CMZ hardware

CD1-k
User Guide

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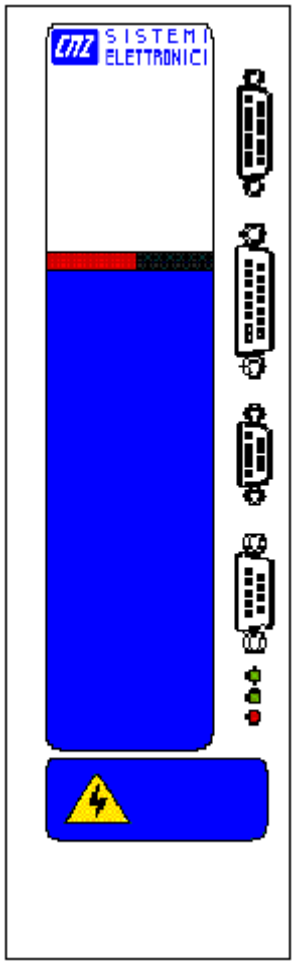

CANopen
Drive

SISTEMI ELETTRONICI

WARNING

This is a general manual describing a series of servo speed amplifiers having output capability suitable for driving AC brushless sinusoidal servo motors. This manual may be used in conjunction with appropriate and referenced drawings pertaining to the various specific models.

Maintenance procedures should be attempted only by highly skilled technicians having good knowledge of electronics and servo systems with variable speed (EN 60204-1 standard) and using proper test equipment.

The conformity with the standards and the "CE" approval is only valid if the items are installed according to the recommendations of the amplifiers manuals. Connections are the user's responsibility if recommendations and drawings requirements are not met.

Any contact with electrical parts, even after power down, may involve physical damage.

Wait for at least 5 minutes after power down before handling the amplifiers (a residual voltage of several hundreds of volts may remain during a few minutes).

CMZ SISTEMI ELETTRONICI drives are conceived to be best protected against electrostatic discharges. However, some components are particularly sensitive and may be damaged. Before handling the drives and, particularly, before any contact with the connectors, the user himself must be earthed. Place or store the drives on conducting or electrostatically neutral areas but not on plastic areas, carpeting or insulation material that may be electrostatically loaded.

CMZ SISTEMI ELETTRONICI does not assume any responsibility for any physical or material damage due to improper handling or wrong descriptions of the ordered items.
Any intervention on the items, which is not specified in the manual, will immediately cancel the warranty.

CMZ SISTEMI ELETTRONICI reserves the right to change any information contained in this manual without notice.

Issue: **1.2**

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Chapter 1 - General description

1 - INTRODUCTION

Series CD1-k drives with CANopen interface are PWM servo drives that provide speed control for AC sinusoidal motors (brushless) with transmitter resolver.

The **CD1-k** system is available as:

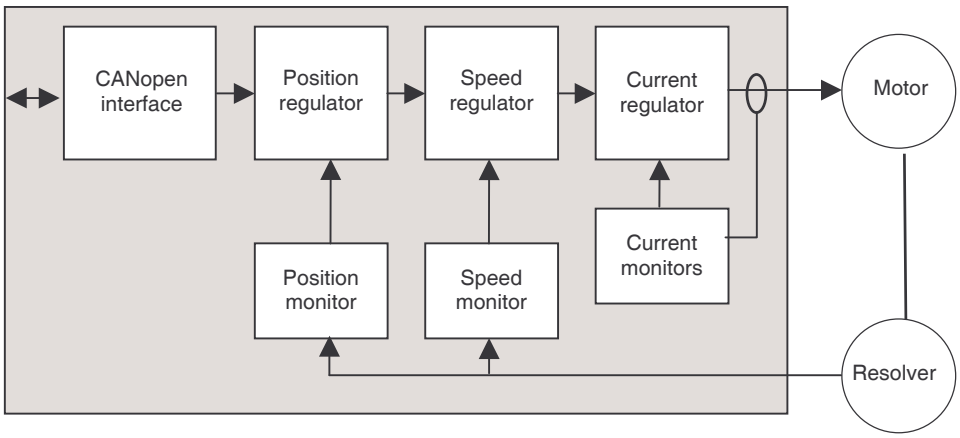
- ✓ a stand-alone single-axis block including all supplies as well as the mains filter, and is 230 VAC or 400/480 VAC mains operated or
- ✓ a 3-axes housing with 400 / 480 Vac supply.

