Low-cost labelling system

Star2000

BOTTLE LABELLING APPLICATION

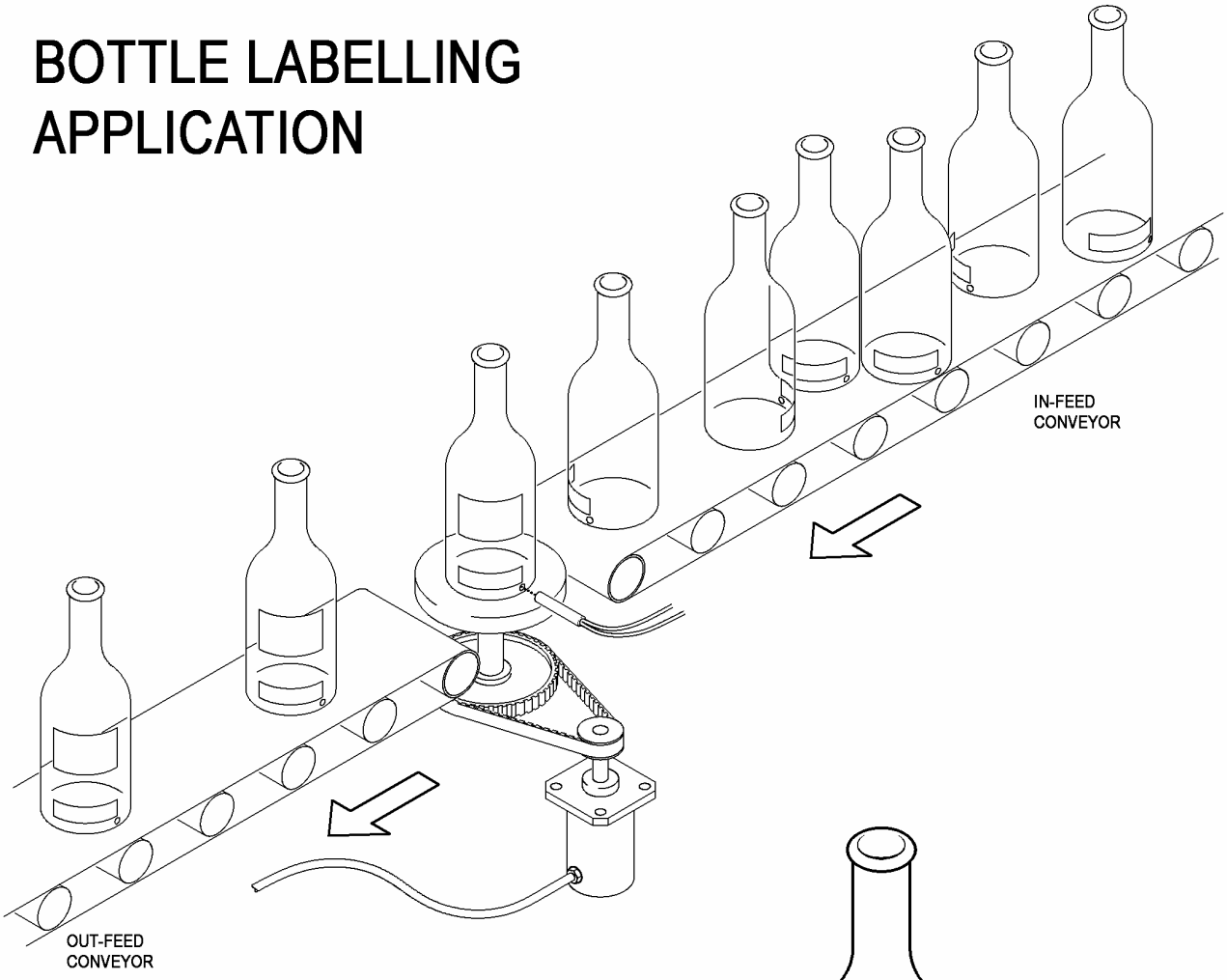


Fig 1

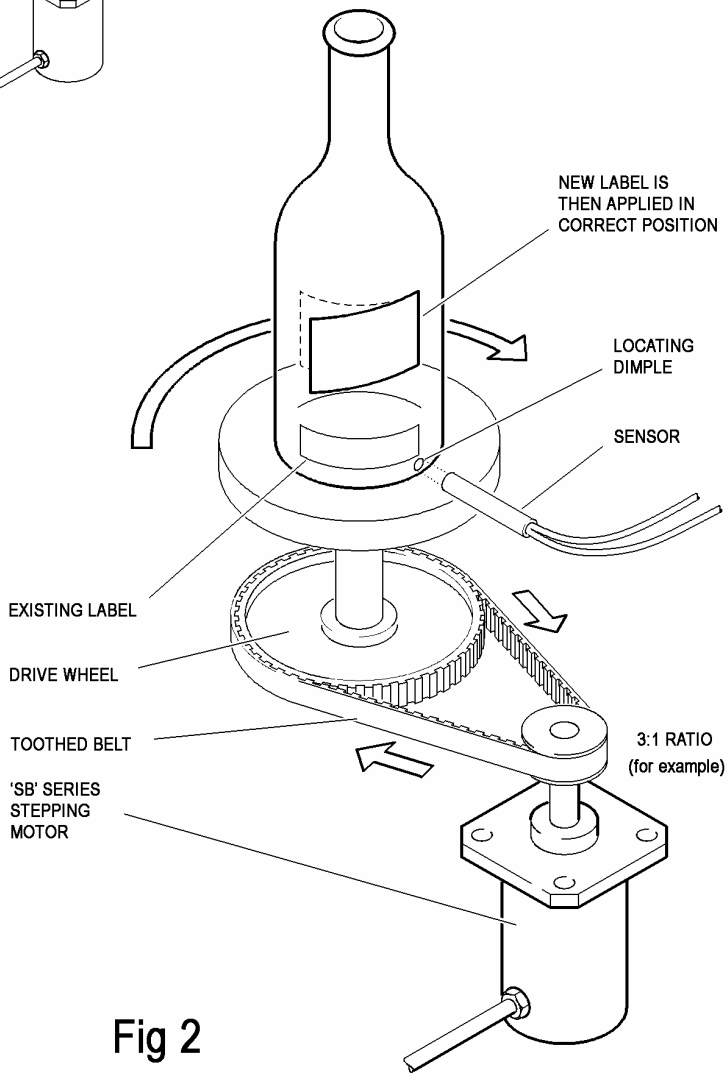


Fig 2

Application description

In this labelling machine example two labels are required to be placed onto bottles. In Fig 1 one label has already been applied to the bottles prior to the in-feed conveyor shown. The in-feed conveyor then transports the bottles to the next label applicator (not shown in Fig 1). At the end of the in-feed conveyor is a turntable onto which the bottles are moved one at a time. The bottles are in random orientation when they are moved onto the turntable. The object of this label applicator is to place a second label onto the top half of the bottle whilst ensuring that it is precisely aligned with the previously applied label at the bottom of the bottle.

The turntable is connected to a stepping motor via pinions and a toothed belt as shown in Fig 2. In this example a gear ratio of 3:1 has been chosen. The gearing can be via a toothed belt (as shown in this example) or via a gearbox fitted to the stepping motor (not shown). The 3:1 gearing increases the torque output from the stepping motor by a factor of three and reduces inertia as reflected back to the motor shaft by a factor of nine.

After the bottle is moved onto the turntable it is rotated until a 'locating dimple' on the body of the bottle moves in front of a sensor (alternatively an appropriate sensor may be set up to detect the leading edge of the first label instead of the 'locating dimple'). When the sensor receives a signal due to the 'locating dimple' (or leading edge of the first label) a signal (IN2 in this example) is given to the control system (Star2000) enabling the turntable to be precisely stopped after a given angle of rotation. The bottle is now located precisely in position for the second label to be applied by the label applicator. When applied, the second label will be correctly located on the bottle in relation to the first label. The bottle is then transported off the turntable onto the out-feed conveyor and the next bottle to be labelled is transported off the in-feed conveyor onto the turntable.

Please note that the description of this labelling application could also be transposed to a printing application i.e. printing onto a previously fitted label for example.

Hardware description

The hardware described in this section comprises the equipment necessary for rotating the turntable shown in Fig's 1 & 2 and stopping it precisely in position so that a label applicator can apply the label to the bottle.

