Design and Development of Communication Access Terminal and Radio Interface Unit of VoIP Based Advanced Integrated Communication System

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ABSTRACT- The advancements in embedded systems with mixed signal technology have not only benefited various civil applications but also defence, especially in communications and networking. ICS is an integrated communication system developed for Naval ships to cater to their onboard external communication requirements. It consists of various types of radios to be interfaced by using generic gateways along with the User Access Terminals to enable communication from. ICS system and its interfaces got evolved along with the available technologies. The development of ICS started during early 80's, initially with a centralized switching based system with analog based terminals. During late 90's, utilizing the 10Mbps LAN technology for both voice and data, ICS MK-II was developed. There a generic microcontroller based User Terminal was developed to combine the functionalities of various terminals. Now in a pursuit to upgrade the existing system, an IP based system called AICS is being developed to satisfy all the basic and emerging communication requirements of Navy. Communication Access Terminal (CAT) and Radio Interface Unit (RIU) are the two main units being designed for providing user's and radio's audio and data interface respectively to Ethernet network, enabling communication through VOIP sessions.
This project focuses on design and development of upgraded Interface and Switching Board (ISB) for final prototypes of CAT and RIU.

I. INTRODUCTION

A. PREAMBLE

The Communication Access Terminal (AT) is an intelligent remote control unit designed to facilitate remote accessing and control of radios with intercom feature on IP backbone. The Radio Interface Unit (RIU) is a Radio Gateway, providing interface to radios on the IP Backbone. With these interfaces, the reception and transmission of the radio can be controlled directly from AT. Interface and switching board (ISB) is main interface board, designed to provide interface to external entities ie the User, in case of AT and Radio, in case of RIU.

Problem Statement

Design and development of new ISB with incorporation of additional features.

II. LITERATURE SURVEY

This chapter brings out the previous work done in the subject area. The survey has been detailed further, covering the evolution and development activities that have taken up till the recent times. In the first part of survey,

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The in house development activities have been enumerated and later few case studies have been briefed covering the similar work undertaken by other companies globally.

A. In House Developments

As part of in house development, along with the evolution of ICS (with the emerging technologies beneath), the design of Access terminals (Remote control units) also have gone through many phases of development. These terminals were designed, around the respective ICS system meeting the functional requirements.

The design and upgrade of Access terminals have taken place in three phases.

A. As part of ICS- MK-I SYSTEM
B. As part of ICS- MK-II and ICS- MK-III SYSTEM
C. As part of AICS SYSTEM

B. AS PART OF ICS-MK-I SYSTEM

Initially as part of ICS-I, total three types of remote control units (access terminals) were designed.

a. RCU : Remote control unit
b. RCSU: Remote control switch unit
c. LCU : Loud speaker unit

The RCU was designed with the objective to access radio as allocated and get its audio on the connected Head Set. The RCSU was designed with the feature to switch radios up to 04 in no. LSU was an extension to these units to provide interface with 1W speaker thereby providing more volume to end operator. These units were designed using analog circuits with no software content and were connected to Centralized Exchange through audio and discrete lines.

III. AS PART OF ICS-MK-II AND ICS MK-III SYSTEM

To combine the functionalities of above mentioned units ie RCU, RCSU and LCU into single unit, as part of optimized design upgrade, an integrated microcontroller based Access terminal called as Intelligent Terminal Unit (ITU) was designed. It also facilitated reduction of large number of interconnections otherwise normally required from remote user location. The two main boards providing control and interface to peripherals were called as controller board and signal switching board respectively.

A. DEVELOPMENTS BY OTHER COMPANIES

Following companies have also developed and supplied the similar access terminals (remote positions) as part of their system.

