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Design and Development of Compact Line Impedance Stabilization Network for Measurement of Conducted Emission

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Abstract:- **In modern life bit commercial Electronic, industrial are defense electronics problem of electromagnetic interference (EMI) is ever growing problem. Accurate and precision measurement of EMI gives vital information about the characteristics of noise (or) EMI which leads to the achievement of electromagnetic comparability. Measurement of conducted emission is an important step towards electromagnetic comparability. Conducted emission can be measured using current probes, voltage probes depending on the applicable measurement standard. In MIL-STD461E a voltage probe method is recommended. A LISN is nothing but a voltage probe associated with impedance stabilization circuit. In the proposed paper a LISN as per MIL-STD461E studied it will be simulated using P-spice software for optimization of its performance. Based on the simulation results a compact LISN will be designed, fabricated and tested for its performance various conducted emission measurements will be carried out using fabricated LISN.**

I. INTRODUCTION

The objective of the paper is to design and development of compact Line Impedance Stabilization Network for measurements conducted emission. Measurement of conducted emission is an important step towards electromagnetic comparability. Conducted emission can be measure using current probes, voltage probes depending on the applicable measurement standard. OrCAD is a proprietary software tool suite used primarily for electronic design automation (EDA). The software is used mainly by electronic design engineers and electronic technicians to create electronic schematics and electronic prints for manufacturing printed circuit boards. The name OrCAD is a portmanteau, reflecting the company and its software's origins: Oregon + CAD. A P Spice circuit description file (*.cir) contains the configuration data for circuit simulation with the OrCAD EE P Spice simulator. The simulator processes such files, and generates a simulation result file (*.out), as well as a binary probe data file (*.dat) for viewing waveforms. PSpice Circuit files are typically generated by OrCAD Capture or other schematic capture application, and may also be entered manually in a text editor. The circuit file contains the component netlist, simulation options, analyses statements, and the output control statements. The component net list comprises a list of all circuit elements, along with the node names connected to their terminals. The netlist topology is converted into an equivalent matrix which is solved to find the circuit state, and is also used to simulation output file..

II .LISN

An LISN is a low-pass filter typically placed between an AC or DC power source and the EUT (Equipment Under Test) to create a known impedance and to provide a Radio frequency (RF) noise measurement port. It also isolates the unwanted RF signals from the power

Fig 1:LISN

source. In addition, LISNs can be used to predict conducted emission for diagnostic and pre-compliance testing.

Function of an LISN:

The Line Impedance Stabilization Network, or LISN, as it is commonly called, is used for the measurement of conducted emissions on power lines. The basic setup for the conducted emissions test is as shown in figure (i). The LISN gets its power from the ordinary wall outlet and feeds the power to the Equipment Under Test (EUT). Any RF noise generated by the EUT is separated by the LISN and fed to the spectrum analyzer for measurement or recording.

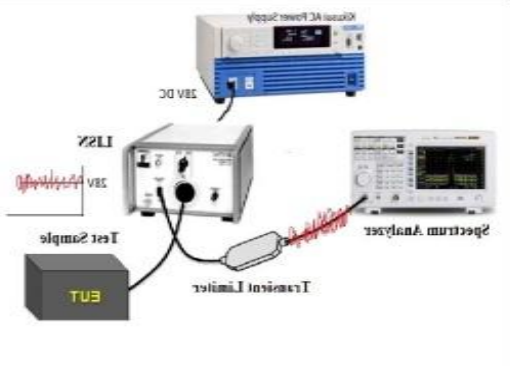

Fig 2:Basic setup for the conducted emissions test

2.1Functions performed by the LISN

The LISN performs four important functions. These are described below.