The system uses a low-cost 'SB' series 2-phase stepping motor and Star2000 stepping motor controller. Providing the stepping motor has been correctly chosen so that it can provide more than the required acceleration and running torques required by the turntable (with the additional weight and inertia of the bottle taken into account) the system can operate in simple 'open-loop' control mode and should never lose position. By using a stepping motor system for this application the equipment is simple, low-cost and very easy to set up. A Windows program called 'WinStar' (a DOS version is also available) is supplied free with the Star2000. The program can be run in the English, German or Italian language as standard and communication is via the RS232 or RS485 / 422 interfaces of the Star2000 stepping motor controller.

The version of the Star2000 used on this application has on-board EEPROM memory available. The EEPROM memory allows up to 16 programs to be stored. The first program (Program 0) can be used to store common parameters such as motor current, acceleration / deceleration times, maximum frequency, etc. leaving each of the remaining 15 programs (Program 1-15) to be used for a different bottle/label combination. Each of the remaining programs requires just one single input instruction to be stored and changing one of these programs can be done in a matter of seconds. Selection of the program to be run is via a simple *high*/*low* signal on four inputs: BCD0; BCD1; BCD2; and BCD4. The Star2000 has a 15VDC output which can be used to power the *high* inputs however the versatility of the Star2000 enables it to also utilize a 24VDC input from another location such as a remote PLC when choosing which program to run for example. When a program is run and the stepping motor stops a 15VDC '*Position Reached*' output is given by the Star2000 which can be utilized by the label applicator as a signal to apply the label to the bottle.

A selection of stepping motors and Star2000 controllers can be seen in Appendix A.

Further information on the correct wiring, and set-up can be attained from the Star2000 handbook:

Stepping motor drives.
Series Star2000
Mod. APS/1, APS/2, APS/3, APS4, APS/5
Version 01/01
Release 20FW0A-43FW0J-43W1A

For operation of the Star2000 with EEPROM memory, the additional manual is available:

APSx-CEO
Version 05/01
Release: 50FW1E).

The following notes refer to this additional manual:

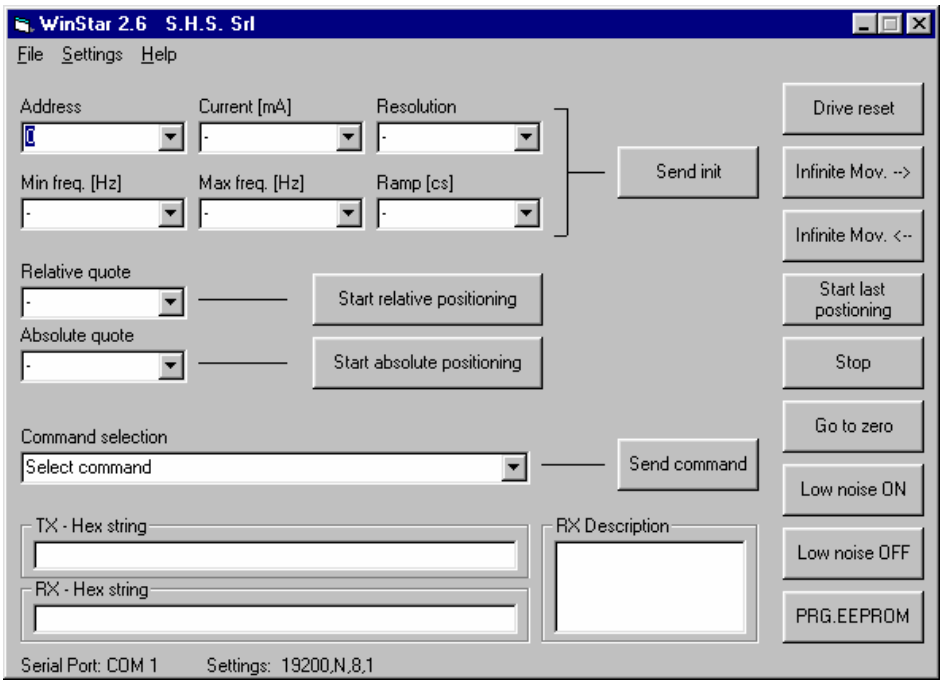
Pages 3 and 4 of the manual detail how you can select 8 or 16 programs. If you chose to utilize 8 programs you select the program number by high/low signals on BCD0, BCD1 & BCD2 (see connection drawing on page 5) and then you can use the three inputs IN1, IN2 & IN3 to give you the correct conditions for which the program will be run.

If however you want to use 16 programs you have to use BCD0, BCD1, BCD2 and IN1 (BCD4) with to select the program number which means you only then have two inputs which you can monitor: IN2 & IN3.

Programming the Star2000 controller using the WinStar Software for 'ZERO AT FLIGHT' inputs setting

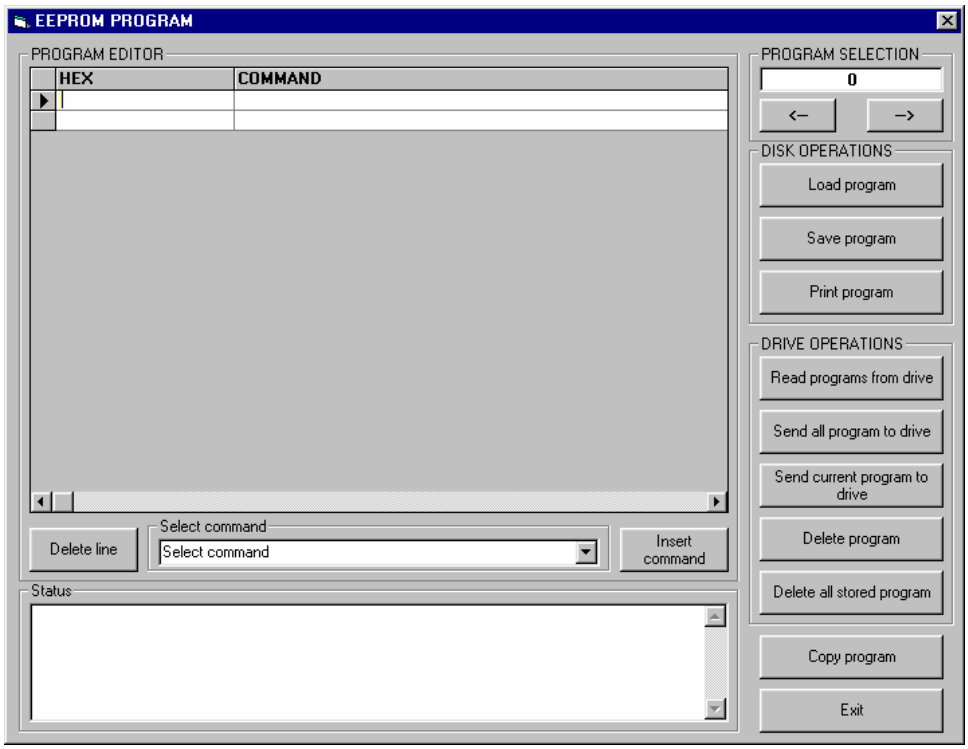
To set up the Star2000 for this labelling application using the WinStar Windows program:

1. Run WinStar software (Winstar26.exe). You will see the following screen:



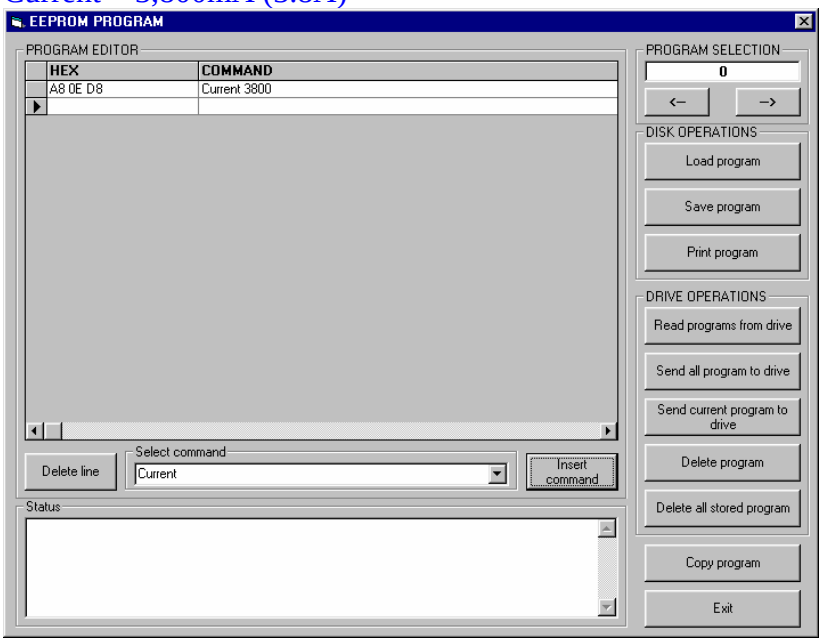
2. Select: ‘Settings’ > ‘Language’ selection to change between Italian, English and German.

