Visvesvaraya Technological University

"JnanaSangama", Belagavi – 590018

Internship Report on

"REAL TIME FLIGHT DATA MONITORING SYSTEM"

Submitted in partial fulfilment for the award of Degree of

Bachelor of Engineering

Submitted By

Ms. MEGHA D M (1VE16EC055)

Under the Guidance

of

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Sri Venkateshwara College of Engineering
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ACY: 2019-2020

SRI VENKATESHWARA COLLEGE OF ENGINEERING

Department of Electronics & Communication Engineering

Certificate

Certified that the **Internship** work entitled **"Real Time Flight Data Monitoring system"** was carried out at **"Hindustan Aeronautics Limited (HAL)"** by **Ms. Megha D M (1VE16EC055)** is a bonafide student of VIII Semester Electronics &Communication Engineering, Sri Venkateshwara College of Engineering. This is in partial fulfilment for the award of Bachelor of Engineering of Visvesvaraya Technological University, Belagavi, during the year **2019-2020.** It is certified that all corrections/suggestions indicated for internship internal assessment have been incorporated in the report. The internship report has been approved as it satisfies the academic requirements in the respect of seminar work prescribed for the said degree.

(Dr. Jijesh J J) **Assoc. Prof. Dept. of E&CE,SVCE, Bengaluru**	**(Dr. Shivashankar)** **Prof. & Head,** **Dept. of E&CE,SVCE, Bengaluru**	**(Dr. Suresha)** **Principal** **SVCE, Bengaluru**

Name of the Examiners Signature with date

1.

2.

INTERNSHIP CERTIFICATE

ರೋಟರಿ ವಿಂಗ್ ಸಂಶೋಧನೆ ಮತ್ತು ವಿನ್ಯಾಸ ಕೇಂದ್ರ
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HAL/DC/RWRDC/HR/PROJ-CERT/ 221 /2019

3rd August, 2019

CERTIFICATE

This is to certify that Ms. Megha DM (USN: 1VE16EC055) a student of BE(Electronics & Communication Engineering), Sri Venkateshwara College of Engineering, Bangalore, has undergone Internship on No-pay-No-fee basis from 04.07.2019 to 03.08.2019 at Ground Test Centre, Rotary Wing Research & Design Centre, Hindustan Aeronautics Limited, Bangalore.

2. Her Punctuality, Conduct, Behavior & Progress in Training were 'VERY GOOD' as rated by the Department Head during her Internship period with us.

(U SUDHAKAR)
MANAGER (HR)

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I would like to extend our sinscere thanks to **Dr. SHIVASHANKAR, Professor and Head, Department of Eelectronics and Communication Engineering, Sri Venkateshwara College of Engineering Bangalore,** for his suggestion which helped me to complete the internship.

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I would like to express our gratitude to **Mr. Gaurav Mathur, Hindustan Aeronautics Limited Bangalore**, for the guidence and assistance rendered by him.

Word cannot express the immense gratitude I have for parents who have been instrumental in shaping my career. I am thankful to all our lectures and friends who have been the source of inspiration to in all endeavours.

Yours Sincerely

Ms. MEGHA D M

(1VE16EC055)

COMPANY PROFILE

Hindustan Aeronautics Limited (HAL) based in Bangalore, India is one of Asia's largest aerospace companies. Under the management of the Indian Ministry of Defense, this state-owned company is mainly involved in aerospace industry, which includes manufacturing and assembling aircraft, navigation and related communication equipment, as well as operating airports.

HAL built the first military aircraft in South Asia and is currently involved in the design, fabrication and assembly of aircraft, jet engines, and helicopters, as well as their components and Spares. It has several facilities spread across several states in India including Nasik, Korwa, Kanpur, Koraput, Lucknow, Bangalore and Hyderabad, etc.

After India gained independence in 1947, the management of the company was passed over to the Government of India. Hindustan Aeronautics Limited came into existence on 1st October 1964. The Company was formed by the merger of Hindustan Aircraft Limited with Aeronautics India Limited and Aircraft Manufacturing Depot, Kanpur. Though HAL was not used actively for developing newer models of fighter jets, the company has played a crucial role in modernization of the Indian Air Force. In 1957 company started manufacturing Bristol Siddeley Orpheus jet engines under license at new factory located in Bangalore.

During the 19805, HAL's operations saw a rapid increase which resulted in the development of new indigenous aircraft such as the HAL Tejas and HAL Dhruv. HAL also developed an advanced version of the MiG-21, known as MiG-21 Bison, which increased its lifespan by more than 20 years. HAL has also obtained several multi-million dollar contracts from leading international aerospace firms such as Airbus, Boeing and Honeywell to manufacture aircraft spare parts and engines.

ABOUT COMPANY

Vision

"To make HAL a dynamic, vibrant, value-based learning organization with human resources expectionally skilled, highly motivated and committed to meet the current and future challenges. This will be driven by core values of the company fully embedded in the culture of the organization.

Mission

To become a globally competitive aerospace industry while working as an instrument for achieving self-reliance in design, manufacture of aerospace defense equipment and diversifying to related areas, managing the business on commercial lines in a climate of growing professional competence.

Values

- **Customer satisfaction**

  We are dedicated to building a relationship with our customers where we become partners in fulfilling their mission. We strive to understand our customers' needs and to deliver products and services that fulfill and exceed all their requirements.

- **Commitment to total quality**

  We are committed to continuous improvement of all our activities. We will supply products and services that conform to highest standards of design, manufacture, reliability, maintainability and fitness for use as desired by our customers.

- **Cost and time consciousness**

  We believe that our success depends on our ability to continually reduce the cost and shorten the delivery period of our products and services. We will achieve this by eliminating waste in all activities and continuously improving all processes in every area of our work.

- **Innovation and creativity**

  We believe in striving for improvement in every activity involved in our business by pursuing and encouraging risk-taking, experimentation and learning at all levels within the company with a view to achieving excellence and competitiveness.

- **Trust and team spirit**

  We believe in achieving harmony in work life through mutual trust, transparency, co-operation and a sense of belonging. We will strive for building empowered teams to work towards achieving organisational goals.

- **Integrity**

  We believe in a commitment to be honest, trustworthy and fair in all our dealings. We commit to be loyal and devoted to our organisation. We will practise self discipline and own responsibility for our actions. We will comply with all requirements so as to ensure that our organisation is always worthy of trust.

ROTARY WING RESEARCH & DESIGN CENTRE

The Rotary Wing Research & Design Centre (RWR&DC) with modern facilities and state-of-the art technologies, spearheads HAL's thrust towards excellence in the field of Helicopter Design. Expertise in the design and development of Rotary wing aircraft has been built up over the last three decades no optimal design, prototype development, ground testing flight testing and progressive induction pf qualified designers. The centre is capable of undertaking challenging Rotary Wing and allied design tasks for civil and Military applications. The objective of the centre is to research, innovative and create designs for rotary wing aircraft to meet indigenous and global requirements.

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CHAPTER 1

INTRODUCTION

Helicopter Real Time Flight Data Monitoring (RTFDM) is a systematic method of accessing, analyzing and acting upon information obtained from flight data to identify and address operational risks before they can lead to incidents and accidents. During helicopter testing various flight test parameters will be telemetered to ground station for safe monitoring of flight. For measuring loads and vibrations on main rotor blades and main gear box the sensors will be placed on main rotor at the locations identified by designer. The data acquisition system (DAS) along with signal conditioner cards will be placed on main rotor stub and sensor output will be terminated to corresponding signal conditioner cards. DAS KAM 500 is configured for the different flight test parameters required by the designers for a particular flight test program. all the parameters are available in PCM format with the configure bit rate. The data is transmitted to ground stations via RF transmitter and RF receiver receives the data at ground station. there is one more DAS KAM 500 in ground station where data is converted back to PCM format for ease of monitoring. The data is monitored via kwork bench quick look software and for ready analysis the parameters needs to be plotted on strip charts. for this purpose, the RTFDM system is used. The information and insights provided by RTFDM can also be used to reduce operational cost and significantly enhance training effectiveness and operational, maintenance and engineering procedures. Information from RTFDM programs is unique since it provides objective data that otherwise is not available. An RTFDM program is a key component of a Safety Management System (SMS). Flight data provided are PCM signals. These signals are stored as data frames. When the pilot requests for one particular parameter, the micro-controller displays the parameter from the real time PCM signal (data frames) acquired during flight. These are main frames and contain sub-frames or mini-frames. The flight testing parameters are placed in sub-frames in the form of 16-bit words. Each sub-frame contains start frame identification word (SFID) followed by different parameters in 16-bit words and this is followed by synchronization word.

1.1 OBJECTIVES

- To identify and address operational risks before they lead to accidents.

- To reduce operational cost and significantly enhance training effectives and operational maintenance.

- To identify and make adjustments to specific aircraft with usually high fuel burn rates.

- To reduce the need for unscheduled maintenance, resulting in lower maintenance costs and increased aircraft availability.

CHAPTER 2

WORK CARRIED OUT

2.1 BLOCK DIAGRAM

The Analog data is acquired in the Data Acquisition System (DAS) from sensors which are installed in the aircraft. These sensor's output corresponds to different parameters that are to be analyzed for critical flight testing. According to the Military standards, all the systems in the aircraft are designed to work in 28V supply. The parameters are configured in KAM-500 using K-workbench software and a frame is built for analyzing the acquired parameters. The PCM output of KAM-500 is fed into the microcontroller which is interfaced with keypad and LCD. The parameters to be monitored are selected through keypad and the analyzed results are displayed in LCD in fig 2.1.

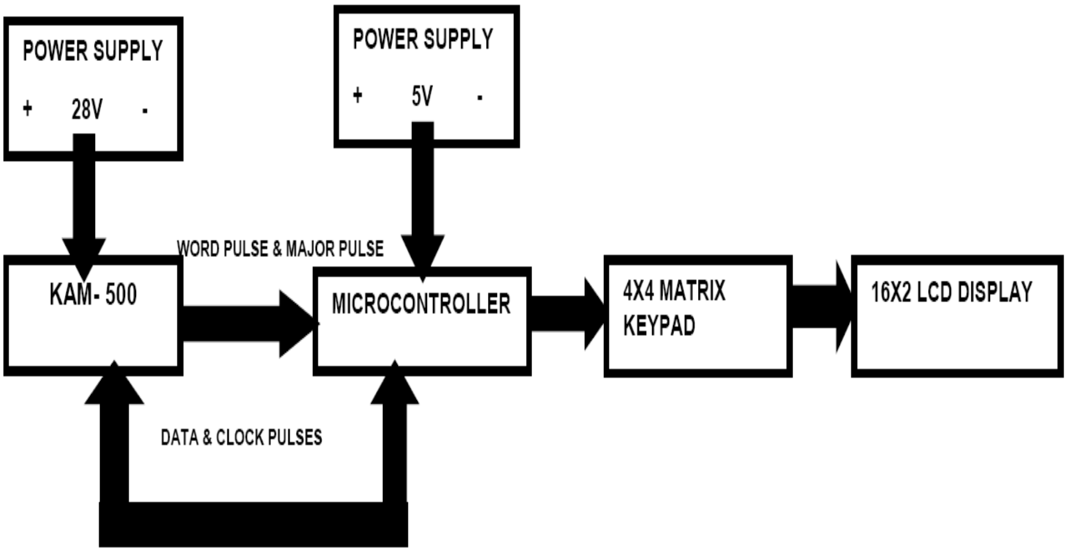


Fig 2.1 Block diagram of RTFDM

A power supply is an electronic power supply that incorporates a switching regulator to convert electrical power efficiently. Like other power supplies, an SMPS transfers power from a DC or AC source to DC loads. Switching regulators are used as replacements for linear regulators when higher efficiency, smaller size or lighter weight is required. KAM-500 data acquisition units (DAU) are airborne acquisition and transmission systems that utilize chassis with a standard backplane that accepts over 100+ user selected modules. This highly configurable system enables fully customized systems to be built.

