the fourth digit has been entered, the new password will be requested again. Once the four digits have been entered, the display will show four zeros. After that, you'll must press the ENTER key to enter in the menu. You"ll can modify the different parameters in the menu or you'll can press the ENTER key continuously until you exit the menu.
Once you exit the menu, the new password will be saved and stored.
If the rekeyed password does not coincide with the password first keyed in, the first keyed password, the password change will not be acknowledged and the old password will remain active.

3.2.3 Control: It indicates whether the parameter setup will be performed on a LOCAL basis, i. e. through the keys of the MP400T unit itself or REMOTELY, i. e. from a PC.

To set LOCAL control, this parameter should be set to '**0**'.
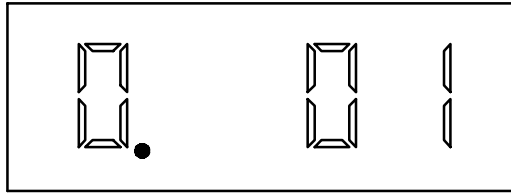

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To select REMOTE control, this parameter should be set to '**1**'.

Default setting: '**0**'

If a REMOTE control mode (1) has been set, a submenu will appear where the **address** assigned to this MP400T can be entered. The address setting range is **01** to **31**.


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After setting the address, exit the programming menu by pressing ENTER again. From now on, the display will <u>always</u> show the address setting and the control of the unit will be performed from a personal computer. Also, the only keys enabled are RESET and DEFAULT.

The only way to return to local control is by pressing for more than 5 seconds the DEFAULT key. In this case, please take into account that all default settings will become active again.

3.2.4 <u>Start:</u> This parameter can have two values, AUTOMATIC='**0**' or MANUAL='**1**' (please see section 3.1).
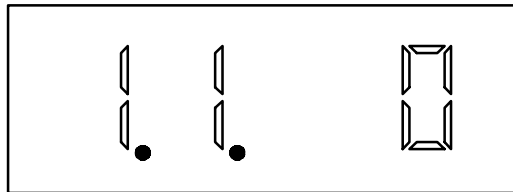
12

If it is AUTOMATIC, the unit will start operation just after the parameter setup is completed, depending of the stop/start switch setting (please see section 2.8).

If the MANUAL setting is active, the unit will not start operation until we tell it to do so by pressing the UP and ENTER keys simultaneously.
Default setting: '**1**'
3.2.5 <u>Phase failure:</u> It indicates what the MP400T unit is supposed to do when a three-phase mains **T**- phase failure occurs (if an R and S phase failure occurs, the unit stops because the power supply for the module is taken from those phases).

If a '**1**' is set, if a T phase failure occurs, the MP400T will stop, alerting that such an alarm exists by activating the INHI_O output and this will show the related alarm code on the display (please see section 3.3.3).

If a '**0**' is set, if a T phase failure occurs, the MP400T will not stop and continue its normal operation, but the display will also indicate the alarm code.
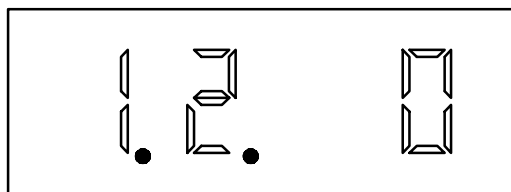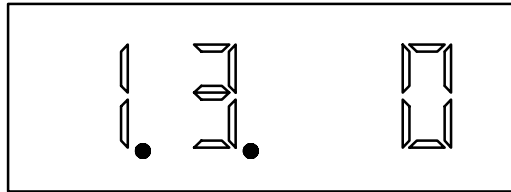

13

Default setting: '**1**'.

3.2.6 <u>Thyristor failure:</u> It indicates whether the thyristor proper operation test is to be carried out.

If '**1**' is set, the text is carried out.
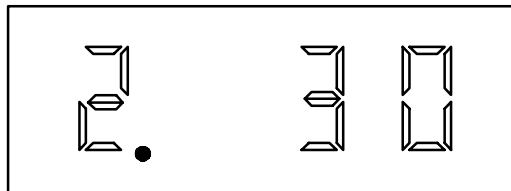If '**0**' is set, the text is not carried out.

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Default setting: '**0**'.

NOTE: The current version does not implement that test, and, therefore, this parameter setting is not relevant.
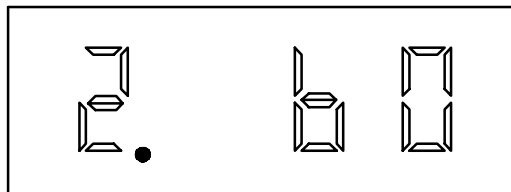
3.2.7 Trigger delay: it indicates the delay degree amount between the three-phase mains period and the time when the unit drives the thyristors. It can take three values.
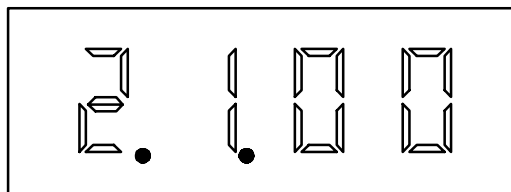
W3C: The display shows '**30**'.

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B6C: The display shows '**60**'.

16

User setup: the setting range is '**0**' to '**90**'. If this setting is selected (by pressing ENTER), its value can be changed. This is indicated by the two rightmost digits.

