Low-cost labelling system

<u>Star2000</u>

Labelling-Printing handbook – 060517.doc Edition: Revision 2 dated - 17th May 2006



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 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.

<u>Programming the Star2000 controller using the WinStar Software for</u> <u>'ZERO AT FLIGHT' inputs setting</u>

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:

🐃 WinStar 2.6 S.H	I.S. Srl			
<u>F</u> ile <u>S</u> ettings <u>H</u> elp				
Address	Current [mA]	Resolution	Send init	Drive reset
Min freq. [Hz] -	Max freq. [Hz] -	Ramp [cs]		Infinite Mov. <
Relative quote Absolute quote	[Start relative positioning		Start last postioning
· •		Start absolute positioning		Stop
Command selection				Go to zero
Select command		•	Send command	Low noise ON
TX - Hex string			RX Description	Low noise OFF
				PRG.EEPROM
Serial Port: COM 1	Settings: 19200),N,8,1		

- 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:

📬, EE	PROM PROGRAM				×
	OGRAM EDITOR				PROGRAM SELECTION
	HEX	COMMAND			0
					<>
		·			DISK OPERATIONS
					Load program
					Save program
					Print program
					DRIVE OPERATIONS
					Read programs from drive
					Send all program to drive
				F	Send current program to drive
[et command	•	Insert command	Delete program
Sta	tus				Delete all stored program
					Copy program
				~	Exit

'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 = 3,8	300mA (3.8A)				
💐 EEPROM PROGRAM			×		
PROGRAM EDITOR			PROGRAM SELECTION		
HEX A8 0E D8	COMMAND Current 3800		0		
AS UE DS	Current 3800		<>		
			DISK OPERATIONS		
			Load program		
			Save program		
			Print program		
			DRIVE OPERATIONS		
			Read programs from drive		
			Send all program to drive		
		F	Send current program to drive		
	command	Insert command	Delete program	Current Ammitted values: from 0 to 12000	ОК
Status			Delete all stored program	[mA]	Cancel
			Copy program		
		Y	Exit	3800	

Minimum frequency = 300 Hz

1 , 1	EPROM PRO	JGRAM	×
_ P	ROGRAM EDIT	10R	PROGRAM SELECTION
	HEX	COMMAND	0
	A8 0E D8	Current 3800	
	20 01 2C	Minimum frequency 300	<>
ЦĽ	•		DISK OPERATIONS
			Load program
			Save program
			Print program
			DRIVE OPERATIONS
			Read programs from drive
			Send all program to drive
			Send current program to drive
	Delete line	Select command	Delete program
S	tatus		Delete all stored program
			Copy program
			Exit

