Design and Development of C-Band Down Converter for Data-link Application

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Abstract – **This paper gives design and development details of C-Band down converter for data-link application. The down-converter facilitates multi channel operation with detected RF output & LO monitoring to verify the performance when system is in use. It converts C band RF input to 900MHz IF output with use of S band LO frequency. It has conversion gain of 35dB and 0.25 dB gain flatness over bandwidth of 120MHz and out-of-band rejection better than 75dBC.**

Keywords: Airborne downconverter, Data link, Amplifier, Built-in-check, Microstrip design

I. INTRODUCTION

DOWN-CONVERTERS are very common for datalink applications now-a-days. Mixers are used for up/down conversion in these designs. Here in this front-end receiver, open-carrier double-balanced mixer has been used because of broader bandwidth with improved linearity, suppression of spurious products and inherent isolation among all ports [1].

Selections of low noise amplifier is very critical in receiver designs. To filter unwanted signals high pass filter and diplexer is used in this design. Ceramic band pass filters have been used to filter out undesired IF and RF signals. Double balanced mixer generates both side bands which can be filtered out by IF filter. Output of band pass filter is applied to mixer through thermopad, which improves return loss of mixer and compensates gain/loss variation over the temperature according to TCR of thermo pad. Two stage MMIC amplifiers along with equalizers, RF Coupler and detector has been used in design to monitor normal working of receiver when system is in use. Digital attenuator has also been used in this design to compensate gain variation over the temperature and frequency.

II. DESIGN APPROACH

Figure 1 shows design approach of Airborne Down converter. It receives input from diplexer and same has been filtered through HPF and amplified by ultralow noise amplifier by 35dB. This is again filtered through BPF and mixed with LO signal in open carrier mixer which generates upper and lower sidebands. Lower side-band passes through bandpass filter at IF side. This is again amplified by gain blocks for required gain. Chip Capacitors of suitable rating have been used to protect all RF, IF, LO ports from unintended DC I/P. RF couplers and detector have been used to monitor LO and IF detector when system is in use. This complete Microstrip design gives benefits of manufacturability, repeatability and low cost. Harmonics and spurious were suppressed using Ceramic BPF. Cascaded low cost MMICs were chosen for appropriate gain so that adequate results over the frequency and temperature are achieved.

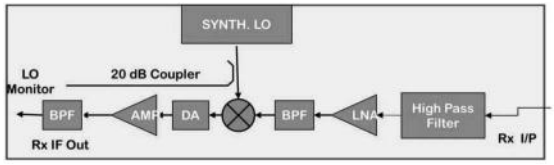

Figure 1. Block diagram of airborne down converter.

III. DESIGN METHOD

In design, Microstrip structure has been used for advantages of hybrid circuits. The established design equation has been used to draw PCB layout using ADS software on Rogers' substrate. Parallel line Coupler for monitoring of LO was designed on same substrate for miniaturized size. Coupler design given by Bryant and Weiss [2] and Kirschning and Jansen [3] were reliable and accurate methods for coupled microstrip lines.

IV. OUTPUT AND MEASUREMENTS

PCB layout of design is shown in figures 3 and 4.

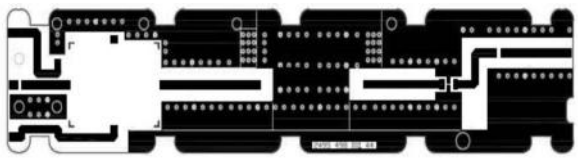

Figure 2. PCB layout of RF side.

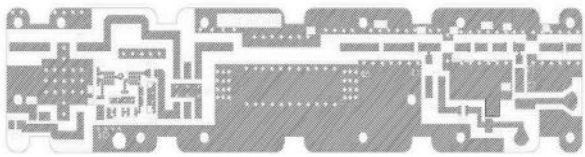

Figure 3. PCB layout of IF side.

Figures 5 and 6 show assembled view of printed PCB with mechanical housing [4], [5].

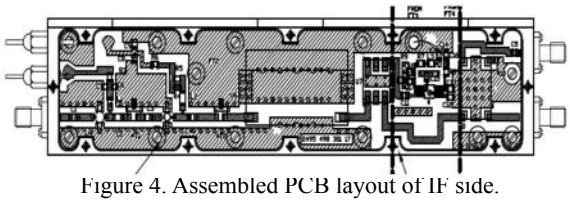

Figure 4. Assembled PCB layout of IF side.