2.2 COMPONENTS USED IN BLOCK DIAGRAM

2.2.1. Power Supply (28v,5v)

A regulated power supply is an embedded circuit; it converts unregulated AC (Alternating Current) into a constant DC. With the help of a rectifier it converts AC supply into DC. Its function is to supply a stable voltage (or less often current), to a circuit or device that must be operated within certain power supply limits.

Fig 2.2 Power Supply

2.2.2 LPC 1768 Microcontroller

The LPC17xx is an ARM Cortex-M3 based microcontroller for embedded applications requiring a high level of integration and low power dissipation. The ARM Cortex-M3 is a next generation core that offers system enhancements such as modernized debug features and a higher level of support block integration. The ARM Cortex-M3 CPU incorporates a 3-stage pipeline and uses a Harvard architecture with separate local instruction and data buses as well as a third bus for peripherals. The ARM Cortex-M3 CPU also includes an internal pre-fetch unit that supports speculative branches. The peripheral complement of the LPC17xx includes up to 512kB of flash memory, up to 64kB of data memory, Ethernet MAC, a USB interface that can be configured as either Host, Device, or OTG, 8 channel general purpose DMA controller, 4 UARTs, 2 CAN channels, 2 SSP controllers, SPI interface, 3 I2C interfaces, 2-input plus. The LPC1768/66/65/64 are ARM Cortex-M3 based microcontrollers for embedded applications featuring a high level of integration and low power consumption.

Fig 2.3 LPC1768 Microcontroller

Features of Microcontroller:

- ARM Cortex-M3 processor, running at frequencies of up to 100 MHz. A Memory Protection Unit (MPU) supporting eight regions is included.
- ARM Cortex-M3 built-in Nested Vectored Interrupt Controller (NVIC).
- Up to 512 kB on-chip flash programming memory. Enhanced flash memory accelerator enables high-speed 100 MHz operation with zero wait states.
- In-System Programming (ISP) and In-Application Programming (IAP) via on-chip bootloader software.
- On-chip SRAM includes:
- 32/16 kB of SRAM on the CPU with local code/data bus for high-performance CPU access. Two/one 16 kB SRAM blocks with separate access paths for higher throughput. These SRAM blocks may be used for Ethernet (LPC1768/66/64 only), USB, and DMA memory, as well as for general purpose CPU instruction and data storage.

- Eight channel General Purpose DMA controller (GPDMA) on the AHB multilayer matrix that can be used with the SSP, I2S-bus, UART, the Analog-to-Digital and Digital-to-Analog converter peripherals, timer match signals, and for memory-to-memory transfers.
- Multilayer AHB matrix interconnect provides a separate bus for each AHB master. AHB masters include the CPU, General Purpose DMA controller, Ethernet MAC (LPC1768/66/64 only), and the USB interface. This interconnect provides communication with no arbitration delays.
- Split APB bus allows high throughput with few stalls between the CPU and DMA.
- Ethernet MAC with RMII interface and dedicated DMA controller (LPC1768/66/64 only).
- USB 2.0 full-speed device/Host/OTG controller with dedicated DMA controller and on-chip PHY for device, Host, and OTG functions. The LPC1764 includes a device controller only.
- Four UARTs with fractional baud rate generation, internal FIFO, DMA support, and RS-485 support. One UART has modem control I/O, and one UART has IrDA support.

2.2.3 LCD Initialization

- Send 38H to the 8 bit data line for initialization.
- Send 0FH for making LCD ON, cursor ON, cursor blinking ON.
- Send 06H for incrementing cursor position.
- Send 01H for clearing the display and return the cursor.

2.2.3.1 Sending Data To LCD

- Make R/W low.
- Make RS = 1, if the data byte of a data to be displayed and make.
- RS=0, if data byte is command.
- Place data byte on the data register.
- Then pulse Enable from high to low.
- Repeat the above steps for sending other data.

2.2.3.2 LCD Pin Description

The LCD discussed in this section has 14 pins. The function of each pin is given in table.

Table 2.1 LCD Pin Description:

Pin	**Symbol**	**I/O**	**Description**
1	Vss	--	Ground
2	Vcc	--	+5V power supply
3	VEE	--	Power supply to control contrast
4	RS	I	RS=0 to select command register RS=1 to select data register
5	R/W	I	R/W=0 for write R/W=1 for read
6	E	I/O	Enable
7-14	DB0-DB7	I/O	The 8-bit data bus

2.2.4 LCD Interfacing

To send any command from table 2 to the LCD, make pin RS=0. For data, make RS=1.Then place a high to low pulse on the E pin to enable the internal latch of the LCD.

Sending commands and data to LCDs with a time delay:

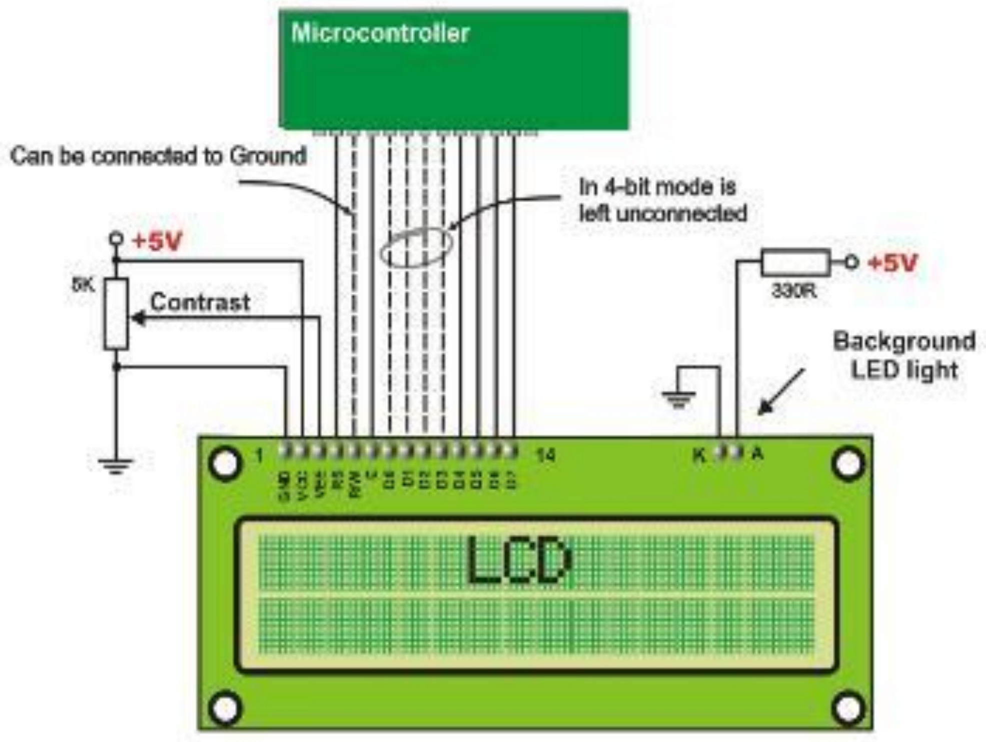


Fig 2.4 LCD Interfacing

2.2.5 4X4 Keypad

A keypad is a set of buttons arranged in a block or "pad" which bear digits, symbols or alphabetical letters. Pads mostly containing numbers are called a numeric keypad. Numeric keypads are found on alphanumeric keyboards and on other devices which require mainly numeric input such as calculators, push-button telephones, vending machines, atms, Point of Sale devices, combination locks, and digital door locks. Many devices follow the E.161 standard for their arrangement.

Typically one port pin is required to read a digital input into the controller. When there are a lot of digital inputs that have to be read, it is not feasible to allocate one pin for each of them. This is when a matrix keypad arrangement is used to reduce the pin count.Therefore, the number of pins that are required to interface a given number of inputs decreases with increase in the order of the matrix.

Fig 2.5 4X4 Keypad

Therefore, the number of pins that are required to interface a given number of inputs decreases with increase in the order of the matrix.

2.2.5.1 4X4 Keypad Pin Configuration

4x4 keypad modules are available in different sizes and shapes. But they all have same pin configuration. It is easy to make 4x4 keypad by arranging 16 buttons in matrix formation by yourself.As given in table 3 a 4x4 keypad will have eight terminals. In them four are rows of matrix and four are columns of matrix. These 8 pins are driven out from 16 buttons present in the module. Those 16 alphanumeric digits on the module surface are the 16 buttons arranged in matrix formation. Initially all switches are assumed to be released. So there is no connection between the rows and columns. When any one of the switches are pressed the corresponding rows and columns are connected. This will drive that column pin low. using this logic, the button press can be detected. The colours red and black are for logic high and low respectively. When any one of the switches are pressed the corresponding rows and columns are connected. This will drive that column pin low. using this logic, the button press can be detected. The colours red and black is for logic high and low respectively.

Here are the steps involved in determining the key that was pressed

Step1: first set all rows to output and set them at +5v. Next set all columns as input to sense the high logic. Now consider a button is pressed on keypad. And that key is at 2nd column and 3rd row. With the button being pressed the current flows as shown in figure. With that a voltage of +5v appears at terminal c2. Since the column pins are set as inputs, the controller can sense c2 going high. The controller can be programmed to remember that c2 going high and the button pressed is in c2 column.

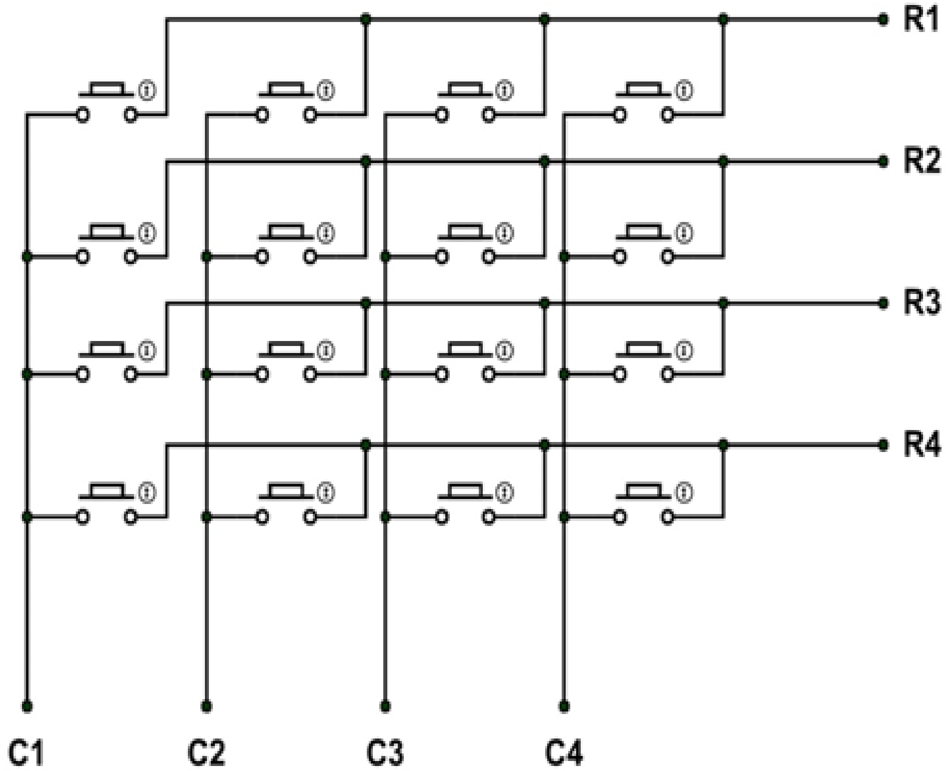


Fig 2.6 Internal Structure Of 4X4 Keypad Module

Step2: Next set all columns to output and set them at +5v. Next set all rows as input to sense the high logic. Since the key pressed is at 2nd column and 3rd row with that current flow a positive voltage of +5v appears at r3 pin. Since all rows are set as inputs, the controller can sense +5v at r3 pin. The controller can be programmed to remember the key being pressed at third row of keypad matrix.From previous step, we have known the column number of key pressed and now we know row number. With that we can match the key being pressed. We can take the key input provided by this way for 4x4 keypad module.

