CHAPTER – V

CONCLUSION

5.1 Review

As shown in the previous Chapters through analytical, design and experimental studies, the PC-based DAS is a very useful building block in radio interferometry. This has enabled the development of a PC-based radio interferometer with the following important characteristics:

a) Standardisation in data structure

b) Flexibility of data manipulation on-line

c) Easy transportability of unprocessed data between different observatories

d) Facility for real-time interference rejection

e) Convenient initial data processing off-line

f) Low cost in system implementation.

Thus the use of PCs in radio interferometers has proved to be an elegant and attractive approach to bring in considerable standardisation, convenience and flexibility at low cost and high reliability. This has been described in the thesis in detail. The main contributions of the thesis are:

a) A detailed analytical study of a DAS

b) Design and development of a PC-based DAS

c) Experimental verification of the DAS by simulation

d) Overall system integration to realise a PC-based radio interferometer

e) Conducting initial astronomical observations.

These studies and investigations have indicated that a PC-based system is attractive in several respects for a small radio interferometer. The preliminary tests conducted so far on astronomical observations, show that this interferometer can give useful *data/results* in an *economical* and elegant manner. Considering the present trends in *PCs, i.e.* availability of more and more computing power at higher and higher speeds at steadily decreasing costs, it is likely that this approach will become more popular and an accepted standard practice in future instrumentation for radio astronomical applications of similar scale.

5.2 Scope for Future Work

Apart from the function of on-line data acquisition and storage, off-line analysis of this data, the PC-based DAS may be extended for use in the following applications:

a) On-line data analysis

b) General purpose DAS

These features are expected to enhance the operation of future radio interferometers.

5.2.1 <u>On-line data analysis</u> : The DAS in its present form can be put to greater use especially in the field of analysis of data. This is so because the host machine is basically a PC with *all* its inherent flexibility and expandability unlike in the conventional approaches, where a dedicated *hardwired* system is usually employed for this purpose. The extra computing power required for the On-line analysis appears to be possible while using a PC-AT and other superior *PCs* as an alternative to the PC-XT used here, without any changes in the DAS add-on card.

5.2.2 General purpose DAS : The data acquisition add-on card has the following specifications:

a) Sampling frequency: 30 samples per second (*max* in the single channel mode)

b) Input *signal* range: 1 mV - 1 V

c) Dynamic range of ADC: 1:4000.

These specifications are adequate for a DAS in most of the radio interferometry applications. Hence, this *PC*-based DAS is quite a general purpose data acquiring and storage system. **As** the data acquired is stored in the hard disk of the same PC itself, this system can be easily adapted for a wide variety of applications by merely changing the operating software. As the analysis *software* is *usually* application specific, it can be developed with ease on the same user friendly host PC. In interferometers, as the baselines become longer and longer, the number of interference fringes per second increase. This would call for higher sampling rates. This system can be made capable of handling higher sampling rates by employing superior *ADCs*, such as, the successive approximation type. Such a system will become a standard *PC*-based unit not only for radio astronomy but also as a general purpose DAS for any other application. In order to store the continuous stream of incoming data, it may become necessary to employ *on*-board memory in this add-on card itself, as the data rates of this digital data would be *very* much higher than in the *current* system. In such cases it would also be necessary to configure this on-board memory as a dual bank switched type to prevent loss of data while transferring it to a *secondary* storage device such **as** the Winchester disk or the MTU, which are relatively slow in operation.

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APPENDIX – A

SENSITIVITY CALCULATIONS

1

$$\Delta T_{min}\dagger = 2 \ \frac{T_{sys}}{\sqrt{B\tau}}$$

Where,

T_{sys} = System temperature (including sky)†

B = Receiver bandwidth

τ = Integration time

† For phase-switching interferometer [Kraus '66].

In this particular application, as $T_{sys} = 1150^o K$, $B = 1$ MHz, and $\tau = 1$ s, the value for ΔT_{min} works out to be 2.3^o K.