CD1-k drives are working via a bus with "**CANopen**" communication protocol.

The drive parameter setting can be made either by means of:

- the **CANopen** bus or
- the specific parameter setting software **Visual Drive Setup**, via the serial port RS-232.

2 - ARCHITECTURE OF THE DRIVE



Electric motor	Electric device that transforms electrical energy into a mechanical movement. This transformation is often made by means of current commutation. Generally, the movement is a rotation but there are also linear motors.
Brushless or synchronous motor	Electric brushless motor. The current commutation is electronically made and requires a position sensor (resolver, encoder, Hall sensor...).
Resolver	Absolute position sensor over one revolution. The resolver is often used with a brushless motor.
Drive	Electric device for the control of electric motors. It also includes a current regulator, a speed servo control and, often, a position servo control.
Current loop Current regulator	Used for the motor current control. The motor torque is generally proportional to the current amplitude.
Speed loop Speed regulator	Allows the motor speed control with a speed input command.
Position loop Position regulator	Allows the motor position control.
Fieldbus	Digital link that allows real time data exchange between various electric devices. The characteristic of fieldbusses is their high protection and error correction level as well as a predictable communication time.
CANopen	Communication protocol on CANbus – Standards: CiA DS301 / CiA DSP402.
Enabled/disabled *(Servo On/Off)*	When a motor is enabled, it is controlled by the drive and the servo loops are operating. When it is disabled, its rotation is free and there is no current in the motor.

Chapter 2 - Commissioning

CAUTION !

Do not make the drive parameter setting by means of both Visual Drive Setup software and CANopen bus at the same time.

1 - INSTALLATION OF THE PARAMETER SETTING SOFTWARE

The **Visual Drive Setup** software is PC compliant under Windows®[1] and allows an easy parameter setting of the **CD1-k** drive.

2 - CHECKING THE DRIVE HARDWARE CONFIGURATION

The standard drive configuration is adjusted to **CMZ SMB / MB motors series** (transformation ratio = 0.5) :

• " P-RES" resolver adjustment board: 4 x 3.92 kOhm 1%

For the adjustment to other resolver types, please see manual "**CD1-k - Installation Guide**".

3 - PUTTING INTO OPERATION

Please see manual "**CD1-k - Installation Guide**" before switching on the drive for the first time.

For switching on the drive, please proceed as follows:

- Switch on the +24V auxiliary supply:
  The green front panel LED "**OK**" must blink (error "No power voltage" displayed).
  The relay contact " DRIVE READY" (pins 9 and 10 of X2) is closed. It is then possible to control the power relay.

- Switch on the power supply:
  The green LED "**OK**" must be continuously lit: the drive is ready to be enabled.

CAUTION !

The 24 V auxiliary supply must **always** be switched on **before** the power supply.

It is mandatory to wait for at least 30 seconds between switching off and on again the drive.

[1] Windows® is a registered trade mark of MICROSOFT® CORPORATION

4 - STARTING AND ADJUSTING THE DRIVE

This chapter describes the commissioning procedure of the drive by means of the " **Visual Drive Setup**" software.

- Connect the serial link RS232 between PC and drive.
- Switch on the drive and start the **Visual Drive Setup** software on the PC, under WINDOWS®.

If the message **No serial communication found** is displayed on the screen, click on OK and check the following points:

- The drive must be on,
- The correct RS232 connection between drive and PC,
- The correct software configuration (**Com.port**, ...).

For a parameter setting of the drive via the **Visual Drive Setup** software:

- Switch the drive to **Local** mode, that means switches address = 0 (see Chapter 3, section 3),
  or
- Disable the **CANopen** communication by means of **Visual Drive Setup**.

