

INDEX

1.	General Description	2
2.	Difference Between Stepper And Servo Motor	3
3.	Working Of Steeping Motor	4
4.	Layout of ET - SMC Module	4
5.	Setup for Experiment	5
6.	Description of Program	5
7.	Listing of Program for Different Models of Kits	
	8085 based Microprocessor kit with LED Display	5
	8085 based Microprocessor kit with LCD Display	6
	8086/8088 based Microprocessor kit with LED Display	7
	8086/8088 based Microprocessor kit with LCD Display	9
	8031/51 based Microcontroller kit with LED Display	10
	8031/51 based Microcontroller kit with LCD Display	12

STEPPER MOTOR CONTROLLER INTERFACE MODULE (ET-SMC)

The ET-SMC Module demonstrates to the students as to how stepper motors can be controlled through I/O Lines and how the stepper motor moves step by step. The students can study the forward/Backward Motion, ½ degree movement of the etc.

General Description:

D.C Stepping Motors: - Stay they are entering into all branches of engineering. There are many systems to monitor various processes and give out control signals in the form of digits but there is only one device to convert these digital pulses into precise incremental motion and that device is stepping motor. Stepping motor is a device, which converts digital pulses into precise angular or linear steps of desired value. The stepping motors in general have the following specifications:

1. Permanent magnet D.C stepping Motors, two phase bifiller wound, Step angle-1.8 degree +/- 5% Non- commutative. Steps / Revolution: 200.
2. Features:
 - Instantaneous response to control pulses.
 - Holds on to the position infinitely in static condition.
 - No burn- out due to locked rotar.
 - Speed can be varied over a wide margin form 0-10,000 step /- sec. Equivalent to 0-3,000 RPM.
 - High torque to inertia ratio. Can be overdriven without any damage.
 - Can be programmed in three parameters namely, **speed, direction and number of steps.**

DIFFERECCE BETWEEN STEPPER AND SERVO MOTOR:-

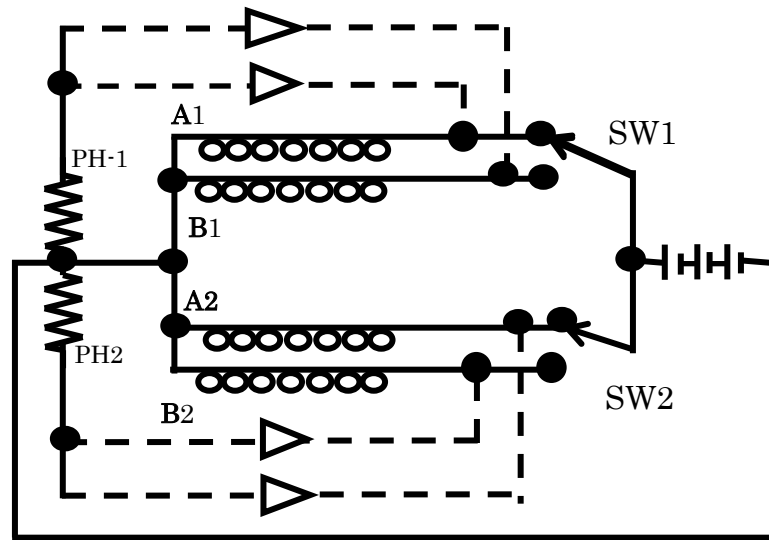
Stepper Motors differ from conventional Servo Motors in the following ways.

- 1) There is no control winding in stepping motors. Both windings are Identical.
- 2) The stepping rate (speed of rotation) is governed by frequency of switching and not by supply voltage.
- 3) A pulse input two phase clock (Instead of continuous pulses) will move the shaft of motor by one step for every pulse, thus number of steps to be moved can be precisely controlled.
- 4) When there is no pulses input, the rotor will remain locked up in the position in which last step was taken. At any time two windings are always energized which lock the rotor electromagnetically.

- 5) Stepping motors can be programmed in three parameters namely:
- A. Direction.
 - B. Speed and
 - C. Number of steps.