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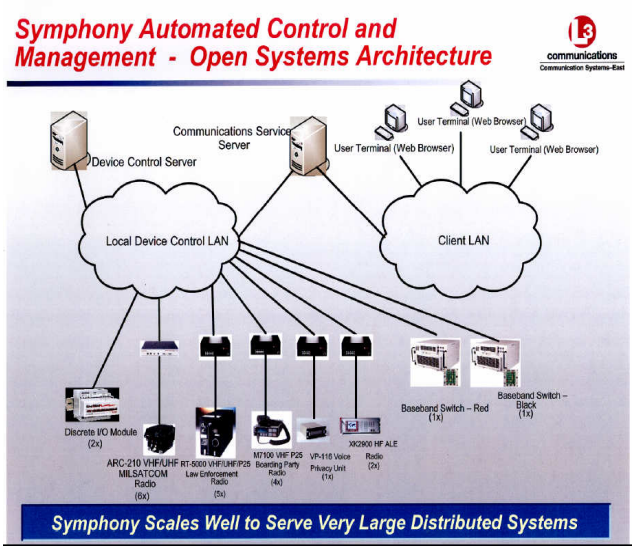
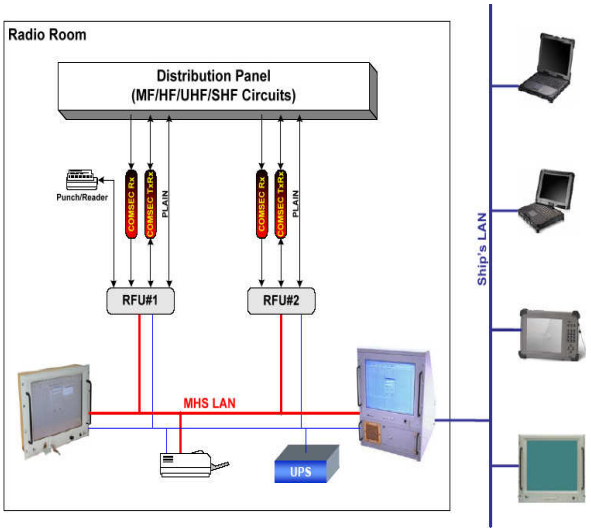
a) SELEX (ITALY)

b) L3 COMMUNICATIONS (US)

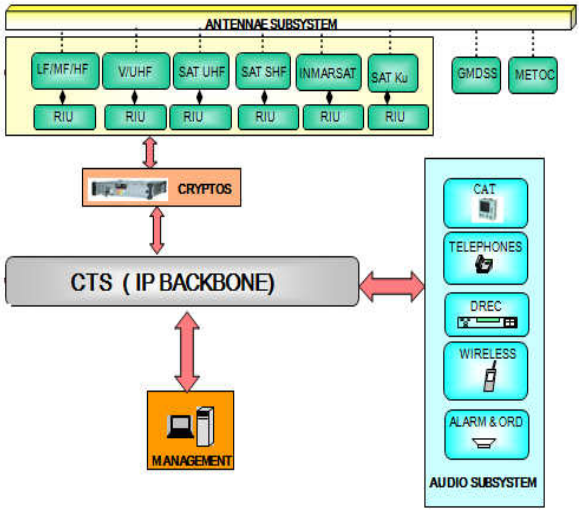


c) EID (PORTUGAL)



B. AS PART OF AICS SYSTEM

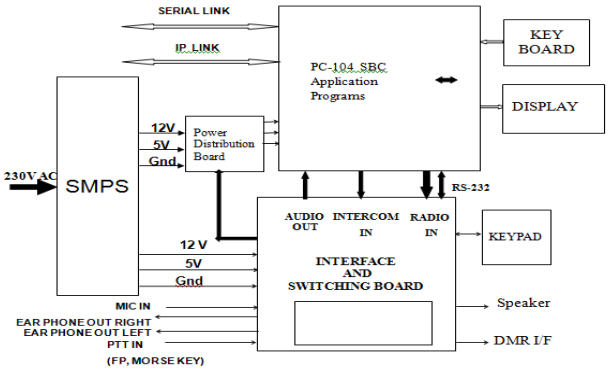
As part of AICS, the CATs and RIUs are being designed by combining the functionalities of controller board and signal switching board of ITUs and provide connectivity as per below block diagram.



