USER MANUAL

PC40

4 Channel Digital to Synchro or

Digital to Resolver

Converter Card

LOW COST BOARDS FOR IBM PC, XT, AT, PS/2 AND COMPATIBLE COMPUTER SYSTEMS

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FEATURES:

- LOW COST

- SYNCHRO OR RESOLVER OPTIONS AVAILABLE

- 12 OR 14 BIT RESOLUTION OPTION

- ACCURACY OF: 4 ARC MINUTE FOR 14 BIT
  6 ARC MINUTE FOR 12 BIT

- INPUT DATA RATE OF: 4000 DEGS PER SEC MAX FOR 14 BIT
  8000 DEGS PER SEC MAX FOR 12 BIT

- 1 TO 4 CHANNELS

- EXCITATION FREQUENCIES OF 60 Hz OR 400 Hz

- DRIVES UP TO 5 VA LOADS

- TRANSFORMER ISOLATED OUTPUTS

- "LOCKED ROTOR" PROTECTION

- SHORT CIRCUIT AND OVERLOAD PROTECTION

- SOFTWARE SUPPLIED FOR DRIVING 1 AND 2-SPEED SYSTEMS

- POWER SUPPLY PROTECTION CIRCUITRY

- SOFTWARE CONTROLLABLE PSU

TABLE OF CONTENTS:

PREFACE:

This manual is written for users of the PC40 series I/O cards. It provides all the necessary information required to successfully operate and program the PC40 series.

This manual assumes:

a) That you have a detailed knowledge of synchro and resolver operation.

b) That you are familiar with the PC environment.

c) That you are capable of writing your own programs or modifying the demonstration software for your own use.

1.0 INTRODUCTION.

The PC40 is a versatile, full size IBM PC card designed for 1 to 4 channels of Digital to Synchro or Digital to Resolver conversion.

Options with output voltages of $90V_{L-L}$ or $11.8V_{L-L}$ are available. Frequency options available are 60Hz or 400Hz. High power outputs of up to 5VA are provided. The outputs are transformer isolated and provide maximum protection to the computer.

The card is double buffered and the 12 or 14 bit angle information is provided in two 8-bit bytes from the computer. The I/O addressing space is switch selectable with a DIP switch. The modules are protected by a power supply protection circuit, whose status can be read. The power supply can be switched on and off under computer control.

1.1 Software.

Complete Pascal and C software drivers and demonstration programs are provided. In addition to the normal single- speed software, two-speed driver software is provided to allow two-speed systems to be set up. In the future, Fortran and Basic software will be provided.

1.2 Applications.

The multi-channel PC40 is designed for use in high performance control and simulation systems. With the high power output, the PC40 is an excellent choice for applications including motor control, antenna positioning, machine tooling, robot axis control and process control.

1.3 Ordering Information.

Numerous models are provided:

PC40-XY-P

where X is: S for 12 bits
T for 14 bits
Y is: A, B, C, D, E, F, or G.
P is: M for 5 VA
N for 4.5 VA
O for 1.5 VA

MODEL	REF VOLTAGE	L-L VOLTAGE	FREQUENCY	TYPE
A	115V	90V	400Hz	SYNCH
B	26V	11.8V	400Hz	SYNCH
C	115V	90V	400Hz	RSVR
D	26V	11.8V	400Hz	RSVR
E*	115V	90V	60Hz	SYNC

The following models do not require ± 15V power supplies, since the power is drawn from the reference:

MODEL	REF VOLTAGE	L-L VOLTAGE	FREQUENCY	TYPE
F*	115V	90V	60Hz	SYNCH
G ***	115V	90V	400Hz	SYNCH

* = This 60Hz version requires external transformers.

** = Only available in 4.5VA, 14 bit.

*** = Only available in 1.5VA, 14 bit.

eg.: PC40-SC-M is a 12 bit 90V, 400Hz, 5VA resolver output converter.