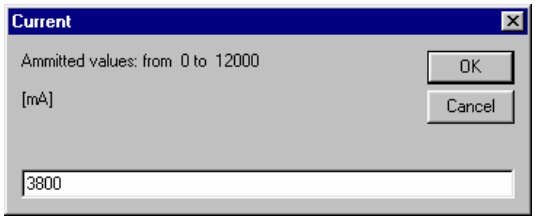
3. Click on the ‘PRG.EEPROM’ at the bottom right of the page and you will see the following screen:



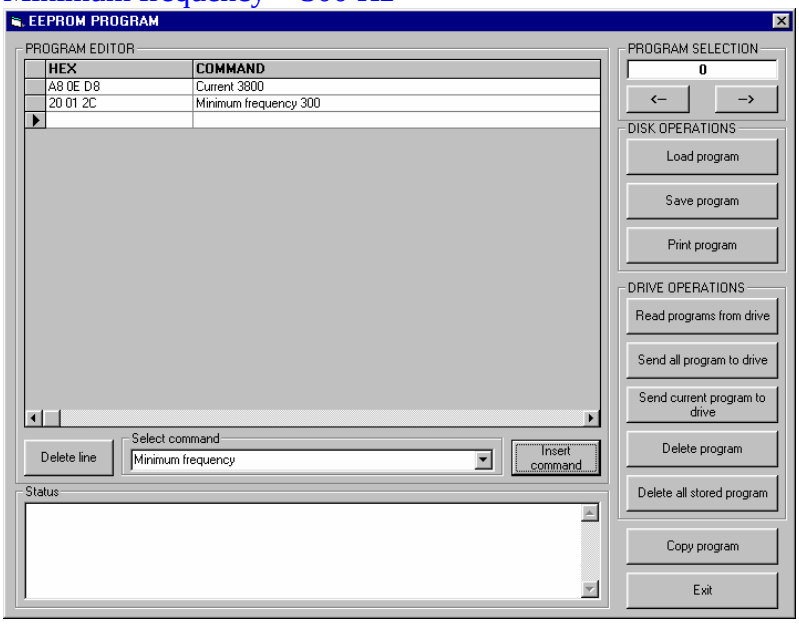
‘**Program 0**’ can be seen at the top right of the screen. In this program you can put all the parameters that the other programs will use. If you do not use this program this way you will have to enter these parameters for each program that you use.

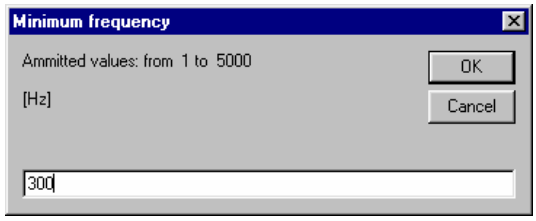
Current = 3,800mA (3.8A)