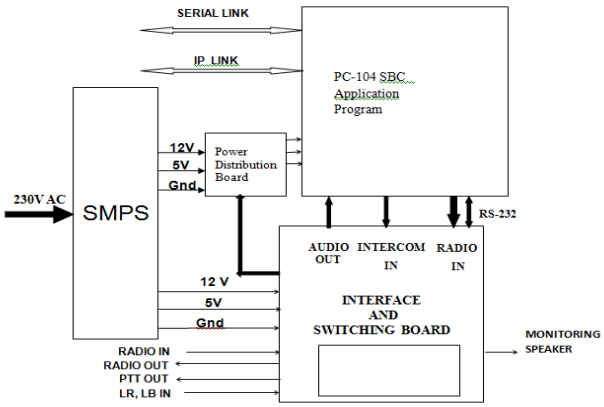
Block Diagram of Advanced Integrated Communication System (AICS)

IV. DESIGN AND IMPLEMENTATION OF PROPOSED INTERFACE AND SWITCHING BOARD

Based on the new functional block diagram for CAT and RIU, emerged after carrying out the feasibility study of new requirements, finalization of components and schemes, a new ISB for CAT and RIU is designed, meeting the requirements of all the additional features envisaged. The H/W design activity started with the finalization of detailed block diagram of CAT and RIU. The finalized detailed block diagram for CAT and RIU is shown in the following figures.



Detailed Block Diagram of CAT



Detailed Block Diagram of RIU

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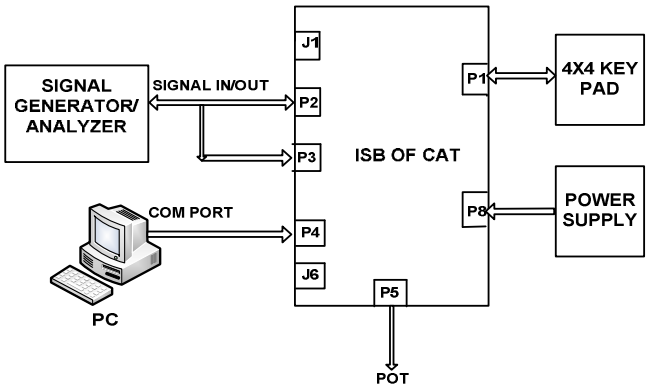
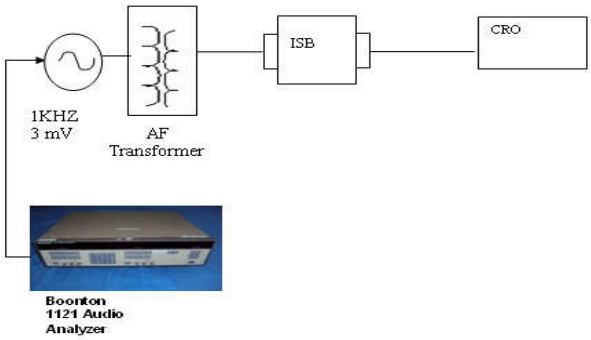
The software work started with the flow diagram finalization of ISB.

V. RESULTS AND DISCUSSIONS

The ISB of CAT and RIU after assembly was tested with few observations. and tested as below.





TEST SETUP

5.1.1 INITIAL CHECKS

a) Check for continuity of +5V (P8-4), +12V (P8-1 and P8-5) and Ground (P8-2 and P8-3) to their respective pins in the power supply.

b) Ensure that jumper settings are as below.

I. For JP6 and P38, it should be set across pin 1-2.

II. For JP1, JP3, JP4 & JP5, it should be set across pin 2-3.

c) Power "ON" the ISB and ensure that ALE signal from microcontroller is available at "P32".

5.2 ON/OFF TEST

a) Check whether the pins ''P8-6'', ''P8-7'' and ''P8-8'' are high (5V Volt) or low (Gnd).

b) If the pins are low, short the pins ''J6-2'' and ''J6-4'' and check whether the pins ''P8-6'', ''P8-7'' and ''P8-8'' become high.

c) If the pins are high, keep the pins ''J6-2'' and ''J6-4'' shorted for about 5 seconds and check for the shutdown message on the PC as below.

d)

0X7E	0X0A	0X0F	0XFF	0XFF	0XFF	0XFF	0XFF	0XFF	0XFF	0XFF	0X7E

5.3 PTT TEST

a) Short pins ''P2-10'' and ''P2-12''.

b) Check for PTT message on PC as below.