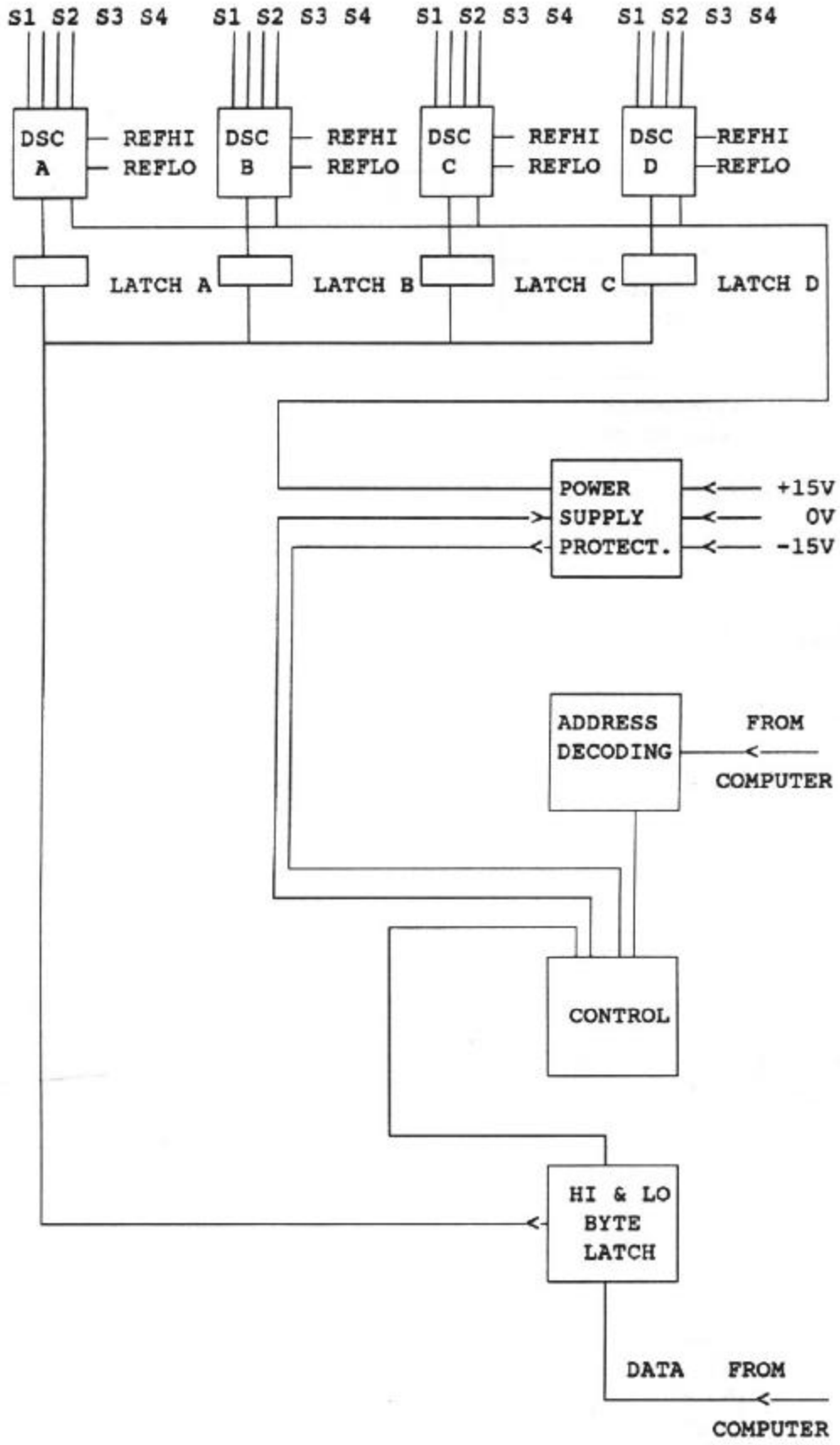
2.0 HARDWARE.

2.1 Architecture:

The PC40 is a full size IBM PC card which can accept up to four channels of digital to synchro or resolver conversion channels. The maximum resolution is 14 bits, however, the resolution can be much improved if a two-speed system is set up with two single-speed systems and the appropriate software drivers.

