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Communication System in Hawk Aircraft Using Integrated Communication

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***Abstract-:* The ICRNI [1] system forms an integrated part of a modern avionics system. The system provides the pilot with an effective and efficient means of performing the communication, radio navigation support and identification functions like Air to Air (A/A) and Air to Ground (A/G) VHF/UHF Radio communication [2]. The pilot requires voice communications between other aircraft as well as between ground stations or ground forces in order to exchange information which is essential for performing the mission. In this application radios which operate in the VHF as well as the UHF frequency band have been used to ensure compatibility with aviation frequency bands. The radios may however, be changed to enable voice communication in other frequency bands, as the particular application requires**
***Keywords:* HAWK, INCOM, Amplitude Modulation, Frequency Modulation, DSP Processor, PLL.**

I. INTRODUCTION

INCOM is an airborne V/UHF transceiver intended for air to air and air to ground two-way half duplex voice communication. The equipment covered by this specification provides radio frequency reception and transmission of Amplitude Modulation (AM) signals on any of 1920 channels in the 108MHz to 155.975MHz of Very High Frequency (VHF) band or 7000 channels in the 255MHz to 399.975MHz of Ultra High Frequency (UHF) band in 25 KHz channel spacing channel. It also provides radio frequency reception and transmission of Frequency Modulated (FM) signals on any of 720 channels in the 156MHz to 173.975MHz of maritime Very High Frequency (VHF) band in the 25 KHz increment.

Additionally this transceiver can be configured to receive one of the following three guard frequencies whenever the respective band of frequency is selected for operation.

243.000MHz UHF (AM)
121.500MHz VHF (AM)
156.800MHz VHF (FM)

The guard frequency corresponding to the band of operation is continuously monitored for reception by an independent guard receiver.

A. INCOM interface with aircraft & operator controls to INCOM

User interface with INCOM, inside the aircraft is through HMI (Human Machine Interface) positioned inside the cockpit. The interface between INCOM system and user is affected through HMI. MIL-STD 1553 BUS controller connects HMI to INCOM transceiver. The operating frequency and modes can be set using the HMI. The preset channel can also be programmed.

II. SALIENT FEATURES

A. Frequency range 108MHz to 399.975MHz with 25 KHz channel spacing.
B. Facility to select AM or FM modes of operation.
C. Guard channel in the VHF AM/VHF FM/UHF AM.
D. Facility to program 40 preset channel.
E. Extensive BITE facility provided.
F. Single wide band antenna operation.
G. Power output of 20 watts provision to select high/low(20/10 watt) power.

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H. Modular construction for easy serviceability and maintainability.
I. MIL STD 1553 bus compatibility.

III. FUNCTIONAL DESCRIPTION

General**:** INCOM 1210A operates on 28 Volts Aircraft power supply.

A. Receiver Function (VHF/UHF)

In, receive mode, the signal received from antenna port is passed through the T/R switch located in the power amplitude module. The switched output is given to main receiver RF input port. In the main receiver module the received RF input signal is passed through an Over load protection switch and then amplified. The amplifier output is given to a 3db splitter. One output of splitter goes to guard receiver input port, the other output signal is amplified or attenuated depending on the signal strength. UHF Tuned Filter (UTF) or VHF Tuned Filter (VHF) depending on the operating frequency of the system filters this amplifier output.
The filtered output is mixed with LO to generated the 70MHz IF output. The LO is generated by synthesizer module. The 70MHz IF output is filtered by selectivity crystal filter and then down converted to 500KHz by mixing with 70.5MHz locally generated crystal oscillator output.

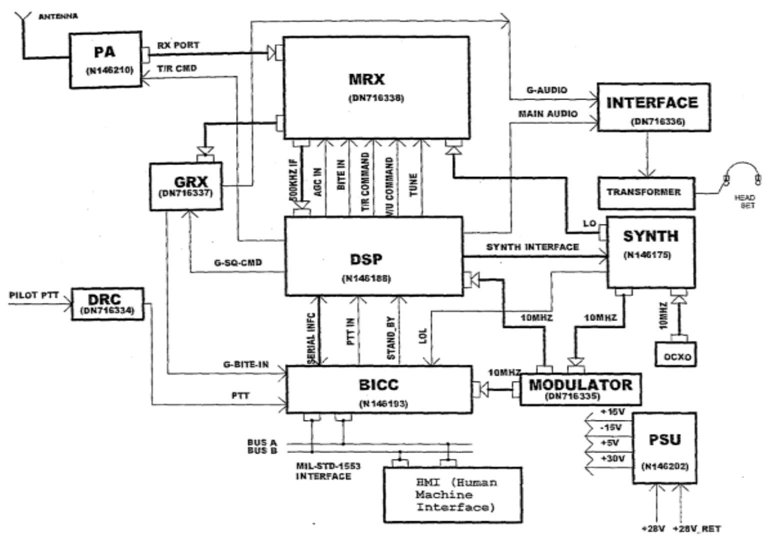

Fig 1: RECEIVER BLOCK DIAGRAM

Digital Signal Processor (DSP) module uses digital signal processors and associated hardware for further IF signal processing. The generated 500 KHz IF signal is converted into digital form by using an analog to digital (A/D) converter. The digital output of A/D is passed to DSP processor for demodulation. The demodulation is done by using software algorithms. Apart from demodulation, it also does the following functions:

1) AGC Generation
2) Audio Filtering
3) Digital Volume Control
4) Squelch Function
5) Synthesizer Code for LO Generation
6) BITE Status of the System

The demodulated output is then given to a digital to analog (D/A) converter to generated the analog audio output. This analog audio is added with audio output from the guard receiver and then filtered by an audio band pass filter located in the interface module. The filtered audio output is boosted to the required level to drive the headset.
The 500KHz IF output is generated in the same way for both AM and FM signals in the main receive module except that the VHF

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tuned filter or UHF tuned filter is selected depending on the operating frequency (VHF or UHF) of the system. The demodulation is carried out by different software algorithms based on the AM or FM mode in the DSP module to generate the demodulated audio in the digital form. The further D/A conversion and audio processing of this demodulated signal is carried out in the same way for both AM and FM modes to drive the headset.