0X7E	0X0A	0X03	0X01	0XFF	0XFF	0XFF	0XFF	0XFF	0XFF	0XFF	0X7E

c) Release pins ''P2-10'' and ''P2-12''.

d) Check for PTT release message on PC as below.

0X7E	0X0A	0X03	0X00	0XFF	0XFF	0XFF	0XFF	0XFF	0XFF	0XFF	0X7E

5.4 AUDIO INPUT TEST

a) Feed 5 mV rms balanced sinusoidal signal (1 KHz) across pins ''P2-2'' and ''P2-3''.

b) Ensure that the same signal with amplified value of around 900mV± 100 mV rmsisavailable across pins "P3-1" and "P3-3" (Gnd).

c) Feed balanced 770mV rms sinusoidal signal (1 KHz) across pin "P2-13" and "P2-14".

d) Ensure that the same signal with amplified value of around 800mV± 100 mV rms is available across pins "P3-2" and "P3-3"(Gnd).

5.5 AUDIO OUTPUT TEST

a) Connect potentiometer on "P5'' as follows:

i. P5-8 –POT1 pin 1
ii. P5-9 –POT1 pin 2
iii. P5-13–POT2 pin 1
iv. P5-15–POT2 pin 2
v. P5-4 – POT3 pin 1
vi. P5-12–POT3 pin 2
vii. P5-2 – POT3 pin 3

b) Feed770 mV rms sinusoidal (1 KHz) signal together to both pins "P3-5'' and ''P3-4''. ''P3-3'' should be grounded.

c) Observe and ensure that the same signal with 330mV ± 100mV rms value is available both at ''P2-6'' and ''P2-9'' pins at maximum position of POT1 and

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POT2. Vary POT 1 & 2 and ensure that the signal varies accordingly.

d) Observe the output across''P5-18'' and ''P5-19'' (Gnd) which should be 9V ± 1V p-p at max. Position of POT3. Vary POT3 and ensure that the signal varies in 0V to 9V p-p range accordingly.

e) Observe and ensure that the same signal with 330mV± 100 mV rms value is available at both the pins "J1.1"and "J1.3" individually.

f) Observe and ensure that the same signal with 770 mV rms ± 50mV rms value is available across pins "P2-15'' and ''P2-16''.

5.6 1KHZ TEST

a) Send 1KHz ON message from PC to ISB as below.

0X7E	0X0A	0X04	0X01	0XFF	0XFF	0XFF	0XFF	0XFF	0XFF	0XFF	0X7E

b) Observe and ensure that 1KHz sinusoidal signal is available at pin "P3-1" and "P3-3"(Gnd).

c) Send 1KHz OFF message from PC to ISB as below.

0X7E	0X0A	0X04	0X00	0XFF	0XFF	0XFF	0XFF	0XFF	0XFF	0XFF	0X7E

d) Observe and ensure that 1KHz sinusoidal signal is not available at pin "P3-1" and "P3-3"(Gnd).

5.7 KEYPAD TEST

a) Press CL/ANS, followed by "1", "2", "3" in succession and "ENT" key.

b) Check for intercom call message on the PC as below.

0X7E	0X0A	0X07	0X01	0X02	0X03	0XFF	0XFF	0XFF	0XFF	0XFF	0X7E

c) Press "RAD", followed by "4", "5", "6" in succession and "ENT" key.

d) Check for Radio call message on the PC as below.

0X7E	0X0A	0X08	0X04	0X05	0X06	0XFF	0XFF	0XFF	0XFF	0XFF	0X7E

e) Press "FCH", followed by "7", "8", "9" in succession and "ENT" key.

f) Check for FCH message on the PC as below.

0X7E	0X0A	0X09	0X07	0X08	0X09	0XFF	0XFF	0XFF	0XFF	0XFF	0X7E

g) Press SPL, followed by "0", "3" in succession and "ENT" key.

h) Check for SPL message on the PC as below.

0X7E	0X0A	0X0A	0X00	0X00	0X03	0XFF	0XFF	0XFF	0XFF	0XFF	0X7E

i) Press "END" and check for END message on the PC as below.