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To move from one setting to another (W3C<-->B6C<-->user setup), press the UP or DOWN key and enable one of the values pressing ENTER.

If the 'user setup' setting has been enabled, its value can be programmed. The setting range is '**00**' to '**90**'.
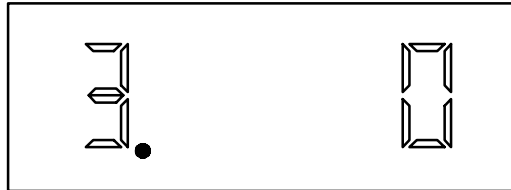
Default setting: '**30**'

NOTE: In B6C configuration highest answer speed can be achieved by means of some small modifications in the hardware (get in contact with your supplier).

3.2.8 Linear: it indicates whether the setpoint as a % corresponds to the mains period degrees or to the voltage to be applied to the load.
It can take two values:

Period degrees (entered as a % referred to 90º): '**0**'.
Voltage at the load connected to the MP400T (entered as % referred to the maximum): '**1**'.

18

Default setting: '**0**'

3.2.9 Setpoint: It indicates as a % the period degrees referred to 90º or the voltage at the load connected to the MP400T referred to the maximum (50 means 50% of the total maximum value). Its meaning will depend on the **'linear'** parameter setting. The setting range is '**00.0**' to '**99.9**'.
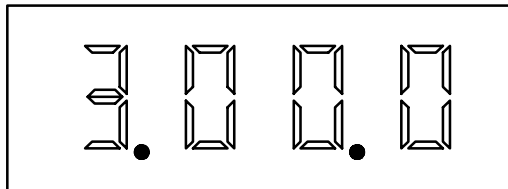

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Default setting: '**00.0**'

3.2.10 Current regulation or limitation: It indicates whether a current regulation is carried out.
        If set to '**1**', the MP400T unit will carry out a current **regulation** upon the load connected to the unit.
        If set to '**2**', the MP400T unit will carry out a current **limitation** upon the load connected to the unit.

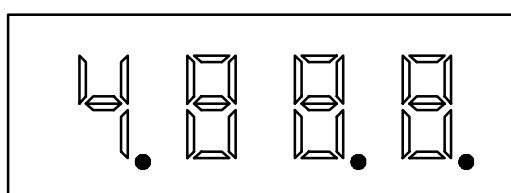   If set to '**0**', no current regulation will be performed.
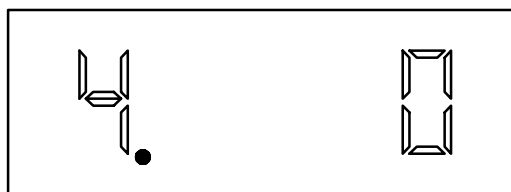
20

Default setting: '**0**'

        If it has been enabled to '**1**' or '**2**', two submenus are accessed.

        1: Regulation

        Proportional constant: It is used for setting the proportional constant value used in the proportional-integral control for current **regulation** or **limitation**. The setting range is '**0.0**' to '**9.9**'.

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Default setting: **'0.5'**
Integral constant: It is used to set the integral constant value used in the proportional-integral control for current **regulation** or **limitation**. The setting range is '**1**' to '**999**'. The units used are hundredths of a second.
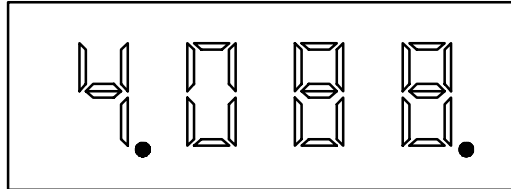
22

Default setting: '**025**'

NOTE: An inappropriate setting of these parameters can cause the control not to operate properly and the system to become unstable.
2. Limitation: in this case, the first value you have to give is the limitation level (xxx) in % of the total. The rest is the same as enabling '**1**'.

3.2.11 Voltage regulation or limitation: It indicates whether a voltage regulation is carried out.
    If set to '**1**' the MP400T unit will carry out a voltage **regulation** upon the load connected to the unit.
    If set to '**2**' the MP400T unit will carry out a voltage **limitation** upon the load connected to the unit.

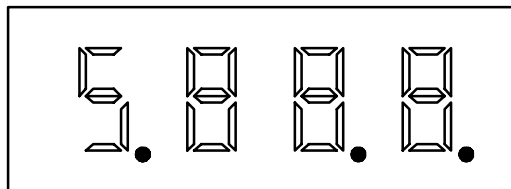   If set to '**0**', no voltage regulation will be performed.

23

Default setting: '**0**'
    If it has been enabled to '**1**' or '**2**', two submenus are accessed.

    1. Regulation:

Proportional constant: It is used for setting the proportional constant value used in the proportional-integral control for current **regulation** or **limitation**. The setting range is '**0.0**' to '**9.9**'.

24

Default setting: **'0.5'**

Integral constant: It is used to set the integral constant value used in the proportional - integral control for current **regulation** or **limitation**. The setting range is '**1**' to '**999**'. The units used are hundredths of a second.
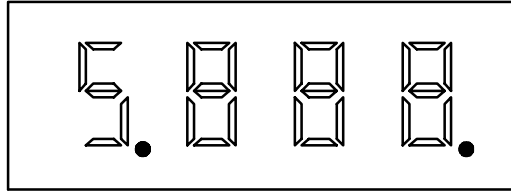
25

Default setting: '**025**'

NOTE: An inappropriate setting of these parameters can cause the control not to operate properly and the system to become unstable.

