Configurable Memory Method for Gain Variation Compensation for RF Systems over Temperature and Frequency

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Abstract-- **Each RF system design has constraint of gain variation over temperature & frequency. This paper contains detailed method to compensate Gain variation over temperature and frequency using configurable memory. It has been implemented in design of RF system containing digital attenuator for defence airborne RF system It is a state of art technology that gives flatness of RF system over temperature and frequency within ±0.25dB.**

Keywords: Gain variations, Configurable memory, Compensation, ARM controller, Beacon Chain,

I. INTRODUCTION

FRONT End RF systems for defence and industrial applications design have to meet severe environmental specifications. In severe environment conditions, the power gain of RF system varies which results as faulty link/ short range or altitude coverage etc.

It is also very difficult to maintain gain flatness within specifications for overall system for broad bandwidth. There are multiple ways available to the selectively amplify or attenuate signals as per the RF system response over bandwidth & temperature. Few gain correction methods using passive components like LC circuits, Pin diode attenuators, AGC, bias variation of gain block digital attenuators etc. but all these methods are tedious time consuming, less reliable and require additional hardware.

In this paper gain variation compensation approach has been discussed for Airborne RF system using configurable memory controlled digital attenuator and synthesisers. The block diagram for Airborne RF system is shown in Fig.1.

In this RF system, three six-bit digital attenuators have been used in Transmit chain, Receive chain and in Beacon chain of operation. As system has to operate in severe temperature range of -20°C to +55 °C thus gain is required to be compensated over temperature and frequency to maintain flatness in ± 0.25 dB.

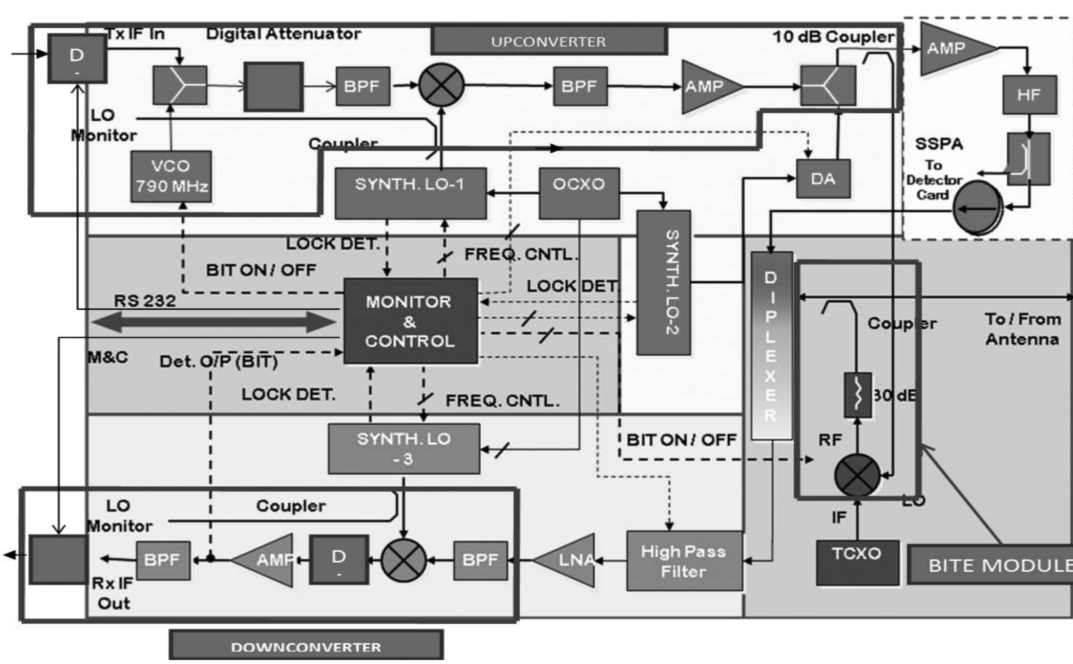

Figure 1. Block diagram of Airborne RF system.

II. DESIGN APPROACH

Complete RF design has been done as per block diagram & specifications to achieve 48 dB Transmit gain & 35 dB Receive gain at room temperature with 2dB attenuator settings for RF system under consideration. In Airborne RF system Monitor & control card consists of ARM controller along with configurable memory. This card provides Characterization of Tx chain & Rx chain at different frequency & temperature has been done to find out variation at different frequency channels & temperatures for Airborne RF System. Airborne RF System characterized over seven temperature levels in -20 ºC to + 55 ºC temperature range & seven Frequency channels in 120MHz.

This gives Tx Gain & Rx Gain Data over seven temperatures & seven frequency channels in Airborne RF system. Comparison gives deviation from average reading in each Tx, Rx & Beacon Chain.