The digital angle information is converted to synchro or resolver format when a channel is strobed. The data for each channel is arranged in two 8-bit bytes. Once the high byte and low bytes have been latched in, the channel strobe must be activated to load the data into the channel latch.

A power supply (PSU) protection circuit has been incorporated, which provides overvoltage protection and reverse power supply protection from the external PSU. The power supply status can be read in, and in addition, the user has full control over the enabling of the power supply. If the PSU protection circuitry is activated, then the PC40 will not allowed to be activated under software control.


S1 S2 S3 S4
S1 S2 S3 S4
S1 S2 S3 S4
S1 S2 S3 S4
DSC A
REFHI
REFLO
DSC B
REFHI
REFLO
DSC C
REFHI
REFLO
DSC D
REFHI
REFLO
LATCH A
LATCH B
LATCH C
LATCH D
POWER SUPPLY PROTECT.
+15V
0V
-15V
ADDRESS DECODING
FROM COMPUTER
CONTROL
HI & LO BYTE LATCH
DATA FROM COMPUTER

PC 40 HARDWARE REQUIREMENTS	
COMPUTER HARDWARE REQUIREMENTS: IBM PC / XT / AT or compatible with 512K RAM	
PARAMETER	VALUE
POWER SUPPLY: 5V from computer	0.3A with 4 chan.
TEMPERATURE RANGE Operating Temp Storage	 0 to 70° C -55 to 125°C
PHYSICAL ATTRIBUTES Fullsize IBM PC card	13.1 x 4.1 x 0.9 in. 33.4 x 10.5 x 2.2cm

2.2 Addressing Requirements.

ADDRESS RANGE IN HEX	STANDARD DEVICE USAGE
000-1FF	Internal System Board
200-20F	Games Port
210-217	Expansion Port
220-24F	Reserved
250-257 *	Not Assigned
258-25F	INTEL "Above Board"
260-277 *	Not Assigned
278-26F	Reserved
280-2EF *	Not Assigned
2F0-2F7	LPT2 (Printer Port)
2F8-2FF	COM2 (Serial Port)
300-31F *	Prototype Board
320-32F	Hard Disk Drives
330-377 *	Not Assigned
378-37F	LPT1 (Printer Port)
380-38F	SDLC Communications
390-39F *	Not Assigned
3A0-3AF	Binary Communications
3B0-3BF	Mono Display Adaptor
3C0-3CF	Reserved
3D0-3DF	Colour Graphics Adaptor
3E0-3E7	Reserved
3E8-3EF *	Not Assigned
3F0-3F7	Floppy Disk Drives
3F8-3FF	COM1 (Serial Port)
400-FFF *	Not Used (Available)

ADDRESSES FOR STANDARD I/O DEVICES

Example:

SW3, 4, 5 & 7 are ON.
The HEX Address is therefore calculated as follows:

+ 200
+ 100
+ 80
+ 20
=3A0

← **After studying the top table, you will notice that this CONFLICTS with the standard "Binary Communications" device, and should therefore NOT be used! In all probability, this card would not function correctly!**

Select any of the "Not Assigned", "Not Used" or the "Prototype Board" Address Ranges ONLY!

SW1	SW2	SW3	SW4	SW5	SW6	SW7	SW8	SWITCH
OFF	OFF	ON	ON	ON	OFF	ON	OFF	ON/OFF
128(x16)	64(x16)	32(x16)	16(x16)	8(x16)	4(x16)	2(x16)	1(x16)	DEC
800	400	200	100	80	40	20	10	HEX

DIP SWITCH SETTINGS FOR SELECTNG PC-40/41/58/59 CARD ADDRESSES

2.3 Interconnections.

2.3.1 Output Connector.

The output connector on the PC40 card is a DB37 **male** connector. The connections are shown below:

1	-15V	20	
2	-15V	21	
3	0V	22	
4	0V	23	
5	+15V	24	
6	+15V	25	
7		26	DS4
8	CS4	27	DS3
9	CS3	28	DS2
10	CS2	29	DS1
11	CS1	30	DREFLO
12	CREFLO	31	DREFHI
13	CREFHI	32	BS4
14	AS4	33	BS3
15	AS3	34	BS2
16	AS2	35	BS1
17	AS1	36	BREFLO
18	AREFLO	37	BREFHI
19	AREFHI		

2.3.2 Pin Definitions.

Note that the prefix A, B, C or D refers to the channel numbers 1, 2, 3, or 4 respectively.

a) +15V, -15V, and 0V are provided from an external power supply. The requirements are as follows:

PC40 models F and G **do not** require external ± 15V power supplies since the power is drawn from the reference.