2. Limitation: in this case, the first value you have to give is the limitation level (xxx) in % of the total. The rest is the same as enabling '**1**'.

3.2.12 Starting peak: It is a peak on the start, before ramp starts. It sets as a % of total voltage value the setpoint at which the system will start operating when it starts working (for example 6.40.0 means 40% of the total voltage value (in degrees, not in Volts). If the '**00.0**' is set, there will be no starting peak.
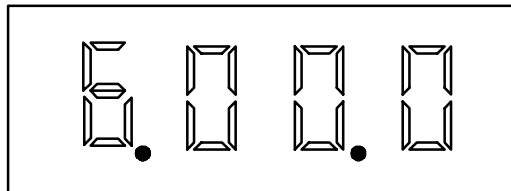
26

Default setting: '**00.0**

'

If the starting peak has been enabled (because its value is other than '**00.0**'), the submenu allowing the starting peak time to be set will appear. The starting peak time value is given in seconds with an accuracy of tenths of a second (maximum 9.9 seconds) (for example 6.1.5.5 means 5.5 seconds).
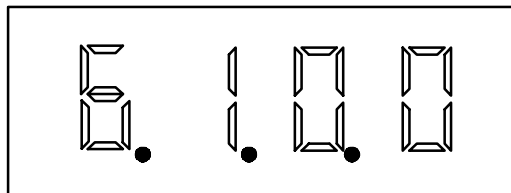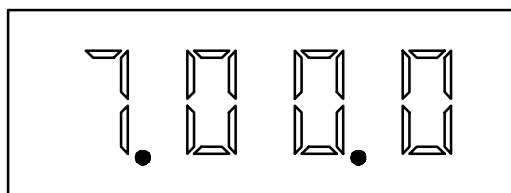

27

Default setting: '**0.0**'

It is usually use to refloat the motor on the start.

3.2.13 Threshold: This is the minimum value as a % of the setpoint at which the system starts operating.

28

Default setting: '**00.0**'

It is usually on starts of motors. If you apply to an AC-motor voltages lower than for example 40% of the total, the motor does not run, but current is there. It is better to apply directly from start voltages starting on this 40%.

3.2.14 Rise ramp: It indicates the time the system will take to carry out the rise ramp, that is, to change from a setpoint equal to the one indicated on the threshold to a setpoint equal to the one indicated in section 3.1.02. This setting is given in seconds. If the setpoint is lower than the threshold, the ramp time will be **0** seconds regardless of the programmed value.
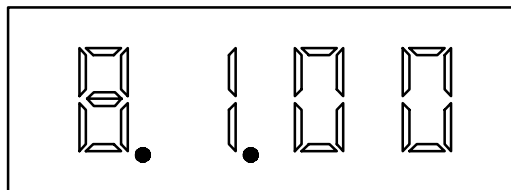

29

Default setting: '**00**'

3.2.15 Fall ramp: It indicates the time that the system will take to carry out the fall ramp, i.e., to change for the current setpoint to a setpoint equal to the one indicated by the threshold. Its setting is given in seconds. If the setpoint is lower than the threshold, the ramp time will be **0** seconds regardless of the programmed value.
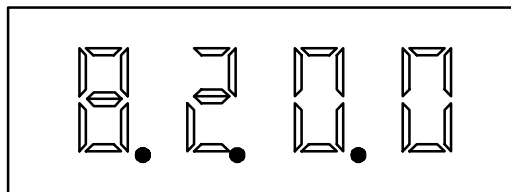
30

Default setting: '**00**'

3.2.16 Temperature: It indicates the maximum temperature in ºC at which the system is allowed to operate without an alarm being activated. The setting range is '**000**' to '**150**'. If a value equal to '**000**' is set, the operation temperature value will not be considered.
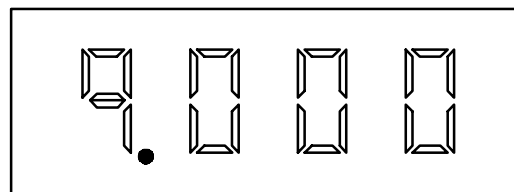
31

Default setting: '**000**'

The temperature parameter is the last programmable value. Once enabled, the MP400T will start operating normally as per the programmed values (please see section 3.1).
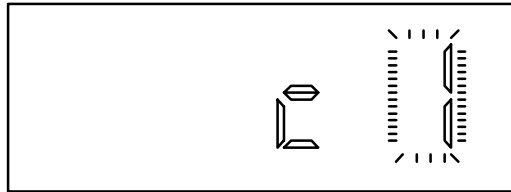

3.3.   Alarm and limitation messages

A total of up to 5 alarms can be displayed.

3.3.1   **Disable_in** (5)

When the disable_in alarm is displayed, the unit stops immediately (the setpoint becomes '**00.0**' regardless of the programmed fall ramp), and the display shows the following message:
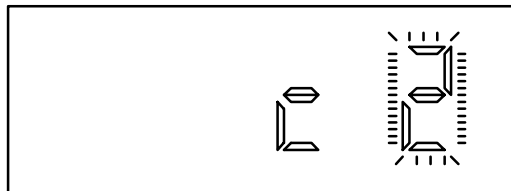
32

The INHI_O also becomes active.