WORKING OF STEEPING MOTOR:-

The stepping action is caused by sequential switching of supply to the two phase of the motor as described in switching diagram. All stepping motors are of bifiller type with six leads. Each of the two phases of motor has double winding with a center tap.



Switching Diagram of DC Stepping Motor.

Switching the supply from one side to another of a phase causes reversal of magnetic polarity with out actually reversing the polarity of supply. Four step-input sequences gives 1.8 degree (Full) step function where as eight step input sequence gives 0.9 (half) step function.

SWITCHING SEQUENCE

STEP	SW-1	SW-2	PH-1		PH-2		PHASE-1		PHASE-2	
			A1	B1	A2	B2	A1	B1	A2	B2
1	1	2	0	1	0	1	0	1	0	1
2	1	4	1	0	0	1	0	0	0	1
3	3	4	1	0	1	0	1	0	0	1
4	3	2	0	1	1	0	1	0	0	0
5	1	2	0	1	0	1	1	0	1	0
							0	0	1	0
							0	1	1	0
							0	1	0	0
							0	1	0	1

That above switching Logic will move the shaft in one direction. To change the direction, read the sequence upward.

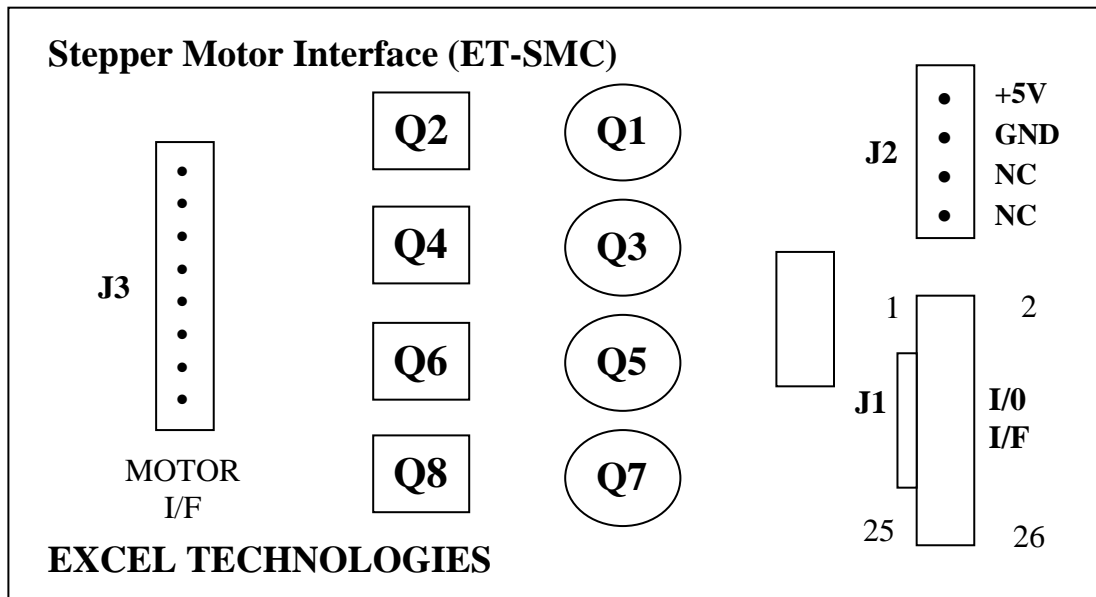
The specified torque of any stepping motor is the torque at stand still (holding torque). This torque is directly proportional to the current in the winding, which is governed by the DC resistance of winding. As the switching sequence starts, the inductive reactance of the winding which increases with the frequency of switching opposes the rise of current to desired level within the time given for one step depending upon the speed of level causes drop in torque as the speed increase. In order to improve torque at high speed, it is necessary to maintain current at the desired level. This can be done by one of the following methods:

- 1) By increasing supply voltage and introducing current limiting resistance in each phase. Introduction of resistance improves the time constant of winding. Seven to nine time the winding resistance in each phase will give very good improvement in torque / speed characteristics.
- 2) By using a constant current source with or without a chopper instead off using a constant voltage source which will give even better performance.