4.1 - DRIVE ADJUSTMENT TO THE MOTOR SPECIFICATIONS

4.1.1 - SELECTION OF THE MOTOR TYPE

A) THE MOTOR USED IN THE APPLICATION IS CONTAINED IN THE MOTOR LIST OF THE PARAMETER SETTING SOFTWARE.

Select, in the motor list, the motor used in the application.
The motor selection will start the automatic calculation of the current loop parameters.

Check that the values of the parameters **Max. current** and **Rated current** are compliant with motor and drive. If necessary, modify them according to the motor and drive specifications.

The parameter **Max current** defines the maximum output current value of the drive. It can vary between 20 % and 100 % of the drive current rating.

The parameter **Rated current** defines the limitation threshold of the drive output RMS current (I^2t).
It can vary between 20 % and 50 % of the drive current rating.

B) THE MOTOR USED IN THE APPLICATION IS NOT CONTAINED IN THE MOTOR LIST OF THE PARAMETER SETTING SOFTWARE.

If the motor used in the application is not contained in the motor list, proceed as follows:

Enter the inductance value between the motor phases and start the current loop calculation procedure.

Check that the values of the parameters **Max. current** and **Rated current** are compliant with motor and drive. If necessary, modify them according to the motor and drive specifications.

Uncouple the motor from its mechanical load and check that the motor shaft is free and that its rotation over one revolution is not dangerous for the operator. Check that the brake is released (the **Autophasing** command does not control the brake).
Then start the **Autophasing** procedure. This procedure calculates the following parameters:

- The parameter **Number of pole pairs**, which defines the number of motor pole pairs,
- The parameter **Phase order**, which defines the motor phases order,
- The parameter **Resolver offset**, which defines the mechanical shift between the motor reference and the resolver reference.

Note
If the parameters **Number of pole pairs**, **Phase order** and **Resolver offset** are known, they can be manually entered and their calculation by means of the **Autophasing** procedure is not required anymore.

4.1.2 - maximum application speed

The parameter **Max. speed** defines the maximum speed at which the drive can control the motor.
This parameter can be:

- lower than or equal to the maximum motor speed,
- slightly higher than the maximum motor speed in the application. This margin allows a speed overshoot that avoids the position loop saturation (position following). This margin can be as small as possible when using a high bandwidth or at low acceleration.

4.1.3 - CONFIGURATION OF THE THERMAL SENSOR

4.1.3.1 - Selection of the sensor type

The motor can be equipped either with a CTN sensor (ohmic resistance = decreasing temperature function) or with a CTP sensor (ohmic resistance = increasing temperature function).

Check that the selected thermal sensor type actually corresponds to the sensor type mounted on the application motor.

4.1.3.2 - Triggering threshold adjustment

Enter the sensor ohmic value (kOhm) corresponding to the required temperature value for the release of the **Motor overtemperature** protection, according to the manufacturer's specifications.

4.1.3.3 - Warning threshold adjustment

Enter the sensor ohmic value (kOhm) corresponding to a warning temperature value.
When the warning temperature is reached, an information is sent via the **CANopen** bus.
Note
When using a CTN sensor, the warning ohmic value will be higher than or equal to the triggering ohmic value.
When using a CTP sensor, the warning ohmic value will be lower than or equal to the triggering ohmic value.

4.2 - I^2T PROTECTION

2 selection modes are available: **Fusing** or **Limiting**.
It is advisable to use the **Fusing** mode during commissioning phases.

In **Fusing** mode, the drive is disabled when the current limitation threshold is reached.