The unit will remain in this position until the alarm disappears, at which moment the system starts operating normally as per the parameter settings programmed in section 3.2.

3.3.2 Temperature switch (4)

When the temperature switch alarm becomes active, the unit stops immediately (the setpoint becomes '**00.0**' regardless of the programmed fall ramp), and the display shows the following message:

33

The INHI_O output also becomes active.

The unit remains in this position until the alarm disappears, at which time the system starts operating normally as per the parameter settings programmed in section 3.2.

3.3.3 Phase failure

If a mains T-phase failure occurs, the display shows the following message:
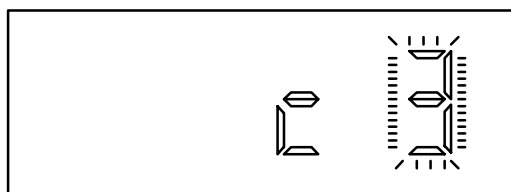
34

The INHI_O output also becomes active.

Depending on the '**phase failure**' parameter setting, the unit will stop automatically.

3.3.4 Temperature

When an overtemperature alarm is displayed, the equipment will stop with a fall ramp time equal to the one programmed in section 3.2.15, showing the operation temperature value on the display:
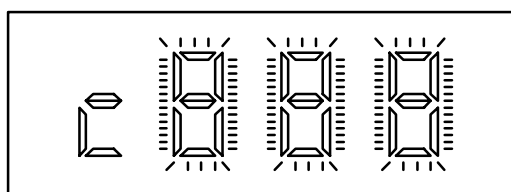

35

The INHI_O output also becomes active.

The unit will remain in this position until the temperature drops 10º C below the value programmed in 3.2.16, at which time the system will start operation normally as per the parameter settings programmed in section 3.2.

3.3.6 Phases exchanged

If any of the power supply phases has been exchanged in the module power supply, the LED next to the display (please see the graph in section 1) will go on without the system normal operation stopping. If connections within the module and thyristors are not correct, the unit may be operating inappropriately.

3.3.7 Alarm priorities

If more than an alarm becomes active at the same time, the message shown on the display will follow the priority order given below (the highest priority has the message disable_in and the lowest priority that for phase interchanged):

1. Disable_in
2. Temperature switch.
3. Phase failure.
4. Temperature.
5. Phases exchanged.

4. Voltage-current regulation / proportional-integral / series

What is limitation and what is regulation?

In order to make it easier to understand we are going to speak about current but is the same with voltage.

Limitation: The module works normally, up and down following the control signal (the control signal means voltage, we are controlling voltage). If the module detects that the current limit has been reached, it limits the current to this maximum value and avoids any increase in respect of this value. If you decrease the control signal the voltage and the current go down.

Regulation: The control signal sets the value of current that you want, independently of the voltage or not (depends on your programming). For example, if you set the control signal 80%, the current grows up as quickly as you programmed with Kp and Ki constants. If load increases, voltage goes down in order to maintain current. If load decreases, voltage goes up in order to maintain the current (only if voltage arrives to the maximum, current current stays stable, as it is impossible to get more current on this load with this maximum voltage). Therefore the module try to maintain the current constant at the set point.

If the **current regulation** and / on **voltage regulation** parameters are set to '**1**', the setpoint value will become the regulation point.

The equation implemented for each of the regulation modes when only one of those is enabled is as follows:

$$Work_{point} = \frac{1}{K_i}(\sum_{0}^{\infty} K_P\, e(t))$$

where:
$Work_{point}$=Setpoint applied to the load.
K_i= Integral control constant.
K_p= Proportional control constant.
$e(t)$= Error.

where Error (t) is defined as follows:
e(t)=(Feedback value(t) - regulation point (t)).

If both voltage and current regulation are enabled, a series voltage-current regulation that follows the equation given below has been implemented:

$$Work_{point} = \frac{1}{K_{iint}} \sum_{0}^{\infty} K_{pint} \, e(t)$$

where:

e(t)= PI voltage(t) - current feedback(t).
K_{iint}=Current integral constant.
K_{pint}= Current proportional constant.
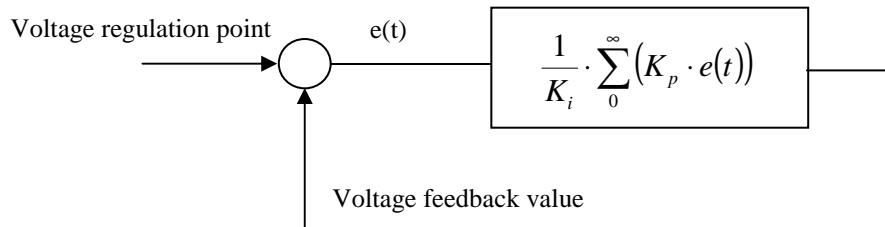
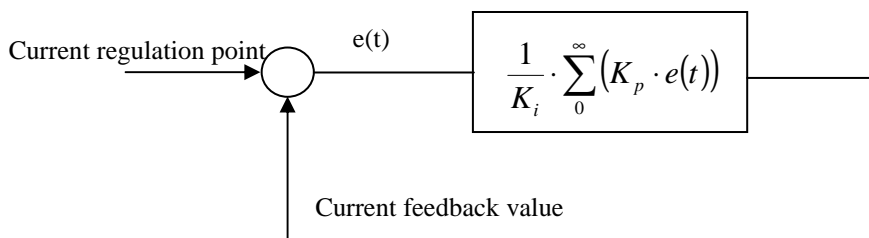where, in turn:

$$PI_{tension}(t) = \frac{1}{K_{ivol}} \sum_{0}^{\infty} K_{pvol} \, e(t)$$

e(t)=(Voltage feedback value (t) - Regulation point (t)).
K_{ivol}=Voltage integral constant.
K_{pvol}= Voltage proportional constant.
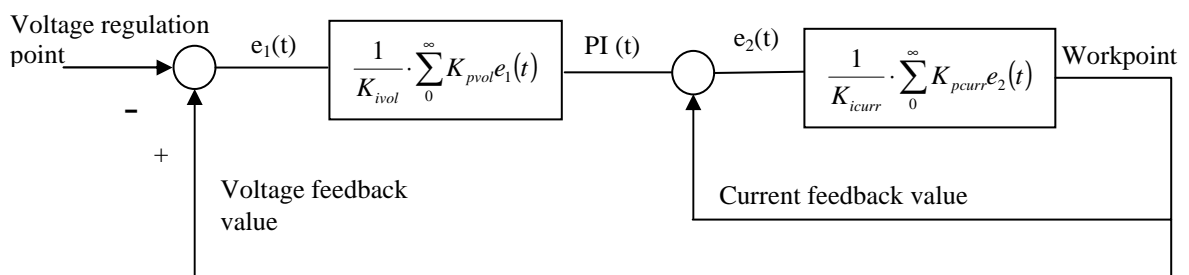
Therefore there are three differens situations:

A)   Only voltage regulation:

B) Only current regulation:

C) Both Voltage and Current regulation:

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APPENDIX A

This appendix includes a brief description of the program used to control a maximum of 31 MP400T units from a personal computer.

A.1   Connection

In order for that control to be performed, the COM1 or COM2 communications port output should have a RS232-RS485 converter connected to it. The converter output (differential output) will be connected to the terminals identified as RS485- and RS485+ in the MP400T equipment.

MP400T output	RS232/RS485 output	SUBD9 (COM1)	SUBD25 (COM2)
RS485+(17)	T×D pin 2	R×D pin 2	R×D pin 3
RS485-(16)	R×D pin 3	T×D pin3	T×D pin 2
GND(7)	GND pin 5	GND pin 5	GND pin 7

The converter is supplied with a 1.5m of cable and connector SUBD9.

The jumpers SW1 y SW2 are used to adapt the converter at different speeds. For our use (9.600 baud) both have to be connected.

With the jumper J1 ON the terminal load (120Ω) is connected. If the length of the transmission wires is high, another terminal load of the same value has to be connected at the end of the line (in parallel with +/-). The transmission line made with twisted pair of 24 AWG in normal ambients at the speed of 9.600 baud, can have an approximate length of max. 1 km. The GND terminal of the RS485 is not indispensable, but is advisable in noisy ambients.

A.2   MP400T control

Execute from windows Install.exe.

PROGRAMMING MANUAL FOR MP400T FOR WINDOWS

CREATING A NEW MODULE

To create a new module, choose the **Module - New** menu options. A dialogue window will appear where the module number as well as a module description will be shown. Once this data has been entered, the window with all default data for the module just created will appear. In addition, a new module can also be created by using the appropriate direct access button.