Minimum frequency	×
Ammitted values: from 1 to 5000	ОК
[Hz]	Cancel
300	

Maximum frequency = 5000 Hz

PROGRAM EDITOR PROGRAM SELECTION AB 0E 06 Current 3800 2011 32: Minimum frequency 300 21138: Maximum frequency 5000 Disk OPERATIONS Load program Save program Print program Disk OPERATIONS Bad program to drive Seelet command Disk OPERATIONS Delete line Seelet command Status Delete program Status Capy program Exit Exit	CETTOM THOUTAN			<u>A</u>		
A 20 0E D8 Current 3000 20 1 20 Minimum frequency 300 21 138 Maximum frequency 5000 DISK OPERATIONS Load program Print program DRIVE OPERATIONS Read programs from drive Send current program to drive Delete line Maximum frequency Delete line Maximum frequency Delete al stored program Delete al stored program	PROGRAM EDITOR -			PROGRAM SELECTION		
20 01 2C Minimum frequency 300 21 13 88 Maximum frequency 5000 Image: Select command Delete inc Maximum frequency Image: Select command Delete inc Maximum frequency Image: Select command Image: Select command Delete inc Maximum frequency Image: Select command Image: Select command Delete inc Maximum frequency Image: Command Delete program Copy program Copy program	HEX	COMMAND		0		
21 3 25 Minimum frequency 5000 DISK OPERATIONS Save program Print program DRIVE OPERATIONS Read programs from drive Select command Maximum frequency Delete line Maximum frequency Status Copy program Copy program	A8 0E D8	Current 3800				
21 13 88 Maximum frequency 5000 Issue program Save program Pint program Pint program Pint OPERATIONS Read programs from drive Send all program to drive Send all program to drive Send current program Delete line Maximum frequency Maximum frequency Status Delete all stored program Copy program Delete all stored program Insert Copy program				<>		
Load program Save program Print program Print program DRIVE OPERATIONS Read program to drive Select command Delete line Maximum frequency Status Delete line Copy program Delete al stored program	21 13 88					
Select command Delete line Status S				DISK UPERATIONS		
Print program Print program DRIVE OPERATIONS Read programs from drive Select command Delete line Maximum frequency Insert Delete line Maximum frequency Delete all stored program Delete all stored program Delete all stored program Cancel				Load program		
Print program Print program DRIVE OPERATIONS Read programs from drive Select command Delete line Maximum frequency Insert Delete line Maximum frequency Delete all stored program Delete all stored program Delete all stored program Cancel						
Print program Print program DRIVE OPERATIONS Read programs from drive Select command Delete line Maximum frequency Insert Delete line Maximum frequency Delete all stored program Delete all stored program Delete all stored program Cancel				Cause average 1		
Delete line Select command Delete line Maximum frequency Status Delete all stored program Delete all stored program OK Delete all stored program OK Delete all stored program OK				Save program		
Delete line Select command Delete line Maximum frequency Status Delete all stored program Delete all stored program OK Delete all stored program OK Delete all stored program OK						
Read programs from drive Select command Delete line Maximum frequency Status Delete all stored program Delete all stored program Copy program				Print program		
Read programs from drive Select command Delete line Maximum frequency Status Delete all stored program Delete all stored program Copy program						
Select command Insert Delete line Insert Status Delete program Copy program Cancel				DRIVE OPERATIONS		
Select command Insert Delete line Insert Status Delete program Copy program Cancel				Band and an elite		
Status Status Copy program Copy program Copy program Copy program Status Copy program Copy p				Read programs from drive		
Status Status Copy program Copy program Copy program Copy program Status Copy program Copy p						
Image: Select command Insert Delete line Maximum frequency Status Delete program Delete line Delete program Copy program Cancel				Send all program to drive		
Image: Select command Insert Delete line Maximum frequency Status Delete program Delete line Delete program Copy program Cancel						
Select command Insert Delete line Maximum frequency Status Delete program Delete all stored program Delete all stored program Copy program Copy program				Send current program to		
Select command Insert Maximum frequency Insert Status Delete program E Copy program	•		Þ	drive	Maximum frequency	>
Delete line Maximum frequency Image: Command line Ammitted values: from 1 to 20000 OK Status Delete all stored program Image: Copy program <th></th> <th>et command</th> <th></th> <th>1</th> <th>in an in option of</th> <th></th>		et command		1	in an in option of	
Status Delete al stored program [Hz] Copy program [Hz]	Delete line Ma	kimum frequency	▼ Insert	Delete program	Ammitted values: from 1 to 20000	01
[H2] Cancel					Ammilia values, nom nito 20000	UK
Copy program	Status			Delete all stored program	[L] -1	
Copy program			<u>ـ</u>		[[12]	Cancel
				1		
Ежн 5000				Copy program		
Exit 5000						
			-	Exit	5000	
	, ·					



🖷 EEPROM PR	OGRAM	2
- PROGRAM EDI	TOR	PROGRAM SELECTION
HEX	COMMAND	
A8 0E D8	Current 3800	
20 01 2C	Minimum frequency 300	<− −>
21 13 88	Maximum frequency 5000	DISK OPERATIONS
22 OF	Ramp 15	DISK OF ERATIONS
		Load program
		Save program Print program
		DRIVE OPERATIONS Read programs from drive
		Send all program to drive
		Send current program to drive
Delete line	Select command	Delete program
Status		Delete all stored program
		Copy program
		Exit

Ramp	×
Ammitted values: from 0 to 255	ОК
[cs]	Cancel
l	
15	

Step resolution = 0 (Full step)		
S, EEPROM PROGRAM		X
PROGRAM EDITOR	PROGRAM SELECTIO	rion ———
HEX COMMAND A8 0E D8 Current 3800 20 01 2C Mirimum frequency 300 21 13 88 Maximum frequency 5000 22 0F Ramp 15 26 00 Step resolution 1/1	O C O DISK OPERATIONS Load program	
	Save program	n
	Print program	
	Read programs from Send all program to	
x	Send current progra drive	ram to Step resolution
Delete line Step resolution	Inset Command Delete all stored pro	M Ammitted values: from 0 to 4
	Copy program	U=hull step I=hair step 2=1/4 of step Cancel
	Exit	

