E I P **E-300**

English

UNITOUR

UNITOUR version 1.04 Instruction Manual
Turning Specific, for E-300ND and CMP Unit

Version: **February 6th 2008**

E I P

UNE GAMME COMPLETE DE CONTROLEURS D'AXES
EINE VOLLSTANDIGE PALETTE VON ACHSENSTEUERUNGEN
A COMPLETE RANGE OF MOTION CONTROLLER

E.I.P. SA
CH-1667 Enney

Phone : 026 / 921 80 40

Fax : 026 / 921 80 49

Table of Content:

Liste of figures:

Liste of tables:

1 Introduction

The E-300 Motion Controllers are aimed at the market segment: special machine-tools, handling Equipment's and assembly automation. Intricate motion control problems and elaborate sequencing can be solved easily. The E-300 controllers are available for 2 axes step-motors.

The **UNITOUR** program provides a set of utilities and an efficient instruction set to write machining programs directly at the controller keyboard. User's programs and machine configuration are memorized in the E-300 RAM. They can be saved in the E-300 FLASH memory.

The aim of this manual is to allow the inexperienced user to master UNITOUR after a thorough reading. Some knowledge of step motor techniques and a practical experience with servo drives are a pre-requisite to avoid a trial-and-error approach.

- The reader is urged to read the chapter 2 (Memory Organization) before attempting to write programs or to use the utilities.
- Chapter 3 is needed to understand the coordinate systems and the machine parameters.
- Chapter 4 contains a description of the operating mode of the keyboard, starting at the power on-switching.
- Chapter 5 contains a formal description of the machining instructions and the chapter 6 tells how a program will be executed. An example appears in chapter 7.

To write machining programs only, we suggest the reading of the following sections:

3.2	Coordinate Systems
4.1, 4.2, 4.4, 4.5, 4.6, 4.7	Utilities
5	Machining Instructions
6	Program Execution
7	Example

2 Memory Organization

2.1 Physical Memories of the E-300 Controller

The memory space is made of 2 different chips:

- a 128 kbyte RAM with battery back-up,
- a 128 kbyte FLASH Memory.

FLASH Memory contain operation system.

The live memory (RAM) is the current working area. An UNITOUR program is always executed from the RAM. The editor and the configuration utilities write to the RAM, never to the FLASH. **Saving edited programs or new configuration data has to be done by the operator**.

2.2 The User's Storage Area

Using the UNITOUR utilities, the user is able to organize its storage area in the live memory. The SAVE utility writes the entire user's area into the FLASH memory.

Within the user's area, a fixed portion is reserved to the configuration parameters, see section 4.3. The remainder is available for programs or numerical data.

The UNITOUR editor stores **"lines"** (10 bytes). An instruction or a numerical data are always stored as one line. 700 lines are available; 100 files may be opened within the line set. The files are numbered 0 to 99. A file is opened by the editor or by the copy of an existing file.

Of course, the user's storage area can be loaded, with external programs or configuration.
This can be made with a PC, equipped of UNICOM software version 3.0 or higher, an RS-232 to RS-485 converter and a serial cable.

3 Coordinate System and Controller Configuration

This section defines the coordinate conventions, provides information about the motion generators and helps calculate the scaling factors.

3.1 Home Position

The stepper motors drives requires a home position before starting any useful work. Two different situations are common:

a) the machine has its own coordinate system, such as a jig boring machine for example.

b) the coordinate system is fixed by the operator anywhere in the travel, example a rotary division table.

In the first case, the slide must be fitted with a home switch for the automatic and precise determination of the initial coordinate system.

Taking the home position can be done by the operator or by the initialization program.

UNITOUR accepts a home switch anywhere in the travel.

If the home switch is not located at the ultimate end of the travel, it must be closed on one side and open on the other side in order to allow an unambiguous decision within the controller (see Figure 3-1)**.**

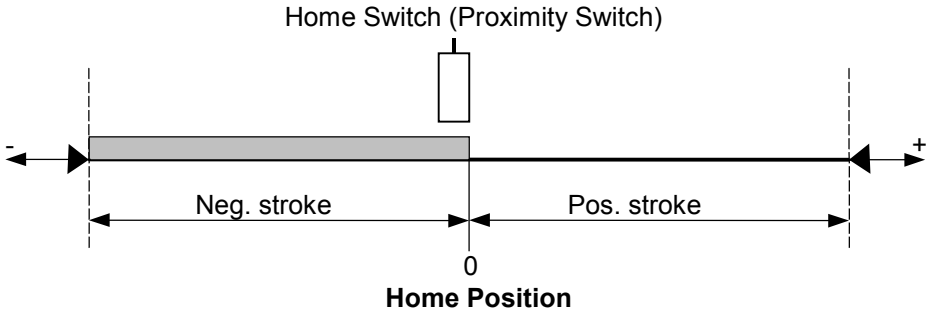

Figure 3-1 : Travel and Home Position

The process of finding the home position has three phases:

Phase 1 : (This phase takes place only if the home switch is active while entering the process). The slide walks out of the home switch.

Phase 2 : Travel toward the home switch and stop with a ramp.

Phase 3 : Travel out of the home switch at reduced speed and immediately stop when the switch deactivates.

The phase 3 is responsible for the accuracy of the home position. It may be useful to notice the direction of the motion in phase 3 in order to take an eventual backlash into account.

The travel speeds are configuration parameters.

The configuration menu has also provision for soft travel limits: STROKE+ and STROKE-.

The direction of the motions involved in the determination of the home position is governed by the sign of REF SPEED in the configuration.

If a soft travel limit is not convenient (with a rotary table, for example) STROKE+ and STROKE- must be set to 0. In this case, set REF variable to 0 (NO) in the REF menu.

3.2 Tool Origin Setting and Coordinate Translation

UNITOUR has provision for a maximum of **16 tools**. Each tool has its own origin. The operating procedure to set a tool origin is dealt with in length in chapter 4. The display of the axis position and the programming are always done with respect to the selected tool.

The moves to be effected by the machine axes can be given as incremental values or as absolute coordinates. This applies to the machining instructions as well as to the set-up motions generated by the "JOGGING" utility.

An incremental move is related to the axis position just before the displacement; the position of the coordinate system does not make sense.

While programming in absolute coordinates, the coordinate system used to measure the positions must be known by the controller.

UNITOUR has provision to translate the coordinate system. Coordinate rotation is not available.

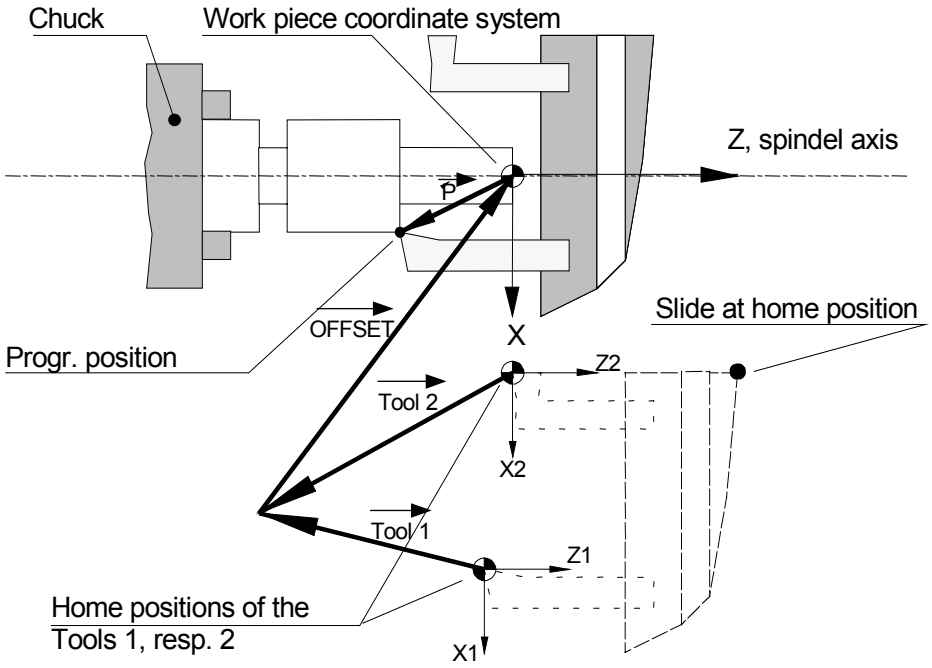

Figure 3-2 : UNITOUR Coordinate Systems

At the home position, the internal axis position registers are reset to zero. The home position defines the origin of the machine coordinate system. The positions of the axes after a move instruction are given by the addition of three vectors: **TOOL, OFFSET** and **P** (where P is the programmed position), refer to Figure 3-2.

TOOL and OFFSET are coordinate translation vectors, their purpose being the definition of a common coordinate system for all tools: the work piece system.

The Machine Coordinate System

When the cross-slide is at its home position, each tool tip defines the origin of its own machine coordinate system.

The Tool Offset

During the set-up procedure, a **Tool Offset** is assigned to each tool in order to allow the programming in a common system, regardless of the tool involved. UNITOUR accepts 16 tools. All tool offset vectors point to a single point in the X-Z-plane.

The OFFSET Vector

OFFSET is common to all tools; the value of its components is entered in the configuration menu. The purpose of the common offset vector is to allow an adjustment of the tool set-up while preserving the relative position of the tools. Such an adjustment is sometime useful when the clamping of the work piece has been changed or when the tool holders are part of a removable fixture. It is good practice to start with a zero OFFSET.

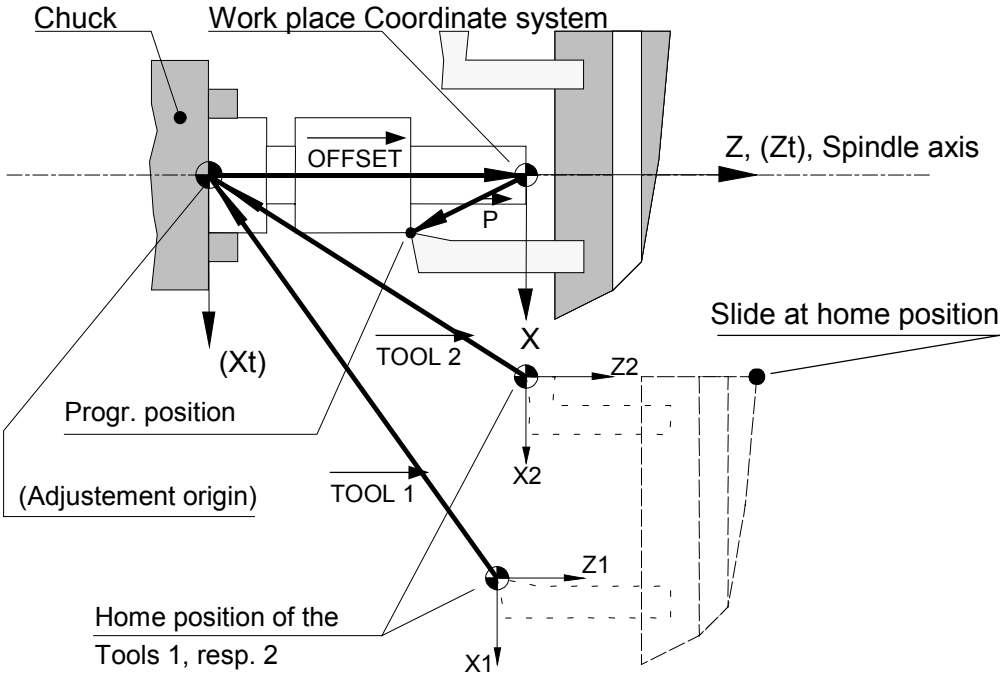

Figure 3-3 : Absolute Tool setting

3.3 Scale Factors and Constants

The factors and constants discussed in this section are to be given for each axis in the configuration menu.