1.5 VA PC40 models require:

150mA average per channel
450mA peak per channel without current limiting.

5 VA PC40 models require:

700mA average per channel
2A peak per channel without current limiting.

Note: The loads can be tuned so that more devices can be driven. See appendix B for details.

All the PC40 models except the F and the G models must have a power supply accuracy of ± 15V + 8%. If the voltage exceeds 16.2 V ± 0.2 V then the power supply protection circuitry will be activated.

b) REFHI and REFLO are the reference input to the digital to synchro / resolver converter. The reference voltage and frequency must be accurate to within ±10% of voltage and frequency.

NOTE: If required, a solid state reference oscillator can be used. The ordering code is PC42.

c) S1, S2, S3, and S4 are the outputs from the converter. These pins are connected to the torque receiver or control transformer. For a resolver type, S1 and S2 are connected to the first stator coil, whilst S3 and S4 are connected to the second stator coil. For a synchro type, S1, S2, and S3 are connected to S1, S2, and S3 of the synchro motor. Note that these outputs are transformer isolated.

2.4 Timing Requirements.

A delay of 100us for settling time is required for a stepped input.

The PC40 uses high-speed components, thereby allowing it to be addressed with zero wait states.

3.0 SOFTWARE.

3.1 Programming the PC40.

3.1.1 Address Allocation:

The PC40 uses 8 consecutive address locations in the I/O space:

ADDRESS ALLOCATION TABLE	
ADDRESS OFFSET FROM BASE	FUNCTION
OFFSET = 0	STROBE CHANNEL 1
OFFSET = 1	STROBE CHANNEL 2
OFFSET = 2	STROBE CHANNEL 3
OFFSET = 3	STROBE CHANNEL 4
OFFSET = 4	LOW BYTE LATCH
OFFSET = 5	HIGH BYTE LATCH
OFFSET = 6	PSU RELAY ON
OFFSET = 7	PSU RELAY OFF
OFFSET = 8	PSU STATUS

3.1.2 Register Functions.

OFFSET 0 TO 3 – CHANNEL STROBE – WRITE ONLY
STROBES THE DATA INTO THE SECOND BUFFER. WRITE A ‘0’ TO THE RELEVANT OFFSET LOCATION.

OFFSET 4 – LOW BYTE LATCH – WRITE ONLY
WRITES LOW BYTE INTO FIRST BUFFER

OFFSET 5 – HIGH BYTE LATCH – WRITE ONLY
WRITES HIGH BYTE INTO FIRST BUFFER

Note that the data is **left justified** and hence the upper 8 bits are stored in the HIGH BYTE LATCH, whilst the lower 6 bits are stored in the LOW BYTE LATCH. See bit weights in the latter bit weight table.

OFFSET 6 – PSU RELAY ON – WRITE ONLY
STROBES THE PSU RELAY ON. WRITE A "0" TO THE RELEVANT OFFSET LOCATION

OFFSET 7 – PSU RELAY OFF – WRITE ONLY
STROBES THE PSU RELAY OFF. WRITE A "0" TO THE RELEVANT OFFSET LOCATION.

OFFSET 8 – PSU STATUS – READ ONLY								
BIT:	D7	D6	D5	D4	D3	D2	D1	D0
	X	X	X	X	X	X	X	X
D0 CLEAR = ERROR D0 SET = OK								

3.1.3 Data format.

BIT WEIGHTS			
BIT		SHAFT ANGLE	
MSB	D14	180.0000	high byte
	D13	90.0000	
	D12	45.0000	
	D11	22.5000	
	D10	11.2500	
	D9	5.6250	
	D8	2.8125	
	D7	1.4063	
	D6	0.7031	low byte
	D5	0.3516	
	D4	0.1758	
	D3	0.0879	
	D2	0.0439	
LSB	D1	0.0220	

NOTE: FOR 12 BIT UNITS D1 AND D2 ARE NOT USED.

eg. An angle of 224 degrees would be 10100000000000 binary or 2800 Hex.