STARTING AND STOPPING UNDER LOAD:

There is a limit for every type of stepping motor as regards the speed at which it will start and stop without loosing step. The limit is due to load torque as well as load inertia. To overcome this, acceleration and deceleration techniques have to be employed. Acceleration means stepping rate on switching should be very low and should increase to desired level gradually depending on inertia to be encountered. Acceleration / deceleration may be as high as 1000 to 3000 step / sec.

Layout of ET-SMC Interfacing Module



SETUP FOR THE EXPERIMENT:

This explanation as well as the explanation of the Program under the heading “Description of the Program” is for 8085 LED Kit. However if you are interfacing the Stepper Motor Module to other Kits, then also refer to the specific instruction before the program listing for that particular Kit also

- 1) Connect the ET-SMC I/F module to the 8255- I port connector J1 of the kit using 26-pin flat FRC cable. The pin No.1 of the connector on the module as well as the kit are marked. Please ensure that the pin no.1 of the connector on the Kit is connected to pin no. 1 of the connector on the module.
- 2) Also connect the +5V to the Module power connector.
- 3) Enter the program given below from the memory location mentioned in the program.
- 4) Connect the Power of the Motor to +5V or as specified on the motor and Run the program and observe that the motor is running.

DESCRIPTION OF THE PROGRAM:

The program initializes the 8255 (PPI-1) in order to make port A as output port. The PA0 to PA3 is connected through buffer and driving circuit to the winding of the stepper motor. The codes for clockwise movement of stepper motor are FA, F6, F5 and F9 (refer switching sequence). These codes are to be outputted in the sequence they are written. In case of anti clockwise movement of the stepper motor output codes are as F9, F5, F6, and F4. The delay routine is called to generate the delay (max of the about 1 sec.) between the steps. This delay can be changed to make faster steps. The minimum delay depends upon the maximum speed of the stepper motor specified.

The speed of steps can be varied by changing the constant at 2031 & 32 and 2037 and 2038. These values are taken by register pair DE and a corresponding delay is generated. Both the delays are added up to give the final delay. The individual delay can be calculated by $(24 N + 17) \times$ basic Machine cycle. Here N is the number stored in D register pair.

NOTE: - Listing of program for various models of Microprocessor and Micro controller kits is given below. Please select the model of kit being used before entering the program into the kit.

1) PROGRAM FOR 8085 KITS HAVING LED DISPLAY:

Connect the J1 of the Kit to the Module through 26 Pin FRC Cable. Ensure that the pin-1 of the J1 at the Kit end is connected to the pin-1 of the

Module connector. Enter the program from address 2000. Execute the program from address 2000

ADDRESS	OP-CODE	LABEL	MNEMONICS	REMARKS
2000	3E 80		MVI A 80	Initialize All Ports As Output Port.
2002	D3 03		OUT 03	
2004	3E FA	START	MVI A FA	Out Put Code For Step 0.
2006	D3 00		OUT 00	
2008	CD 30 20		CALL 2030	Delay Between Two Steps.
200B	3E F6		MVI A F6	Out Put Code For Step 1.
200D	D3 00		OUT 00	
200F	CD 30 20		CALL 2030	Delay Between Two Steps.
2012	3E F5		MVI A F5	Out Put Code For Step 2
2014	D3 00		OUT 00	
2016	CD 30 20		CALL 2030	Delay Between Two Steps.
2019	3E F9		MVI A F9	Out Put Code For Steps 3
201B	D3 00		OUT 00	
201d	CD 30 20		CALL 2030	Delay Between Two Steps.
2020	C3 04 20		JMP 2004	