3.3.1 The Length Scale Factor, SCALEK

This factor allows the programming of the travels directly in engineering units (1 mm, 1 inch or 1 degree).

For a step motor drive, SCALEK is the number of pulses required at the input of the translator to effect one unit of travel.

E.I.P. Power Stage for 2 phases step-motors works usually in Micro-steps mode. 8 micro-steps are necessary to produce an entire Step. With current motors, (200 steps per revolution) 1600 Micro-steps are necessary for one revolution.

Examples:

a) Lead screw slide driven by a 1.8 degree stepper:

Timing belt 1:2 from motor to screw, thread pitch 5 mm, length unit 1 mm.

1600 pulses for one motor revolution,
3200 pulses for one lead screw revolution,
3200/5 pulses for 1 mm, then **SCALEK = 640**

b) Rotary Table:

2-phase motor with 200 Steps per revolution, motor directly drives worm gear 1:40, unit: 1 degree.

1600 pulses (8 Micro-steps for one Step) for one revolution of the table,
1600*40/360 pulses per degree, **SKALEK = 177.778**.

c) Belt Driven Slide:

2-phases Step-motor with 200 Steps/rev., reduction gear 1:10, transport belt pitch 3 mm, driving pulley 35 teeth, length unit 1 inch.

1600 pulses for one motor revolution,
16'000 pulses for one pulley revolution or for 105 mm (35 teeth with 3mm),
105 mm = 105/25.4 = 4.133858 inches
16'000/4.133858 = 15481,9 pulses per inch, **SCALEK = 3870,48**.

3.3.2 Frequency Division Ratio, DIV

The Figure 3-4 is a plot of the pulse frequency generated by the motion generator, i.e. the speed of the axis, during a single motion. The magnitude of the acceleration and of the deceleration decreases linearly with the speed in order to compensate for the weakening of the motor torque. The maximum of the frequency has to be set for each axis to preserve a sufficient torque margin at high speed.

The DIV parameter sets the highest frequency according to

DIV = 11906/fmax [kHz]

With DIV = 120, a fmax of approx. 100 kHz is obtained.

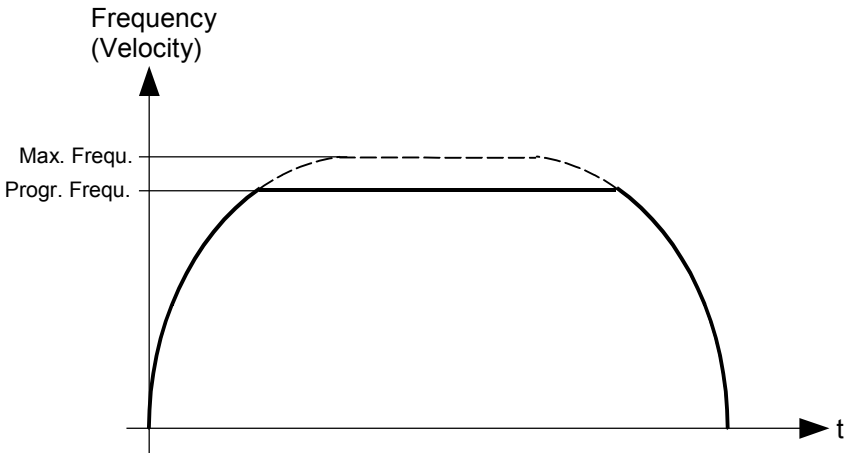

Figure 3-4 : Frequency or Speed versus time

Example:

2-Steps motor with 200 Step/rev. (1600 micro-steps/rev.), max. speed 1500 rev/min

1500 rev/min = 25 rev/sec,
fmax = 25*1600 = 40'000 Hz,

DIV = 11906/40 = 297.

3.3.3 Acceleration Constant, KUP, Deceleration, KDN

These two parameters define the initial (or final) slope of the ramps. Their values are given in kHz/s or kpulse/s^2. As before, the frequency is the step frequency.

Values from 200 to 2000 kpulse/s^2 are generally used.

3.3.4 The Speed Scale Factor, FEEDK

The speed scale factor (or Feed Constant) allows the feed values to be given in engineering units: mm/s, m/min, rev/sec, etc.

FEEDK = pulse frequency for one feed unit [kHz]

Examples: (For the electro-mechanical arrangements, see the examples of sect. 3.3.1)

a) The feed rate is expressed in en m/min.

SCALEK = 640, i.e. 640 pulses for 1 mm,
or 640'000 pulses for 1 m,
or a frequency of 640 kHz for 1 m/s,
640/60 kHz for 1 m/min, **FEEDK = 10,667**

b) ***Rotational in degree per second***.

SCALEK = 177.778 , i.e. 177.778 pulses for 1 deg,
or 0.177778 kHz for 1 deg/s, **FEEDK = 0.177778**

c) Speed in yard/min.

SCALEK = 3'870,48 pulses/inch
1 yard = 36 inches, i.e. 3'870,48 * 36 pulses for one yard,
thus, for 1 yard/min the required frequency is (3,87048 * 36)/60 kHz,
FEEDK = 2,32229.

The actual feed rate can be at most equal to the maximum speed as set by DIV. The highest attainable speed, expressed in the chosen unit, is given by

11906/DIV/FEEDK

N.B. The feed rate is in accordance with the programmed value only if the panel potentiometer is turned fully CW.

3.3.5 Soft Travel Limits, STROKE + / STROKE -

The soft travel limits must be expressed in the length unit of section 3.3.1. Enter the negative limit with a minus sign. Positioning and jogging motions are automatically limited to STROKE+, resp. STROKE- . Contouring motions are not a priori limited, but an over travel results in a fault situation, see section 7.3. "Fault Processing".

Due to internal register capacity limitations, the travel limit parameters have to meet:

$|STROKE+/-| * SCALEK * DIV < 2^{31}$ ($2,147 * 10^9$)

Violation of the above rule is signaled by the controller when the Configuration menu is left.

3.3.6 Permanent Coordinate Translation, OFFSET

Please, refer to Figure 3-2. OFFSET must be entered in the lenght unit.

3.3.7 Current Boost Command, BOOST

This parameter controls the action of the /BOOST line and its range is limited to 0..3.

BOOST = 0 :	/BOOST is always disactivated (high)
BOOST = 1 :	/BOOST is active during a move (low) and inactive whenever the axis is at rest
BOOST = 2 :	/BOOST is always activated (low)
BOOST = 3 :	/BOOST is high during a move and low at rest.

With the 2-phases Step-motors, BOOST is normally set to 1. At rest, the current is reduced to about 60% of it set value.

It is possible to set BOOST to 0 with small motors or to set BOOST to 2 if the full torque is required at rest.

4 Keyboard operating mode and UNITOUR utilities

This chapter describes the operation of the E-300 motion controller running under UNITOUR. The description starts at the power-up and supposes that all connections to the outer world are established. The menus are discussed in the sequence required for a first approach of the controller. The programming, the editor, the debugging are subject of the following chapters.

For the key designations, please refer to the diagram attached to this manual.

4.1 Switching the Power On

The display shows the version of the system program during 1 second.

After this, the "Power-On" program is executed, (see chapter 6) and the UNITOUR menus are now accessible.

UNITOUR has a **cycle counter** to accumulate the number of machined work pieces. "n" is the number of pieces since the last reset of the counter.

During the execution of any program, the operator has access to all menus and it can make use of the utilities. A program can be stopped by depressing the STOP button.

4.2 Menu Selection

The arrow keys are used to select a menu (▼ or ▲).

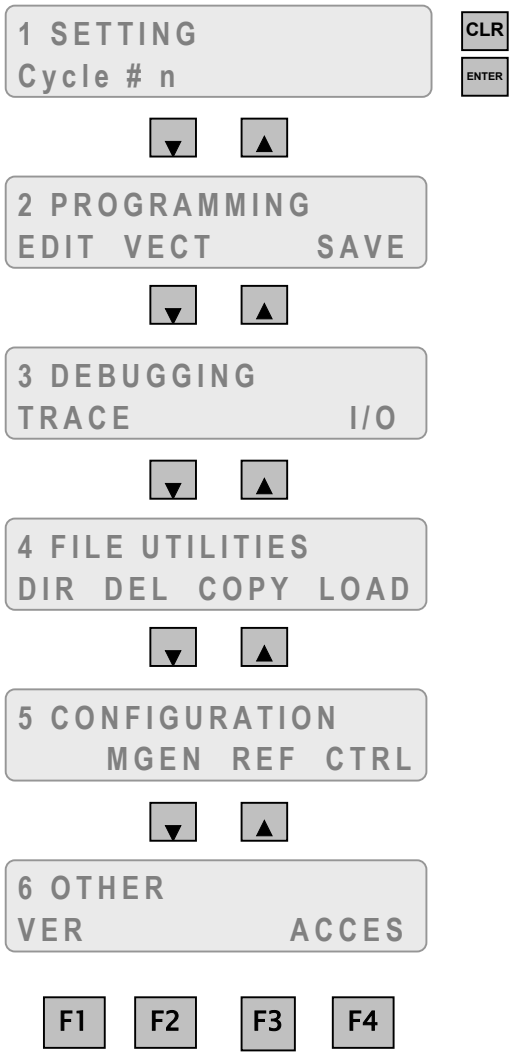

Figure 4-1 : List of menus

A menu offers up to 4 options. An option is entered by one of the function key, F1 to F4. The lower line of the display contains the labels of the function keys. The ESC key is always active to escape from a sub-menu. If a menu has only one option (Menu 1: Setting), access is provided by the "ENTER" Key.

The piece counter is reset by the CLR-key.

If the "No Access" message is displayed when attempting to enter a function, the access to this function is not granted, see section 4.8.2.

4.3 CONFIGURATION Menu

4.3.1 MGEN, Configuration of the Motion Generators

The F2 key enters this sub-menu, starting from the CONFIGURATION menu. The parameters to be specified to the controller are organized in rectangular array: vertically, the arrow keys select the physical parameter; horizontally, the axis keys (X, Z) specify the axis to which a parameter belongs.

All these parameters have been discussed at chapter 3, a listing appears below.

DIV	Frequency divider
KUP	Acceleration Constant
KDN	Deceleration Constant
SCALEK	Length Scale Factor
FEEDK	Speed Scale Factor
DFACTOR	Multiplier for the display and programming, see below
STROKE +	Stroke in Positive Direction
STROKE -	Stroke in Negative Direction
OFFSET	Common Translation Vector
BOOST	Current Booster Action , see the driver booklets

The **DFACTOR** parameter is used to program directly in diameter, i.e. usually we set DFACTOR(X) = 2, DFACTOR(Z) = 1.

4.3.2 REF, Configuration of the Home (or Reference) Position

Enter the REF sub-menu with the F3 key. As before, the parameters are organized in a rectangular array.

SPEED TO REF	Speed of the axis while searching its home position. Enter the speed in engineering units, as defined by FEEDK. A minus sign changes the direction of the home search.
REF INPUT NB	Assign the home switch input to the axis. See table 4.1. Enter 8 for no switch. The home function will not make any motion.
SWITCH	Enter "1" for a normally open home switch, "0" for a normally closed switch.
REF BACK SPEED	This entry is the ratio of the speeds of the two phases of the home position determination. For example SPEED TO REF is 100 mm/s and the ratio is 5. The axis will move out of its home switch at 20 mm/s. A high entry enhence the accuracy of the home position.

4.3.3 CTRL, Assignment of the Control Inputs

This sub-menu is intended to assign a physical input to two program execution functions. This assigned inputs then work as if they were ored with the panel keys.

If an external control input is not required, assign input 64 to this particular function.

EXTERNAL START:	Program Start, uses a normally open contact. Works like the Front Panel START Button.
EXTERNAL STOP:	Program Abort, normally closed contact. Works like the Front Panel STOP Button.