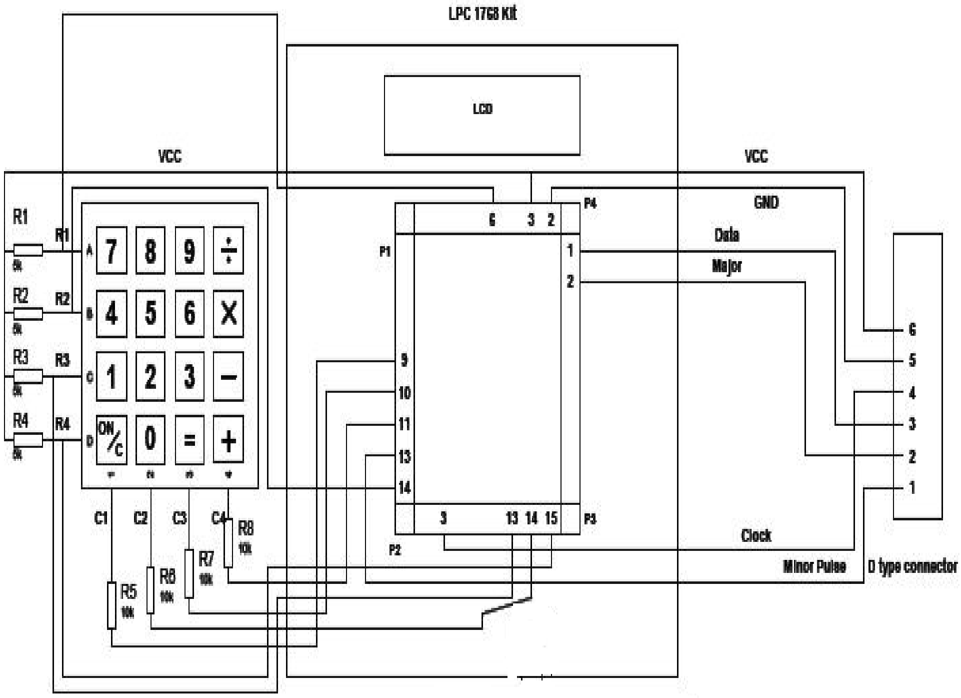
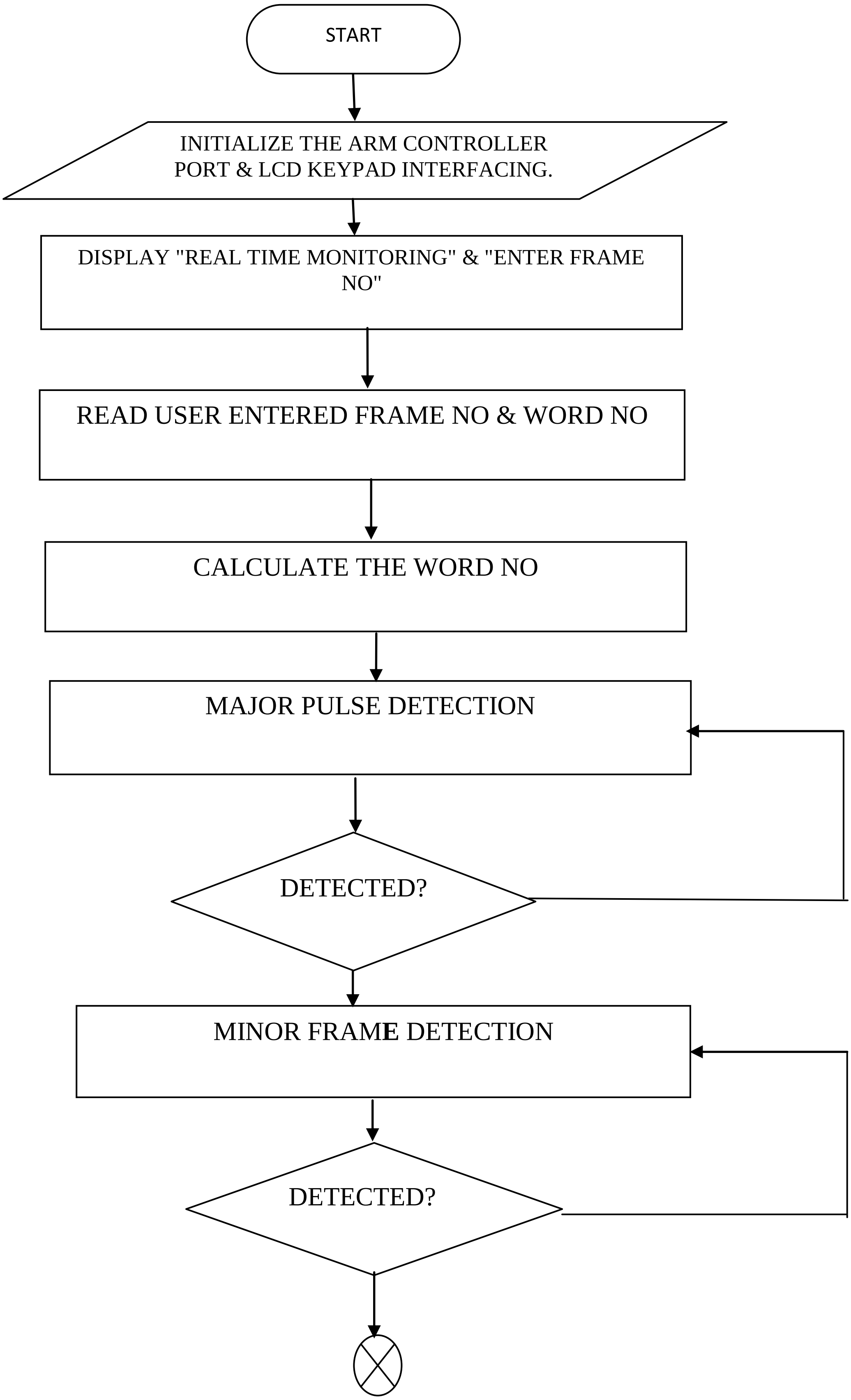
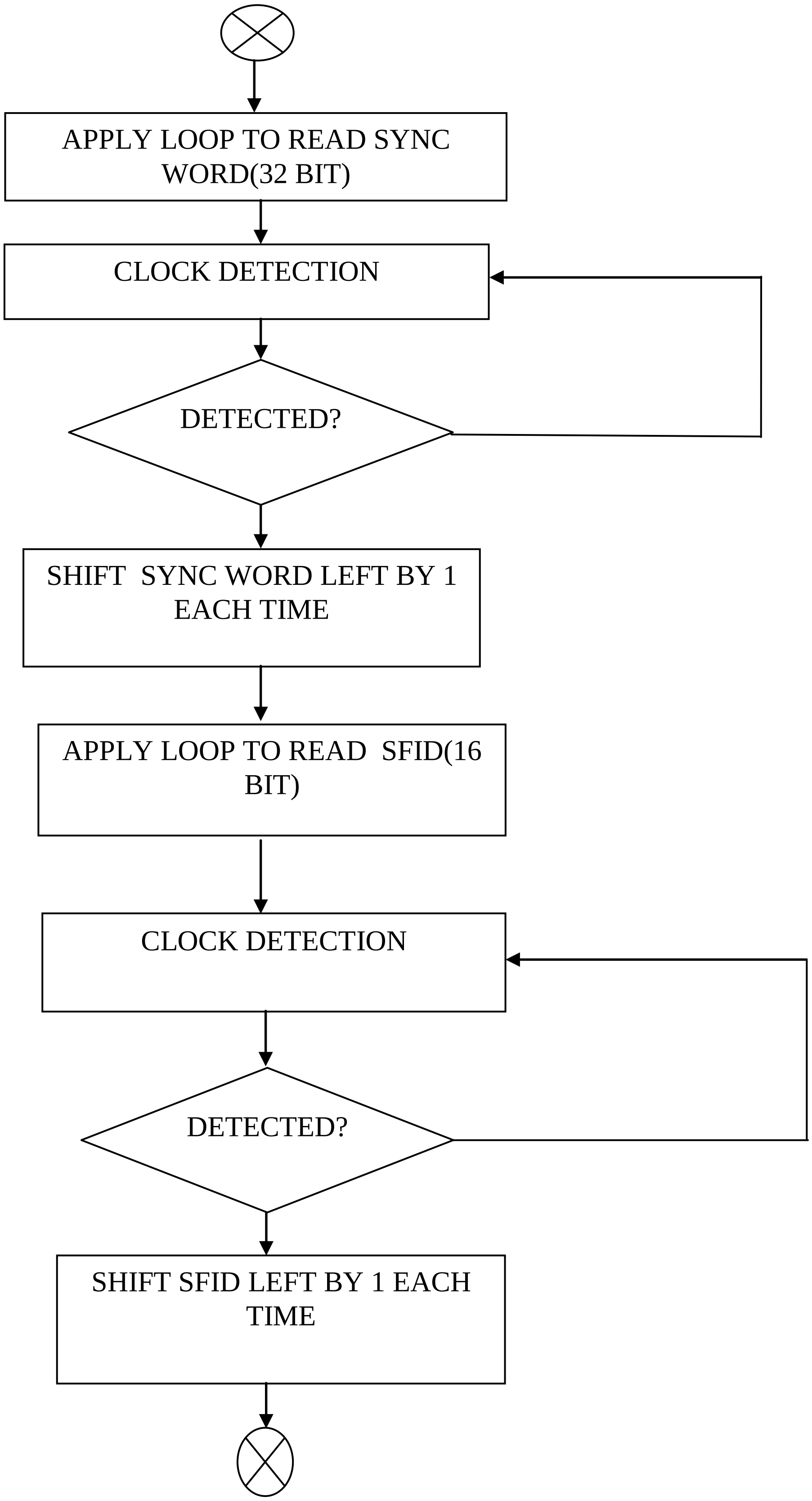


Fig 2.7 Circuit Diagram Of RTFDM

The circuit is designed as above with the help of keypad user is allowed to enter the frame number and word number based on the choice, which will be displaced on LCD screen. Once the frame number and word number is entered by the user the sync word with respect to the entered frame and word number is displayed which help us obtain the required real time data of flight either at ground run or during flight.

2.3 FLOW CHART




APPLY LOOP TO READ SYNC WORD(32 BIT)
CLOCK DETECTION
DETECTED?
SHIFT SYNC WORD LEFT BY 1 EACH TIME
APPLY LOOP TO READ SFID(16 BIT)
CLOCK DETECTION
DETECTED?
SHIFT SFID LEFT BY 1 EACH TIME