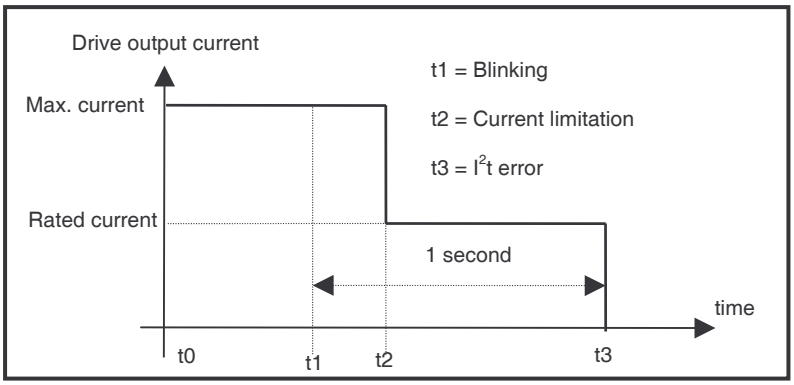
In **Limiting** mode, the motor current is only limited at the value defined by the **Rated current** parameter when the limitation threshold is reached.

4.2.1 - OPERATION OF THE CURRENT LIMITATION IN "FUSING" MODE

When the drive output RMS current (I^2t) reaches 85 % of the rated current, the **OK** LED is blinking on the drive front panel. If the RMS current (I^2t) has not dropped below 85 % of the rated current within 1 second, the I^2t error is released and the drive disabled (otherwise, the blinking is inhibited).

When the drive output RMS current (I^2t) reaches the rated current value, the I^2t limits the drive output current at this value.

Diagram of the drive output current limitation in an extreme case (motor overload or shaft locked):



The maximum current duration before release of the blinking display is depending on the value of the parameters **Rated current** and **Max. current**. This value is calculated as follows:

$$T_{dyn} \text{ (second)} = t_1\text{-}t_0 = 3{,}3 \times [\text{ rated current (\%) / max. current (\%)}]^2$$

The maximum current duration before limitation at the rated current is also depending on the value of the **Rated current** and **Maximum current** parameters. This value is calculated as follows:

$$T_{max} \text{ (second)} = t_2\text{-}t_0 = 4 \times [\text{rated current (\%) / max. current (\%)}]^2$$

NOTE 1
When the "Max. current / Rated current" ratio is close to 1, the Tdyn and Tmax values given by the above formula are quite below the real values. But this formula remains very precise as long as the "Max. current / Rated current" ratio is higher than 3/2.

NOTE 2
The drive I^2t signal can be displayed on the digital oscilloscope by selecting the **I^2t** signal in the **Channel** menu. The threshold values of the I^2t signal, for the protection mode described above, are calculated as follows:

Triggering threshold of the Idyn signal (%) = [**Rated current** (%)]^2 / 70
Current limitation threshold (%) = [**Rated current** (%)]^2 / 50

The corresponding RMS current value of the drive can be calculated as follows:

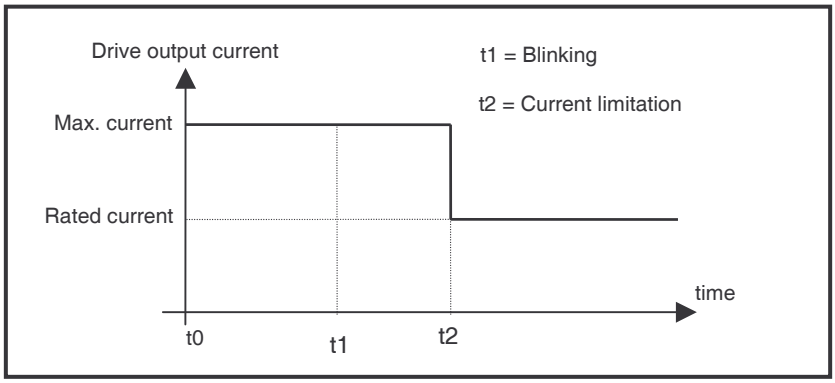
Drive RMS current (%) = [I^2t signal value (%) x 50]$^{1/2}$

4.2.2 - CURRENT LIMITATION IN "LIMITING" MODE

When the drive output RMS current (I^2t) reaches 85 % of the rated current, the **OK** LED on the drive front panel is blinking. When the RMS current (I^2t) drops below 85 % of the rated current, the blinking is inhibited.