1. Stable Line Impedance:

The first function is to provide stable, This is important because the outlet can vary greatly depending on how and where the wiring is connected The amount of EUT noise present related to the impedance of the power line vs the two impedances effectively create a voltage divider network allowing only a fraction of the noise voltage to reach the measurement port. Therefore, the ability to achieve reliable and consistent measurement results depends highly on the reliability and consistency of the LISN impedance during the test

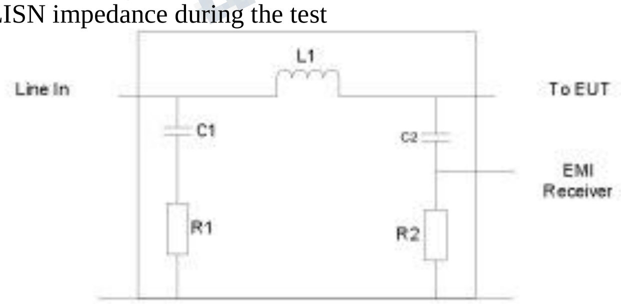

Fig 3: Circuit diagram of LISN

The FCC and CISPR "recommended" circuit for the LISN is shown in Figure 2 above. However, this simple circuit may not always perform as intended because of stray capacitances and inductance present in the constructed circuit, as they have significant impact on the circuit performance at RF frequencies. In particular, the stray capacitance may cause resonance, and as a result the impedance may have unexpected dips. The LISN has to be designed and built very carefully in order to comply with the curve shown in figure 3 across the entire frequency range.

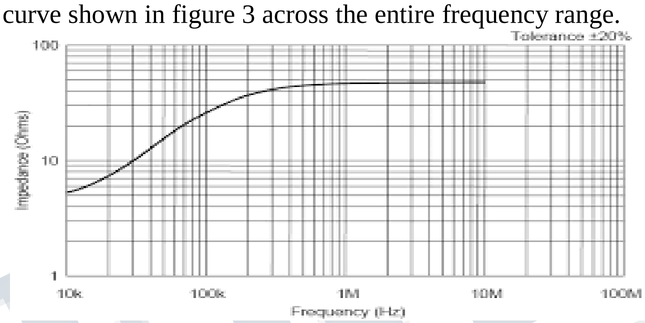

Fig 4: LISN Impedance vs frequency graph

LISN Prevents External Noise Coupling In Another very important function of the LISN is to isolate the external noise which may be present on the power line. The 50 micro-Henry inductance presents a high impedance to the outside RF noise while allowing the lower frequency power to flow through to the EUT. The first 1.0 microfarad line to ground capacitor forms the first stage of a two-stage filter, working with the inductor to accomplish this goal. Suitable Connection to the Measuring Equipment A spectrum analyzer or EMI receiver is typically used as the measuring meter for this test. The input stage of these devices is very sensitive, and prone to damage. The LISN is designed to allow the low-level RF noise from the EUT to easily couple through the 0.1-microfarad capacitor to the 50-ohm input of the measuring meter, while the The 10k-ohm resistor reduces the low frequency power line voltage. Knowing the basic functions of the LISN, it will be easy to understand why so many different types of LISNs are needed. One reason is that the LISNs are used for different tests and correspondingly different frequency ranges. Let us consider first the 50 micro- Henry LISN discussed above. This LISN is used for FCC compliance as well as CISPR testing in the range of 150 kHz to 30 MHz. However, if the testing required begins at 10 kHz, a two stage circuit is needed with an additional L-section comprised of a 250 micro-Henry inductor and an 8-microfarad capacitor. This LISN with

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the extra filter works better in the 10 kHz to 150 kHz region than the single stage circuit 50 micro-Henry LISN.
Also, the value of the inductor is based on the anticipated inductance of the power line for the intended installation of the product. As discussed previously, MIL-STD specifies a 50 micro-Henry inductor for the LISN. This value was selected because it represents the inductance of power distribution wiring running for approximately 50 meters, which is representative of a wiring system on a ship or cargo aircraft. However, for smaller platforms such as fighter aircraft, inductance values may be substantially lower than 50 µH, in which case 5 µH LISNs are recommended. In addition, higher EUT current requirements require higher current handling components, which add to the variety of LISNs needed. The current handling capability of an LISN has two important aspects; temperature and saturation of the inductor. The characteristics required by the regulations do not include the performance testing under load. Therefore, some suppliers manufacture LISNs that use inductors with magnetic core material. Inadequate current carrying capability would be discovered easily due to temperature rise. However, saturation of core may not be discovered easily. Utilizing air core inductors avoids saturation and unreliable operation. Operating voltages may also be a reason for additional models of LISNs. LISNs are made for AC voltage operation as well as DC. The working voltage levels also may be different. Finally, the number of phases in the power supply may require more variations in the LISN types.