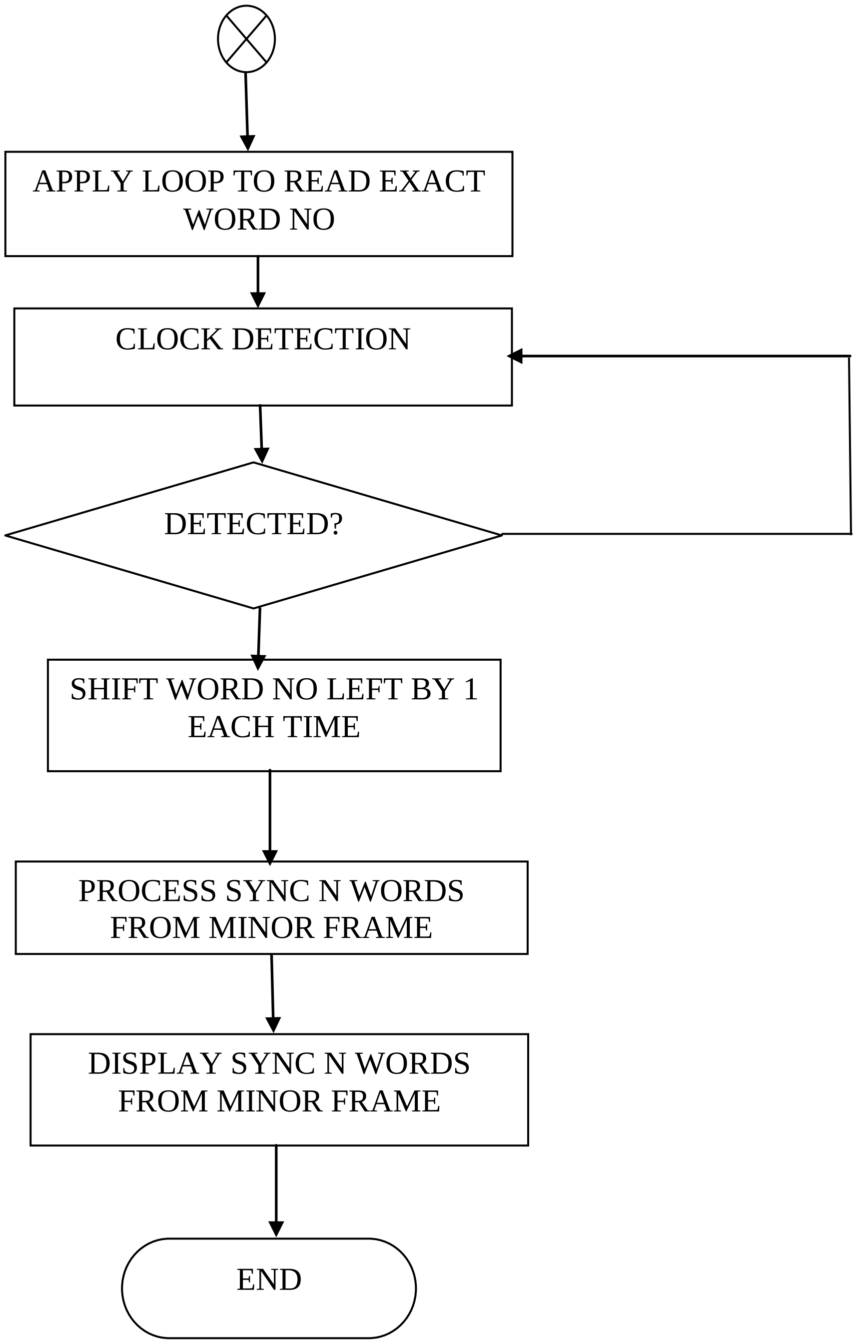


Fig 2.8: Flow chart of RTFDM

Start and initialize the arm controller port and LCD Keypad interfacing.Display Real time monitoring and enter the frame number and read the user entered frame number and then calculate the word number, if major pulse is detected the shift sync word left by 1 each time if it is not detected again check the major pulse. Now apply loop to read SFID which is of 16 bit,if clock is detected then shift SFID left by 1each time.Now apply loop to read exact word number,if clock is detected shift word number byb 1 each time. Then process sync N words from minor frameand display sync N words from minor frame and end the process.

2.4 SAFETY OUTCOMES

Identifying causal and contributory factors and accident consequences 7 safety outcomes are taken in order to assess the capabilities of different device types to support an FDM programme for business aviation, it was necessary to firstly, define requirements.

- Loss of control in flight
- Runway excursion
- Controlled flight into terrain
- Runway incursion
- Airborne conflict
- Ground handling
- Airborne and post-crash fire

2.5 BENIFETS

FDM strongly contributes to increased flight safety and operational efficiency by:

- Providing data to help in the prevention of incidents and accidents. Fewer flight accidents not only reduce material losses and insurance costs, but also keep passengers' confidence high.
- Improved operational insight: providing the means to identify potential risks and to modify pilot training programs accordingly.
- Improved fuel consumption: FDM provides the ability to identify and make adjustments to company operating procedures or specific aircraft with unusually high fuel burn rates.
- Reduction in unnecessary maintenance and repairs: FDM data can be used to help reduce the need for unscheduled maintenance, resulting in lower maintenance costs and increased aircraft availability.
- Improved ground conditions and airports: in certain cases, airlines can use the data captured from their FDM program to support requested changes to air traffic control and airport procedures.

CHAPTER 3

HARDWARE IMPLEMENTATION

KAM-500 transmitter modules encode data into a format suitable for transmitting to an external source e.g. another rugged data acquisition unit, a recorder or an RF transmitter.

3.1 KAM 500

The Koncept Alpha Module-500 (KAM-500) system is a general-purpose On-board Data Acquisition System which is a user configurable and programmable system. The system consists of chassis and modules. A black rectangular framework, made up of Aluminium is called chassis which is the main support of the system whereas the Modules are basically PCB cards that can be screwed into the chassis.

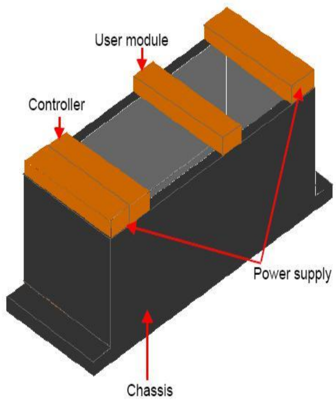


Fig 3.1 AcraKam 500/Kam Chassis with 12 User Slots and Isometric View of Single Chassis

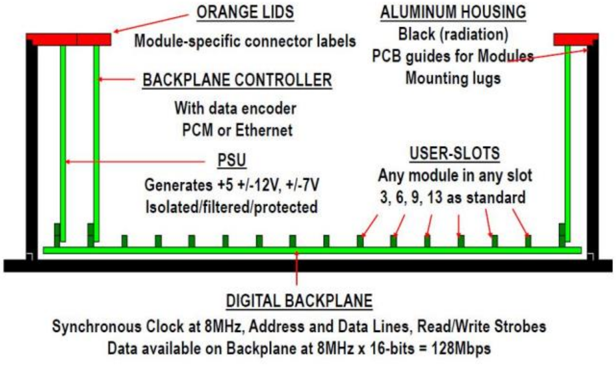


Fig 3.2 Chassis

3.2 POWER SUPPLY

The main feature of power supply is to convert the nominal 28V aircraft power into the voltages required by modules. The Power supply has the reverse polarity protection, indefinite short-circuit protection, EMI filtering and no derating with temperature which makes the system to have high tolerance.

3.3 BACKPLANE CONTROLLER UNIT (BCU)

The BCU functions as two modules in one namely PCM encoder and backplane controller. There is only one BCU allowed per chassis. The backplane connects all the modules in the chassis. The backplane controller organizes data transfer and programs all modules in chassis via KAM-500 backplane.

Fig 3.3 Backplane Controller Unit (BCU)

3.4 USER MODULES

A Generic user module has 52-way Double Density top block connector, standard front panel where there is no wire connection and the cards are screwed into the chassis, 2Mbytes of EEPROM, Non- volatile logic and a standard backplane as shown in the fig 3.4.

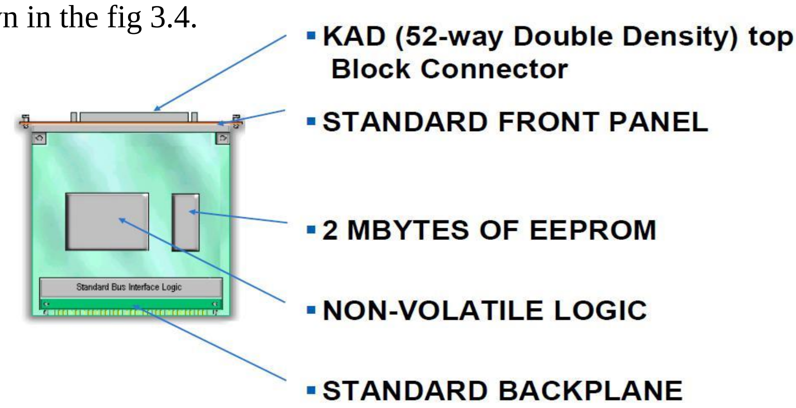


Fig 3.4 Generic User Module

3.4.1 KAD/TCG/102/C

The KAM/TCG/102 can accept time from an IRIG-B time source, from its onboard GPS receiver (external antenna required), or from an external GPS receiver outputting NMEA messages and a one-PPS signal. The received time is written to an internal timer and to a real-time clock that maintains time during power-down (when an external battery is connected). The time can be used for synchronization of a distributed Acra KAM-500 data acquisition system.

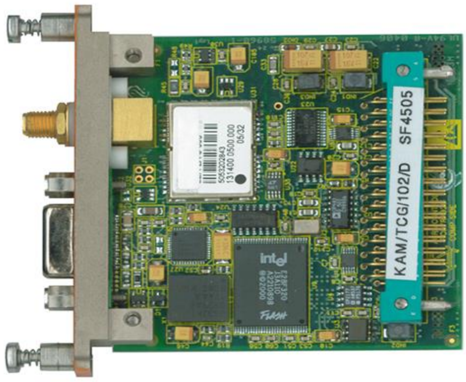


Fig 3.5 Time code generator (TCG)

3.4.2 KAD/ADC/112 24 channel Differential-ended ADC

The KAD/ADC/112 is used to condition and digitize up to 24 D/E analog channels. At the heart of the KAD/ADC/112 is a hard-wired state-machine that over-samples all channels at a rate between 48 ksps and 96 ksps and digitally filters any noise above the user-programmable cutoff frequency.

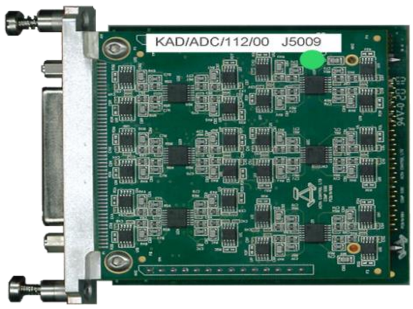


Fig 3.6 KAD/ADC/112 24 channel Differential-ended ADC

3.5 DATA ACQUISITION

Data acquisition (DAQ) is the process of measuring an electrical or physical phenomenon such as voltage, current, temperature, pressure, or sound with a computer. A DAQ system consists of sensors, DAQ measurement hardware, and a computer with programmable software. KAM-500 acquires data from acquisition modules installed in the chassis, these samples are scheduled by BCU over the backplane. The same process is repeated over and over. KSM-500 is usually used to setup this sampling schedule. So, this schedule or the repetitive time sequence in which all data sampled is called acquisition cycle. Samples are taken at the start of acquisition and at regular samples thereafter called as isochronous sampling which is shown in fig 3.7

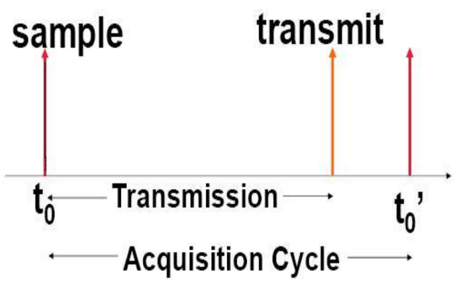


Fig 3.7 Isochronous Sampling (1 Sample per Cycle)

The KAD/BCU/101 has the following PCM encoder outputs:

- **DATA**
  S/E BTTL output with 100Ω resistor in series.
- **DCLK**
  S/E BTTL clock output with 100Ω resistor in series. Becomes the inverse of the DATA output when the module is configured to generate an ARINC-573/717 data stream.
- **WORD_PULSE**
  S/E BTTL output with 100Ω resistor in series. High for the last bit of each word. Its falling edge is aligned to the end of the last bit of each word.

- **MINOR_PULSE**

  S/E BTTL output with 100Ω resistor in series. High for the last word of each minor frame. Its falling edge is aligned to the end of the last bit of each minor frame.

- **MAJOR_PULSE**

  S/E BTTL output with 100Ω resistor in series. High for the last word of each major frame. Its falling edge is aligned to the end of the last bit of each major frame.

- **TIMING, BIT-RATES AND COMMUTATION**

  fig 4.8 shows examples of timing for NRZL and Bi-Phase L (BIØ-L). For maximum bit-rates and supported PCM transmission. The KAD/BCU/101 allows variable word lengths and non-standard commutation (that is, samples of a specific parameter not evenly spaced in the PCM frame). However, by default 16 bit word length and evenly spaced commutation is used.