0X7E	0X0A	0X0B	0XFF	0XFF	0XFF	0XFF	0XFF	0XFF	0XFF	0XFF	0X7E

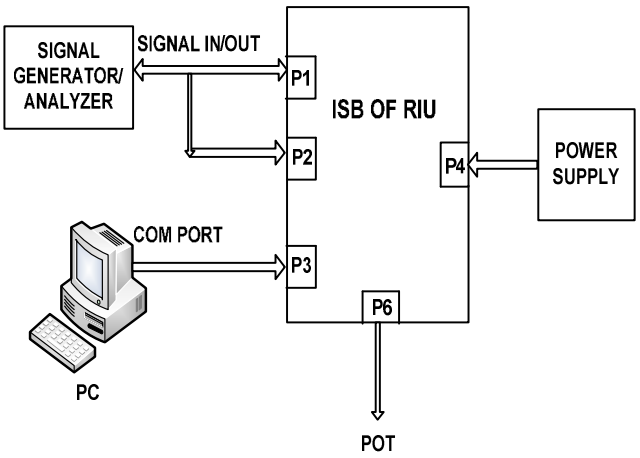
j) Send Keypad backlight message from PC through COM Port as below .

0X7E	0X0A	0X12	0X01	0XFF	0XFF	0XFF	0XFF	0XFF	0XFF	0XFF	0X7E

k) Check for 5V between pins P1-9 and P1-10.

VI. ATP FOR TESTING ISB OF RIU

i. Make the PTP setup as per below Figure.



1.1 INITIAL CHECKS

a) Check for continuity of +5V (P4-4), +12V (P4-1 and P4-5) and Ground (P4-2 and P4-3) to their respective pins in the power supply.

b) Ensure that the jumper for ""JP1, "JP6", and "JP7"is put across Pin-2 and 3 and for "JP2"to "JP5", "JP9"to "JP14" is putacross pin 1&2.

1.2 ON/ OFF TEST

a) Check whether the pins"P4-6", "P4-7"and "P4-8""are high (5V) or low (Gnd).

b) If the pins are low, short the pins "P6-7"and "P6-8" and check whether the pins "P4-6", "P4-7"and "P4-8" become high.

c) If the pins are high, keep the pins "P6-7"and "P6-8" shortedfor about 5 seconds and check for the shutdown message on the COMPort of the PC as below.

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0X7E	0X0A	0X0F	0XFF	0XFF	0XFF	0XFF	0XFF	0XFF	0XFF	0XFF	0X7E

1.3 PTT TEST

e) Send the PTT Activate message from the "COM PORT" of the PC to the ISB as below.

0X7E	0X0A	0X03	0X01	0X01	0X00	0X01	0X01	0X00	0XFF	0XFF	0X7E

f) Ensure that the pins "P1-13"and "P1-14" are shorted.

g) Send the PTT deactivate message to the ISB as below.

0X7E	0X0A	0X03	0X00	0X00	0X00	0X01	0X01	0X00	0XFF	0XFF	0X7E

h) Ensure that the pins "P1-13" and "P1-14" become open.

1.4 AUDIO IN TEST

a) Connect a Potentiometer on "P6" to following pins:
   I. P6-2 -POT pin 1
   II. P6-4 - POT pin 2
   III. P6-3 - POT pin 3

b) Feed 0dBm balanced sinusoidal signal (1 KHz) across pin "P1-1" and pin "P1-2".

c) Observe the output across pin "P2-2"and "P2-3" (Gnd) which should be 900mV ± 100mV rms.

d) Observe the output across pin"P6-6"and "P6-8" (Gnd) which should be 9V±1V p-p at maximum position of potentiometer. Vary the potentiometer and check for the signal varying in the range from 9Vp-p to 0V.