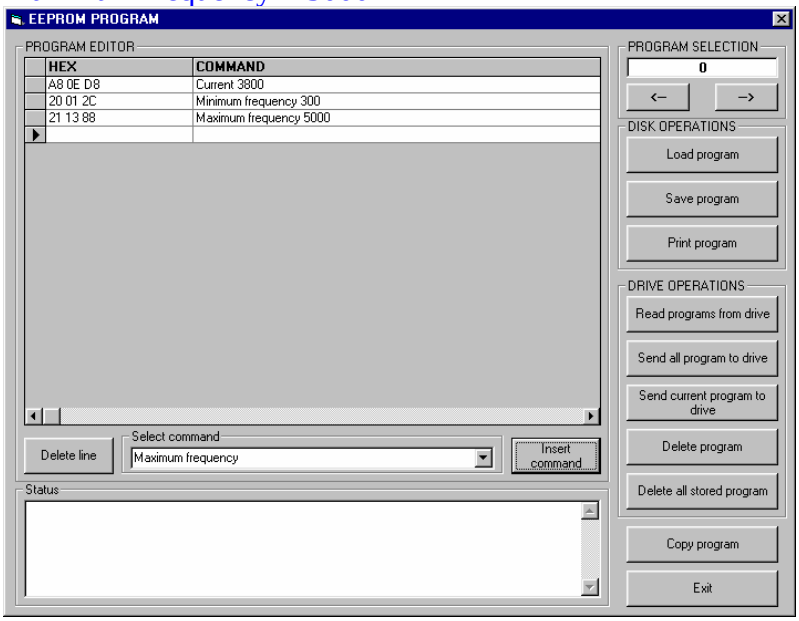


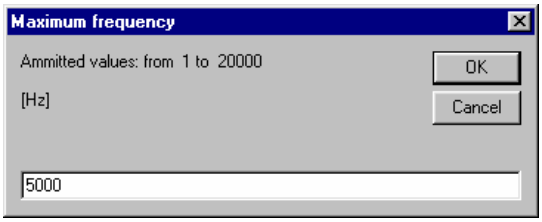
Minimum frequency = 300 Hz



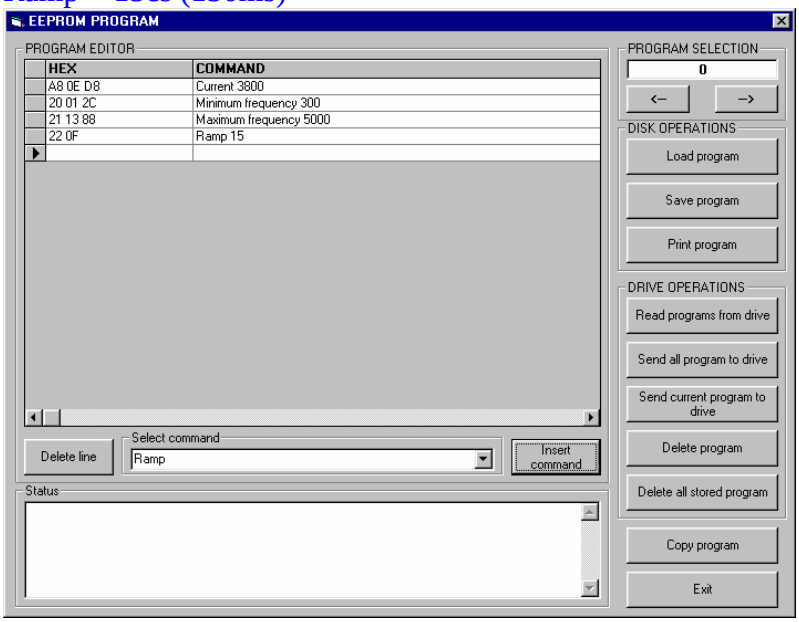


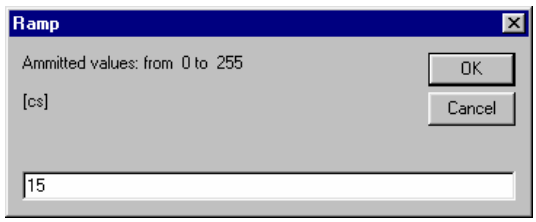
Maximum frequency = 5000 Hz



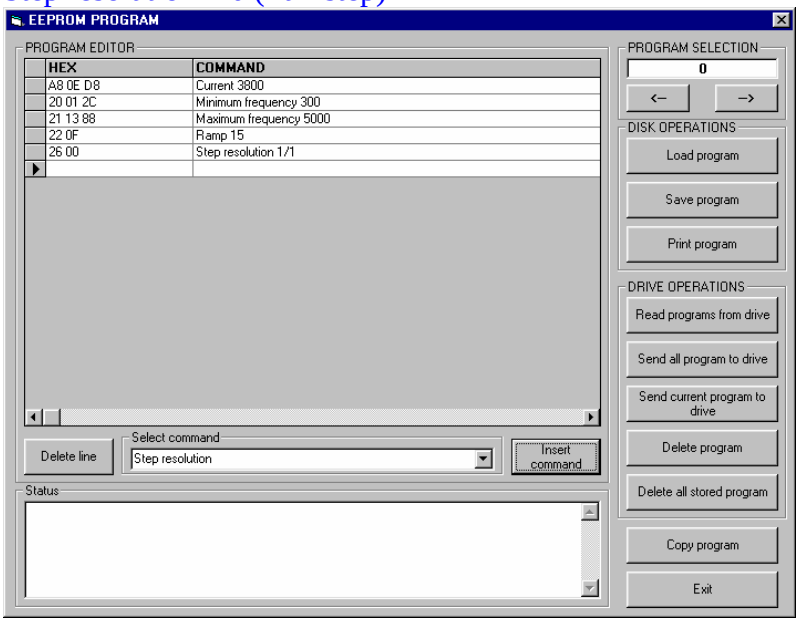


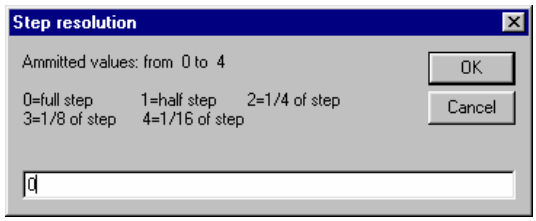
Ramp = 15cs (150ms)



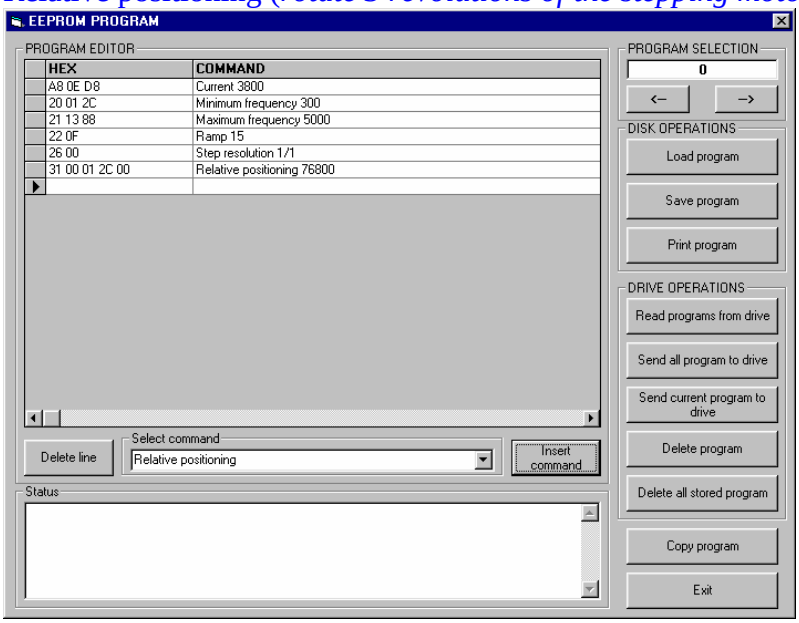


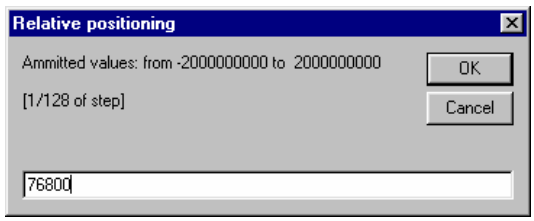
Step resolution = 0 (Full step)