When the drive output RMS current (I^2t) reaches the rated current value, the I^2t protection limits the drive output current at this value.

Diagram of the drive output current limitation in an extreme case (motor overload or shaft locked):



The maximum current duration before release of the blinking display (t1 - t0) and before limitation at the rated current (t2 - t0) is calculated the same way as in the "Fusing" mode.

4.3 - SERVO LOOP ADJUSTMENT

4.3.1 - REGULATOR PARAMETERS

The **Autotuning** procedure identifies the motor and load specifications and calculates the speed/position loop parameters.
In speed mode **P**, **PI** and **PI²**, only the speed loop gains are calculated.
In **Position** mode, the gains of both speed **and** position regulators are calculated.

The operator can select a bandwidth (**Low**, **Medium** or **High**) as well as the filter type (**standard**, **antiresonance** or **max. stiffness**).

The **Autotuning** procedure can be executed with the motor disabled or enabled (i.e. vertical load).

Before executing the **Autotuning** procedure, check that the motor shaft is free and that its rotation over one revolution is not dangerous for operator and machine. Check that the brake is released (the **Autotuning** command does not control the brake).

For a complete adjustment, the **Autotuning** procedure must **always** be executed in **Position** mode (at power on, the drive is automatically in **Position** mode).
But the drive can also be controlled in **Speed** mode. In this case, after the execution of the **Autotuning** procedure in **P**, **PI** or **PI²** mode:

- check that the motor is correctly running in both directions,
- check the **response at a small displacement without Idc saturation** (oscilloscope function).

In case of loud noise in the motor at standstill or when running, check the rigidity of the mechanical transmission between motor and load (backlashes and elasticities in motor and couplings).
If necessary, start a new **Autotuning** procedure by selecting a lower bandwidth.

If the instability remains, start a new **Autotuning** procedure by activating the **Antiresonance** filter. If necessary, adjust more accurately the loop response stability by adjusting the stability gain.

4.3.2 - LOOP ADJUSTMENT WITH A VERTICAL LOAD

In the case of an axis with vertical load, proceed as follows:

Select the **Limiting** current limitation mode.

Initialize the speed loop gains corresponding to the unloaded motor (execute therefore the **Autotuning** procedure with the motor uncoupled from its mechanical load).

Couple the motor with its load. If possible, make a control in speed mode; otherwise, close the position loop with a stable gain.

Move the axis by means of the speed input command until a stall position where one motor revolution is not dangerous for operator and machine (far enough from the mechanical stops).

Execute then the **Autotuning** procedure with the motor at standstill. If the axis is moving, this means that the **Autotuning** has not been accepted by the drive.

4.4 - ROTATION / COUNTING DIRECTION

The counting direction can be reversed by selecting the **Reverse movement** in the **Visual Drive Setup** parameter setting software.

5 - PARAMETER SAVING

When all adjustments have been made, the parameters may have to be **stored** in a non volatile EEPROM (the drive must be disabled).

Chapter 3 - Functional features

1 - LOGIC INPUTS

1.1 - "ENABLE" INPUT

Activating the **ENABLE** input during the operation makes the axes decelerate. At the end of the deceleration, the motor is automatically disabled.
The motor is enabled via the **CANopen** bus or via the **Visual Drive Setup** software, as the **ENABLE** input is disabled.

Notes:
- The drive inhibiting function is activated if the " **ENABLE**" **input is disconnected** from the +24V potential.
- The **Deceleration** parameter can be parameter set via the **CANopen** bus.

1.2 - "LIMIT SWITCH" INPUTS

The "Limit switch" inputs are inputs for a detection sensor that allows to stop the motor with maximum deceleration. The purpose of both limit switches, when they are mounted at the right place on the axis stroke, is to protect the mechanics in case of uncontrolled movements.

The limit switches are only defined according to the motor hardware rotation. They are independent from the "rotation/counting direction" selection.