DELAY ROUTINE: - Now Enter from the Address 2030 onward

2030	11 00 00		LXI D - 00 00	Generate A Delay
2033	CD BC 03		CALL 03BC	
2036	11 00 00		LXI D - 00 00	Generate A Delay
2039	CD BC 03		CALL 03BC	
203C	C9		RET	Return

Note:-

- To change the Direction, reverse the switching sequence from FA, F6, F5, F9 to F9, F5, F6, FA.**
- To vary the speed change the data at location 2032 and 2038 (FROM 00 TO 0F OR 05).**

2) PROGRAM FOR 8085 KITS HAVING LCD DISPLAY:

Connect the J1 of the Kit to the Module through 26 Pin FRC Cable. Ensure that the pin-1 of the J1 at the Kit end is connected to the pin-1 of the Module connector. Enter the program from address 2000. Execute the program from address 2000.

ADDRESS	OP-CODE	LABEL	MNEMONICS	REMARKS
2000	3E 80		MVI A 80	Initialize All Ports OF 8255-1 As Output Port.
2002	D3 03		OUT 03	
2004	3E FA	START	MVI A FA	Out Put Code For Step 0.
2006	D3 00		OUT 00	
2008	CD 30 20		CALL 2030	Delay Between Two Steps.
200B	3E F6		MVI A F6	Out Put Code For Step 1.
200D	D3 00		OUT 00	
200F	CD 30 20		CALL 2030	Delay Between Two Steps.
2012	3E F5		MVI A F5	Out Put Code For Step 2
2014	D3 00		OUT 00	
2016	CD 30 20		CALL 2030	Delay Between Two Steps.

2019	3E F9		MVI A F9	Out Put Code For Steps 3
201B	D3 00		OUT 00	
201d	CD 30 20		CALL 2030	Delay Between Two Steps.
2020	C3 04 20		JMP 2004	Jump to START

DELAY ROUTINE: - NOW ENTER FROM THE ADDRESS 2030 ONWARD

2030	11 00 00		LXI D - 00 00	Generate A Delay
2033	CD A6 03		CALL 03BC	
2036	11 00 00		LXI D - 00 00	Generate A Delay
2039	CD A6 03		CALL 03BC	
203C	C9		RET	Return

Note:-

1. To change the Direction, reverse the switching sequence from FA, F6, F5, F9 to F9, F5, F6, FA.
2. To vary the speed change the data at location 2032 and 2038 (change 00 TO 0F OR 05).

3) PROGRAM FOR 8086 KITS HAVING LED DISPLAY:

FOR ET-8086:

Connect the J3 of the Kit to the Module through 26 Pin FRC Cable. Ensure that the pin-1 of the J3 at the Kit end is connected to the pin-1 of the Module connector. Enter the program from address 0000:0200.

FOR ET-8086AD:

Connect the J1 of the Kit to the Module through 26 Pin FRC Cable. Ensure that the pin-1 of the J1 at the Kit end is connected to the pin-1 of the Module connector. Enter the program from address 0000:0200.

The Program should be entered at location 0000:0200 ie 0000 as segment address and 0200 as offset address. Execute the program from 0000:0200

ADDRESS	OP-CODE	LABEL	MNEMONICS	REMARKS
0000:0200	BA FE FF		MOV DX, FFFE	Initialize All Ports OF 8255-1 as Output Ports.
203	B0 80		MOV AL, 80	
205	EE		OUT DX,AL	
206	BA F8 FF	START	MOV DX, FFF8	Send output code FA for first step.
209	B0 FA		MOV AL, FA	
20B	EE		OUT DX,AL	
20C	E8 21 00		CALL 0230	Delay between two steps.
20F	B0 F6		MOV AL, F6	Send output code F6 for second step.
211	EE		OUT DX,AL	
212	E8 1B 00		CALL 0230	Delay between two steps.
215	B0 F5		MOV AL, F5	Send output code F5 for third step.
217	EE		OUT DX,AL	
218	E8 15 00		CALL 0230	Delay between two steps.
21B	B0 F9		MOV AL, F9	Send output code F9 for fourth step.
21D	EE		OUT DX,AL	
21E	E8 0F 00		CALL 0230	Delay between two steps.
221	EB E3		JMP 0206	Jump to START