3.2 Software Drivers and Demonstration Software.

3.2.1 Operation.

The following algorithm is provided.

STEP 1: GET PSU STATUS.

STEP 2: IF NO PSU ERROR THEN SWITCH RELAY ON AND CONTINUE, ELSE SWITCH RELAY OFF AND EXIT.

STEP 3: WRITE HIGH BYTE TO HIGH BYTE LATCH (OFFSET 5).

STEP 4: WRITE LOW BYTE TO HIGH BYTE LATCH (OFFSET 4).

STEP 5: STROBE THE RELEVANT CHANNEL STROBE.

STEP 6: DELAY 100us FOR SETTLING TIME.

The following formula can be used to convert the shaft angle to two digital bytes:

$$\text{HIGH BYTE} = \left\lfloor \frac{\text{ANGLE}}{360} * 65536 \right\rfloor \text{ DIV } 256$$

$$\text{LOW BYTE} = \left\lceil \frac{\text{ANGLE}}{360} * 65536 \right\rceil \text{ MOD } 256$$

[shaft angle in degrees]

NOTE: The high byte and low byte can be written to in any order.

Full software drivers for single and dual speed systems are provided. They are written in C and Pascal. Fortran and Basic drivers will be available shortly. Also included, is full demonstration software, which can be used in real applications.

3.2.2 Software Drivers.

A number of driver routines are provided in the PC40.X file in turbo Pascal and Borland C++ on the accompanying disc. They can be set up as units, include files, or simply inserted in a single program file if desired. They are:

write_angle : load a channel with an angle.

write_2speed_angle : load 2 channels with an angle and a speed ratio for a two speed system.

PSU_error : get PSU status.

PSU_on : switch PSU on.

PSU_off : switch PSU off.

set_base : set card base address.

For C the function prototypes are:

```
void set_base(unsigned int base_add);

     input parameters:    base_add


void write_angle(int chan_num, float angle);

     input parameters:    chan_num  [channel number]
                          angle     [in degrees]
```

```
void write_2speed_angle(int ratio, int chan_num1,
                        int chan_num2, float angle);
```

input parameters: ratio [gearing ratio]
chan_num1 [fine channel]
chan_num2 [coarse channel]
angle [in degrees]

```
int  PSU_error();
```

parameters: none

This function returns true if there is an overvoltage condition at the PSU.

```
void PSU_on();
```

parameters: none

```
void PSU_off();
```

parameters: none

When using the drivers, the include file PC40.h must be incorporated in the source file. Please remember to create project files for Borland C++ or make files for Microsoft C, QuichC, etc. "exe" files also provided.

For Pascal the function prototypes are:

```
procedure set_base(base_add : word);
```

input parameters: base_add

```
procedure write_angle(chan_num : integer; angle : real);
```

input parameters: chan_num [channel number]
angle [in degrees]

```
procedure write_2speed_angle(ratio : integer; chan_num1,
                                chan_num2 : integer;
                            angle : real);
```

input parameters: ratio [gearing ratio]
chan_num1 [fine channel]
chan_num2 [coarse channel]
angle [in degrees]

```
function  PSU_error : boolean;
```

parameters: none

```
procedure PSU_on;
```

parameters: none

```
procedure PSU_off;
```

parameters: none

When using the drivers, the unit PC40.TPU must be incorporated in the source file.

Note:The channel parameters are **0 to 3** for channels **1 to 4**.

3.2.3 Sample Programs.

Sample programs are provided in Turbo Pascal and Borland C++. These versions of C and Pascal can be easily modified to other versions of C and Pascal by merely modifying the **clrscr** and **delay** functions to the equivalents. The 'exe' files are also provided.