For checking the wiring of the limit switch inputs:
- move the motor in one direction,
- activate the limit switch placed in the rotation direction (artificially, if necessary),
- check then the motor stopping; if the motor goes on moving, reverse the wiring of the limit switch inputs.

Notes:
- When activating a limit switch input, the motor is stopped with maximum deceleration.
- The limit switch inputs are activated if **disconnected** from the +24V potential.

1.3 - "LOW SPEED" INPUT

When this input is activated, the drive switches to protected mode if the motor speed is exceeding the critical "Low speed" threshold.

Note:
- The **Low speed** parameter cannot be higher than 33 % of the **Max. speed** parameter.
- The **Low speed** input is activated if **disconnected** from the +24V potential.
- The **Low speed** threshold can be parameter set via the **CANopen** bus.

1.4 - "INDEX" INPUT

In **Homing** mode, the **Index** input is used for a homing on the axis.

2 - BRAKE CONTROL

The **CD1-k** drive has got a control for the operation of a "powerless" brake.
The brake control is enabled (relay open) or disabled (relay closed) according to the drive status (**enabled** or **disabled**).

3 - ADDRESSING SWITCH / SPEED SELECTION

Each drive of the network must be configurated with one single address.
A DIP8 switch accessible to the operator allows the configuration of the drive address as well as of the of the **CANopen** bus communication speed.

- Addressing (6 selection bits)

Status of the cursors						Address
6	**5**	**4**	**3**	**2**	**1**	
OFF	OFF	OFF	OFF	OFF	OFF	0
OFF	OFF	OFF	OFF	OFF	ON	1
OFF	OFF	OFF	OFF	ON	ON	3
...	...	...	...	...	...	...
ON	ON	ON	ON	ON	ON	63

- Communication speed (2 selection bits)

Status of the cursors		Speed
8	**7**	
OFF	OFF	1Mbits
OFF	ON	500Kbits
ON	OFF	250Kbits
ON	ON	125Kbits

Note:

- Address **00** must only be used in **Local** mode.
- An address ≠ **00** is used in **Remote** mode (use of the **CANopen** bus).

Chapter 4 - Troubleshooting & Maintenance

1 - ERRORS

1.1 - "SYSTEM" ERROR

If the red "SYS" LED is lit at power on, the logic board is defective.

- Check that the EPROM (firmware memory) is correctly plugged on the drive.
- Check for no conducting dust that may involve short-circuits on the drive logic board.

1.2 - NON STORED ERRORS

1.2.1 - BUS ERROR

This error is only displayed when there is a synchronization loss by the **SYNC** message.
The error is cancelled as soon as the communication is restored.

1.2.2 - NO POWER VOLTAGE

If the error occurs when commissioning the drive:

- Check for the power supply to be on.

1.3 - STORED ERRORS

If an error occurs on the drive, it can generate the detection of several other errors which are only a consequence of the initial one. In order to make diagnostic and maintenance easier, the errors are displayed and processed with the precedence described below. For safety reasons, the power must be turned off for the cancelling of some errors that requires the handling of the drive; in this case, the drive is automatically reset when power is turned on again. If power is not turned off, do not forget to make a RESET immediately after the error is cancelled.

1.3.1 - "BUSY" ERROR

- If the **BUSY** error is displayed after power on, the AUTOTEST procedure has failed and the drive is not ready for operation.

- If the **BUSY** error is displayed after execution of the **Autophasing**, this procedure has failed because of an external cause and the calculated parameters are wrong.
  Check at first the status of the drive logic inputs. Check that the motor is unloaded and the shaft movement is free during the procedure.

- If the **BUSY** error is displayed after execution of the **Autotuning**, this procedure has failed because of an external cause and the calculated parameters are wrong.
  Check at first the status of the **ENABLE** input. Then check that the motor shaft is free during the execution of the procedure.

- This error may also occur during a homing procedure which "time out" is too low.

1.3.2 - "EEPROM" ERROR

- Check for the presence of the EEPROM and check its correct orientation.

- If the error remains, the EEPROM may not be correctly initialized (**CHECKSUM**) or is not compatible with the drive software.