2

$$\Delta S_{min} = \frac{k \ \Delta T}{A_e}$$

Where,

k = Boltzmann's constant (= 1.38 x 10^{-23} joule/^{o}K)

$A_e = \sqrt{A_E \times A_W}$

A_E = Collecting area of the eastern arm

A_W = Collecting area of the western arm

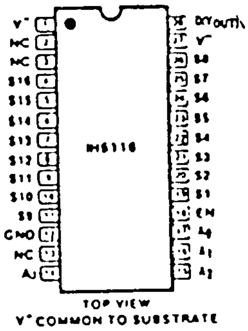
As $A_E = A_W = 64\ m^2$, and using the result of the previous calculation the minimum detectable flux works out to be 49.59 x 10^{-26} $watts/m^2/Hz$. The comfortable detection level is usually taken five times this value, which is around **250** x 10^{-26} $watts/m^2/Hz$ for this system.

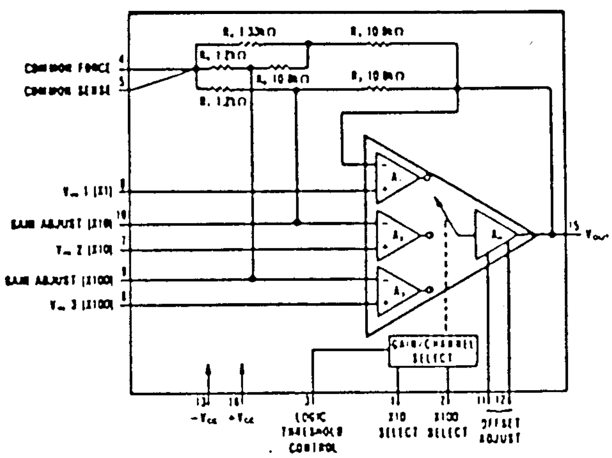
† $T_{sky} = 55\ \lambda^{2.5}$ [Haliday, '76.]

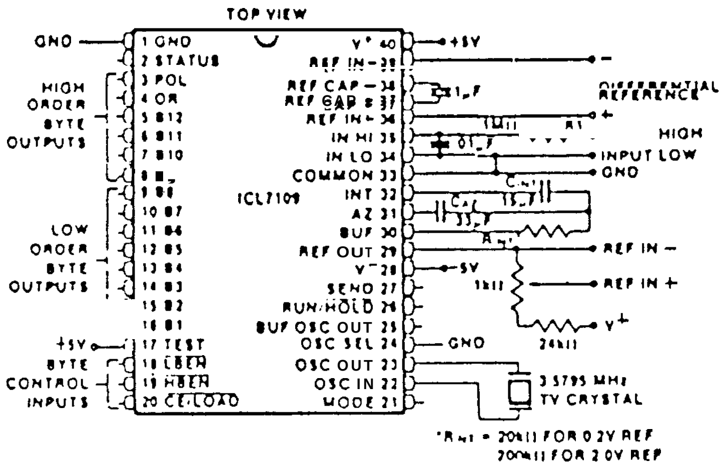
As λ is 2 m in this case, T_{sky} works out to be 310° K.

APPENDIX – B

PIN-OUT DETAILS



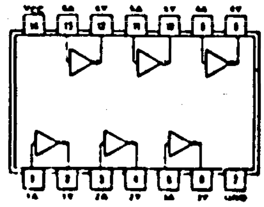


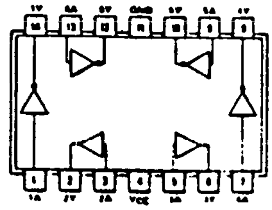


HEX INVERTERS

04

positive logic:
$Y = \bar{A}$

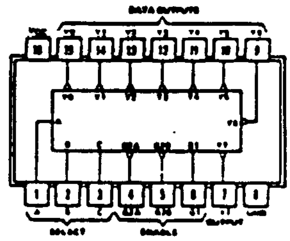




SN5404 (J) SN7404 (J, N) SN5404 (W)
SN54H04 (J) SN74H04 (J, N) SN54H04 (W)
SN54L04 (J) SN74L04 (J, N) SN54L04 (T)
SN54LS04 (J, W) SN74LS04 (J, N)
SN54S04 (J, W) SN74S04 (J, N)

3- TO 8-LINE **DECODERS/DEMULTIPLEXERS**

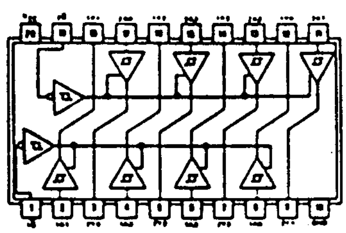
138



SN54LS138 (J, W) SN74LS138 (J, N)
SN54S138 (J, W) SN74S138 (J, N)