The following programs are for single-speed systems:

PC40eg1.c and PC40eg1.pas
PC40eg2.c and PC40eg2.pas

The following programs are for two-speed systems:

PC40eg3.c and PC40eg3.pas
PC40eg4.c and PC40eg4.pas

Program Descriptions:

PC40eg1.X prompts the user for a channel number and an angle, and loads the received data into the system.

PC40eg2.X prompts the user for a channel number and then steps through from 0 degrees to 360 degrees in steps of 20 degrees. The delay between steps is 1 second.

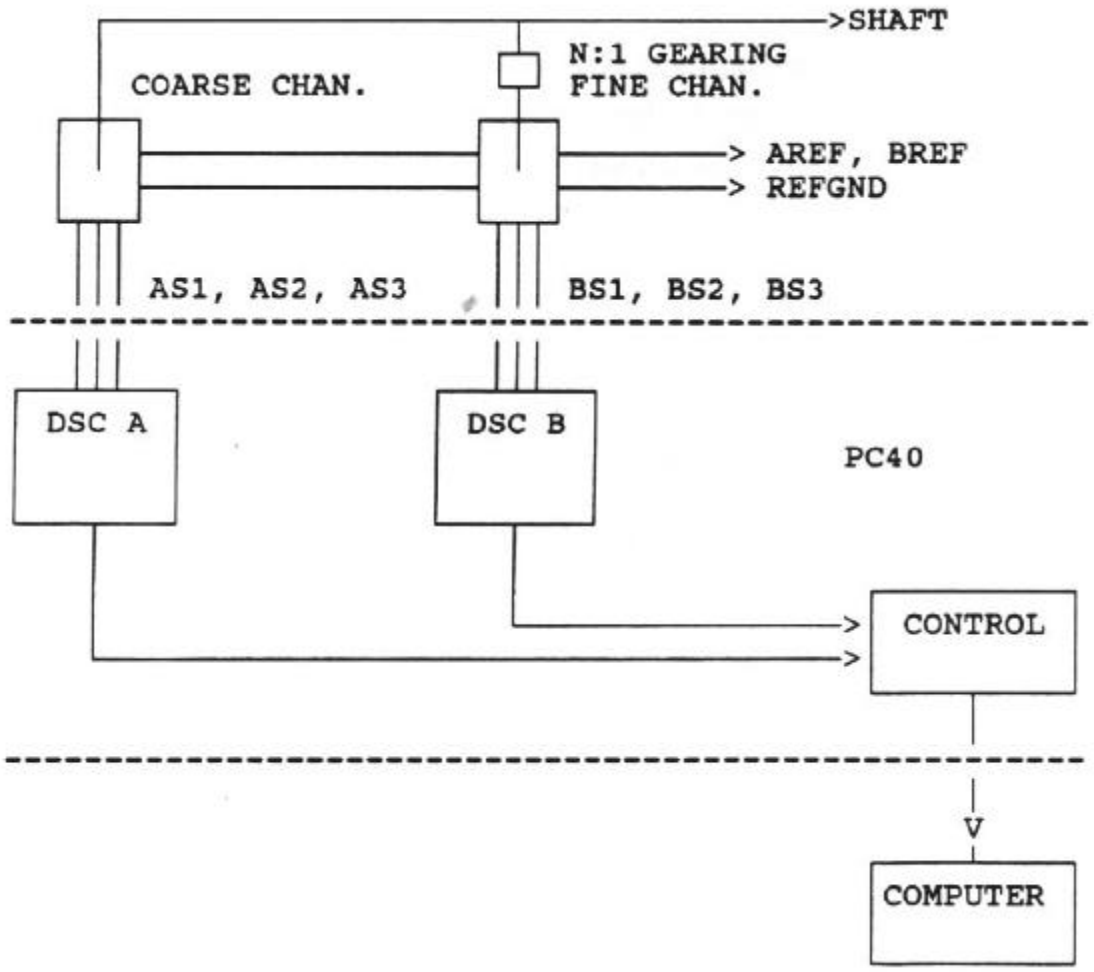
PC40eg3.X prompts the user for two channel numbers, the speed ratio and an angle and loads the received data into the system.

