Case Study of

Cable Modem Termination System (CMTS) Up converter System level design, Testing and Troubleshooting

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RFIC Solutions Inc.

RFIC Solutions Inc is a fabless RF Design House focused primarily on wireless Solutions, with Headquarters in SanJose, USA and design center in India. We design highly integrated system on chip (SOC) and system on a package (SOP); custom ICs, IP cores using state-of-art GaAs, InGaP/GaAs, InP, CMOS and SiGe Semiconductor processes utilizing MESFET, pHEMT and HBT devices. Expertise includes LNA, PA, Switch, complete transceivers/RFICs & RF Modules for any wireless system including WLAN, WiMax, PCS and Cellular applications.

RFIC Solutions Inc. is a Total solution provider for RF & Microwave. Our Business model encompasses Design IPs, Design services, PCB Design services, Layout services, Foundry services & Supply of complete RF chips.

The Client:

The client was a US based organization, one of the big supplier of networking equipment and network management for the Internet headquartered in San Jose, California. It designs and sells networking and communications technology and services. Products includes Routers, switches, network management, interfaces and modules, optical networking, wireless systems, RF and mixed signal board designs.

Design Challenges:

The Client had an existing Up converter board which was part of CMTS (Cable Modem termination System) that had design and specification compliance issues. They wanted new solutions to the existing design that will help the Up converter board to comply with DRFI (Downstream RF Interface Specifications) specs on noise floor and spur specifications.

RFIC Solutions was chosen to help in finding solutions on various issues in the board within 6 months. It was a mixed signal & RF design board, operating from 54 MHz to 870 MHz. RFIC was asked to deliver on following objectives.

1. RFIC Solutions will review the current schematic and board.
2. Based on the current issues related to board, RFIC Solutions Inc. will propose different versions of board by modifying the existing board.
3. RFIC will replace some Chips currently used on the board with alternative chips to optimize the performance (like spur rejection).
4. RFIC Solutions will do the testing of the board.
5. RFIC Solutions will deliver modified board versions based on test results of revised boards.

Issues with the Board:

1. Current Test results showed noncompliance to DRFI specs (Downstream RF Interface Specifications).
2. The 2nd and 3rd Harmonic were too high and were missing the specifications on spurious.
3. Noise floor was too high.
4. Oscillations at 2.3 GHz create many difficulties in meeting DRFI specification.
5. The passive components were taking too much space on board, which increased the size of board and increased parasitic.

Our Solution:

The client chose RFIC Solutions because of our innovative design service model whereby we utilize some of our existing Design IPs, Reference designs/boards and project execution process. We presented a project plan which was efficient in time & engineering resources. RFIC solutions has innovative and cost-effective pricing model that addressed the defined design requirements of our client. The low cost design service was possible through RFIC solutions India design center, where a team of dedicated engineers is providing high quality RFIC design solutions to our customers.

RFIC performed a critical design review of the existing system/board. RFIC solved all the layout related issues like grounding, power supply, long traces, coupling, usage of IC's in power up/power down mode, shielding etc in first phase. RFIC Solutions provided feedback on improving the specification. Based on technical reviews and recommendations we proposed different board versions for testing.

RFIC Solutions provided full support to the team of engineers working at client side during fabrication, testing and troubleshooting of modified board designs. Our RF specialist design team delivered high performance boards with flexibility to test and troubleshoot the boards.

RFIC Solutions Key Contributions:

RFIC Solutions Inc. studied and recommended changes in existing board to achieve DRFI compliant specifications for noise floor and spur. Here is the summary of key recommendations and solutions by RFIC, that helped improve the results:

1. Test Results showed that RFIC's modified board version had improved noise floor and spur specs. RFIC played a major role in testing and troubleshooting of this board. Earlier, the noise floor and spur were off by ~15dB and after modifying the design and

troubleshooting RFIC's modified board, results were very close within 3dB to the DRFI specs. Our measured results showed 2-5 dB better performance than the current client boards in terms of noise floor and spurs.

2. RFIC team made some major contribution by providing recommendation to replace the first stage VGA chip by LNA. RFIC did the VGA simulation and found that VGA has a tendency to oscillate around frequency of 2.7 GHz. We replaced the VGA in our modified board version with LNA and that made it more stable, but the second stage VGA still had a tendency to oscillate. Very careful matching had to be done to make this 2nd stage VGA stable under all conditions.
3. RFIC solutions Inc. also recommended to change the supply voltage of Clock buffer/ Driver to improve the noise floor and spurious performance. We increased the supply voltage for the clock buffer IC, upon which the test results showed improved noise floor.
4. Our improved Design grounding, symmetry of the layout and addition of filters also helped reducing harmonics, and spurious performance.

Benefits for client:

RFIC Solutions Inc. was able to provide on time, cost efficient service to our client which helped them modify the board designs to much better performance within 8 months, from the start of project. The client achieved:

- Required specification with small modifications in design and board.
- Same board size so client was able to replace it in existing systems without redesigning the complete system setup.
- Efficient & focused usage of engineering resources at their location.
- Higher satisfaction through our continual service improvement and support.