MODULE WINDOW
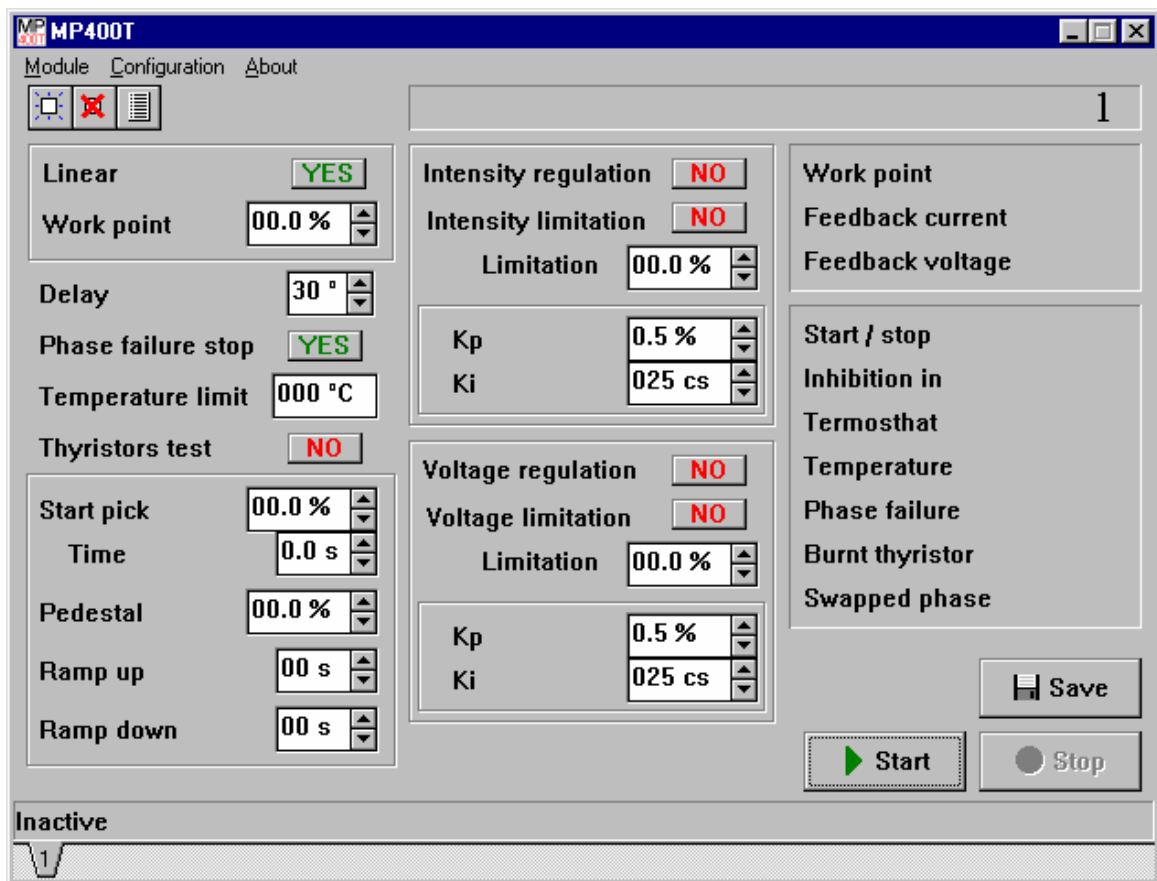

A module's window contains different types of controls and displays:

YES/NO Buttons: These buttons toggle between YES and NO, and display at every moment the appropriate parameter status.

Entering data: This type of indicators allow to change a parameter value by using the keyboard as well as to enable it by using the *Enter* key. After pressing Enter, they are

output to the appropriate module. If a value higher than the maximum allowed is entered, the value changes automatically to the maximum allowed value.
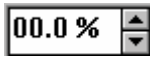
00.0 % ⇅ **Entering data by using the increase and decrease buttons**: they allow to enter a value from the keyboard and enable it by using the *Enter* key and, also, to increase or decrease the parameter value by using the arrow buttons located to the right of the control element, in which case the value is updated each time any of the buttons is pressed.

▶ **Start** **Start button**: This button outputs all parameter values to the appropriate module and sets it in operation. The button remains disabled until the module is stopped.

⏺ **Stop** **Stop button**: It shuts down the module. This button is disabled while the module remains stopped.
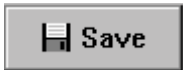
💾 **Save** **Save button**: It stores all module parameters, such that they can be retrieved later.

\1\2\4\10\ **Module select lids**: By using these lids, one of the existing modules can be quickly selected.

■ **1** On the upper right corner, next to Module No, a red box will appear if a communications error with the current module exists.

In addition, the module window will be split up in three differentiated sections:

Linear	YES
Work point	00.0 % ⇅
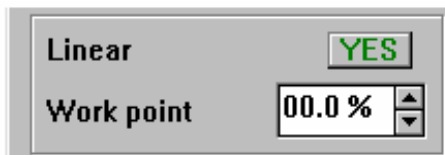
On the left of the window, the setpoint parameter section is shown. This data can be modified while the module is in operation by using the appropriate controls, as previously explained.

Intensity regulation	NO
Intensity limitation	NO
Limitation	00.0 %
Kp	0.5 %
Ki	025 cs

Voltage regulation	NO
Voltage limitation	NO
Limitation	00.0 %
Kp	0.5 %
Ki	025 cs

On the center of the screen, the menu to control the MP400T as a regulator or limitator is displayed.

Delay	30 "
Phase failure stop	YES
Temperature limit	000 ºC
Thyristors test	NO
Start pick	00.0 %
Time	0.0 s
Pedestal	00.0 %
Ramp up	00 s
Ramp down	00 s

On the left of the screen, the module initial parameter section is displayed. This data can only be modified while the module is stopped, while if the module is in operation, access to the control for these parameters is disabled.
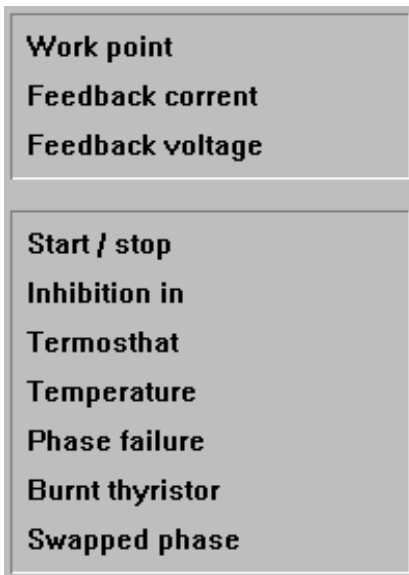
The third section on the screen is split up in two differentiated parts: The upper part shows the actual module operating data, while the lower part shows the module alarm start/stop switch status.

ALARM WINDOW
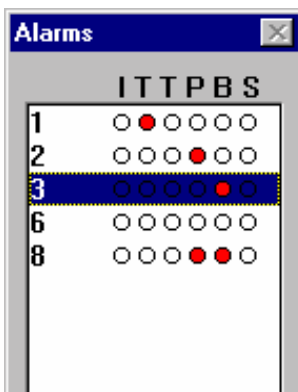
Whenever an alarm is output from list of the operating modules, the program shows a window where a modules is displayed in which the alarms output in each module are marked. This window can only disappear at the moment in which no module remains with an existing alarm and, also, the window is always shown above the main program window such that its presence can not avoided.