B. Transmitter function (VHF/UHF)

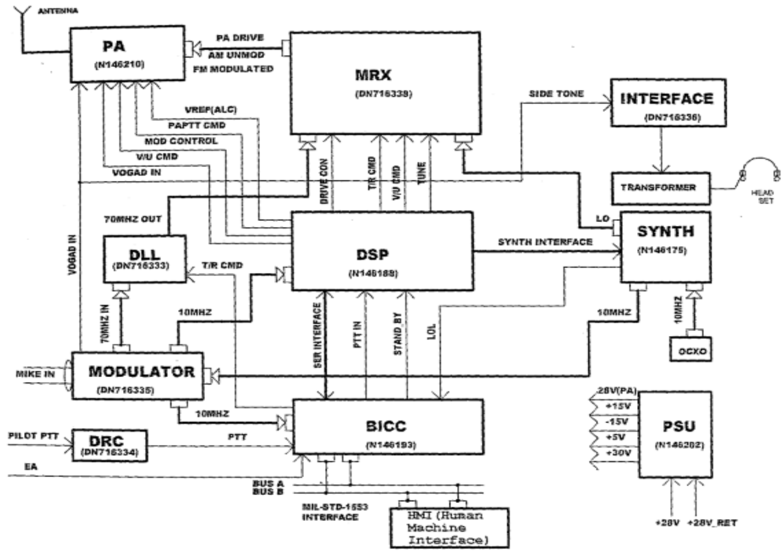

Fig 2: TRANSMITTER BLOCK DIAGRAM

1) Amplitude modulation

a) In transmit condition; the microphone output is fed to the Voice Operated Gain Controlled Device (VOGAD). Located in the modulator to generate the constant audio output level for modulation. The audio output from VOGAD is given to the power amplifier module.

b) The 70MHz drive required for preamplifier is generated in the modulator module by a Voltage Controlled Oscillator (VCO). The VCO output is phase locked with 10MHz system reference by a Phase Locked Loop(PLL). The 10MHz system reference is generated by a high stability Oven Controlled Crystal Oscillator (OCXO).

c) The phase locked 70MHz output is fed to the DLL module for filtering. The filtered output is then fed to main receiver module for UP conversion. In the main receiver, this 70MHz output is mixed with LO generated by synthesizer. The UP converted output is passed through either UTF or VTF depending on the system operating frequency. The filtered output is amplified by the preamplifier located in the main receiver and fed to power amplifier for further amplification.

d) In power amplifier module, the preamplifier output is passed through a PIN attenuator whose attenuation is controlled by Automatic Level control (ALC) voltage. The VOGAD output from the modulator is super imposed on this ALC voltage for amplitude modulation. The amplitude modulated and level controlled up converted carrier is passed through the subsequent stages of the amplifier chain to boost the power of the signal.

e) The final amplifier output is passed through a T/R switch and filtered by the VHF or UHF low pass filter depending on the operating frequency of the system. The output of this filter is fed to antenna through the directional coupler.

f) The directional coupler couples the portion of the RF power output to generate the ALC voltage required for the level control. The coupled RF output is detected and compared with the reference voltage set for rated power. The output of this comparator is given as ALC voltage and it keeps the RF output power within the limits.

2) Frequency Modulation

a) During FM transmit condition, the microphone output is fed to the Voice Operated Gain Controlled device (VOGAD) to generate the constant audio output level for modulation.

b) The 70MHz drive required for preamplifier is generated in the modulator module by a Voltage Controlled Oscillator (VCO). The constant radio output from the VOGAD is fed to modulation port of the VCO to effect the Frequency Modulation (FM). The VCO output is phase locked with 10MHz system reference by a Phase Locked Loop (PLL). The 10MHz system reference is generated by a high stability Oven Controlled Crystal Oscillator (OCXO).

c) The phase locked 70MHz frequency modulated output is fed to the DLL module for filtering. The filtered output is then fed to main receiver module, this 70MHz output is mixed with LO generated by synthesizer module. The up converted output is passed through VTF. The filtered output is amplified by the preamplifier located in the main receiver and fed to power amplifier module for further amplification.

d) In power amplifier module, the preamplifier output is passed through a PIN attenuator whose attenuation controlled by Automatic Level Control(ALC) voltage. The level controlled up converted carrier is passed through subsequent stages of amplifier chain to boost the power of the signal. The final amplifier output is passed through a T/R switch and then filtered by the VHF low pass filter. The output of this filter is fed to antenna through the directional coupler.

e) The directional coupler couples the portion of the RF power output to generate the ALC voltage required for the level control. The coupled RF output is detected and compared with the reference voltage set for the rated power. The output of this comparator is given as ALC voltage and it keeps the RF output power within the limits.

IV. DRAWBACKS

In INCOM input fed manually, it is fixed with certain frequency and if we need to change the frequency we need change the whole hardware design for that frequency, so it is very complicated to design hardware whenever frequency changed.

V. CONCLUSION

The communication system described in this article is used to transmit only voice channels between air to air, air to ground. since it is a integrated communication there is no further modification possibilities.

VI. FUTURE SCOPE

To overcome the drawbacks mentioned in this communication system we can use other communication systems like SDR[3] , in which we can reprogram for higher frequency use. Communication is highly secured and if we change the frequency no need to design hardware for that changed frequency. In SDR we can transmit both data and voice.

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