Delay Routine: - Now Enter from the Address 0230 onward

0000:0230	BB FF 0F	DELAY	MOV BX, 0FFF	Delay routine.
233	E8 07 00		CALL 023D	
236	BB FF 0F		MOV BX, 0FFF	
239	E8 01 00		CALL 023D	
23C	C3		RET	
23D	4B	DELAY1	DEC BX	
23E	75 FD		JNZ 023D	
240	C3		RET	

Note: -

1. To change the Direction, reverse the switching sequence from FA, F6, F5, F9 to F9, F5, F6, FA.
2. To vary the speed change the data at location 232 and 238 (Change 00 to 0F).

4) PROGRAM FOR 8086 KIT HAVING LCD DISPLAY (BASIC & ADVANCE KITS) :

FOR - ET-8086LCD

Connect the J2 of the Kit to the Module through 26 Pin FRC Cable. Ensure that the pin-1 of the J2 at the Kit end is connected to the pin-1 of the Module connector. Enter the program from address 1000:0100. Execute the Program from address 1000:0100

FOR - ET-8086 – AD-LCD

Connect the J1 of the Kit to the Module through 26 Pin FRC Cable. Ensure that the pin-1 of the J1 at the Kit end is connected to the pin-1 of the Module connector. Enter the program from address 1000:0100. Execute the Program from address 1000:0100

ADDRESS	OPCODE	LABEL	MNEMONICS	REMARKS
1000:0100	B0 80		MOV AL,80	Initialize All Ports of 8255-1 as Output Ports
0102	BA 07 88		MOV DX,8807	
0105	EE		OUT DX,AL	
0106	B0 FA	START	MOV AL, FA	Send FA to port 1 for Step1.
0108	BA 01 88		MOV DX,8801	
010B	EE		OUT DX,AL	
010C	E8 41 00		CALL 0150	Call Delay
010F	B0 F6		MOV AL, F6	Send F6 to port 1 for Step 2.
0111	EE		OUT DX,AL	
0112	E8 3B 00		CALL 0150	Call Delay
0115	B0 F5		MOV AL, F5	Send F5 to port 1 for Step 3.
0117	EE		OUT DX ,AL	
0118	E8 35 00		CALL 0150	Call Delay
011B	B0 F9		MOV AL, F9	Send F9 to port 1 for Step 4.
011D	EE		OUT DX, AL	
011E	E8 2F 00		CALL 0150	Call delay
0121	EB E3		JMP 0106	Jump to START

DELAY ROUTINE: Now Enter the Program from address 150 onwards

1000:0150	B9 01FF	DELAY	MOV CX, FF01	Delay routine
153	CD AA		INT AA	
155	C3		RET	Return

NOTE: - This program will continuously move the motor in one direction. To change the direction of the motor, one needs to feed the codes FA, F6, F5 and F9 in reverse order, i.e., F9, F5, F6 and then FA.

5) PROGRAM FOR 8031/51 KIT HAVING LED DISPLAY:

Connect the J4 of the Kit to the Module through 26 Pin FRC Cable. Ensure that the pin-1 of the J4 at the Kit end is connected to the pin-1 of the Module connector. Enter the program from address 2000.