This sub-menu also contains the following parameters:

MAX RPM 10 Volts: Sets the spindle rotational speed for an analogue output of 10 Volts. This parameter makes sense when the spindle is fitted with a variable speed drive.

DISPLAY FORMAT 1-6: Sets the number of digits to be written after the decimal point when the controller displays the axis position.

LANGUAGE: Sets the language of the controller for the utilities and the instruction mnemonics according to the table below. The configuration menu always appears in English.

LANGUAGE	Messages	Instructions
0	English	English
1	French	French
2	German	German
4	French	English
5	German	English

JOG SPEED Sets the JOGGING Speed. Parameter value can vary between 1 and 255. 255 is the maximum system speed.

2 HANDS START This parameter allow to configure the " 2 hands Start" on 2 chosen input EXTERNAL START and 2 HANDS START. Only Inputs 0 to 7 can be used for this.

Value "8" in parameter 2 HANDS START stop the 2 hands start mode.

When "2 Hands Start mode" is active, START Button of the front panel become inactive.

4.4 The "SETTING" Menu

This menu contains all functions required to set the home position, to define the tool offsets, to effect "jogging" moves. It is also possible to choose spindle speed and changing state of outputs 4 to 7.

The display shows the position of two axes in the piece coordinate system, i.e. the offset of the selected tool is taken in account. The number at right in the lower line of the display is the incremental motion effected while depressing (and holding) the ▲, ▼, ◄, or ► keys.

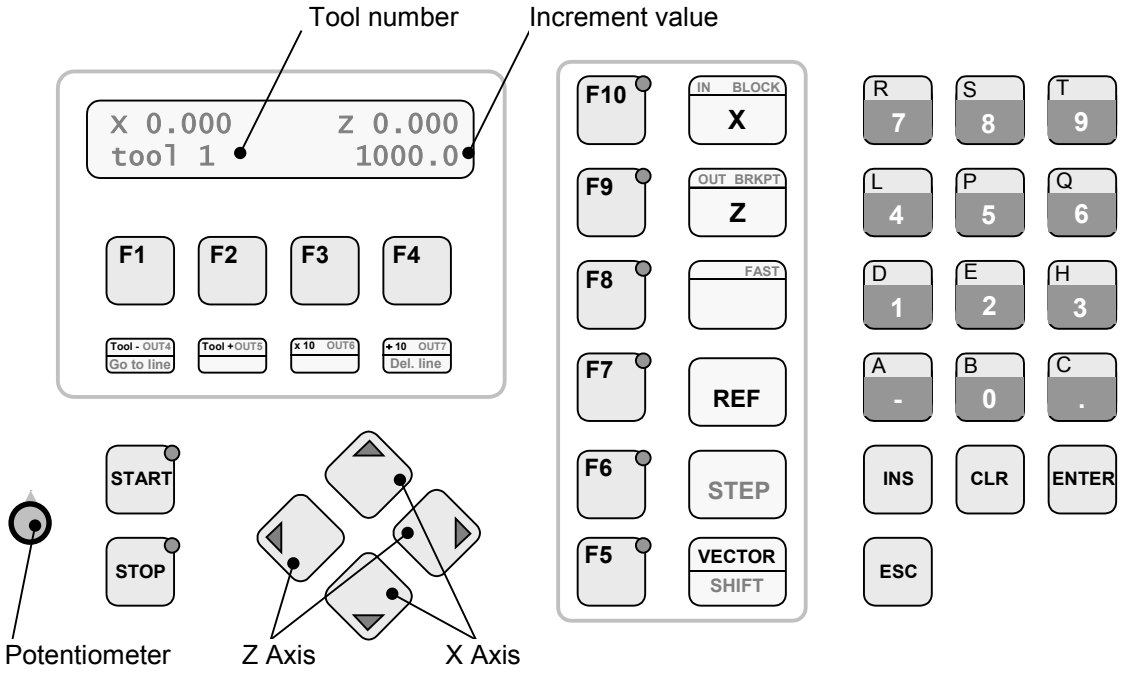

Figure 4-2 : Setting menu

Key Functions in the SETTING Utility:

'F1' : Decrements the selected tool.

'F2' : Increments the selected tool.

'F3' : Multiplies the incremental motion by 10.

'F4' : Divides the incremental motion by 10.

'F5' : "START PROGRAMME" selection. See chap. 4.4.3, "F5 menu".

'REF' : Homing of the selected axis.

▲ : Manual motion of the X axis in - direction

▼ : Manual motion of the X axis in + direction

► : Manual motion of the Z axis in + direction

◄ : Manual motion of the Z axis in - direction

F10 : Axis X selection

F9 : Axis Z selection

'ESC' : Returns to the main menu, see the note below

Potentiometer : Controls the velocity of all axes.

Note:

- The ESC key must be depressed for half a second in order to avoid inadvertent abortion of a setting session.

4.4.1 Home Position

After switching the controller on, no programmed motion is possible before a homing of all axes. The screen displays the message "MAKE HOME POS". However, jogging moves are

allowed before the homing. Remember, the homing velocity is a parameter of the configuration menu.

4.4.2 Jogging

A depression of one of the following keys "◄", "►", "▲","▼",generates an incremental move, whose length is displayed right in the lower line. The key must be held for the whole duration of the motion in order to get the selected length. Releasing the key before the end of the move stops the axis with a ramp. A new depression generates a complete increment.

Jogging Speed is configurable by a CTRL menu parameter. This allow to choose a speed lower as the maximum system speed. Speed scale become more fine.

4.4.3 F5 Function

The menu accessed by F5 key (Vector Menu) allows the following possibilities:

- Choosing the number of the program who is executed when the START KEY of front Panel is depressed.
- Choosing spindle speed.
- Displaying the state of outputs 4 to 7.

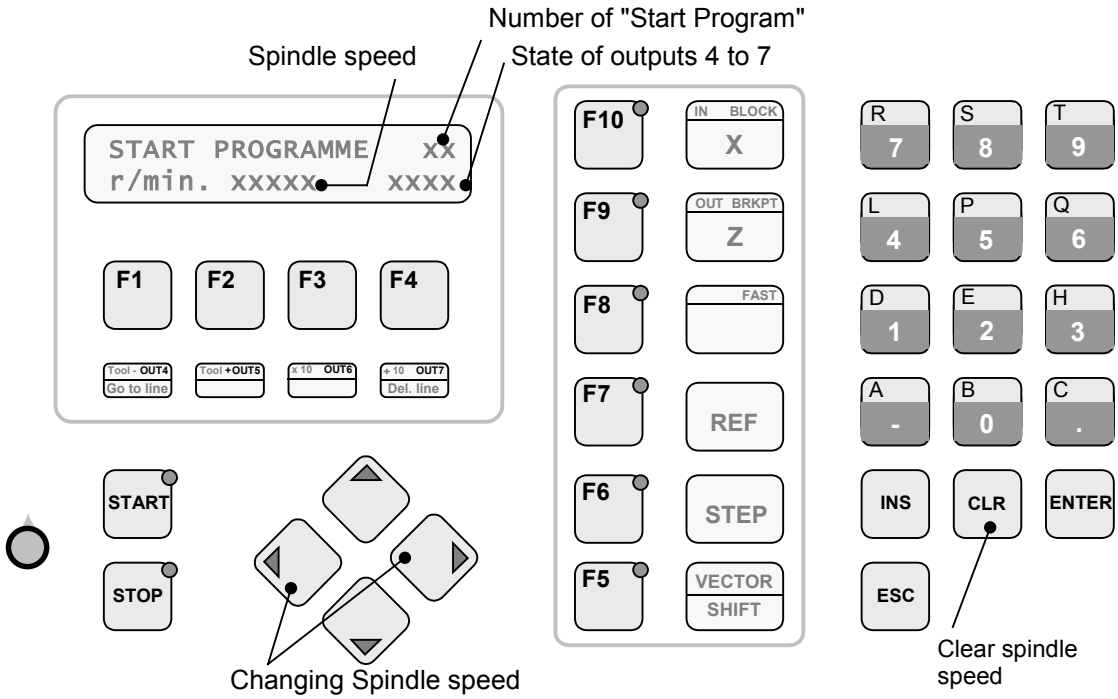

Figure 4-3 : Vector menu

Key Functions in Vector Menu:

Numerical Keys: Choose of "START PROGRAMME"
"◄" et "►": Choose of spindle speed
F1: Change of Output 4 state
F2: Change of Output 5 state
F3: Change of Output 6 state
F4: Change of Output 7 state
ESC: Return to Setting menu

4.5 The "PROGRAMMING" Menu

This menu contains all the functions needed to write, execute and to save programs.

4.5.1 VECT: Program Execution (Vectors)

In this sub-menu, the operator selects two programs:

- the POWER-ON-PROGRAMME, which comes to execution just after switching the power on,
- the START PROGRAMME, i. e. the program which is started after each depression of the START button (or after each activation of the designated external "Start" input).

It is important to notice that the Power-on-Program is executed after a full stop of the controller through the STOP button (or the corresponding external input). If this initialization program is not wanted, simply assign the program number 100 to the Power-on-Program.

4.5.2 SAVE: Saving User's Programs in FLASH memory

All open files, the machine configuration and the tool settings are written to the FLASH memory at once.
In order to avoid writing over valuable data, the following warning is displayed.

To save Programs press the F1 Key, to save Configuration press the F2 Key. In other case press the F4 key to cancel the operation.

After writing operation, one of the following message is displayed:

Or

A writing error is an indication of hardware problem.

4.5.3 Program Edition: EDIT

The screen prompts the operator to enter the number of the file to be edited. The first line (line #0) of the selected program comes to the screen.

If the program is write protected, a warning is displayed, see section 4.7.1.

The upper line displays the instruction mnemonic and the value of its arguments, if present. The lower line shows the line and the program numbers and other arguments of the instruction. The blinking cursor stays on the instruction name.

If the edited file is still empty, the instruction "NOP" and the line 0 are displayed.

An instruction and its arguments are entered through the numerical keypad:

- if the cursor is at the beginning of the screen line, an instruction is entered.
- if the cursor is within the line, an argument is entered.

While entering an instruction code, the name of the instruction is displayed and the cursor goes to the first argument.

The "CLR", "-" and "." keys are also instruction codes. The "ENTER" key terminates the input of an argument. ENTER is not required for single digit arguments. When an argument is entered, the cursor goes to the next argument. While entering arguments, the CLR key repositions the cursor to the preceding argument, the ENTER key to the next argument.

Arguments which appear as names are also entered through the numerical keys.

Entering a program line overwrites the former line.

The F5 key has the action of a "shift lock" key in order to double the number of instructions entered by a single key depression. The second group of instructions is accessed when the light of the F5 key is on.