DELETING THE MODULE

To delete a module, choose the **Module - Delete** menu options. A confirmation to delete the module will be requested, and, if so desired, all module data contained in the data file will be deleted. In addition, a module can also be deleted by pressing the appropriate direct access button.

SAVING MODULE DATA

Data for a module can be saved for later retrieval by using the **Module - Save** menu options or by pressing the **Save** button which is displayed on all module screens. In addition, all data for all modules can be saved by selecting the **Module - Save All** menu options at the same time.

DIRECT ACCESS BUTTON

The main program window contains a series of buttons by means of which a series of actions can be carried out quickly:

 It creates a new module. The result is equivalent to using the **Module - New** module options.

 It deletes the current module. The result is equivalent to using the **Module - Delete** menu options. This button is disabled if no module exists or if the current module is operating.

 It displays a list of current modules. The result is equivalent to using the **Module - List** menu options. This button is disabled if no module exists.

LIST OF MODULES

Choosing the **Modules - List** options or the appropriate direct access button allows access to a window that displays a list of existing modules, together with its modules status: A green box, when the module is operating, a red box if there is a communications error with the module (this box may appear together with the green box or just alone, which indicates that an attempt has made been attempted to start the module, no response has been received from the module).

This window also displays the **Show** and **Label** buttons. The first one displays the module data for the module currently selected on the list on the main module screen (the result is equivalent to double clicking the desired module on the list). The second button allows to change the label for the module selected.

CHANGING A MODULE'S LABEL

The label describing the modules can be changed on the List of Modules window. To change it, simply choose the desired module and press the **Label** button that appears on the right of the window.

COMMUNICATIONS

The communications port used by the program can be displayed by using the **Configuration - Communications** menu options. The window that appears displays all existing ports in the computer, which may or may not the available for the program (for example, usually the COM1 port is not available because it is used by the system's mouse).

ACCESS PASSWORD

Access to the program is limited by a password of up to 8 characters, which is to be entered whenever the program is run.

The password can be changed by choosing the **Configuration - Password** menu option. A screen will appear where the new password should be entered and Please reenter the password to enable it and avoid errors.
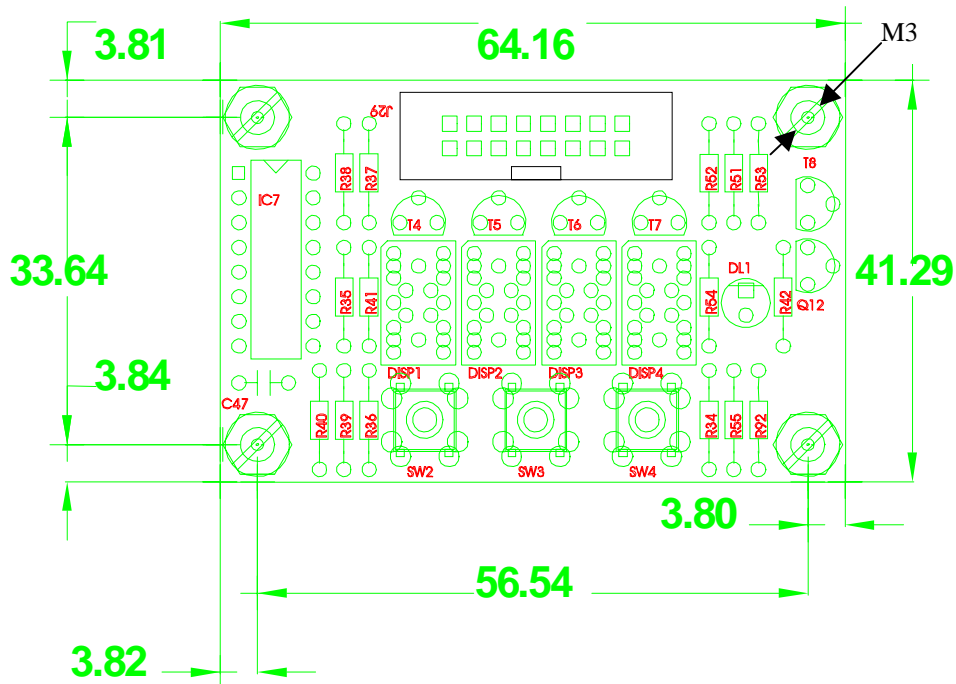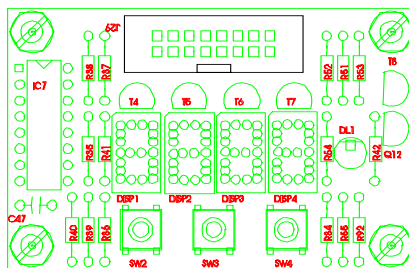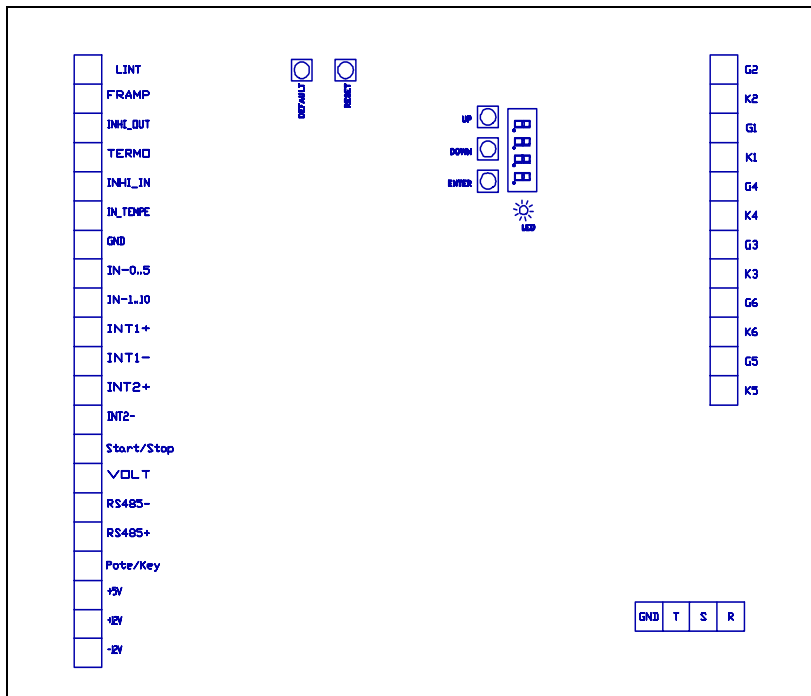
APPENDIX B