OCTAL BUFFERS/LINE ORIVERYLINE RECEIVERS

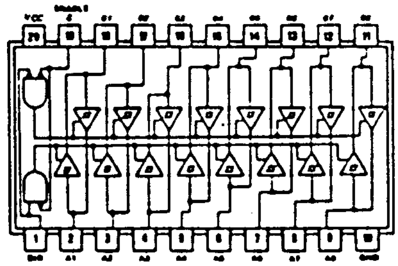
244 **NONINVERTED 3-STATE OUTPUTS**



SN54LS244 (J) SN74LS244 (J, N)

OCTAL **BUS TRANCEIVERS**

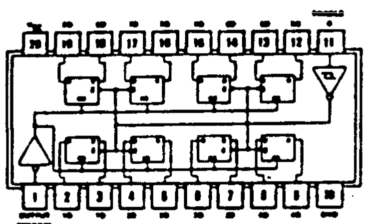
245 **NONINVERTED 3-STATE OUTPUTS**



SN54LS245 (J) SN74LS245 (J, N)

OCTAL **D-TYPE LATCHES**

373 **3-STATE OUTPUTS**
COMMON **OUTPUT** CONTROL
COMMON **ENABLE**



SN54LS373 (J) SN74LS373 (J, N)
SN54S373 (J) SN74S373 (J, N)

APENDIX – C

HELICAL ANTENNA - EMPIRICAL RELATIONS

I. Beam pattern:

$$E = (\sin 90/n)\frac{\sin(n\psi/2)}{\sin\psi/2}\cos\phi$$

$$\psi = 360^{o}\,[S_{\lambda}(1-\cos\phi) + 1/2n]$$

II. Half power beam width:

$$B_{hp} = \left[\frac{52}{C_{\lambda}\sqrt{nS_{\lambda}}}\right]^{o}$$

III. First nulls beam width:

$$B_{fn} = \left[\frac{115}{C_{\lambda}\sqrt{nS_{\lambda}}}\right]^{o}$$

IV. Directivity:

$$D = 1.5{C_{\lambda}}^{2}nS_{\lambda}$$

V. Terminal resistance:

$$R = 140C_{\lambda}\Omega$$

Where,

n = number of turns

C_{λ} = circumference in free-space wavelengths

S_{λ} = spacing in free-space wavelengths

L_{λ} = turn length in free-space wavelengths

a = pitch angle

APPENDIX – D

LIST OF ABBREVIATIONS

A	Ampere
ADC	Analog to Digital Converter
A/D	Analog to Digital
BL	Baseline
BW	Bandwidth
cm	Centirnetre
CMOS	Complimentry Metal Oxide Semiconductor
CMRR	Common Mode Rejection Ratio
D/A	Digital to Analog
DAS	Data Acquisition System
dB	Decibel
dc	Direct Current
dec	Declination
DOS	Disk Operating System
DRAM	Dynamic Random Access Memory
DUT	Device Under Test
ECL	Eimmeter Coupled Logic
EGA	Expanded Graphics Adapter
EM	Electro magnetic
EPROM	Erasable Programmable Read only Memory
E^2PROM	Electrically Erasable Programmable Read only Memory
FET	Field Effect Transistor
HF	High Frequency
HP	Hewlett Packard

contd...

IBM	International Business Machines
IC	Integrated Circuit
IF	Intermediate frequency
ISR	Interrupt Service Routine
Kb	Kilo bytes
Km	Kilometre
LNA	Low Noise Amplifier
LO	Local Oscillator
m	Meter
Mb	Mega bytes
MHz	Mega Hertz
MOS	Metal Oxide Semiconductor
MTU	Magnetic Tape Unit
mm	Millirnetre
μ P	Microprocessor
mV	Milli volts
MUX	Multiplexer
NF	Noise figure
Op-Amp	Operational Amplifier
OS	Operating System
PC	Personal Computer
PCB	Printed Circuit Board
PGA	Programmable Gain Amplifier
PIN	p-channel Intrinsic n-channel
PSD	Phase Sensitive Detector
PVC	Polyvinylchloride
RAM	Random Access Memory

contd...

RF	Radio frequency
s	Seconds
S/H	Sample and Hold
S/W	Software
TTL	Transistor Transistor Logic
TV	Television
UHF	Ultra High Frequency
VHF	Very High Frequency
VSWR	Voltage Standing Wave Ratio