ADDRESS	OP-CODE	LABEL	MNEMONICS	REMARKS
2000	75 81 65	START	MOV SP, # 65	Initialize stack
2003	90 FF 03		MOV DPTR,# FF03	Initialize 8255-1 all Port as Output Port
2006	74 80		MOV A, # 80	
2008	F0		MOVX @DPTR, A	
2009	90 20 80		MOV DPTR,#2080	
200C	E0		MOV A,@DPTR	Read mode
200D	F9		MOV R1, A	
200E	A3		INC DPTR	
200F	E0		MOVX A,@DPTR	Read no. of steps
2010	FA		MOV R2, A	
2011	A3		INC DPTR	
2012	E0		MOVX A,@DPTR	Read speed
2013	FB		MOV R3,A	
2014	A3		INC DPTR	
2015	E0		MOVX A,@DPTR	Read direction
2016	90 FF 00		MOV DPTR,# FF00	
2019	54 FF		ANL A, # FF	
201B	70 26		JNZ 26	Check for CLKWISE
201D	EA	CLK	MOV A, R2	
201E	FD		MOV R5, A	
201F	7C 05	CLK-2	MOV R4, # 05	Rotate 20 steps in CLKWISE
2021	74 FA	CLK-1	MOV A, # FA	
2023	11 69		ACALL 2069	
2025	74 F6		MOV A, # F6	
2027	11 69		ACALL 2069	
2029	74 F5		MOV A, # F5	
202B	11 69		ACALL 2069	
202D	74 F9		MOV A, # F9	
202F	11 69		ACALL 2069	
2031	DC EE		DJNZ R4, EE	
2033	DD EA		DJNZ R5, EA	
2035	E9		MOVA, R1	

2036	64 00		XRL A, # 00	Check for single mode
2038	70 02		JNZ 02	
203A	80 FE		SJMP FE	
203C	E9	CLK-FULL	MOVA, R1	Check for continuous mode
203D	64 01		XRL A, # 01	
203F	70 02		JNZ 02	Check for oscillatory mode
2041	80 DA		SJMP DA	
2043	EA	ANTICLK	MOVA, R2	ROTATE ANTI CLK
2044	FD		MOV R5, A	
2045	7C 05	ANTICLK-2	MOV R4,# 05	ROTATE 20 STEPS ANTICLKWISE
2047	74 F9	ANTICLK-1	MOVA,# F9	
2049	11 69		ACALL 2069	
204B	74 F5		MOVA, # F5	
204D	11 69		ACALL 2069	
204F	74 F6		MOVA, # F2	
2051	11 69		ACALL 2069	
2053	74 FA		MOVA, # FA	
2055	11 69		ACALL 2069	
2057	DC EE		DJNZ R4, EE	
2059	DD EA		DJNZ R5, EA	
205B	E9		MOV A, R1	Check for single mode
205C	64 00		XRL A, # 00	
205E	70 02		JNZ 02	
2060	80 FE		SJMP FE	Check for continuous mode
2062	E9	ANTICLK-FULL	MOVA, R1	
2063	64 01		XRL A, # 01	Check for oscillatory mode
2065	70 B6		JNZ B6	
2067	80 DA		SJMP DA	
2069	F0	OUT	MOVX @DPTR, A	Out data at port A
206A	EB		MOV A, R3	
206B	FE		MOV R2, A	
206C	7F FF	LOOP	MOV R7, # FF	Create delay
206E	DF FE		DJNZ R7, FE	
2070	DE FA		DJNZ R2, FA	
2072	22		RET	Return

For controlling the mode, speed, direction and no. of steps, enter the desired codes at Address 2080 onward as per table given below and execute the program from address location 2000

LOCATION	CODE	FUNCTION
2080	00	SINGLE MODE
	01	CONTINUOUS MODE

	11	OSCILATORY MODE
2081	00-FF	NO. OF STEPS (DATA GIVEN WILL BE MULTIPLIED BY 20 FOR CALCULATING THE NO. OF STEPS)
2082	0-F	SPEED COUNT
2083	00 01	CLOCKWISE ROTATION ANTICLOCKWISE ROTATION

6) PROGRAM FOR 8031/51 KIT HAVING LCD DISPLAY:

Connect the J1 of the Kit to the Module through 26 Pin FRC Cable. Ensure that the pin-1 of the J1 at the Kit end is connected to the pin-1 of the Module connector. Enter the program from address 6000. Execute the Program from address 6000