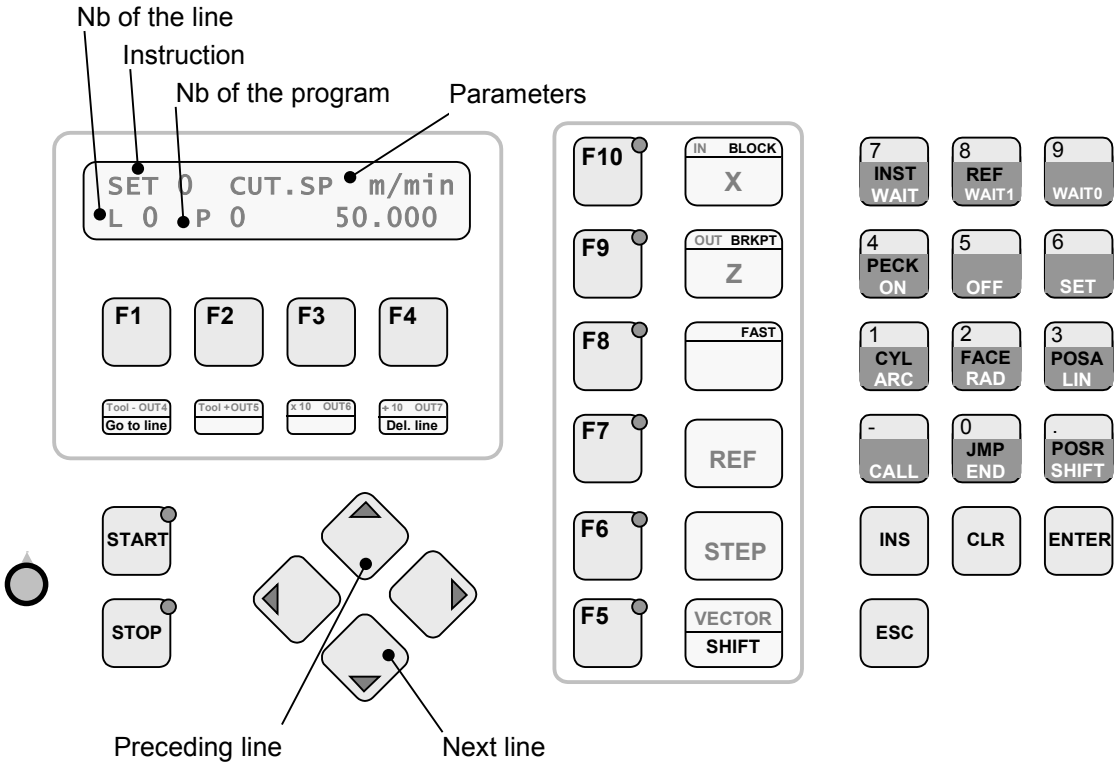

Figure 4-4 : Program Edition

Key Functions for the Program Editor:

'▲' :	Display of the preceding line.
'▼' :	Display of the next line.
'F1' (GO TO LINE):	Go to the line entered at the keypad.
'ESC' :	Quit the edited program and select a new file. Press ESC again to return to the main menu.
'F5' :	Access to the second instruction group.
'F10' (BLOCK) :	Set or reset the "End Block Flag" (toggle action) in contouring instructions. The key lights show the status of the toggle.
'F9' (BRKPT) :	Set or reset a "BReaK PoinT flag". The key lights show the status of the toggle.
'F8' (FAST) :	Set or reset the "Fast Speed Flag" in motion instructions. The key lights show the status of the toggle.
'F4' (EFF) :	This key enters a sub-menu to delete program lines. F3 key allow to confirm the deletion.

4.6 The "DEBUGGING" Menu

4.6.1 The TRACE Function

This utility makes sense during the execution of a program only. It shows the instruction actually being executed. As UNITOUR has a multi-task executive, the task to be traced has to be selected by F1, which rotates the task number.

The screen shows the instruction in the editor format. The lower line displays the task number, the line and the program being traced, for example:

S 1 L 45 P 12

This means executing task 1, program 12 at line 45. When an unwanted program stop arises, for example, the operator is able to fix the problem: may be a zero speed or a missing acknowledge signal.

4.6.2 Input/Output Function, I/O

This utility is intended to test and debug the hardware functions. The status of all controlled inputs and outputs are made visible; the state of the outputs can be set by key depressions. The spindle speed can be set (if the machine is fitted with a variable speed drive).

The screen has three sections: the inputs, the outputs and the spindle speed. The LED of key F10 is an image of the input status, the LED of key F9 is the image of the output. The spindle rotational speed is displayed in Rev/Min.

Warning: Spindle speed refresh is not automatic. Depressing of key F3 is necessary to refresh this value.

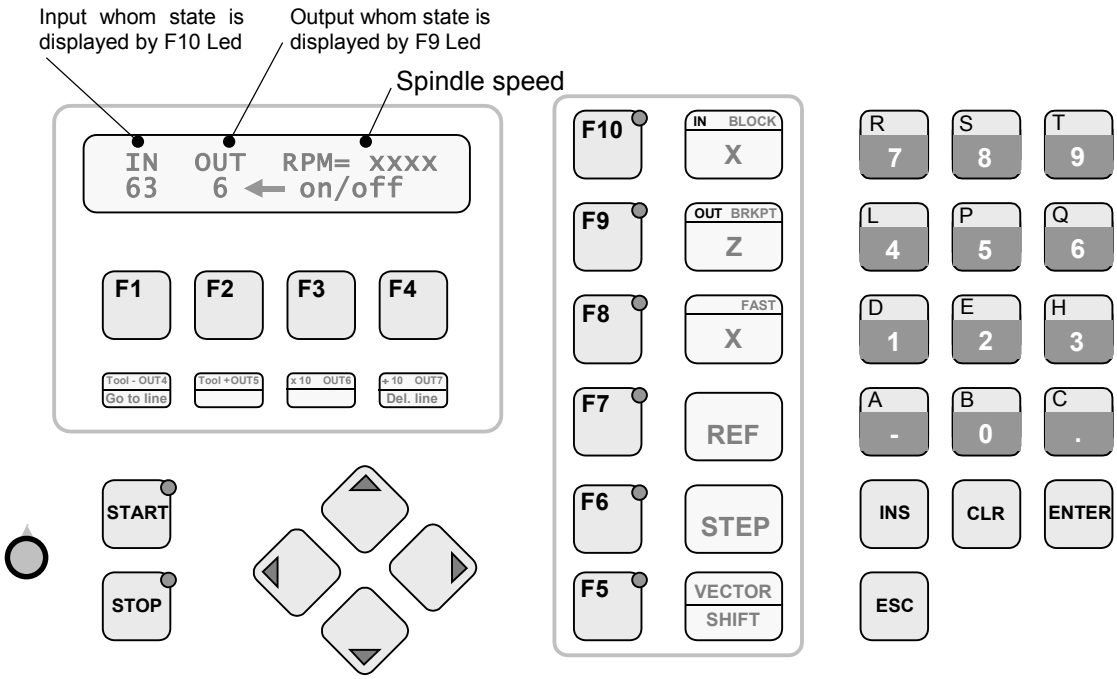

Figure 4-5 : Input-Output Menu

Key Functions in I/O Utility:

'F1' : Sets the cursor on the input number.

'F2' : Sets the cursor on the output number.

'F3' : Sets the cursor on the spindle speed. Allows to refresh this value, (it's not do automatically).

'F4' : Toggles the selected output ON and OFF.

Numerical Keys: Enters an input or an output, enters the spindle speed.

'ESC' : Returns to the main menu.

Number as Argument in Instruction	Physical Input	Number as Argument in Instruction	Physical Output
0	IN(0)	0	OUT(0)
1	IN(1)	1	OUT(1)
2	IN(2)	2	OUT(2)
3	IN(3)	3	OUT(3)
4	IN(4)	4	OUT(4)
5	IN(5)	5	OUT(5)
6	IN(6)	6	OUT(6)
7	IN(7)	7	OUT(7)
8	SIM0	8	SIM0
9	SIM1	9	SIM1
10	SIM2	10	SIM2
11..15	FLAG(1..5)	11..15	FLAG(1..5)
16..59	IN(16..59)	16..63	OUT(16..63)
60	INA (X)		
61	INB (X)		
62	INA (Z)		
63	INB (Z)		

Table 4-1 : UNITOUR Inputs and Outputs

The inputs IN(0..7) are general purpose Inputs. They can be accessed on the back of the controller housing.

The pseudo-I/O SIM0, SIM1, SIM2 are the activation status of the simultaneous UNITOUR tasks, see Instruction SIM.

FLAG(1..5) are general purpose flags, which can be set/reset by ON/OFF.

IN(16..59) and OUT(16..63) are implemented by the I/O extension modules. Each module must be given an address by the switch setting of Table 4-2. One input and one output module may have the same address.

O = Open
C = Close

Switch Setting 4 3 2 1	Address IN OUT
O O C O	16...23
O O C C	24...31
O C O O	32...39
O C O C	40...47
O C C O	48...55
O C C C	56...63
C O O O	64...71
C C C C	0...7

Table 4-2 : IN/OUT Module Addresses

OUT(0) à OUT(7) are outputs implemented within the basic E-300 housing. They are available through the back panel connector, see "Installation and Start-up" Manual.

4.7 File Manipulation, FILE UTILITIES

The file utilities always act on the RAM contents.

4.7.1 DIR: File Directory

The screen gives information about all open files. A file can be opened by the editor or by the copy of an existing file.

```
FILE  TAIL  PROT FREE
  12    45    NO   630
```

The above example means:

- file 12 is open
- its size is 45 lines
- it is not protected
- there are still 630 lines free in the user area.

If the required file does not exist (was not opened), the message is as follows:

```
PROG TAIL PROT LIBR
  18 NOT FOUND  630
```

The DIR utility may be used in several ways:

- To view all the files: *Use the arrow keys to explore the directory.*
- To view the status of a particular file: *Enter its file number (followed by ENTER). One of the above screen shows the file status.*
- To alter the protection status of a file: *The F3 key toggles the protect bit (YES = protected, NO = access granted).*

A protected file cannot be edited or deleted. To give the end user a selective access to a subset of files, open the editor but close the DIR utility.

4.7.2 DEL: Delete a File

Depressing the F1 key will delete all files with the exception of the file 99, which is usually dedicated to the power-up program. Depress F4 to delete a single file. The screen then prompts to enter the file number.

In order to avoid unwanted deletion, the message "CLR to DELETE" prompts for a second key depression. CLR deletes the file, ESC returns to the menu "FILE UTILITIES" without deletion. An attempt to delete a protected file introduces the Directory screen with the file status displayed.

4.7.3 COPY: File Copy

The screen prompts to enter the SOURCE FILE number and then the DESTINATION FILE number. Several action can take place:

- The source file is not open: no action, return to "FILE UTILITIES"
- The destination file doesn't exist : a new file is created
- The destination file already exist : The destination file and the source file are concatenated.
- The memory space available is too small for the file to be copied: no action done, only the screen warns the operator.

4.7.4 LOAD: Load the entire FLASH memory into the RAM

The LOAD destroys the RAM contents. Thus, a warning message is issued.

If the Load is not desired, depress F4 Key to return to main Menu. Else, press F1 Key to load programs or F2 key to load the Configuration parameters. The following screen appears.

4.8 Menu "OTHER"

4.8.1 Version Number, VER

During the depression of the F1 key, the version numbers of the programs installed in the controller are displayed.

These data may prove valuable for service purpose.

4.8.2 Access Flags and Access Code, ACCESS

In order to grant selective access, individual access flags can be assigned to the functions. For example, the machine operator may have access to the Jogging menu but not to the editor.

Whatever the status of the access flags, entering the access code grants the general access. After switching the power on, there is no access to functions with the flag set.

To have a general access, proceed as follows:

- Select the ACCES sub-menu,
- The message "ENTER ACCESS CODE" prompts the operator to enter the code

31415

- Press ENTER to terminate the entry.
- Press ESC to return to the menu selection.

(Generally the entry of any number terminates with ENTER and typing errors can be corrected with CLR).

Entering the access code while the general access is granted will protect all functions with an access flag set.

To set the individual access flags, select the ACCESS menu and enter the code as described above. The functions (or group of functions) may be selected with the arrow keys. Entering a "1" gives the access, with a "0", the function is accessible only after introduction of the code.

5 UNITOUR Instructions

The UNITOUR instructions are described using the mnemonics of the editor. The numerical key needed to enter the instruction at the keypad is given in the description. In the formal presentation below, the mnemonics are written in capitals, the arguments in lower case characters.

An instruction occupies a line in the user's storage area. We shall call "Line Address" or "Address" the number obtained by the concatenation of the decimal line number and the decimal file number, the file number being written with two decimal figures.

Examples : 1245 is the address of line 12 in program 45,
102 is the address of line 1 in program 2,
6 is the address of line 0 in program 6, …

The arguments displayed as litterals by the editor are entered by the numeric keys.