This appendix contains a brief description of the additional display MP400D.

B.1 Additional external display MP400D

This is an additional display (get in contact with your distributor) for the remote control of MP400T witch is supplied with 1m of wire.

B.2 Picture of MP400D

Figura 1

CONNECTION

R	R phase
S	S phase
T	T phase
G	Ground

1	LINT	Regulation is performing output
2	FRAMP	Ramp end output
3	INHI-OUT	Disable output
4	TERMO	Temperature switch input (the other input is connected to +5V)
5	INHI-IN	Disable input (the other is connected to +5V)
6	IN-TEMPE	Thermoresistor
7	GND	ground
8	IN 0-5Vdc	External setpoint input 5V
9	IN 0-10Vdc	External setpoint input 10V
10	INT1+	1ª current sensor
11	INT1-	1ª current sensor
12	INT2+	2ª current sensor
13	INT2-	2ª current sensor
14	Start/Stop	Start switch
15	VOLT	voltage feedback
16	RS485-	PC communication
17	RS485+	PC communication
18	Pote/Key	Potentiometer switch /keyboard
19	+5Vdc	Potentiometer auxiliary power supply output
20	+12Vdc	Auxiliary power supply output
21	-12Vdc	Auxiliary power supply output

2	K5
3	G5
5	K6
6	G6
8	K3
9	G3
11	K4
12	G4
14	K1
15	G1
17	K2
18	G2

7/10/04

B6C

W3C

M6C

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Figura2

SEMIKRON
innovation+service

J:\MP400TCaemp400conlimit.doc

7/10/04
30/35

J2

LINT
FRAMP
INHI-OUT
TERMO
INHI-IN
IN-TEMPE
GND
IN 0-5Vcc
IN 0-10Vcc
INT1+
INT1-
INT2+
INT2-
Star/Stop
VOLT
RS485-
RS485+
Pote/Key
+5V
+12V
-12V

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21

SW5 SW1

IC7

J29

G2–K2
G1–K1
G4–K4
G3–K3
G6–K6
G5–K5

J19

SW2

DISP1
SW3
DISP2

DISP3
DISP4
SWU

D11

XT1
C11

R47
IC2
IC2
R46
R44 R117
R43 R119
R11
IC5

C71
J22
IC19
IC1
IC4
IC15
IC16
IC12
AR7
R116
R123 R122
R125
R124
J25
IC14
IC13
IC6
R57

R81

TR8
TR9

TR1

IC3 IC2 IC1

J1
GND
T
S
R

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165.04

28.15

M4

35.53

74.37

235.04

88.90

8.09

5.00

114.99

45.04

Figure 3

Figure4

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R   S   T

K2   K4   K6
G2   G4   G6

K1   K3   K5
G1   G3   G5

U   V   W

W3C-CONTROL

R S T GND

-12V	21
+12V	20
+5V	19
POTE/KEY	18
RS485+	17
RS485-	16
VOLT	15
START/STOP	14
INT 2	13
INT 2	12
INT 1	11
INT 1	10
IN 1..10V	9
IN 0..5V	8
GND	7
IN-TEMPE	6
INHI-IN	5
TERMO	4
INHI-OUT	3
FRAMP	2
L.INT	1

K5
G5
K6
G6
K3
G3
K4
G4
K1
G1
K2
G2

POTE/KEY   START/STOP

THERMAL SENSOR

POT. 10V
WORK POINT

THERMAL-TRIP   INHIBIT

SEE 1.6

R1

A

R2   LOAD

B

OR

6V

A

B

LOAD

A

A

B

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104

77

Board components labeled: J5, 6, 1, F1, C11, D3, TR1, C1, T2, T1, R12, J6, IC, C10, GND, C8, C7, IC3, J2, C14, C6, R11, R5, R6, R4, J1, C4, C9, SW2, SW1, IC2, C5, R3, IC1, C1, R8, R10, R1, R2, R9, R7, C2, C3, D1, D2