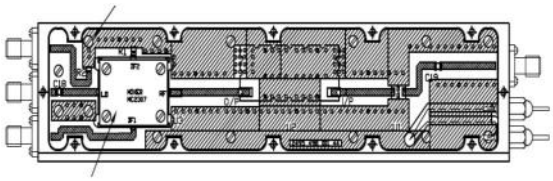

Figure 5. Assembled PCB Layout of RF side mounting details is shown in Fig 6.

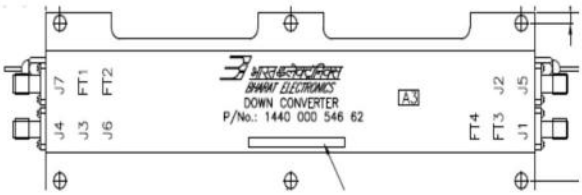

Figure 6. Mechanical housing of down converter.

Figure 7 shows frequency versus gain variation of Down Converter. Gain Variation of 0.3 dB was achieved at room temperature over 120 MHz Band width. Noise figure variation is shown in Fig.8. Module operates in Class A with Current consumption of 125mA@ 5V and 70mA@12Volt.

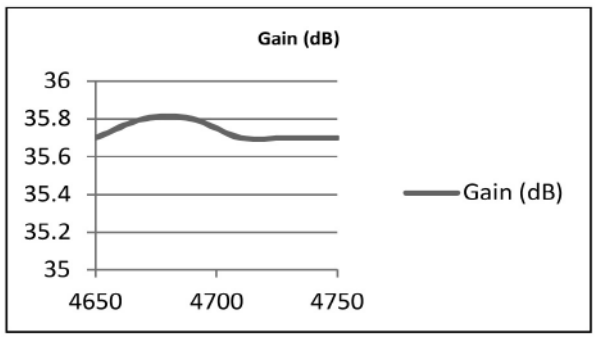

Figure 7. Frequency versus gain of down-converter.

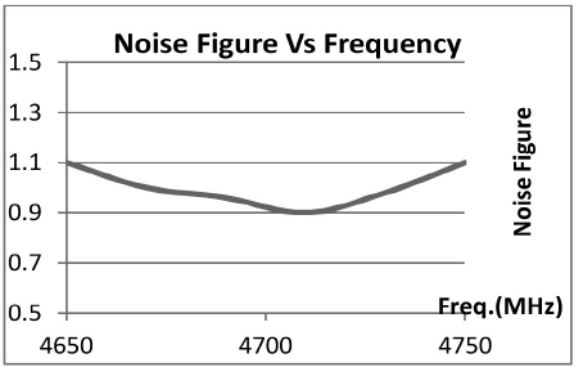

Figure 8. Noise figure versus frequency of down-converter.

V. CONCLUSION

In developed airborne down converter module, gain of 35±1 dB and gain flatness of ±0.25dB over 120 MHz bandwidth was achieved. The developed airborne down-converter module has built-in device to monitor the health of down converter module with multiple IF, LO signals during application. Digital attenuator module makes it suitable to realise reconfigurable system.

Developed module meets EMI/EMC-461E standard because of conductive enclosure. Results meet simulated parameters over -30°C to +55°C. Gain flatness over the frequency and temperature range of the module is <0.25dB. Input, Output Return Loss at all RF, IF & LO Ports <18 dB were achieved.

REFERENCES

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[2] T.G. Bryant and J.A. Weiss, "Parameters of microstrip transmission line and coupled pair microstrip line", *IEEE Trans. Microwave Theory & Techniques,* vol. MTT-16, no. 12, pp. 1021-1027, Dec. 1969.

[3] M. Kirschning and R.H. Jansen, "Accurate wide range design for the frequency dependent characteristic of parallel coupled microstrip lines, *Ibid.* vol. MTT-32, no. 1, pp 83-90, January 1984.

[4] Data sheet of M/A-COM MC4520 Open Carrier Double Balanced Mixer.

[5] Datasheet of RF2046 Transistors.

[6] Data sheet of AG203-86 Transistor.

Amit Tiwari, FIETE obtained Bachelor in Engineering in Electronics and Communication and Master of Technology in Microwave Engineering from IT-BHU. He has 18 years of R&D experience. He served MITS and Institute of Engineering, Jiwaji University Gwalior as an assistant professor. He is currently working as Manager, in Development & Engineering-Microwave Components of Bharat Electronics Limited, Ghaziabad. He has designed and developed C-Band Airborne RF Transceivers, IFF Tx-Rx Unit for AEW&CS, IFF Transmitters for Radars, SSPA, Receivers its components for Data link and Radar applications. He has published various research papers and articles in international journals and conference proceedings.

He has been honoured with IETE Sh. Devi Singh Tyagi Award 2018. He has received various awards for innovative efforts, six sigma, technical symposiums etc.