ADDRESS	OP-CODE	LABEL	MNEMONICS	REMARKS
6000	75 81 65	START	MOV 81,# 65	Initialize stack
6003	90 28 0B		MOV DPTR,# 280B	Initialize 8255 – I;All Ports as Output port.
6006	74 80		MOVA,# 80	
6008	F0		MOVX @DPTR,A	
6009	90 60 80		MOV DPTR,# 6080	
600C	E0		MOVX A,@DPTR	Read mode
600D	F9		MOV R1,A	
600E	A3		INC DPTR	
600F	E0		MOVX A,@DPTR	Read no. of steps
6010	FA		MOV R2, A	
6011	A3		INC DPTR	
6012	E0		MOVX A,@DPTR	Read speed
6013	FB		MOV R3, A	
6014	A3		INC DPTR	
6015	E0		MOVX A,@DPTR	Read direction
6016	90 28 08		MOV DPTR,# 2808	
6019	54 FF		ANL A,# FF	
601B	70 26		JNZ 26	Check for CLKWISE
601D	EA	CLK	MOVA,R2	
601E	FD		MOV R5, A	
601F	7C 05	CLK-2	MOV R4,# 05	Rotate 20 steps in CLKWISE
6021	74 FA	CLK-1	MOVA,# FA	
6023	11 69		ACALL 6069	
6025	74 F6		MOVA,# F6	
6027	11 69		ACALL 6069	
6029	74 F5		MOVA# F5	
602B	11 69		ACALL 6069	

602D	74 F9		MOVA, F9	
602F	11 69		ACALL 6069	
6031	DC EE		DJNZ R4,EE	
6033	DD EA		DJNZ R5,EA	
6035	E9		MOVA,R1	
6036	64 00		XRLA,# 00	
6038	70 02		JNZ 02	Check for single mode
603A	80 FE		SJMP FE	
603C	E9	CLK-FULL	MOVA,R1	Check for continuous mode
603D	64 01		XRLA,# 01	
603F	70 02		JNZ 02	Check for oscillatory mode
6041	80 DA		SJMP DA	
6043	EA	ANTICLK	MOVA,R2	Rotate ANTICLKWISE
6044	FD		MOV R5,A	
6045	7C 05	ANTICLK-2	MOV R4,# 05	Rotate 20 steps in ANTICLKWISE
6047	74 F9	ANTICLK-1	MOVA,# F9	
6049	11 69		ACALL 6069	
604B	74 F5		MOVA,# F5	
604D	11 69		ACALL 6069	
604F	74 F6		MOVA,# F6	
6051	11 69		ACALL 6069	
6053	74 FA		MOVA,# FA	
6055	11 69		ACALL 6069	
6057	DC EE		DJNZ R4,EE	
6059	DD EA		DJNZ R5,EA	
605B	E9		MOVA,R1	
605C	64 00		XRLA,# 00	
605E	70 02		JNZ 02	Check for single mode
6060	80 FE		SJMP FE	
6062	E9	ANTICLK-FULL	MOVA,R1	Check for continuous mode
6063	64 01		XRLA,# 01	
6065	70 B6		JNZ B6	Check for oscillatory mode
6067	80 DA		SJMP DA	
6069	F0	OUT	MOVX @DPTR,A	Out data at port A
606A	EB		MOVA,R3	
606B	FE		MOV R6,A	
606C	7F FF	LOOP	MOV R7,# FF	Create delay
606E	DF FE		DJNZ R7,FE	
6070	DE FA		DJNZ R6,FA	
6072	22		RET	Return

For controlling the mode, speed, direction and number of steps, enter the desired codes at Address 6080 onward as per table given below and execute the program from address location 6000

LOCATION	CODE	FUNCTION
6080	00 01 11	SINGLE MODE CONTINUOUS MODE OSCILATORY MODE
6081	00-FF	NO. OF STEPS (DATA GIVEN WILL BE MULTIPLIED BY 20 FOR CALCULATING THE NO. OF STEPS)
6082	0-F	SPEED COUNT
6083	00 01	CLOCKWISE ROTATION ANTICLOCKWISE ROTATION

*****END*****