5.1 NOP

No OPeration

CLR	**NOP**

The No Operation instruction does nothing. It is useful to reserve space in a program for future additions. While editing, an empty line appears as a NOP.

5.2 END

Program or Sub-Program End. Used to terminate a sub-program or a program.

0	**END**

Notice:

An END is not required if the remainder of the file is empty.

5.3 CALL

Sub-Program Call

–	**CALL <address>**

Up to 10 nesting levels are permitted.

When a sub-program terminates, the main program resumes at the line immediately after the CALL instruction.

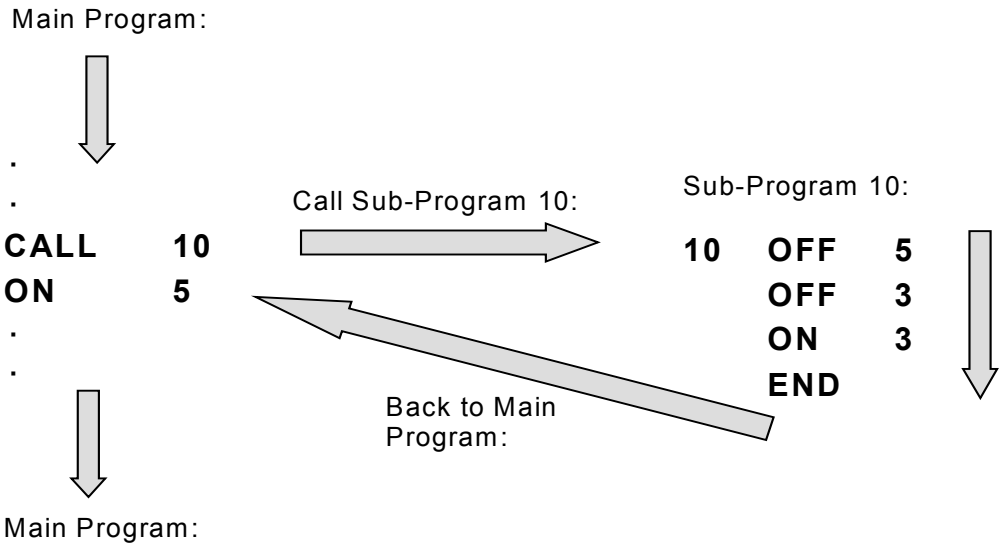

Figure 5-1 : CALL Instruction Example

Important Notice: The UNITOUR editor has an insert/delete line function. Insertion and deletion alter the numbering of the lines in a file. To avoid line referencing problems, it is recommended, but not mandatory, to organize the program files in order to call only at line 0 in a file.

5.4 SET

Set Parameter Value or Set Mode

6	**SET <parameter> <value>**

The parameters 0, 1, 3 and 4 set an operating mode of the controller. The parameters 2, 5, 6, and 7 set the value of a mechanical or geometric constant. Once established, a mode or a value remains constant until changed by a new SET instruction.

The parameters in the pairs 0-1 and 3-4, are mutually revocable, i.e. setting the parameter 1 automatically cancels the parameter 0, for example.

Parameters:

Spindle Rotational Speed Parameter Pair:

6	SET 0	Constant **CUT**ting **Sp**eed	value [m/min]
6	SET 1	Constant Spindle **RPM**	value [rev/min]

6	SET 2	**MAX** Spindle RPM	value [rev/min]

Cutting Feed Parameter Pair:

6	SET 3	**FEED/r (per Revolution)**	value [mm/rev]
6	SET 4	**FEED**	value [m/min]

6	SET 5	**Circ**ular **DEF**inition	value [degre]
6	SET 6	Drill **GAP**	value [mm]
6	SET 7	Drill **DELAY**	value [s]
6	SET 8	Drill **FINAL PASS**	value [mm]
6	SET 9	Drill **DEAD ZONE**	value [mm]

SET 0 "CUT.SP", CONSTANT CUTTING SPEED:

This is the default mode. The cutting speed is maintained at the set value by a suitable variation of the rotational speed of the spindle. (The mode works with a variable speed drive only !).

Notice:
The constant cutting speed modus applies only to the instructions LIN, ARC, FACE and CYL. Of course, the selected tool is relevant in computing the spindle speed.

SET 1 "RPM", CONSTANT SPINDLE ROTATIONAL SPEED:

Sets a constant rotational speed, regardless of the tool position along the X-axis.

SET 2 "MAX.RPM", HIGHEST SPINDLE SPEED:

The parameter MAX.RPM sets a limit to the spindle speed when the tool reaches the axis of the spindle in the constant cutting speed mode.

SET 3 "FEEDr" FEED RATE GOVERNED BY THE SPINDLE ROTATION:

The feed rate of the slides is given in mm per spindle revolution. The velocity of the slide is constant during the execution of a contouring motion (LIN, ARC, CYL, FACE). The feed rate is computed at the beginning of the motion.

SET 4 "FEED", "ABSOLUTE" FEED RATE:

FEED sets a feed rate in m/min, regardless of the rotational speed of the spindle. This feed rate is valid for all axes.

SET 5 "CIR.DEF", CIRCULAR DEFINITION:

CIR.DEF sets the resolution of the polygonal approximation used in generating circles. The default value is 5 degrees.

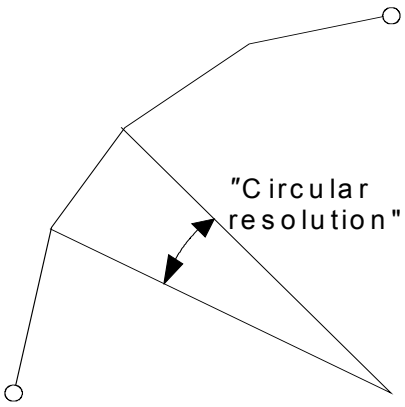

Figure 5-2 : Circular Definition

SET 6	"GAP", DRILL GAP:

The drill gap is used in the automatic peck drilling, see section 5.22. The default value is 0.2 mm. The drill gap value must be **lower** than FINAL PASS value.

SET 7	"DELAY", DWELL TIME:

Dwell time used at the end of the automatic drill cycle in order to obtain the dimensional accuracy. The default value is 0.3 second, see section 5.22.

SET 8	"FINAL PASS":

Value of the final pass of decreasing drilling (see chapter 5.22). Default value is 0 mm. This parameter allows to calculate decreasing value of drilling and the pass number. She can be modified by UNITOUR to obtain an integer pass number.

SET 9	"DEAD ZONE":

This is the distance where the drill can move forward at fast speed before drilling. Default value is 0 mm. DEAD ZONE must be smaller than drilling depth (see chapter 5.22).

5.5 LIN

Linear Segment (Interpolation)

3	**LIN <tool> <coordinate axis X> <coordinate axis Z>**

A straight motion is generated from the actual position to the specified coordinate.

Notices:

1) The tool number must between 1 and 16.
2) Tool number 0 means "the tool specified in the last LIN instruction"
3) The slide velocity is given by the SET instruction.

4) A continuous path with sharp edges induces steps in the axis velocities. The step motors will be able to follow such a path at very low velocities only. This limitation can be overcome with a division of the path into separate "blocks".

   A "block" is a set of straight and/or circular segments executed with a constant tangential velocity. An "end-of-block flag" must be set at each sharp edge of a path. The path velocity will ramp down and up at each end-of-block. An end-of-block flag is signaled by the F10 LED. An end-of-block flag is automatically set at every LIN or ARC instruction; it must be removed by the F10 key if a continuous path is desired.

5) To effect fast speed motions without modification of the mode set by the SET instruction, the move instruction can be flagged by the F8 key. The velocity will then be the same as used for jogging motions. The fast speed flag affects one line only, i.e. the next motion will again be governed by the feed mode. The fast velocity flag is signaled by the F8 LED.

Limitation:
It is not legal to use a LIN or an ARC instruction in the simultaneous tasks 1 or 2.

5.6 RAD

Setting the Mode and the Radius for Circular Interpolation

2	**RAD <mode> <radius>**

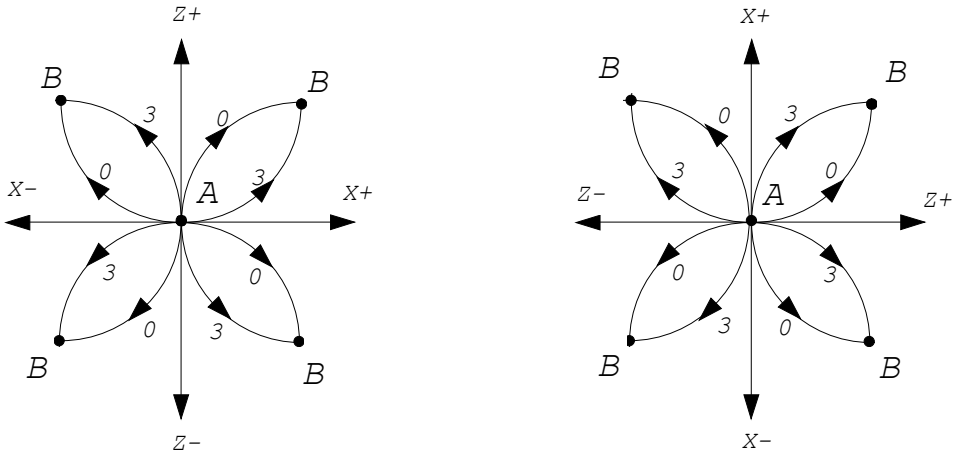

Figure 5-3 : Mode

"mode" 0 or 3 gives the CW or CCW direction according to Figure 5-3.
"radius" is always a positive number.

Limitation:
This instruction must be followed by an ARC instruction.

5.7 ARC

Generation of a Circular

1	**ARC <tool> <coordinate axis X> <coordinate axis Z>**

A circular segment is generated with the specified tool, starting at the actual position of the slide to the specified coordinate and with a radius set by the previous RAD instruction.

Notice:

See the notes 2, 3, 5 under the instruction LIN.

1) A circular segment is approximated by a polygonal contour. The computations are done after each edition session and the results are deposited in a memory buffer. (The STOP Led blinks during the computations). It may happen, that the space available for the buffer gets to small. In such a situation, it's possible to reduce the circular resolution (SET 5).

Limitations:

1) The ARC instruction must be preceded by a RAD instruction.
2) The instructions LIN, RAD and ARC are the sole legal instructions in a continuous path.
3) A circular segment must be smaller than 180 degrees.
4) It is not legal to use an ARC instruction in the simultaneous tasks 1 or 2.

5.8 SHIFT

Incremental Shift of the Slide.

,	**SHIFT <displacement axis X> <displacement axis Z>**

The incremental shift motion in the two axes is not taken in account in the computation of continuous paths generated by the instructions LIN, ARC, RAD.
Thus, a contour contained in a sub-program can be called several times with a shift in between.

Notices:

1) This instruction shifts only continuous paths generated by the instructions LIN, ARC and RAD. The POSA instruction cancels the shift on the implied axis.
2) In order to preserve the absolute position of a path, it is recommended that the sum of all shifts be to zero.

5.9 ON

Switch an Output ON.

4	**ON <output #>**

For the output number, please refer to Table 4-2.

Notice:

- When an ON instruction is placed within a block, it will be executed before the path of the block, see notice 4) under the LIN instruction.

5.10 OFF

Switch an Output OFF.

5	**OFF <output #>**

Notice:

- When an OFF instruction is placed within a block, it will be executed before the path of the block, see notice 4) under the LIN instruction.

5.11 WAIT1

Wait if Input is 1.

8	**WAIT1 <input #>**

The program does nothing as long as the designated input is 1 (true).

See the notice under the ON instruction.

5.12 WAIT0

Wait if Input is 0.