- To cancel this error, make a new parameter setting of the drive and save the new parameters.

1.3.3 - "°C MOTOR" ERROR

If the error occurs when commissioning the drive:

- Check the **CTN/CTP** parameter setting, the **Triggering threshold** and the **Warning threshold**.
- Check the wiring of the thermal sensor on the drive.

If the error occurs during the operation:

- Check that the triggering threshold is compliant with the manufacturer's specifications of the sensor.
- Check the motor temperature and look for the reason of this overheating (mechanical shaft overload, duty cycle too high, ...).

1.3.4 - "POWER STAGE" ERROR

If the error occurs at the drive commissioning:

- Check the terminal voltage of the power transformer secondary.

If the error occurs during the operation:

- Check the braking system operation during the motor braking phases.
- Check the sizing of the braking resistor with regard to the operation cycle.
- Check for no short-circuit in the motor wiring and at the motor terminals.

1.3.5 - "RESOLVER" ERROR

- Check the resolver connection on the drive connector X1.
- Check the resolver transformation ratio with regard to the P-RES components.

1.3.6 - "COUNTING" ERROR

If the error occurs at the drive commissioning:

- Check the resolver transformation ratio with regard to the P-RES components.

1.3.7 - "POSITION FOLLOWING" ERROR

If the error occurs during the axis motion:

- Check the position loop adjustment.
- Check the coherence of the **Static threshold** parameter with regard to the motion cycle.

1.3.8 - "LOW SPEED" ERROR

- Check that the **Low speed** parameter is coherent with regard to the axis motion speed.
- Check the wiring of the "Low speed" input.

1.3.9 - "CURRENT OFFSET" ERROR

If the "Current offset" error occurs at power on, this means that the offset compensation procedure has failed and the drive is not ready for operation. This error cannot be cancelled.

1.3.10 - "INIT 400V" ERROR

If the "INIT 400V" error occurs on a CD1-k **400**/I drive, at power on:

- Check that the drive powering has been correctly made.
  This error cannot be cancelled.

1.3.11 - "I^2T" ERROR

- Check the rated current value required from the drive with regard to the current table in pulse cycle.
- Check the drive rated current value defined in the **Rated current** parameter with regard to the current required for the operation cycle.

2 - ERROR RESET

A stored error can be cancelled as follows:

- by means of the parameter setting software **Visual Drive Setup**, via the serial link RS232,
- by means of the **RESET** function issued from the **CANopen bus**,
- by switching off the drive supply.

3 - OPERATION PROBLEMS

3.1 - MOTOR DOES NOT MOVE

- Check that the drive is on.
- Check for no error on the drive.
- Check the wiring of the logic command inputs.
- Check that the drive is enabled.

3.2 - MOTOR ENABLED BUT LITTLE TORQUE

- Check the parameters **Max. current** and **Rated current**.

3.3 - SHAFT LOCKED – ERRATIC OSCILLATIONS - ROTATION AT MAXIMUM SPEED

- Check the resolver wiring on the X1 connector and the mechanical mounting of the resolver on the motor.
- Check the coherence of the motor parameters (number of pole pairs, resolver wiring, motor phase).

3.4 - DISCONTINUOUS MOTOR ROTATIONS WITH ZERO TORQUE POSITIONS

- Check the wiring of the three phases between motor and drive.

3.5 - LOUD CRACKLING NOISE IN THE MOTOR AT STANDSTILL

- Check that the Motor - Drive - Host system ground connections comply with the wiring recommendations.
- Check the rigidity of the mechanical transmission chain between motor and load (backlashes and elasticity in the gears and couplings).
- Start a new **Autotuning** procedure by selecting a lower bandwidth than the initial one.

4 - SERVICE AND MAINTENANCE

When exchanging a drive on a machine, proceed as follows:

- Check that the new drive has got the same voltage and current ratings as well as the same hardware configuration as the one to be replaced.

- Reload and save the parameters of the old drive via the serial link or the **CANopen** interface.

  The new drive is now ready for operation.

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