1.5 AUDIO OUT TEST

a) Connect a Potentiometer on "P6" to following pins:
   i. P6-2 – POT pin 1
   ii. P6-4 - POT pin 2
   iii. P6-3 - POT pin 3

b) Feed770 mV rms sinusoidal signal across pins "P2-4"and"P2-3" (Gnd).

c) Send PTT activate message from the PC to the ISB through "COM PORT".

d) Observe the output across pin "P1-3"and "P1-4" which should be 0dBm ± 3dBm balanced signal.

e) Observe the output across pin "P2-2"and "P2-3" (Gnd) which should be 770mV ± 50mV rms.

f) Observe the output across pin "P6-6"and "P6-8" (Gnd) which should be 8V±1V p-p. Vary the potentiometer and check for the signal varying in the range from 8Vp-p to 0V.

g) Send PTT deactivate message from the PC to the ISB.

1.6 STATUS TEST

a) Feed 12V to both Pins"P1-11"and "P1-12". Check for the corresponding status message on the PC as below.

0X7E	0X0A	0X06	0X00	0X00	0X00	0X00	0X00	0XFF	0XFF	0XFF	0X7E

b) Feed 0V to both the pins"P1-9"and "P1-10". Check the corresponding status message on the PC as below.

0X7E	0X0A	0X06	0X00	0X01	0X01	0X01	0X01	0XFF	0XFF	0XFF	0X7E

TEST RESULTS FOR ISB-CAT

Input signal (mic) at P2 1and P2 2	1st stage	2nd stage	Last stage	Signal to Line In of PC104 P3 1
3mV	45mV	540mV	1.08V	1.08V

Ear Piece and loudspeaker signal levels.

Signal at P3 4and P3 5(lineout of PC104)	Signal at P2 13 and P2 15 (Dat Recorder)	Signal at P2 4 and P2 5 (earpiece)	Signal at P5 13(Speaker)
1V	1V	Varying from 0 to 1V according to POT of earpiece	Varying from 0 to 8V(p-p) according to POT of speaker

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6.2 TEST RESULTS FOR ISB-RIU

Signal at P1 1and P1 2	Signal to Line In of PC104 P2 2
0dBm	1.4V

Signal at P2 4(line out of PC104)	Signal at pin P1 3 and P1 4
1V	0dBm

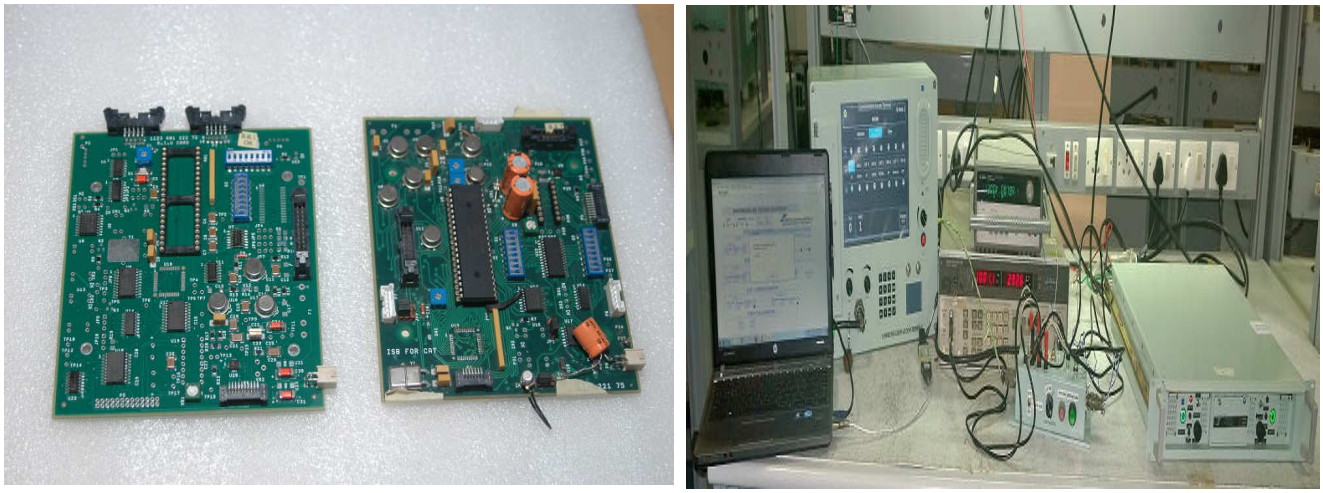

FIG 6.4: Test Setup of CAT and RIU integrated with ISB and PC104

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