9	**WAIT0 <input #>**

The program does nothing as long as the designated input is 0 (false).

See the notice under the ON instruction.

5.13 WAIT

Dwell Time

7	**WAIT <time in seconds>**

The program does nothing till "time" is elapsed.

See the notice under the ON instruction.

5.14 REF

Home Position

F5	**8**	**REF <axis>**

The designated axis searches its home position; the travel velocity is given in the configuration menu.

Axis: 0 - X 1 - Z

5.15 JMP

JMP transfers the program control to another line within the same file or within another file.

F5	**0**	**JMP <address>**

This instruction may prove useful to jump over a program segment during the debugging phase.

See the notice under the ON instruction.

Limitation:
It is not legal to built an endless loop in the task 0, in the "START PROGRAMME" and in the "POWER ON PROGRAMME".

5.16 INST

Special Instructions

F5	7	INST <instruction #>

Instruction #:

0) BREAK This instruction allows to suspend program execution. In this state, START button Led blinks, depressing START button resume program execution.

Unlike as for Pause Flag (see chap. 5.23), BREAK instruction don't keep care of mode (Normal or step-by-step). Program execution will always be suspended.

1) START This instruction allows to execute a program continuously. After an INST START Instruction, program jump at line 0 from START PROGRAM, increment Cycle counter and execute a new cycle.

Useful when a machine is equipped with an automatic bar loader. In this case usage of instructions WAIT0, WAIT1 will be necessary.

Example: **Backward and forward motion Program with input 6 acknowledge**

```
0       3 LIN 1 3.0 4.0     ;Displacement
1       3 LIN 1 0.0 0.0     ;Displacement to 0 0
2       7 WAIT0 6           ;waiting on input 6=0
3 F5    7 INST START        ;Return to line 0
```

5.17 SIM

Simultaneous Task Activation

F5	CLR	SIM <task #> <address>

UNITOUR can control three simultaneous tasks. The main program, the "START PROGRAMME", is the task 0. Usually, the tasks 1 and 2 are called by the task 0. "address" points to the beginning of the simultaneous task. A simultaneous task stops if it encounters the instruction END.

A simultaneous task can be momentarily paused by setting the boolean element SIM1 (or SIM2) in Table 4-1 and then reactivated by setting SIM1/2 to one again. Use instructions ON or OFF.

Calling a simultaneous task already active transfers its activity to the new calling address. The STOP button aborts all tasks.

Notices:
1) See the notice under CALL instruction.

2) In the tasks 1 and 2 it is legal to program endless loops with the JMP instruction.

Limitation:
The instructions LIN, ARC, RAD, PECK, CYL and FACE are not allowed in the tasks 1 or 2.

5.18 POSA

Single Axis Absolute Positioning Move

F5	3	POSA <tool> <axis> <coordinate> <feed rate [m/min]>

POSA moves "tool" along "axis" from the actual position to "coordinate".

The fast speed flag (Key and LED F8) overrides "feed rate".

Notices:
1) A tool number is mandatory.
2) The "constant cutting speed mode" does not use the tool specified in the POSA instruction to compute the spindle speed.
3) The "feed per revolution" mode does not work; the feed rate specified in the instruction (or the fast speed) applies.

Limitation:
- A RAD or ARC instruction are not allowed directly after a POSA instruction.

5.19 POSR

Single Axis Incremental Positioning Motion.

F5	,	POSR <axis> <displacement> <feed rate [m/min]>

POSR moves the slide along "axis", the value of the move is "displacement".

The fast speed flag (Key and LED F8) overrides "feed rate".

Notices:
1) See notice 3) under POSA
2) The incremental motion "displacement" may be positive or negative. Its value is a direct displacement, never a increment of the diameter.

Limitation:
- A RAD or ARC instruction are not allowed directly after a POSA instruction.

5.20 CYL

Stock Removal in Turning.

F5	1	CYL <tool> <n> <coordinate 1> <coordinate 2>

This instruction is a repetitive cycle to remove material in turning.

At the start of the turning cycle, the tool must be located in the corner of the blank part. CYL generates "n" rectangular motions to reach the point given by "coordinate 1, coordinate 2".

At exit of CYL, the tool is left at the cut diameter, but out of the work piece, see Figure 5-4.

The cutting depth is computed by the controller. "n" must by 1 to 7; with n = 0, CYL becomes a NOP.

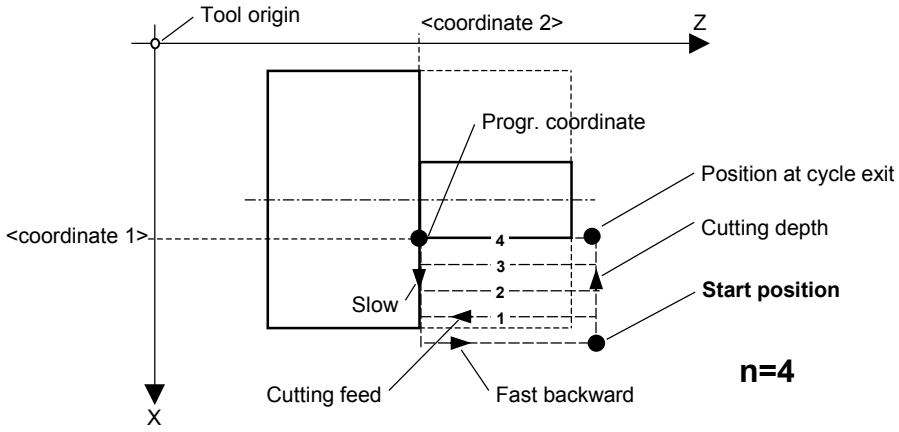

Figure 5-4 : Turning cycle CYL

Notices:

1) A tool number must be specified.
2) The motion toward the piece can done at high speed if the flag F8 is set.

Limitations:

1) A RAD or ARC instruction are not allowed directly after a POSA instruction.
2) The CYL instruction is not allowed directly after a SHIFT instruction.
3) CYL is not legal in the simultaneous tasks 1 and 2.

5.21 FACE

Stock Removal in Facing.

F5	2	FACE <tool> <n> <coordinate 1> <coordinate 2>

This instruction is a repetitive cycle to remove material in facing.

At the start of the turning cycle, the tool must be located in the corner of the blank part. FACE generates "n" rectangular motions to reach the point given by "coordinate 1, coordinate 2".

At exit of FACE, the tool is left in the plane of the face, but out of the work piece, see Figure 5-5.

The cutting depth is computed by the controller. "n" must by 1 to 7; with n = 0, FACE becomes a NOP.

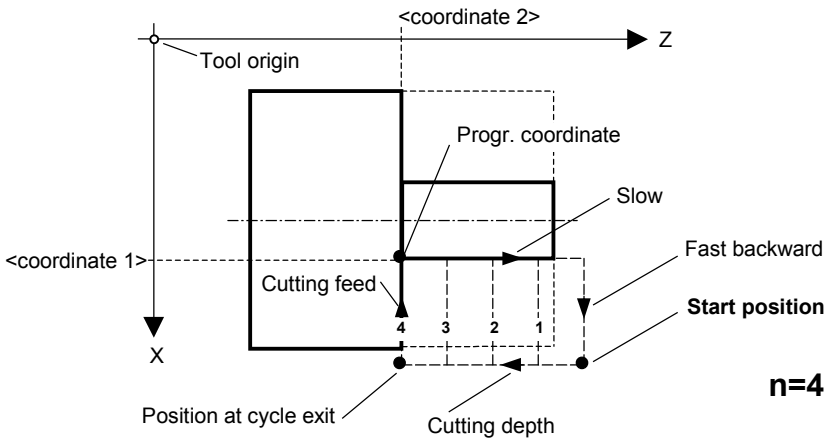

Figure 5-5 : Facing cycle FACE

Refer to the notices and the limitations under the CYL instruction.

5.22 PECK

Drilling with Automatic Peck Cycle.

F5	4	PECK <tool> <axis> <mode> <end position> <plunge>

Arguments of the PECK instruction:

"tool"	Selected tool.
"axis"	Axis must be specified as the instruction works with auxiliary axes too.
"mode"	mode = 0: Backward motion of the drill to the start position
	mode = 1: backward motion of the plunging depth.
"end position"	Coordinate of the hole ground.
"plunge"	Value of the plunging depth.

When the drill goes forward at rapid speed, it stops before the actual hole ground. This is especially important with small drills. This gap is a parameter loaded by the instruction SET 6. Its default value is 0.1 mm.

The dwell time at the end of the drilling is set by the instruction SET 7 and the default value of the dwell time is 0.3 second.

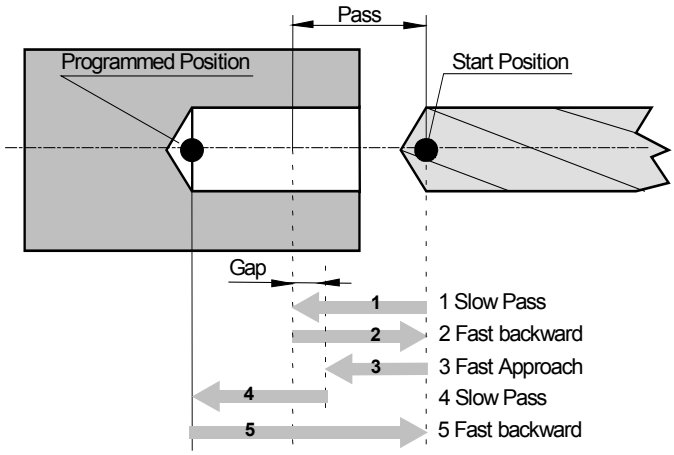

Figure 5-6 : Drilling with Peck cycles

Additional drilling functions:

To additional parameters are now available to complete drilling functions:

- **FINAL PASS** parameter, who allows to perform decreasing drilling and used to calculate decreasing value and pass number.
- **DEAD ZONE** parameter, who allows to perform fast approach movements in already drilled holes.

Final Pass is introduced in SET 8 FINAL PASS instruction (see chapter 5.4).

DEAD ZONE is introduced in SET 9 DEAD ZONE instruction (see chapter 5.4).

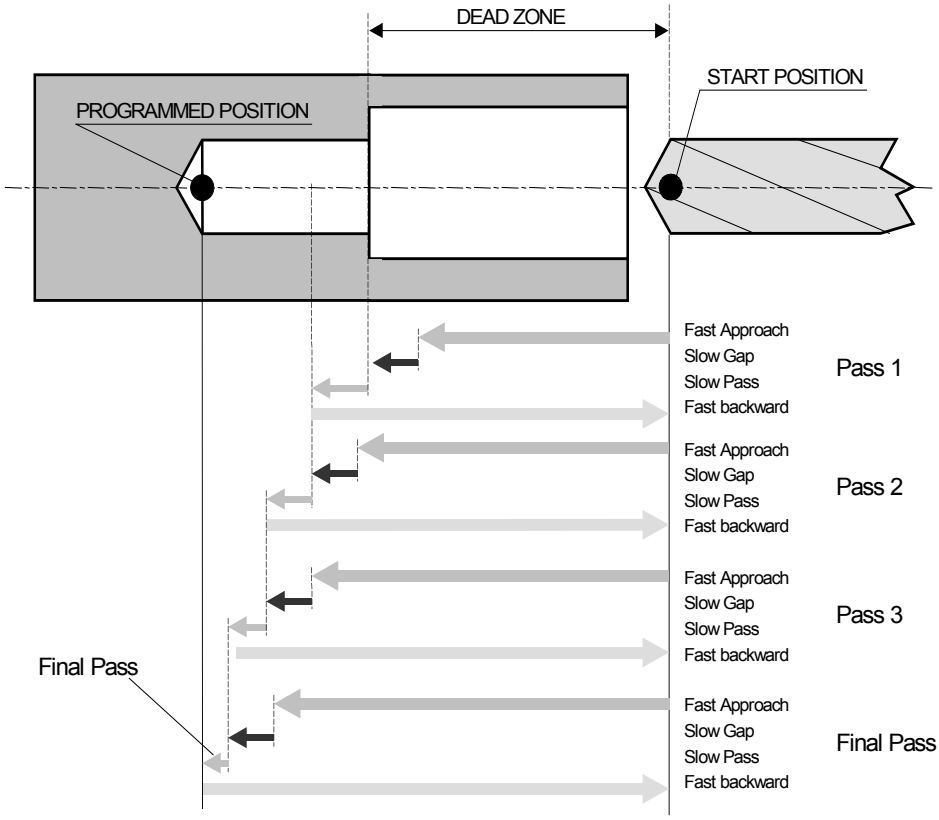

Figure 5-7 : Decreasing drilling and Dead Zone

Example:

We want to drill one 20 mm depth hole with a fist pass of 8 mm and a final pass of 2 mm. This hole is at bottom of an other 10 mm depth hole.