PC40eg4.X prompts the user for two channel numbers, the speed ratio and then steps through from 0 degrees to 360 degrees in steps of 20 degrees. The delay between steps is 1 second.

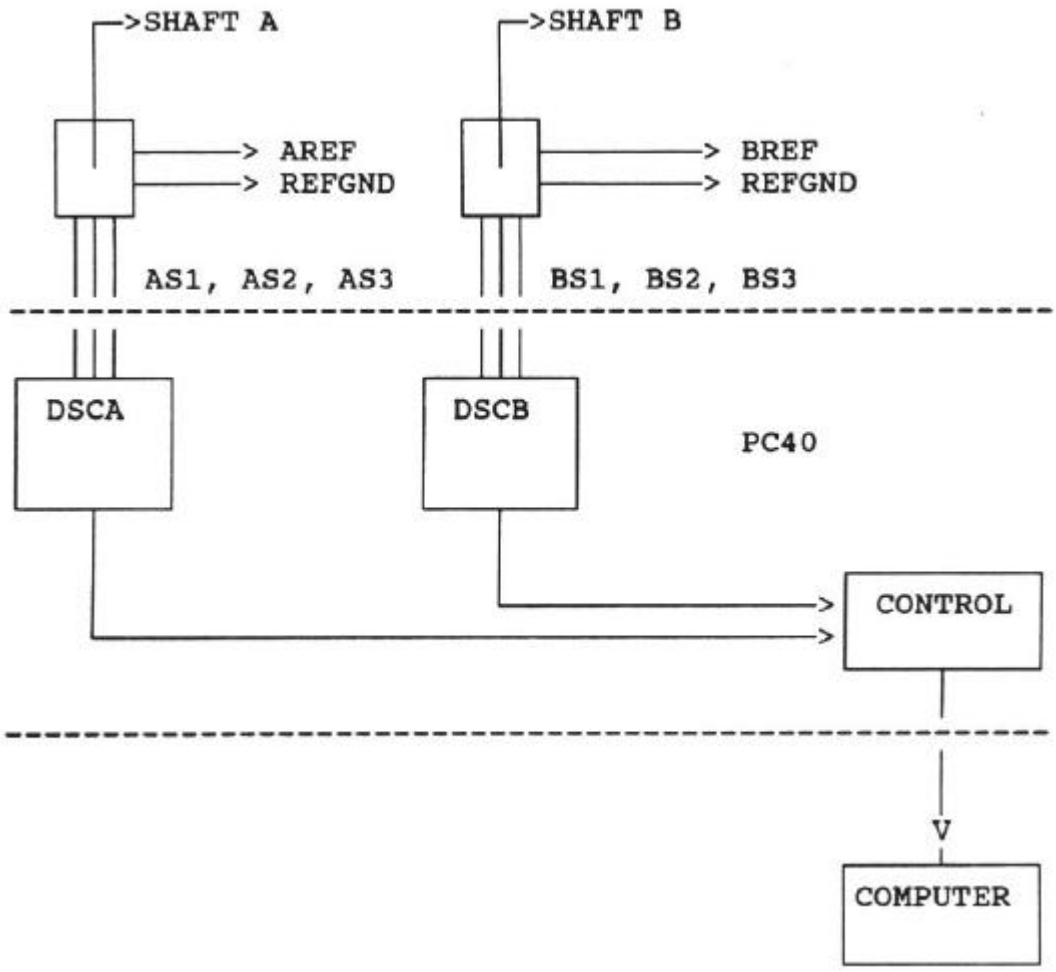
Note that the channel numbers in the software are **0 to 3** for channels **1 to 4**.

4.0 SINGLE AND DUAL SPEED SYSTEM SETUP.

Dual speed system:



2-Channel Single Speed System



BIBLIOGRAPHY:

1) SYNCHRO CONVERSION : ILC DATA DEVICE CORPORATION, 1990.

2) SYNCHRO AND RESOLVER CONVERSION : ANALOG DEVICES, 1980.

APPENDIX A

SPECIFICATIONS

APPENDIX B

LOAD TUNING

APPENDIX C

APPLICATIONS

(From Synchro & Resolver Conversion - Analog Devices)