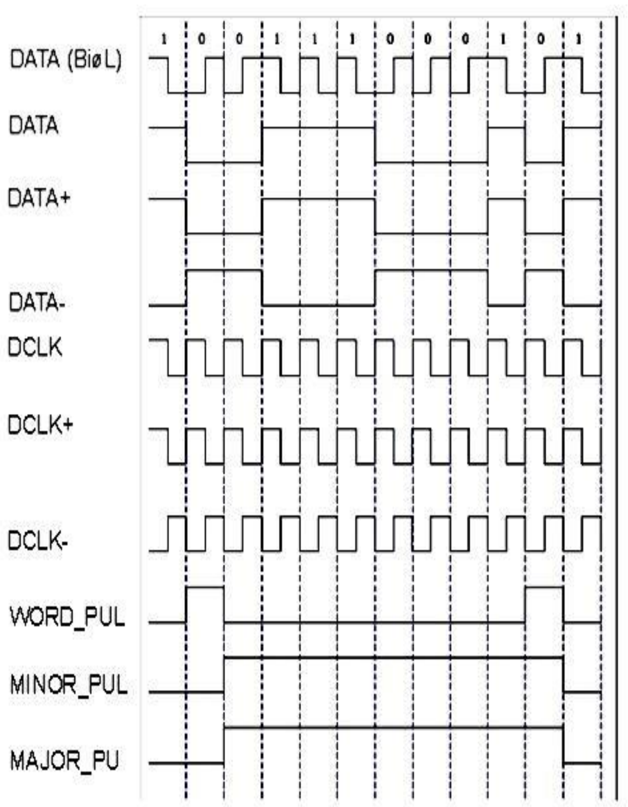


Fig 3.8 Timing For Outputs

CHAPTER 4

SOFTWARE IMPLEMENTATION

Integrated environment from which KAM-500 tools can be launched is done using K Work bench .It enables tools to be used with minimum user- input and clearly shows the optimum order in which tools should be launched and also groups and orders tools by function

4.1 INTRODUCTION

KAM-500 (KAM System Manager) is an integrated environment for configuring Acra KAM-500 systems. It consists of a suite of software tools to configure hardware, signal conditioning, and defining data transfer within Acra KAM-500 systems. Acquired data can be viewed in real-time via Quicklook. KSM-500 also offers uploading of data from Compact Flash cards for playback in Quicklook via ASCII file format. KSM-500 provides support for IRIG-106 PCM, Ethernet, CAIS, Firewire, MIL-STD-1553, ARINC-429, RS-422/RS-232 and other protocols. In practical terms, KSM-500 is a collection of software utilities, each one addressing specific user requirements. Thus, KSM-500 provides utilities to facilitate the verification of airborne FTI system and ground station configurations, in addition to facilities for reporting, archival and retrieval of test results and system configurations. KSM-500 tools can be developed, tested and distributed independently, facilitating more robust and focused software utilities which better meet user requirements.

4.2 k-WORKBENCH

Integrated environment from which KSM-500 tools can be launched is done using kWorkbench. It enables tools to be used with minimum user-input and Clearly shows the optimum order in which tools should be launched and also Groups and orders tools by function.kWorkbench uses the standard Windows file association to view these files as shown in fig 4.1.

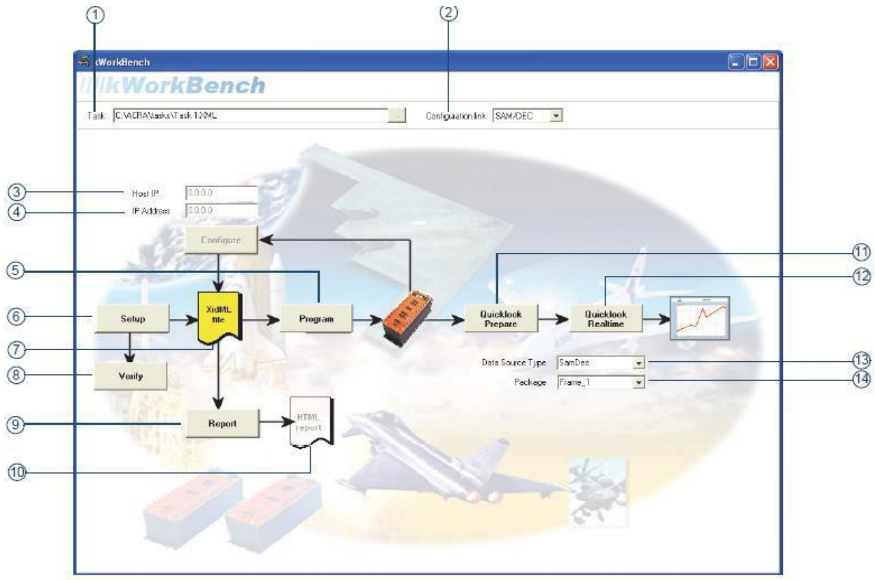


Fig 4.1 Workflow

4.3 SYSTEM CONFIGURATION

kDiscover automatically identifies and lists all Acra KAM-500 hardware that is powered up and connected to the PC through an Ethernet or SAM/DEC programming link. Details of instrumentation such as serial number, part reference, and automatically generated names are stored in the output HTML.

4.3.1 KDISCOVER

kDiscover automatically identifies and lists all Acra KAM-500 hardware that is powered up and connected to the PC through an Ethernet or SAM/DEC programming link. Details of instrumentation such as serial number, part reference, and automatically generated names are stored in the output HTML.

Fig 4.2 kDiscover operation

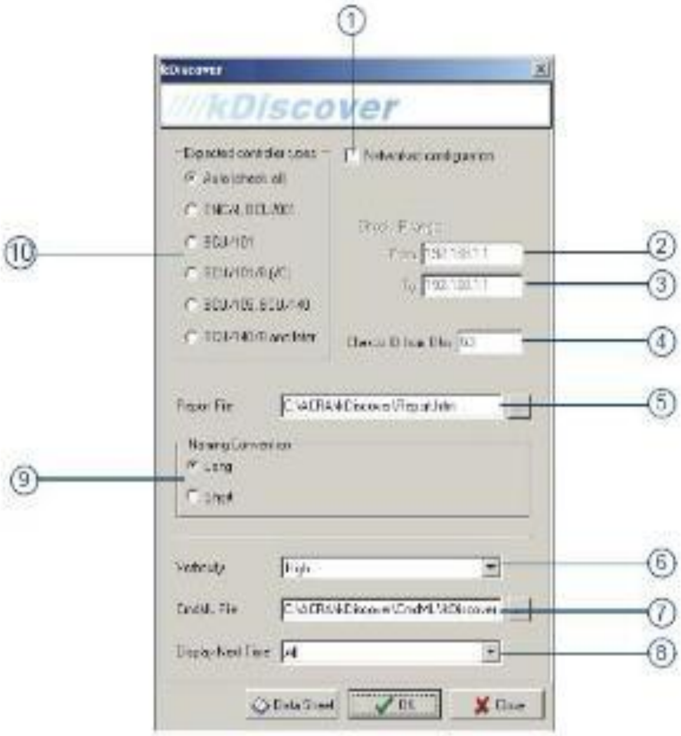


Fig 4.3 kDiscover

The description of each setting in instruments is explained in below table.

Table 4.1 kDiscover description

No.	Setting	Description
1	Networked Configuration	Determines if the programming link is using Ethernet -L:E For connection over Ethernet -L:P For connection over SAM/DEC
2	CheckIP range From	First IP address of the network range to scan
3	CheckIP range To	Last IP address of network range to scan
4	Chassis ID	Select the highest Chassis IDs to run kDiscover through the system
5	Report File	Output report file
6	Verbosity	High: generates all messages Medium: generates Errors and Warnings Low: generates Errors
7	CmdML File	Specifies CmdML file the tool will use
8	Display NextTime	Determines display of tool next time it run

4.3.2 KSETUP

kSetup creates and defines tasks representing Acra KAM-500 instrumentation. The Task Explorer enables you to visualize a task through a standard windows tree view and construct a task with DAUs and modules. The Module Setup panel enables you to define module and parameter settings. Each module is described in a corresponding Acra KAM-500 data sheet.

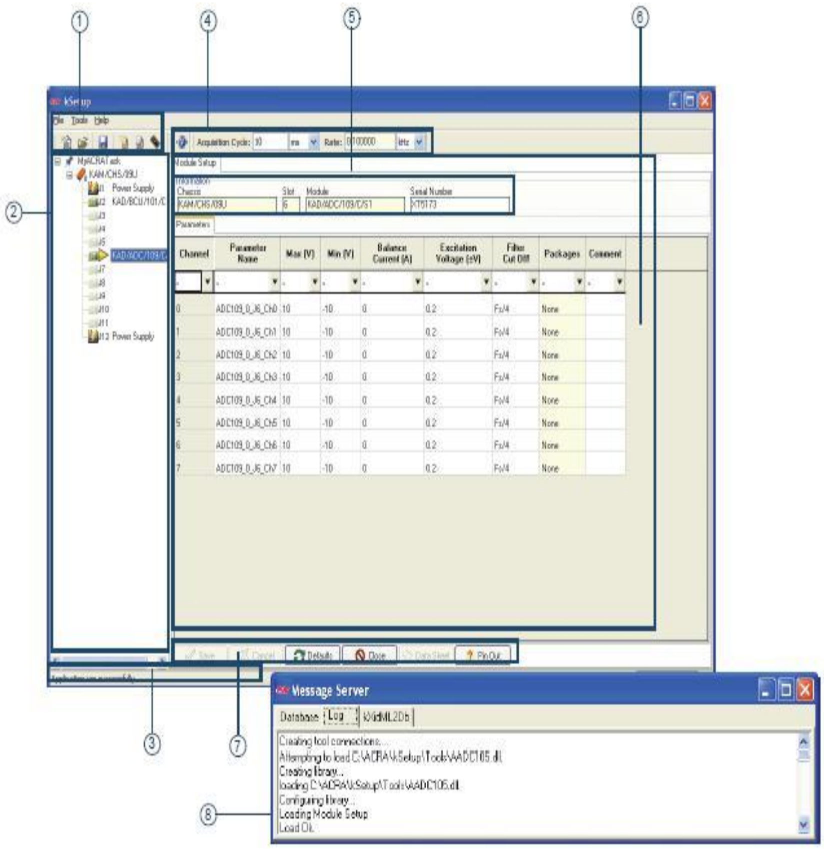


Fig 4.4 kSetup

Description of each setting is explained in table 4.2.

Table 4.2 kSetup Description

Sl No	Settings	Description
1.	Menu and Standard toolbar	You can access menu items in this panel.
2.	Task Explorer	Multiple tasks and modules can be navigated using the Task Explorer.
3.	Status bar	Information on the current software process is displayed in the status bar.
4.	Acquisitioncycle toolbar	You can set the acquisition cycle for Ethernet acquisition from the edit box and view the current acquisition rate.
5.	Information panel	Information on the module you are configuring is displayed in this panel, this is part of the Module Setup panel.
6.	Module Setup panel	You can configure module parameters and channels in this area.This is the only section of the interface which changes with each module.
7.	Setup functions	Setup functions can be accessed using these buttons, this is part of the Module Setup area.
8.	MessageServer dialog box	All messages generated from kSetup are displayed in the message Server dialog box. kSetup does not support MsgML. Message Server is always running in a separate interface from kSetup.

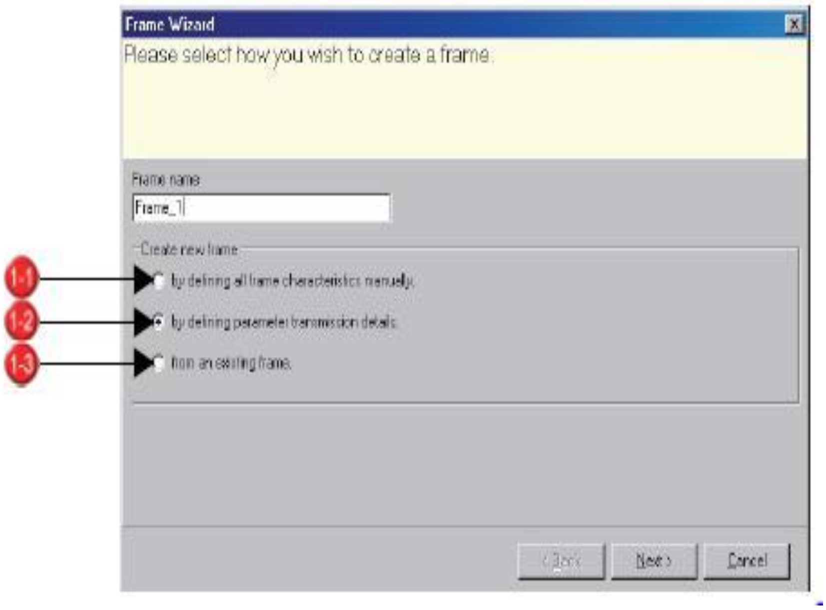


Fig 4.5 Frame wizard window

The frame wizard window opens where the user can select different type of settings as shown in fig4.6 and as described in Table6 .