To do this, we place tool at beginning of the first hole who is defined as "zero position". We set a dead zone of 10 mm, a final pass of 2 mm, a first pass of 8 mm and a programmed position of 10+20 = 30 mm.

Corresponding program is:

```
6       SET     4 FEED 1.0                  ;slow speed
6       SET     6 GAP 1 mm                  ;1mm Gap
6       SET     8 FINAL PASS 2.0 mm         ;final pass =  2 mm
6       SET     9 DEAD ZONE 10 mm           ;dead zone of 10 mm
3       LIN     1 0.000 0.000               ;start position
F5 4    PECK    1 Z 0 -30.000 8.0000        ;tool 1, axis Z, ret. start pos. mode, hole bottom = 30 mm, first pass = 8 mm
```

UNITOUR will execute the following passes:

1st pass = 8 mm
2nd pass = 6 mm (8 – 2)
3rd pass = 4 mm (6 – 2)
4th pass = 2 mm (4 – 2)

Notice:

1) The "constant cutting speed mode" does not use the tool specified in the PECK instruction to compute the spindle speed.
2) Tool number must be specified.
3) FINAL PASS and DEAD ZONE parameters are set to 0 at Power-up of E-300. Thus we are working in the standard drilling mode.

Limitations:

1) A RAD or ARC instruction are not allowed directly after a PECK instruction.
2) The PECK instruction is not allowed directly after a SHIFT instruction.
3) PECK is not legal in the simultaneous tasks 1 and 2.

5.23 Pause Flag F9

A Pause Flag can be set at any instruction in a program. The pause flag has no action if the program runs in **Normal mode**, but the program will pause at each flag in **Step by step mode**. During Edition, Pause Flag can be toggle with the F9 Key and is displayed by the F9 Led. In listed Program in this Manual, Pause Flag is indicated by the ***** character.

For more details, see chapter 6.

5.24 End-of-Block Flag F10

To obtain a contouring motion with a constant path velocity, the "End of Block Flag" must be reset at each instruction within the block. During the edition, the F10 key toggles the end-of-block flag. In listed Program in this Manual, End-of-Block Flag is indicated by the **&** character.

See also the notice 4) under instruction LIN.

5.25 Fast Speed Flag F8

This flag, set or reset by the F8 key overrides the programmed feed rate, see notice 5) under LIN instruction. In listed Program in this Manual, Fast Speed Flag is indicated by the **+** character.

6 Program Execution

The program execution is governed by the push buttons START and STOP, by the inputs designated in the CTRL configuration and by the execution mode selected by the F6 Key (Normal or Step-by-Step mode).

6.1 The Execution Modes

- **Normal mode (F6 Led OFF):**

  Normal execution mode. The Pause Flags in the instruction are ignored. The START button is lit.

- **Step by Step mode (F6 Led ON):**

  The Pause Flag stops the program before the execution of the flagged instruction. The simultaneous tasks go on unless a flagged instruction is encountered.

  During the pause, the START Led is blinking. A depression of START restart the program till the next flagged instruction. This mode is especially useful with the TRACE utility.

6.2 START, PAUSE, STOP Key Functions

Remember that the inputs designated by the CTRL configuration are effectively ORed with this push buttons.

START

When the Led of the START and STOP buttons are off, a depression of START effectively starts the program designated as "START PROGRAMME" by the VECT menu.

If the red STOP Led is on, the program designated as "POWER ON PROGRAMME" comes to execution.

PAUSE

The STEP key (F6) pauses the running program at the end of the current instruction. However, a motion is immediately stopped to 0-velocity by the normal ramp-down process, i.e. the true position is preserved.

The START button Led is blinking and the STEP Led (F6) is lit. To resume execution, press START again.

STOP

A first depression of STOP while a program is running immediately stops the execution. The current motions are ramped to 0-velocity, the outputs and the DAC are reset. The true positions of the axis are preserved. Execution may be resumed by depressing START.

The first depression of STOP has the same action as the STEP key.

A second depression aborts the current program. The pilot Led of STOP is on and the program which will come to execution when depressing START is the "POWER ON PROGRAMME".

After switching the controller on, the mode is "Normal Mode" and the POWER ON PROGRAMME is automatically executed. If a power on program is not wanted, enter 100 as power on vector.

Notice:

- Most utilities are available while a program is running. However, the editor should be used with care: a line insertion or deletion will move the portion of the user's memory above the current line. Catastrophic failures may result.

6.3 Fault Processing

Three fault situations are processed by UNITOUR:

- the fault generated within the motor drivers,
- the over-travel as detected by software limits, (only in contouring mode, in positioning and vector modes, the travel is a priori limited),
- the over-travel detected by the limit-switches (no in standard software).

When a fault situation arises, UNITOUR immediately stops all motions but the digital outputs remain unchanged. The screen shows one of the messages:

AXIS a FAUTE press STOP	**STROKE OVERRUN press STOP**	**OVER STROKE press STOP**

where "a" stands for the axis, X, Z.

Depressing STOP resets all outputs and the DAC. In the first fault situation, the screen shows:

AXIS a FAULT JOGGING +/- -> ESC

The faulty axis can be moved slowly with the JOG keys. This is useful when the driver is fitted with hard-wired limit switches. The ESC key then returns the controller to the normal status. If the fault remains, some thing must be wrong with the driver.

In any case the controller executes the POWER ON PROGRAMME after a recovery from a fault situation.

CAUTION:
The STOP button is by no means an emergency stop as required by the current regulations.

7 Sample Program

7.1 Introduction

A program can be written in many different ways with a correct result. The proposed example offers several advantages:

1) A file is dedicated to the operations to be effected by a particular tool. Thus, it is a simple matter to alter the sequence of the tools, to suppress a part of the machining cycle during the debugging of the program.

2) Whenever possible, a cycle starts with a motion along the Z axis; this will limit the possibility of collisions.

3) The idea of a "pseudo-origin-tool" allows the tool selection in a linear tool arrangement without collision, see Figure 7-1.

7.2 Machine Data

The lathe has a variable speed drive, its run command is output number 4.

- The maximum rotational spindle speed is 3000 rev/min.
- The output number 6 controls a valve for the cooling fluid.
- The orientation of the coordinate system is shown in Figure 7-1, and the origin of the work piece system in on its face.
- The blank part is a bar with a diameter of 10 mm.

3 tools and a bar stop are required:

1) A triangular tip cutter for rough- and finishing cut.
2) A center drill
3) A cut-off chisel.
4) A bar stop.

The tool tips are arranged along an approximately straight line A-B. This line will become our pseudo-tool, say tool number 10.

Any move along X is allowed when tool 10 is at its Z-origin. To switch from one tool to another, we shall always return to the line A-B.

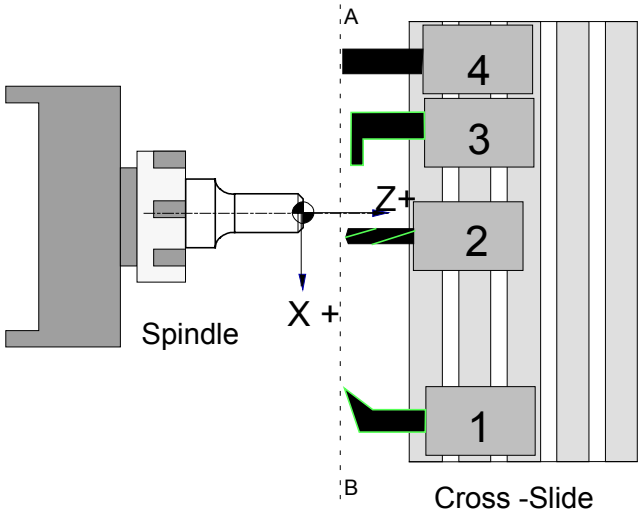

Figure 7-1 : Tool Arrangement

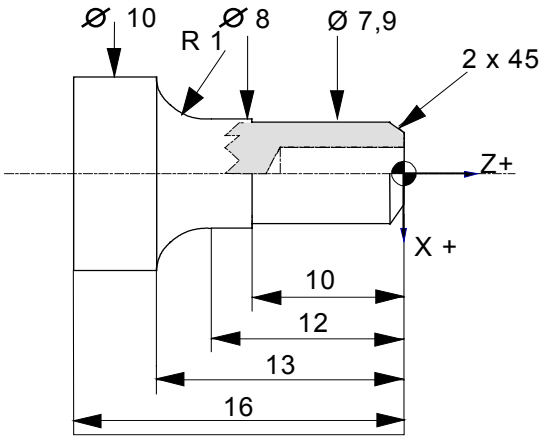

Figure 7-2 : The Piece to be machined

7.3 Description of the Operations

Operation 1 (Op1), tool 1.

- Rough machining of diameter and face

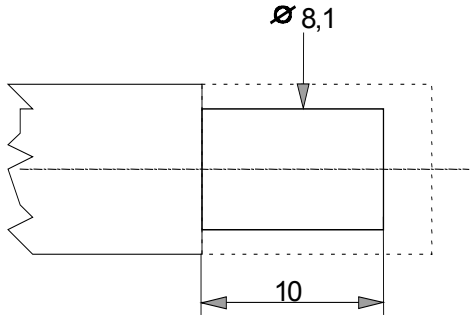

Figure 7-3 : Rough Machining

Operation 1a (Op1a), tool 1.

- Finishing of the face, chamfer in 2 or 4 passes

Operation 2 (Op2), tool 2.

- Drilling with peck cycle

Operation 3 (Op3), tool 3.

- Cut-off

Operation 4 (Op4), tool 4.

- Positioning the bar stop

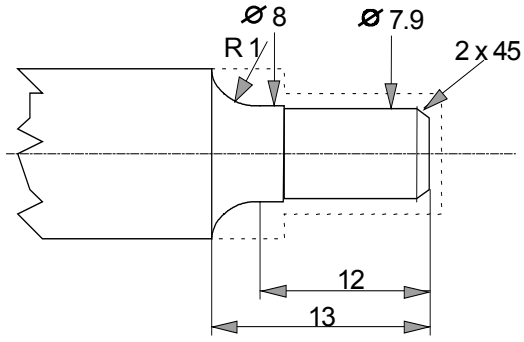

Figure 7-4 : Finishing

7.4 Program

Two versions of the tool 1 cycle are proposed:

1) As a path in a sub-program. This path can then be called several times, machining in forward direction,
2) The path is executed forward and backward to reduce the machining time.

Notes:

- In the following program we will works with diameter (DFACTOR(X) parameter = 2, see chapter 4.3.1)
- In POSA instruction, the speed rate (last parameter) can be equal to 0 if the fast mode is selected (+), see chapter 5.18.