Relative positioning (*rotate 3 revolutions of the stepping motor (3 x 25,600 = 76,800) clockwise*)



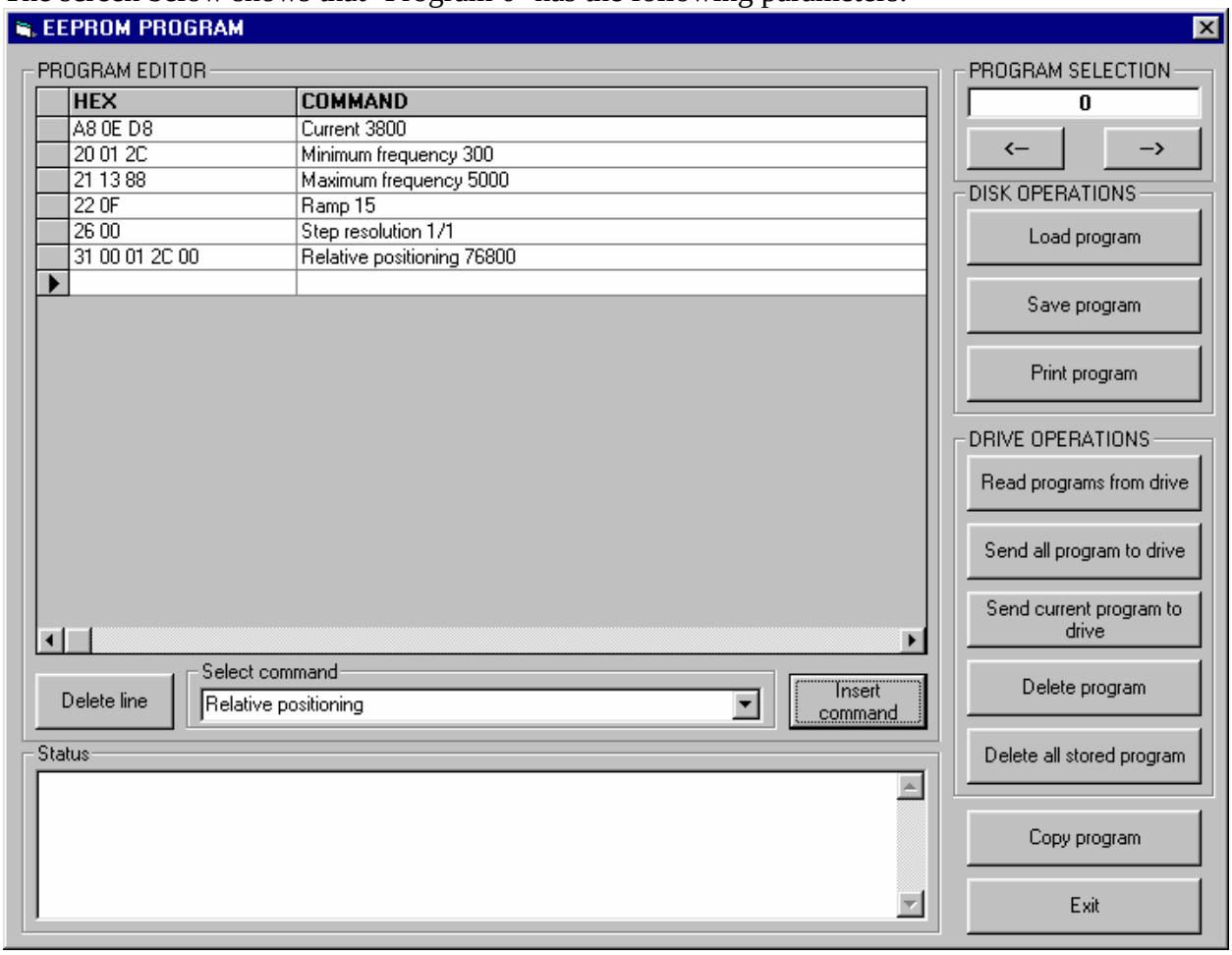


The parameters set up in '**Program 0**' are therefore:

Current = 3.8A
Minimum Frequency = 300Hz
Maximum Frequency = 5000Hz
Ramp = 150ms
Step resolution = Full-step
Distance to travel = 3 revs of the stepping motor

With this data the stepping motor will rotate for up to three rotations (equating to one rotation of the turntable) however when the Star2000 gets a high input on IN2 it will make one revolution (1/3 rotation of the turntable) and then stop.