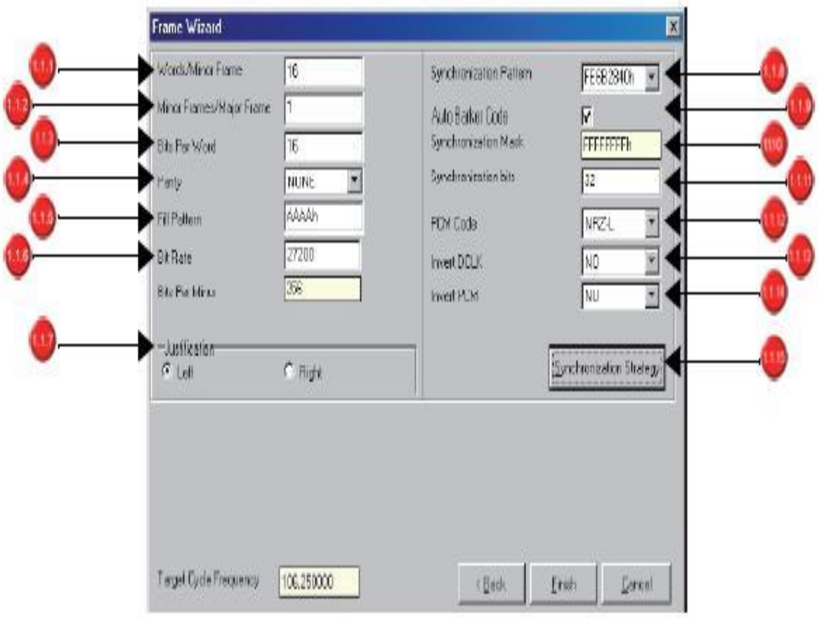


Fig 4.6 Frame wizard Specifications

User can select different type of settingsas described in Table 4.3.

Table 4.3 Frame Wizard Description

Sl. No	**Settings**	**Description**
1.	Words/Minor Frame	Shows the minor frame index of the first occurrence of this parameter in the frame. It is set when the parameter is placed.
2.	Minor Frames/Major Frame	Sets the number of minor frames in a major frame.
3.	Bits Per Word	Default number of bits per word can be changed for particular words later on.
4.	Parity	ODD, EVEN or NONE.
5.	Fill Pattern	Bit pattern that is transmitted during parts of the frame where no parameter has been defined.
6.	Bit Rate	Values may be quantized depending on the encoder module.
7.	Justification	When a parameter is placed in a word that is larger than the parameter, it can be left justified (MSB of parameter = MSB of word) or right justified (LSB of parameter = LSB of word) by default.
8.	Synchronization	Hexadecimal pattern that is the sync word, this can be any pattern with a trailing 'h'.
9.	Pattern Auto Barker Code	Automatically sets the URC pattern to the Barker code when the synchronization bits field is changed.

10.	Synchronization Mask	The synchronization mask is used in conjunction with the synchronization word when receiving a frame.It allows you to mask parts of the synchronization word.
11.	Synchronization bits	Number of bits in the synchronization word.
12.	PCM Code	Code used for bit transmission, the options are dependent Choices are: NRZ-L, RZ, BIØ-L, NRZ-S, NRZ-M, DBIØ-M, DBIØ-S, BIØ-M, BIØ-S, DM-M, DM-S, RNRZ-L(11), RNRZ-L(13), RNRZ-L(15), RNRZ-L(17)
13.	Invert DCLK	Shifts the data clock in phase by 180°
14.	Invert PCM	Shifts the PCM by 180°.
15.	Synchronization Strategy	Displays the Sub Frame Strategy dialog box.

IRIG-PCM MAP File opens after the settings are specified in Frame wizard. The first column is reserved for SFID and last two columns for SYNC word in the frame. The required parameters can be placed in rest of the minor frames based on the sampling rate which can be selected using different type of commutations (e.g. 1:1, 1:3,1:15) as shown in Figure 4.8.

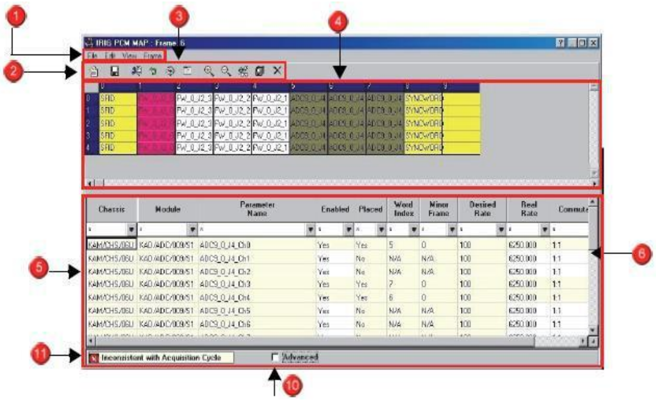


Fig 4.7 Frame building

4.3.3 KPROGRAM

kProgram can verify and program instrumentation based on task information expressed in XidML. It preserves previous calibration data, adjusting module cache images using existing values. kProgram verifies that the data throughput and sequencing requirements described can be realized on the available instrumentation, and then programs the modules.

4.3.4 kQUICKLOOK

kQuicklook is a software tool for real-time visualization and analysis. It is a data view package for single users, intended primarily for lab-bench or pre-flight testing. It allows data to be viewed on user defined displays using an independent output format for each parameter viewed.

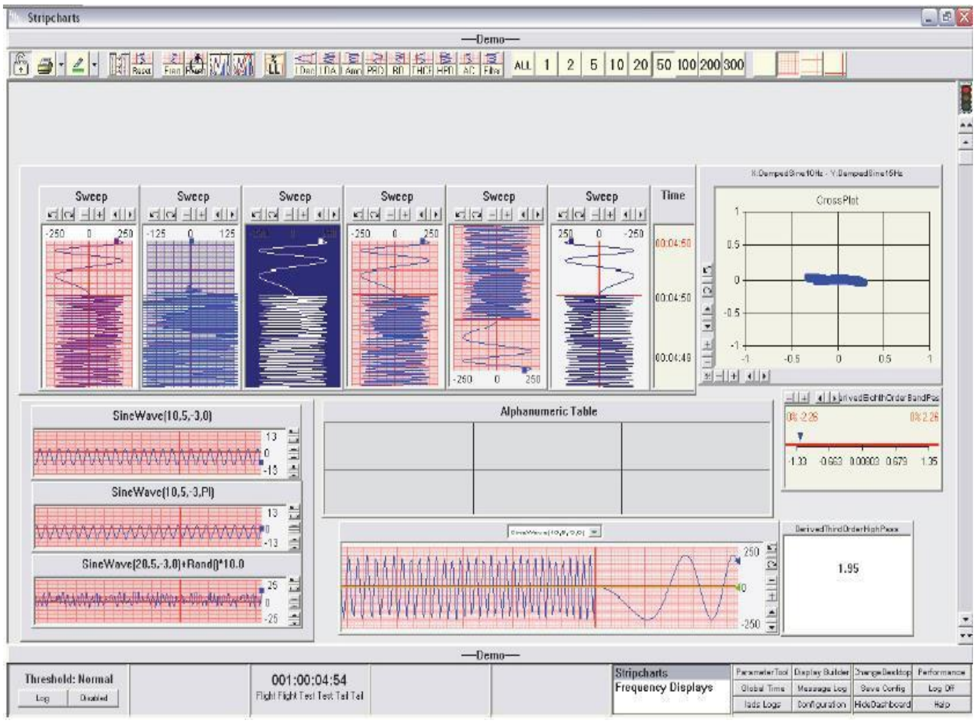


Fig 4.8 User defined display

The following fig 4.9 shows the workbench flow of KSM-500 Software for configuring a system.