Meaning of the Graphical Symbols:

& = End-of-Block Flag (F10)
* = Pause Flag (F9)
+ = Fast Speed Flag (F8)
F5 = "Shifted" numerical key pad
Op = Operation

```
VECT :  START       PROGRAMME 0
        POWER ON    PROGRAMME 99

File 0      ; Main Program intended to call the individual tool sub-programs.

  0 00          4   ON      6                       ; Cooling valve on
  1 00          -   CALL    98                      ; Spindle motor on
  2 00          -   CALL    1                       ; Tool 1
  3 00          -   CALL    2                       ; Tool 2 Drill cycle
  4 00          -   CALL    3                       ; Tool 3 Cut-off
  5 00          -   CALL    4                       ; Tool 4 Cut-off
  6 00          -   CALL    97                      ; Spindle motor off

File 1      ; Tool number 1, triangular tip cutter

  0 01   * + F5 3   POSA    10 Z 0.0000 0.          ; Backward to the AB line
  1 01          6   SET     CUT.SP m/min 100.0000   ; Set cutting speed
  2 01          6   SET     FEEDr mm/r 0.0500       ; Set feed per revolution
  3 01   * + F5 3   POSA    1 X 10.0000 0.0000  Op1 ; Diameter
  4 01   * + F5 3   POSA    1 Z 1.0000 0.0000       ;
  5 01   * + F5 2   FACE    1 2 0.0000 0.0000       ; Facing in 2 passes
  6 01   * + F5 1   CYL     1 2 8.1000 -11.0000     ; Rough cutting, diameter
  7 01   & * +  3   LIN     1 3.9000 0.0000         ; Chamfer
  8 01   & *    3   LIN     1 7.9000 -2.0000        ; End of chamfer
  9 01   & *    3   LIN     1 7.9000 -10.0000       ; Finishing
 10 01          6   SET     FEEDr mm/r 0.0300       ; New feed per revolution
 11 01   & *    3   LIN     1 8.0000 -10.0000       ; Diameter 8 mm
 12 01     * +  ,   SHIFT   0.7500 0.7500           ; Shift in X and Z
 13 01          -   CALL    7                       ; First pass
 14 01   & * +  3   LIN     1 10.0000 -10.0000 Op1a ; Backward motion
 15 01     * +  ,   SHIFT   -0.2500 -0.2500         ; Cutting depth
 16 01          -   CALL    7                       ; 2nd pass
 17 01   & * +  3   LIN     1 10.0000 -10.0000      ; Backward
 18 01     * +  ,   SHIFT   -0.2500 -0.2500         ; Cutting depth
 19 01          -   CALL    7                       ; 3d path
 20 01   & * +  3   LIN     1 10.0000 -10.0000      ; Backward
 21 01     * +  ,   SHIFT   -0.2500 -0.2500         ; The shift add to zero
 22 01          -   CALL    7                       ; 4 th pass

File 2      ; Tool number 2, Drill.

  0 03   * + F5 3   POSA    10 Z 0.0000 0.0000      ; Backward to the AB line
  1 03          6   SET     RPM r/min 3000.0000     ; Constant RPM
  2 03          6   SET     FEEDr mm/r 0.1000  Op2  ; Drill feed
  3 03   * + F5 3   POSA    2 X 0.0000 0.0000       ; At center
  4 03   * + F5 3   POSA    2 Z 0.1000 0.0000       ; Z position of drill
  5 03       F5 4   PECK    2 Z 0 -10.0000 3.0000   ; Drilling w. peck cycle
```

```
File 3      ; Tool number 3, Cut-off chisel.

 0 04    * + F5   3    POSA    10 Z 0.0000 0.0000      ; Backward to the AB line
 1 04    * + F5   3    POSA    3 X -11.0000 0.0000     ; At diameter
 2 04    * + F5   3    POSA    3 Z -16.0000 0.0000     ; Z-position
 3 04             6    SET     CUT.SP m/min 80.0000    ; Set cutting speed
 4 04             6    SET     FEED m/min 0.0400       ; Set feed rate
 5 04    & *      3    LIN     3 -1.5000 -16.0000      ; Cut-off
 6 04      *  F5   3    POSA    3 X 0.1000 0.0300       ; End of cut-off
 7 04    * + F5   3    POSA    3 X -11.0000 0.0000     ; Out of the bar

File 4      ; Tool number 4,  Bar stop.

 0 05    * + F5   3    POSA    10 Z 0.0000 0.0000      ; Backward to the AB line
 1 05    * + F5   3    POSA    4 X 0.0000 0.0000       ; X-position
 2 05    *  F5    3    POSA    4 Z 0.0000 1.0000       ; Z-position

File 7      ; Contouring Sub-program

 0 07    & * +    3    LIN     1 8.0000 -10.0000       ;  First element in path
 1 07      *      3    LIN     1 8.0000 -12.0000       ;
 2 07             2    RAD     3 1.0000
 3 07      *      1    ARC     1 10.0000 -13.0000      ;
 4 07    & *      3    LIN     1 10.5000 -13.0000      ;  Last element


File 10     ; Second version. Toll number 1, Triangular cutter

 0 10    * + F5   3    POSA    10 Z 0.0000 0.0000
 1 10             6    SET     CUT.SP m/min 100.0000
 2 10             6    SET     FEEDr mm/r 0.0500
 3 10    * + F5   3    POSA    1 X 10.0000 0.0000
 4 10    * + F5   3    POSA    1 Z 1.0000 0.0000
 5 10    * + F5   2    FACE    1 2 0.0000 0.0000
 6 10    * + F5   1    CYL     1 1 9.0000 -12.5000
 7 10    * + F5   1    CYL     1 1 8.1000 -11.5000
 8 10    & * +    3    LIN     1 3.9000 0.0000
 9 10    & *      3    LIN     1 7.9000 -2.0000
10 10    & *      3    LIN     1 7.9000 -10.0000
11 10    & *      3    LIN     1 8.0000 -10.0000
12 10             6    SET     FEEDr mm/r 0.0300
13 10      * +    ,    SHIFT   0.1000 0.1000
14 10    & *      3    LIN     1 8.0000 -10.0000       ; Beginning of path
15 10      *      3    LIN     1 8.0000 -12.0000
16 10             2    RAD     3 1.0000
17 10      *      1    ARC     1 10.0000 -13.0000
18 10    & *      3    LIN     1 10.5000 -13.0000      ; End of path
19 10      * +    ,    SHIFT   -0.1000 -0.1000         ; Cancel the shift
20 10    & * +    3    LIN     1 10.0000 -13.0000      ; Backward along the path
21 10             2    RAD     0 1.0000
22 10      *      1    ARC     1 8.0000 -12.0000
23 10    & *      3    LIN     1 8.0000 -10.0000       ; End of path

File 97     ; End of machine cycle

 0 97             5    OFF     4                       ;  Spindle motor off
 1 97             5    OFF     6                       ;  Cooling valve off

File 98     ; Start cycle

 0 98             6    SET     RPM r/min 1500.0000     ;  Constant RPM
 1 98             4    ON      4                       ;  Spindle motor on

File 99     ; Power-on Program, homing all axes

 0 99    F5       8    REF     Z
 1 99    F5       8    REF     X
```

Op3

Op4

Op1

Op1

7.5 Set-Up Procedure for the Sample Program

(All necessary tools and utilities to edit a program, to define the tool origins and to run the program are contained in the "SETTING" menu, see section 4.4)

The origin of the work piece coordinate system is located at the center of the face.

The tool number is made identical with the corresponding program for clarity.

To set-up the tools, it is necessary to touch the rotating bar; the slide is moved under manual control. The program 98 is momentarily designated as the START PROGRAMME in order to start the spindle.

Selecting the START PROGRAMME is done by depressing F5; the START button runs the selected program.

The START PROGRAMME can call any tool cycle. Running program 97 stops the spindle motor and move the slide in a safe position.

7.6 The First Run

First, call the program 4 to set the bar stop.

To run a tool cycle safely, place a pause flag at each motion and run the program with the Step-by-step mode. Select the tool cycles one after another.

To run the entire machining cycle, run the program 0. It is easily possible to modify the sequence of calls in the program 0 to momentarily delete a part of the cycle or to alter the order of the operations, for example, replace CALL 1 by CALL 10 to test the 2nd version of the cycle of the tool 1.

8 E300 Wiring

8.1 Compact Controller Type E300-CMP

8.1.1 Compatibility with E-600

The I/O EXT connectors and E600-3 connectors are same between E300-CMP and E600-Base. The I/O connector is similar but not fully compatible with E600. Therefore, plugging of E600 cable into E300 connector is not destructive. The position of some signals is the same as E600.

Following table show the differences between I/O connectors:

E300 and E600 I/O 19 pin comparison		
Pin	E300	E600
A	0V	0V
B	OUT4	OUT4
C	OUT5	OUT5
D	OUT6	OUT6
E	OUT7	OUT7
F	IN0	Analog GND
G	IN4	DAC out
H	OUT0	OUT0
J	IN1	+5VDC (output)
K	IN5	ADC input
L	IN2	IN2
M	IN6	IN6
N	IN3	IN3
P	IN7	IN7
R	0V	AGND
S	OUT1	OUT1
T	OUT2	OUT2
U	OUT3	OUT3
V	+24VDC	+24VDC

Tableau 8-1 : E300 et E600 I/O comparison

The ANALOG I/O doesn't exists in E600. The RS-232 pinning is not the same as E600.

8.1.2 I/O Connector

The I/O connector regroups 24 VDC inputs and outputs, and 24V supply for them.

Pin	Signal
A	0 V, output return
B	OUT(4), 24 V, 1 A
C	OUT(5), 24 V, 1 A
D	OUT(6), 24 V, 1 A
E	OUT(7), 24 V, 1 A
F	IN(0) 24V input
G	IN(4) 24V input
H	OUT(0), 24 V, 1 A
J	IN(1) 24V input
K	IN(5) 24V input
L	IN(2) 24V input
M	IN(6) 24V input
N	IN(3) 24V input
P	IN(7) 24V input
R	0 V, output return
S	OUT(1), 24 V, 1 A
T	OUT(2), 24 V, 1 A
U	OUT(3), 24 V, 1 A
V	Unregulated +24 VDC supply

Tableau 8-2 : E300 I/O Connector, 19 pin Burndy

Each output can deliver 1A but the sum of the 8 output currents must not exceed 4 ampere.

8.1.3 I/O EXT Connector

This connector regroups the signals for external I/O modules like E-500-I1, I2, I3 and E-500-ODC1.

8.1.4 RS 232 Connector

RS-232 connector is designed to connect the E300 to a PC through a 1 to 1 cable, for use the NewWincom or APEX software.

8.1.5 E-600-3 Module, 2 Phase Step-by-Step Motor Translator from EIP

"Slow/fast decay" system translator, with 1600 microsteps.

Pin	Signal
A	B phase winding
B	B phase winding
C	A phase winding
D	A phase winding
E	INA 24V input
F	INB 24V input
G	+24VDC supply
H	0V

Tableau 8-3 : E600-3 Connector, 8 pin Burndy

8.1.5.1 Current Setting

The rotative selector is designed to choose the peak to peak current corresponding to the motor. The value of the current is obtained when the BOOST signal is active. Otherwise the current is

reduced to 60% of the selected value.

Position	Current	Position	Current
0	2.0 A	5	5.3 A
1	2.7 A	6	6.0 A
2	3.3 A	7	6.7 A
3	4.0 A	8	7.3 A
4	4.6 A	9	8.0 A

Tableau 8-4 : E600-3, Current Setting

8.1.6 ANALOG I/O Connector

This connector regroups analog inputs and outputs. This is a D-sub 9 pole male type:

Pin	Description	Remarque
1	+5Vref	OUT
2	ADC1	IN
3	ADC2	IN
4	DAC0	OUT
5	DAC1	OUT
6	AGND	-
7	AGND	-
8	AGND	-
9	AGND	-

Tableau 8-5 : E300 Analog I/O connector