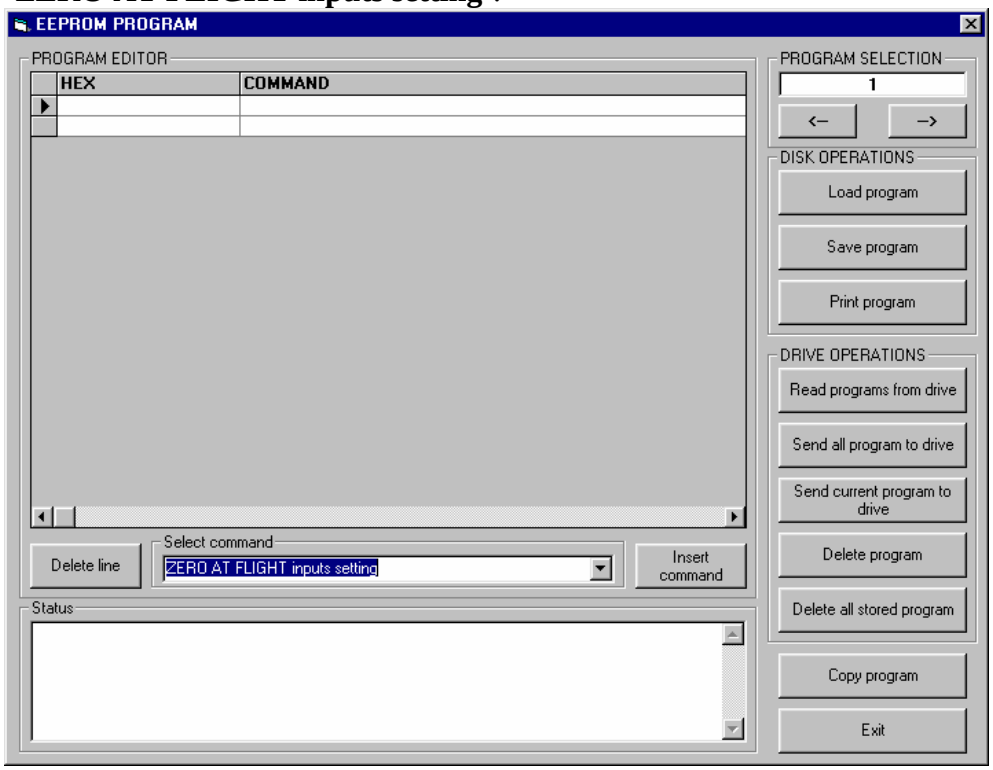
The screen below shows that ‘Program 0’ has the following parameters:



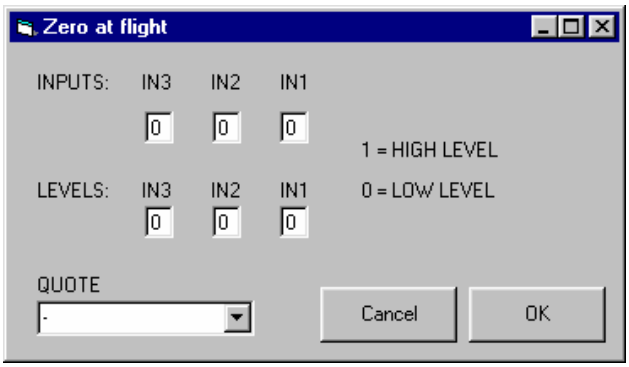
Save the program and then change the program number to 1 (top right of screen).

N O T E : Changings in ‘Program 0’ are only valid after switching OFF and ON the power supply!

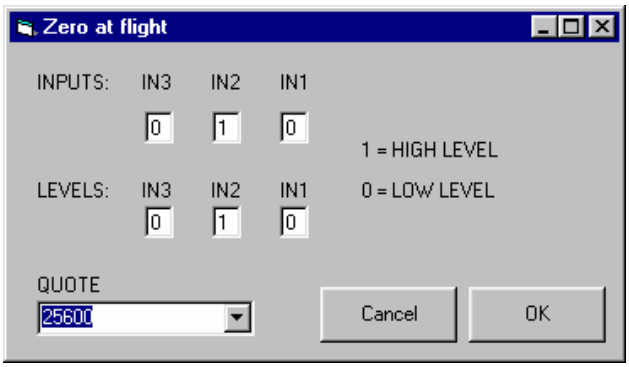
4. For ‘**Program 1**’ we want the stepping motor to make one revolution when IN2 goes from **LOW** to **HIGH**. Click on the ‘down arrow’ in the ‘Select command’ box and scroll down and select: ‘**ZERO AT FLIGHT inputs setting**’.



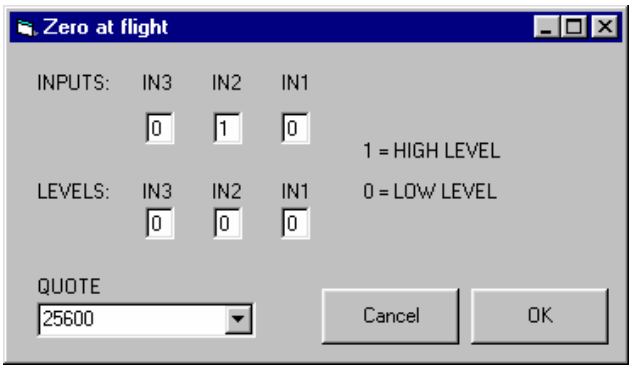
5. Click on the ‘Insert command’ button to the right of ‘Select command’ and you will see the following ‘pop-up’ screen:



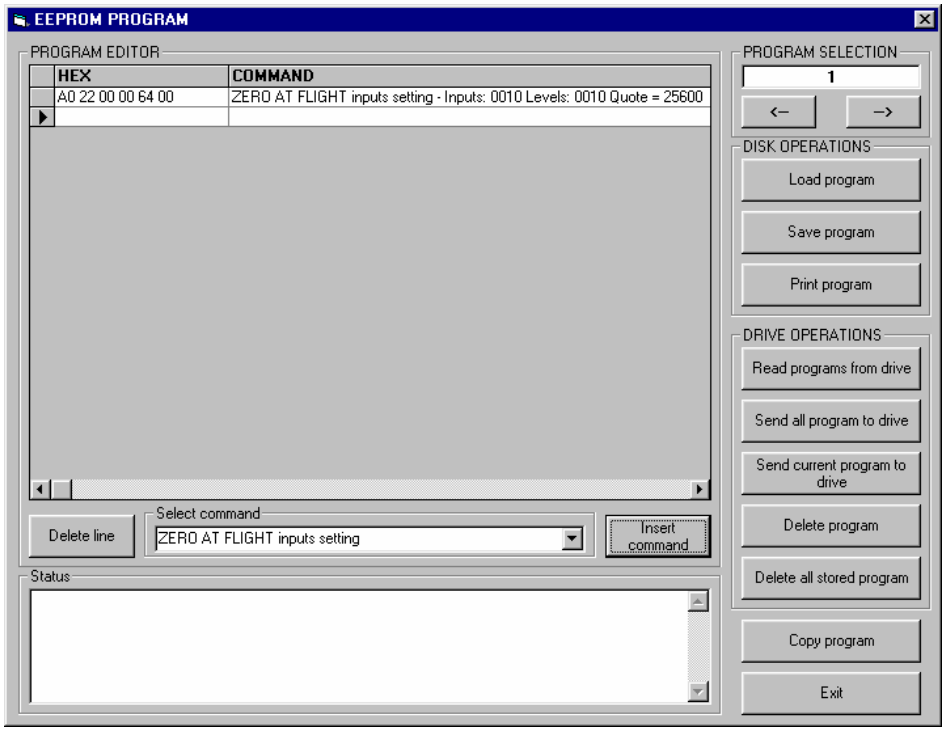
6. You can now set which inputs are high/low and in the quote box select what distance you would like to move (*with the Star2000 there are always 25,600 steps per revolution irrespective of whether you are driving in full-step or 1/16th step, etc.*).



In this example when input IN2 changes from LOW to HIGH the stepping motor will make one revolution. If you require the motor to make one revolution when the input IN2 goes from HIGH to LOW you would chose the following:



7. Click on the ‘OK’ button to see the following screen:



You can repeat this procedure for other programs if required (but it is not needed in this example).

8. Save and print the program before running.

9. The function of the Star2000 is now as follows:

   - Power up to Star2000 and all the elementary commands from ‘**Program 0**’ are loaded.
   - Select ‘**Program 1**’ and start with the input ‘Valid Strobe’ (see page 5 of the APSx-C-EO manual….. connector ‘J2’ pin 8).
   - The motor will start to make up to 5 revolutions.
   - When ‘IN2’ signal is given (either HIGH to LOW or LOW to HIGH depending upon how it was set up) the stepping motor will continue for one revolution and then stop.

10. Program 2 up to program 15 can also be set up in similar fashion to program 1 (described above) so that each program represents a different bottle / label combination.

11. Programs are selected using the inputs BCD0, BCD1, BCD2 & BCD4 and a ‘start’ signal (from the sensor for example).

Appendix A – Available Hardware

The following SB series stepping motors and Star2000 stepping motor controllers are available (2006 prices):

SB Series stepping motors typically used for heavier glass bottle applications

Motor type	Holding Torque	Rotor Inertia	Phase Current when connected in Parallel	Phase Current when connected in Series	Price Each
SB-6630-50-4-0.4	10Nm	3950gcm²	10A	5A	£ 371.43
SB-6630-37-4-0.66	6.6Nm	2660gcm²	6.8A	3.4A	£ 291.84
SB-6630-24-4-0.4	3.2Nm	1390gcm²	6.8A	3.4A	£ 212.24

SB Series stepping motors typically used for lighter glass bottle or plastic bottle applications

Motor type	Holding Torque	Rotor Inertia	Phase Current when connected in Bipolar	Price Each
SB-6600-30-2-0.37	1.95Nm	425gcm²	4.7A	£ 163.27
SB-6600-20-2-0.37	925mNm	248gcm²	3.8A	£ 119.39
SB-6600-15-2-1.6	540mNm	131gcm²	1.5A	£ 107.14

THERE ARE MANY MORE STEPPING MOTORS AVAILABLE IN THE 'SB' SERIES NOT DETAILED HERE!

Star2000, 2-phase stepping motor controllers with on-board EEPROM memory

Type	Input Voltage Supply	Output Motor Voltage	Maximum Current output	Price Each
APS-1-B-EO	30-90VDC	30-90VDC	4A	£ 336.98
APS-1-B-EP	22-63VAC	30-90VDC	4A	£ 395.38
APS-2-B-EO	30-90VDC	30-90VDC	6A	£ 368.61
APS-2-B-EP	22-63VAC	30-90VDC	6A	£ 434.31
APS-3-B-EO	30-90VDC	30-90VDC	10A	£ 390.51
APS-3-B-EP	22-63VAC	30-90VDC	10A	£ 459.85
APS-4-B-EO	75-155VDC	30-140VDC	12A	£ 452.55
APS-4-B-EP	55-100VAC	30-140VDC	12A	£ 536.50
APS-5-B-EO	155-195VDC	155-190VDC	10A	£ 506.08
APS-5-B-EP	110-135VAC	155-190VDC	10A	£ 607.06

The prices in Appendix A) refer to UK supply only. For equipment supplied to a customer outside the UK, a small surcharge will apply to these prices.

Typical combinations of stepping motor and Star2000 drive are:

- SB-6630-50-4-0.4 stepping motor (10Nm)
  APS-3-B-EO controller (10A)
  Total Price £ 761.94 lot net

- SB-6630-24-4-0.4 stepping motor (3.2Nm)
  APS-1-B-EO controller (10A)
  Total Price £ 549.22 lot net

- SB-6600-20-2-0.37 stepping motor (540mNm)
  APS-1-B-EO controller (4A)
  Total Price £ 456.37 lot net

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