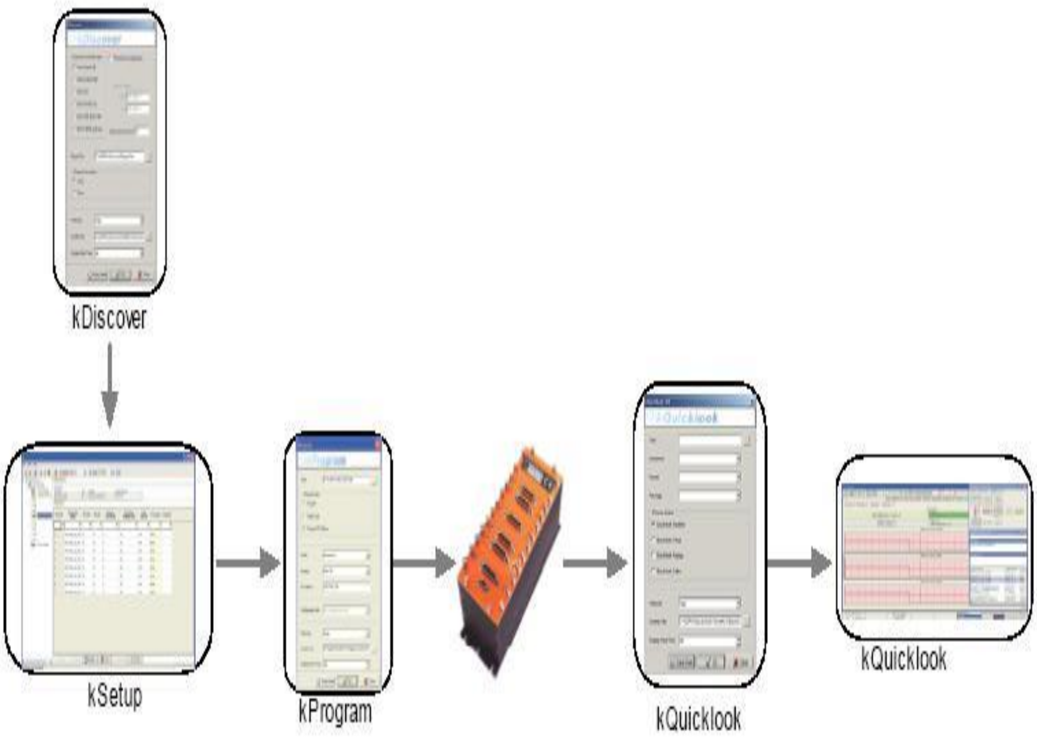


Fig 4.9 workbench flow

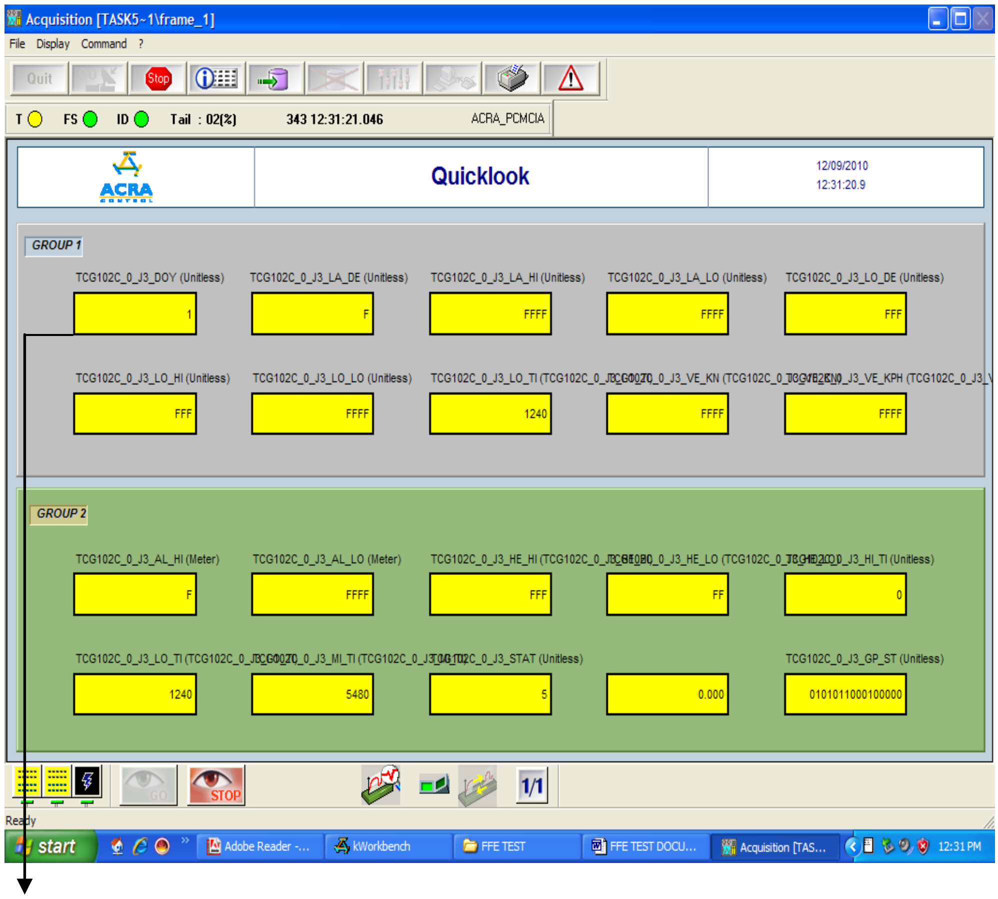
CHAPTER 5

RESULTS AND DISCUSSION

5.1 SAMPLE OUTPUT

kQuicklook is a software tool for real-time visualization and analysis. It is a data view package for single users, intended primarily for lab-bench or pre-flight testing.

5.1.1 Before GPS Locking TCG DOY



TCG DOY

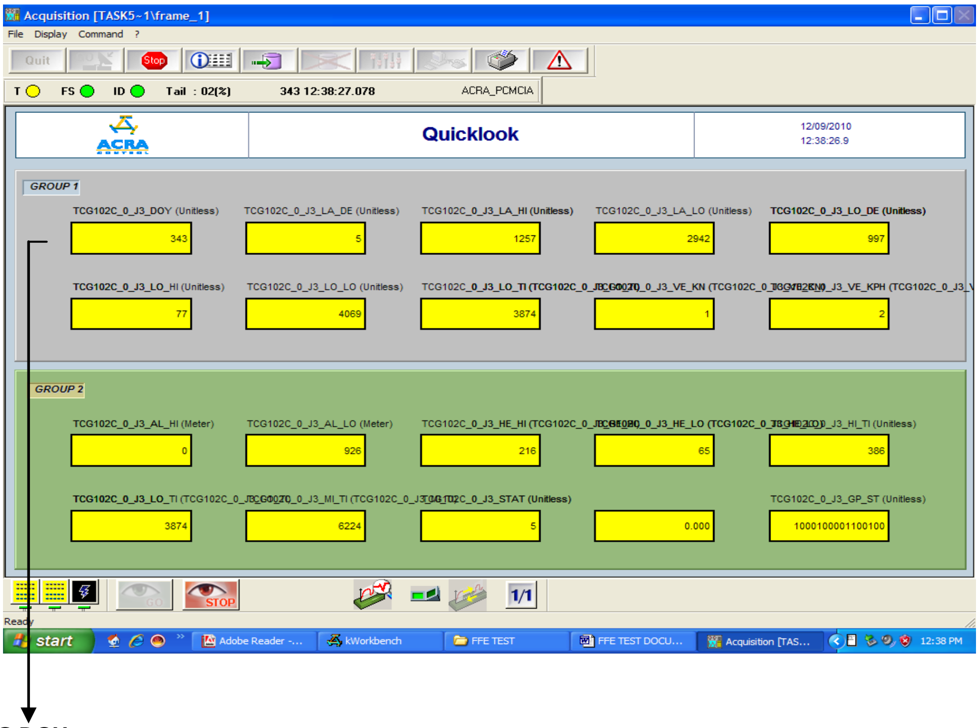
Fig 5.1 Before GPS Locking TCG DOY

GPS status register

- R(15) 1 indicates no error in the incoming GPS data stream (GPSLock BIT)
- R(14) 1 indicates that the Fix Flag was not set R(15)= 0, which means that the GPS position is not fully trusted
- R(13) 1 indicates that a checksum error was detected R(15)=0

- R(12) 1 indicates that less than the minimum configured number of satellites are used, which can affect the quality of the received data
- R(11) 1 indicates that one of the DOP (Dilution of Precision) figures was outside a specified range
- R(10) North/South indicator: 0 the latitude read is in the northern hemisphere; 1 the latitude read is in the southern hemisphere
- R(9) East/West indicator: 0 the longitude read is east of the Greenwich Meridian; 1 the longitude read is west of the Greenwich Meridian
- R(8)Reserved for future use
- R[7:4] Binary n: Number of satellites in view
- R[3:0] Binary n: Number of satellites used to calculate position

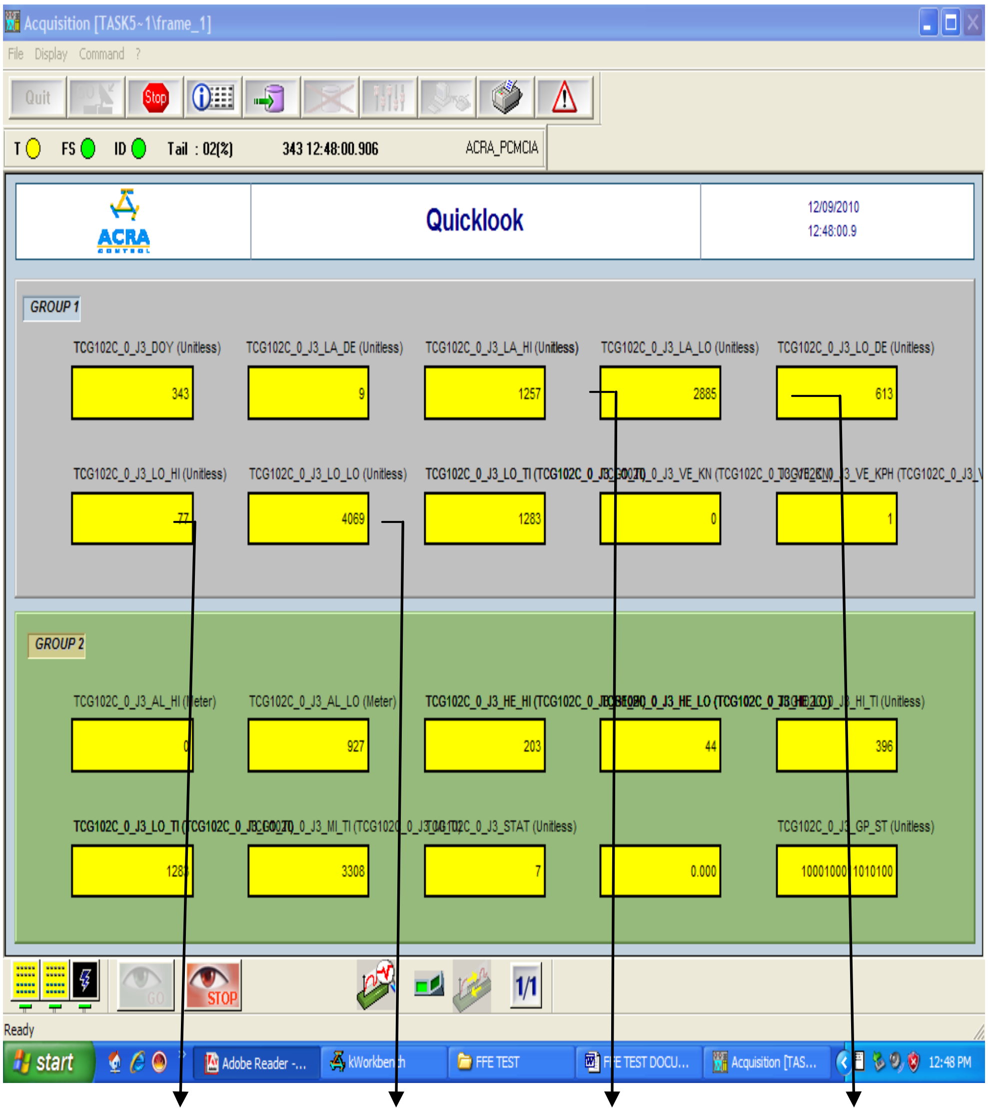
5.1.2 After Locking TCG DOY And TCG_GP_ST (MSB =1 DENOTES GPS LOCKING), Checked On 09/12/2010 (DOY = 343)



TCG DOY

Fig 5.2 After GPS Locking TCG DOY

5.1.3 Combined GPS TIME IS 7:06:38:74 And ACTUAL TIME IS 12:36 SO COMING PROPERLY (5:30 DIFFERENCE)



LONGITUDE HILONGITUDE LO LATITUDE HI LATITUDE LO

Fig 5.3 Combined GPS Time

5.2 GPS SENSOR'S OUTPUT VERIFICATION IN QUICK REALTIME & MSO

By using KAD/TCG/001/C (Time Code Generator) Card, the GPS sensor's output is acquired in KAM-500. The parameters like Altitude , Latitude etc., are added in the frame as shown in Figure 5.4. The parameter values are checked in Quick Realtime and those values are verified in MSO as shown in Figure 5.5 and 5.6 respectively.