Therefore to compensate this deviation attenuation level needs to increase or decrease as per requirement. Therefore control word has to be applied to digital attenuator in such a way as soon as temperature reaches to particular level the controller should retrieve compensatory control word and apply it to digital attenuators of Tx, Rx & Beacon Chain. For Intermediate temperature range control word of previous temperature level has to be maintained until it reaches to next temperature level.

III. DESIGN METHOD

In the Airborne RF system Design ARM controller along with Configurable memory has been used to select multiple channel of operation, to Control mode of operation (normal/ built in Test), to Monitor Forward Transmit power, Receiver output, etc. LM20 Temperature Sensor has been mounted on housing near to highest heat dissipation point in SSPA to protect the circuit with temperature problems and truly characterize the temperature data.

Control word of digital attenuator has to be ascertained as per characterization data of system at different temperature and frequency levels. This will give fixed control word for particular frequency and temperature. These control words were stored at memory location assigned through microcontroller. In operational conditions as soon as these temperature levels reach at particular frequency channel, the ARM controller retrieves the control ward and digital attenuators, insertion loss varies accordingly. Thus by this method gain variation of ± 0.25 dB was achieved in system for temperature range of -20 ºC to + 55 ºC over 120MHz bandwidth.

This feature can be implemented and extended to any RF system containing Analog Attenuator, phase shifters, AGC etc.

TABLE 1 -- CHARACTERIZED DATA RECODING TABLE

Temp	Transmitter Chain							Receiver Chain							Beacon Chain						
	01	02	03	04	05	06	0C	01	02	03	04	05	06	0C	01	02	03	04	05	06	0C
-20°C																					
-10°C																					
+ 5°C																					
+15°C																					
+25°C																					
+35°C																					
+45°C																					
+55°C																					
+70°C																					

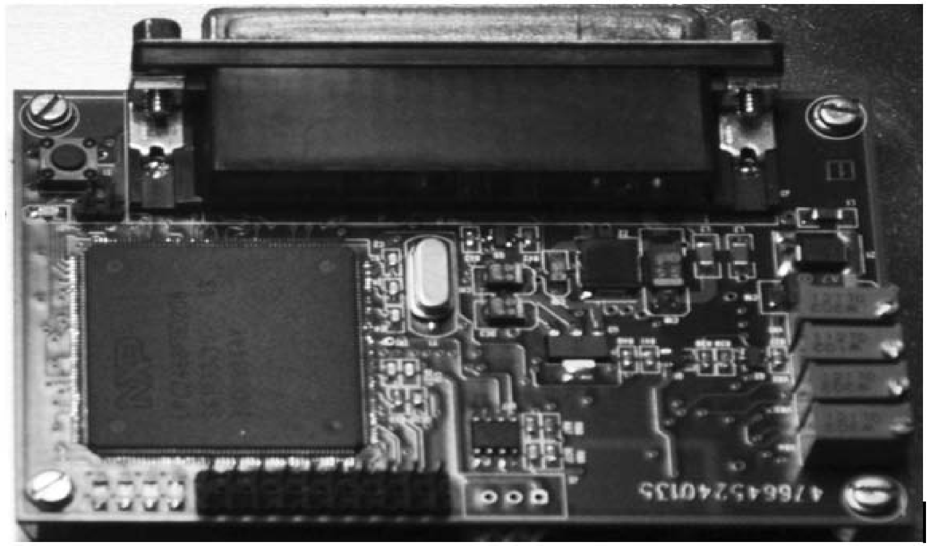

Figure 2. ARM based Monitor and Control Card.

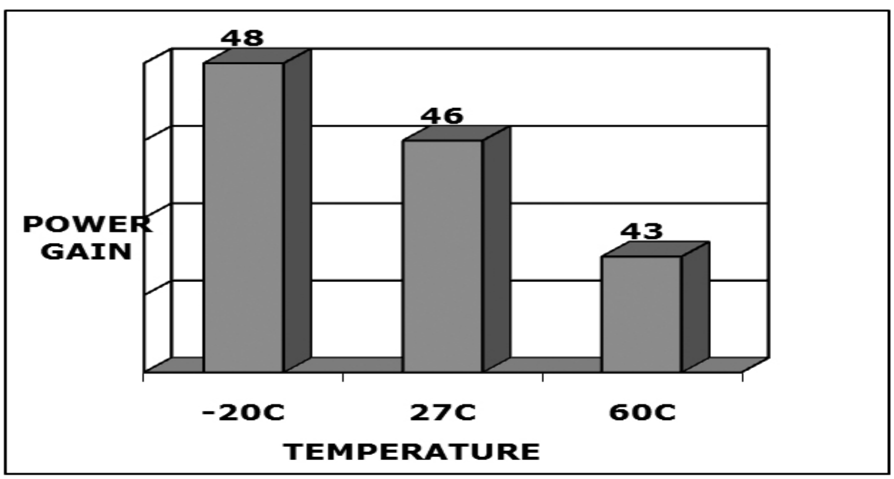

Figure 3. Gain variation over the temperature

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