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

PROGRAM EDITOR			- PROGRAM SELECTION			
HEX	COMMAND		0			
A8 0E D8	Current 3800			=11		
20 01 2C	Minimum frequency 300		<−			
21 13 88	Maximum frequency 5000			_		
22 OF	Ramp 15		DISK OPERATIONS	- 1		
26 00	Step resolution 1/1		Load program			
31 00 01 2C 00	Relative positioning 76800		· · ·			
			Save program			
			Print program			
			DRIVE OPERATIONS			
			DRIVE OPERATIONS	- 1		
			Read programs from driv	/e		
			Send all program to driv	e		
			Send current program to drive	•		
		►	uive		Relative positioning	×
Select co	ommand		D.L.		Troldere positioning	
Delete line Relative	positioning	Insert command	Delete program		Ammitted values: from -2000000000 to 200000000	
	,				Animitted values: non-200000000 to 20000000	OK
Status			Delete all stored progra	m	M H00 () 1	
		A	· · ·		[1/128 of step]	Cancel
				-		
			Copy program			
		-	Exit		76800	
1		7	Exit		Jugood	
			·	_		

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.

🖷 EEPROM PROGRAM		01	×
- PROGRAM EDITOR			PROGRAM SELECTION
HEX	COMMAND		0
A8 0E D8	Current 3800		
20 01 2C	Minimum frequency 300		<− −>
21 13 88	Maximum frequency 5000		DISK OPERATIONS
22 OF	Ramp 15		DISK UPERATIONS
26 00	Step resolution 1/1		Load program
31 00 01 2C 00	Relative positioning 76800		
			Save program
			Print program
			DRIVE OPERATIONS
			Read programs from drive
			Send all program to drive
		F	Send current program to drive
	ct command stive positioning	Insert command	Delete program
Status			Delete all stored program
		-	Copy program
		T	Exit

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**'.

S, EEPRUM PRUGRAM	×
PROGRAM EDITOR	PROGRAM SELECTION
	Load program
	Save program
	Print program
	DRIVE OPERATIONS
	Read programs from drive
	Send all program to drive
x	Send current program to drive
Delete line ZEROAT FLIGHT inputs setting Insert	Delete program
Status	Delete all stored program
	Copy program
×	Exit

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

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.).*

🖷 Zero at I	ilight				_ 🗆 ×
INPUTS:	IN3	IN2	IN1		
	0	1	0	1 = HIGH LEVEL	
LEVELS:	IN3 0	IN2 1	IN1 0	0 = LOW LEVEL	
QUOTE 25600		•	[Cancel	ок

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:

💐 Zero at	ilight				_ 🗆 🗵
INPUTS:	IN3 0	IN2	IN1	1 = HIGH LEVEL	
LEVELS:	IN3 0	IN2	IN1 0	0 = LOW LEVEL	
QUOTE 25600		•		Cancel	ок

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

🖷 EEPROM PROGRAM		X
PROGRAM EDITOR		PROGRAM SELECTION
HEX	COMMAND	1
A0 22 00 00 64 00	ZERO AT FLIGHT inputs setting - Inputs: 0010 Levels: 0010 Quote = 25600	<-
		<>
		DISK OPERATIONS
		Load program
		Save program
		Print program
		DRIVE OPERATIONS
		Read programs from drive
		Send all program to drive
	Т	Send current program to drive
Delete line ZERO AT	mand FLIGHT inputs setting Command	Delete program
Status		Delete all stored program
		Copy program
	v	Exit

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).

<u> Appendix A – Available Hardware</u>

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

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	3950gcm ²	10A	5A	£ 371.43
SB-6630-37-4-0.66	6.6Nm	2660gcm ²	6.8A	3.4A	£ 291.84
SB-6630-24-4-0.4	3.2Nm	1390gcm ²	6.8A	3.4A	£ 212.24

SB Series stepping motors typically used for heavier glass bottle applications

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	425gcm ²	4.7A	£ 163.27
SB-6600-20-2-0.37	925mNm	248gcm ²	3.8A	£ 119.39
SB-6600-15-2-1.6	540mNm	131gcm ²	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

Туре	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) <u>Total Price £ 549.22 lot net</u>
- SB-6600-20-2-0.37 stepping motor (540mNm) APS-1-B-EO controller (4A) <u>Total Price £ 456.37 lot net</u>