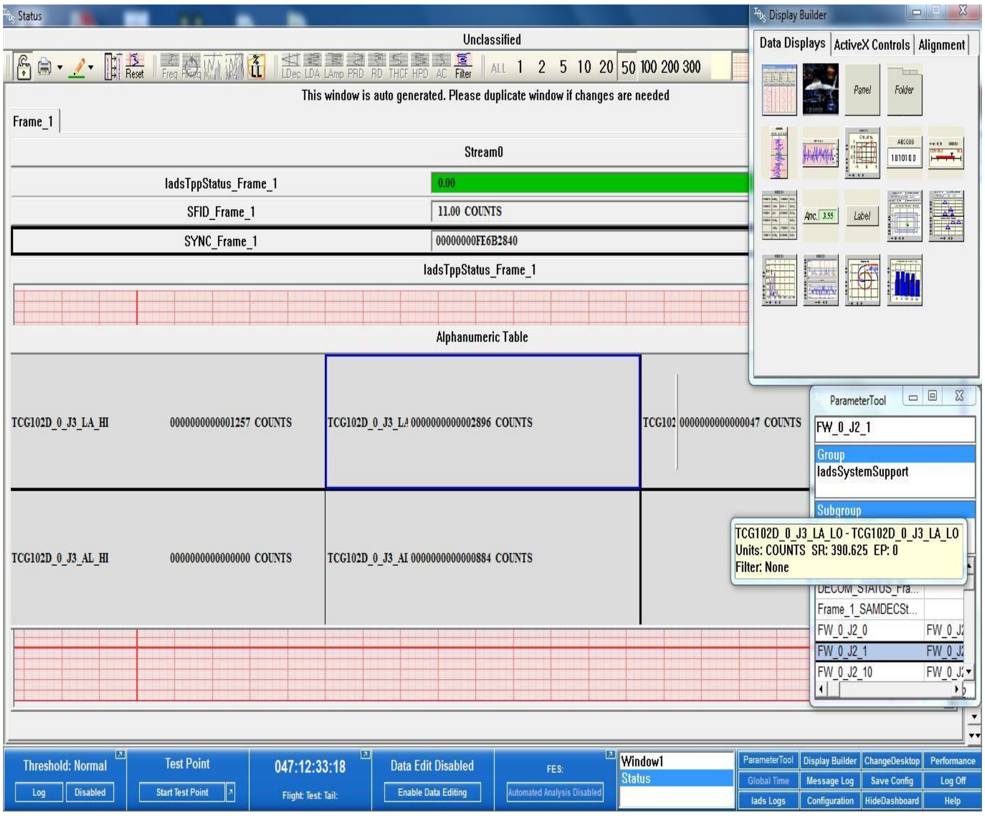


Fig 5.4 TCG output in Quick Realtime

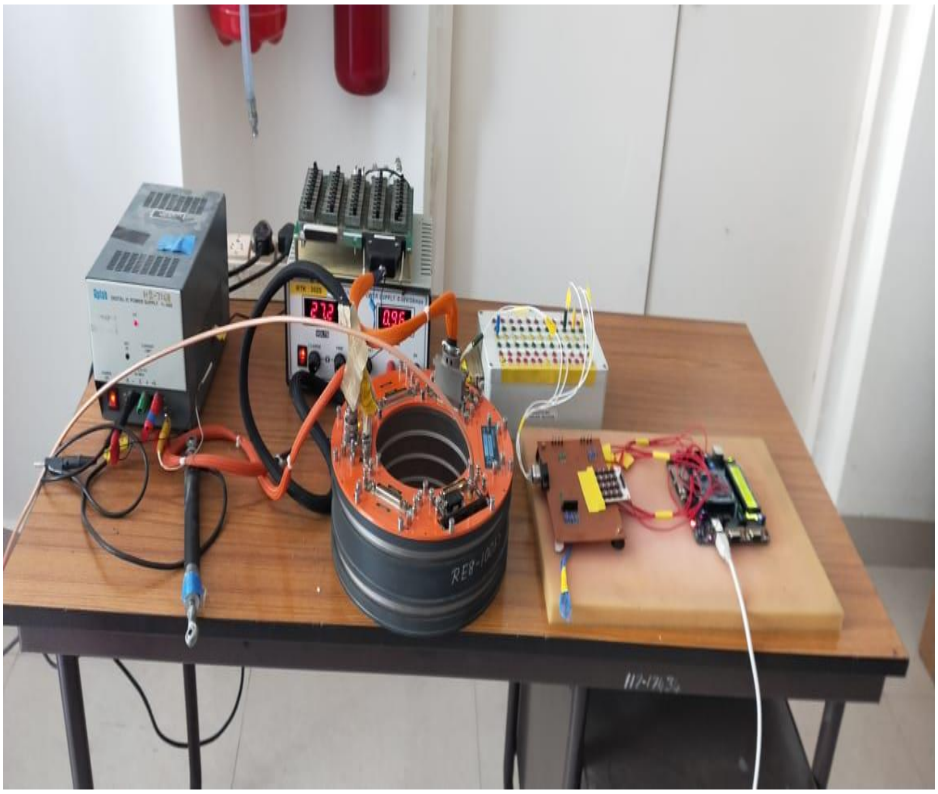


Fig 5.5 RTFDM System Image

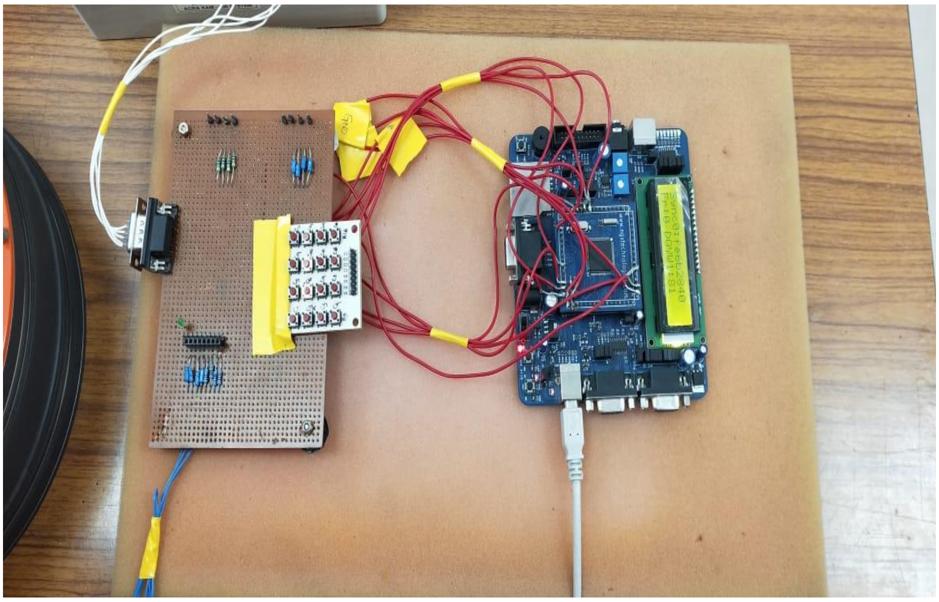


Fig 5.6 Sample Output from microcontroller of word 1(DOY)

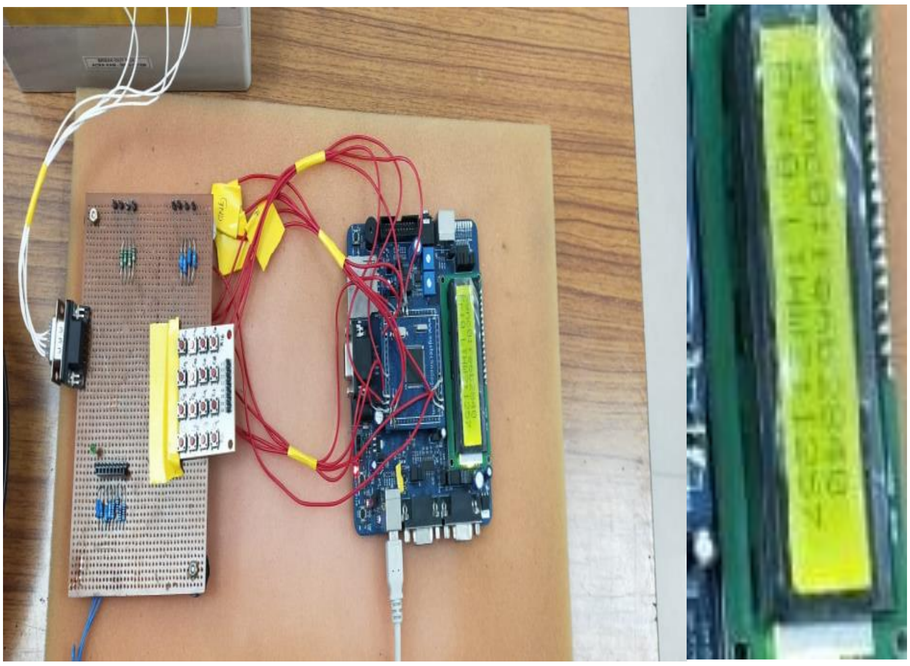


Fig 5.7 Sample Output from microcontroller of word 2(LTH)

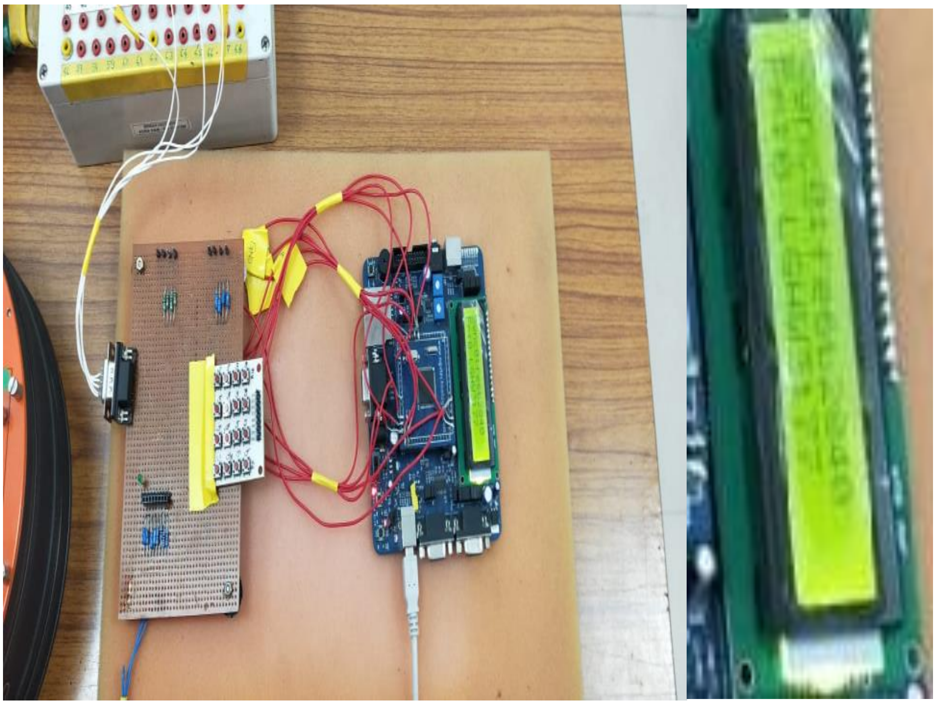


Fig 5.8 Sample Output from microcontroller of word 3(LGH)

CHAPTER 6

6.1 SCOPE OF WORK CARRIED OUT

Flight data provided are PCM signals. These signals are stored as data frames. When the pilot requests for one particular parameter the micro-controller displays the parameter from the real time PCM signal (data frames) acquired during flight. These are main frames and contain sub-frames or mini-frames. The flight-testing parameters are placed in sub-frames in the form of 16-bit words. Each sub-frame contains start frame identification word (SFID) followed by different parameters in 16-bit words and this is followed by synchronization word.

The KAM-500 system is a general-purpose on-board data acquisition system which is a user configurable, programmable. DAS KAM 500 is configured for the different flight test parameters, required by the designer, for the particular flight test program. All the parameters are available in PCM format with the configured bit rate. With the help of keypad which is interfaced with microcontroller, the pilot is able to fetch critical flight test parameter to be monitored the real time value of the parameter is displayed.

6.2 FUTURE SCOPE

- In future the number of parameters read can be increased accordingly to the pilot’s requirement and placed along the major frame so that the pilot can monitor other purposes.
- Video data can also be implemented for visual monitoring.
- We may introduce displaying warnings or corrective actions for pilot in case any parameter real time value deviates from the desired range of values.

CONCLUSION

In the internship I understood working principle Real time flight data monitoring system and evaluated the performance of the system. Also got an opportunity to interact with all the team members and found that the critical parameters from sensor’s output of the aircraft are acquired and the desired parameter is based on the pilot’s choice is displayed and analyzed. The data is acquired and analyzed using data acquisition system and the required Configurations are done in kWorkbench software for analysis of parameters. The frame is built in kWorkbench for analyzing the parameters in Quicklook real time and MSO. The programme for PCM frame detection is implemented in Keil uVision and is debugged for checking whether the data is synchronized with the system.

REFERENCES

[1] M. L. McDaniel.“First flights of Advanced Unmanned Aircraft-Fundamentals of Planning and in Execution “, in AIAA Aviation and Aeronautics Forum and Exposition,2017.

[2] S.Myschik, M.Heller,F. Holzapfel, and G.Sachs,”Low-cost Wind Measurement System For Small Aircraft”, in AIAA Guidance, Navigation, and Control Conference And Exhibit, 2004

[3] F. Ruffier, N. Franceschini, "Optic flow regulation the key to aircraft automatic guidance", Robotics and Automations Systems, vol. 50, pp. 177-194, 2005.

0nline available:

[4]https://maker.pro/arduino/tutorial/how-to-interface-arduino-and-the-mpu-6050-sensor

[7]https://www.grc.nasa.gov/www/k-12/UEET/StudentSite/dynamicsofflight.html

[8]https://www.livescience.com/40102-accelerometers.html

[9]https://howthingsfly.si.edu/flight-dynamics/roll-pitch-and-yaw

[10]https://www.uavnavigation.com/company/blog/uav-navigation-depth-inertial-navigation