MIL-STD-461:

MIL-STD-461 is a United States Military Standard that describes how to test equipment for electromagnetic compatibility. Various revisions of MIL-STD-461 have been released. Many military contracts require compliance to MIL-STD-461E. The latest revision (as of 2015) is known as "MIL-STD-461G". While MIL-STD-461 compliance is technically not required outside the US military, many civilian organizations also use this document. People at electromagnetic compatibility test labs typically set up their anechoic chamber to comply with MIL-STD-461, in order to support people who try to make the products they design comply to MIL-STD-461.

Spectrum analyzer tracking generator:

A tracking generator provides spectrum analyzers with additional measurement capability beyond that of the basic spectrum analyser. The tracking generator enables some basic network measurements to be made, thereby providing additional capability beyond basic spectrum analysis. In view of this a tracking generator considerably extends the applications for which a spectrum analyzer can be used, making them more flexible and versatile.

III. HARDWARE DESCRIPTION

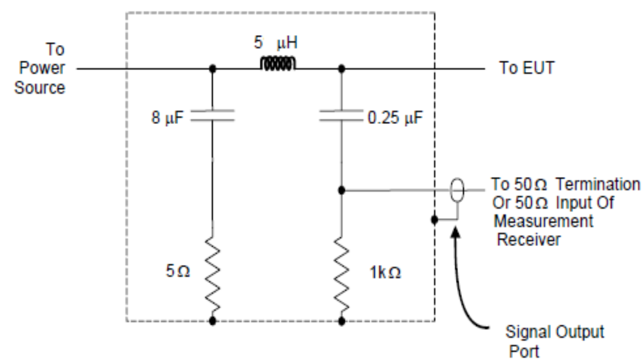

Fig 5:LISN block diagram

The input (Power Source) is connected to the AC main. Capacitor, C2 and inductor, L1 form a filter to help reject high frequency noise from the main power source so that it does not affect the unit under test or influence the noise measurements. Additionally, the filter also serves to supress any emissions from the EUT back to the AC main power. The unitunder test (EUT) is connected to the output side of the LISN. A high pass circuit comprised of C1 and R1 is used to couple the emissions from the EUT to a connector at the test receiver port on the LISN. A spectrum analyzer or noise meter (terminated in 5 ohms) is used to monitor the emissions. The project consists of the following components present in it, they are:

- Film capacitors
- 20W TO220 High Power Resistors
- Axial Resistor
- Air core inductor
- N connectors

RF connector

A coaxial RF connector (radio frequency connector) is an electrical connector designed to work at radio frequencies in the multi-megahertz range. RF connectors are typically used with coaxial cables and are designed to maintain the shielding that the coaxial design offers. Better models also minimize the change in transmission line impedance at the connection. Mechanically, they may provide a fastening mechanism (thread, bayonet, braces, blind mate) and springs for a low ohmic electric contact while sparing the gold

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surface, thus allowing very high mating cycles and reducing the insertion force. Research activity in the area of radio-frequency (RF) circuit design has surged in the 2000s in direct response to the enormous market demand for inexpensive, high-data-rate wireless transceivers

IV ABOUT PSPICE

SPICE is a powerful general purpose analog and mixed-mode circuit simulator that is used to verify circuit designs and to predict the circuit behavior. This is of particular importance for integrated circuits. It was for this reason that SPICE was originally developed at the Electronics Research Laboratory of the University of California, Berkeley (1975), as its name implies: Simulation Program for Integrated Circuits Emphasis.

Desinging circuit in PSpice software

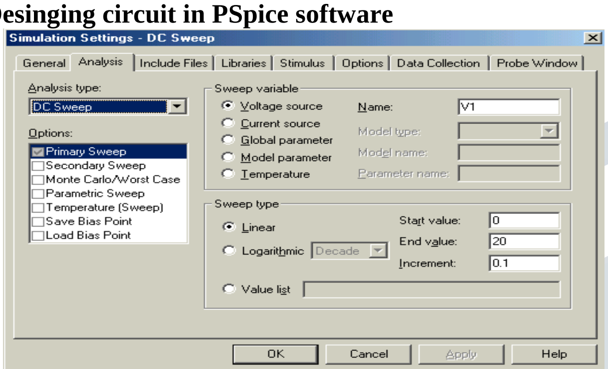

Fig 6: Setting for the DC Sweep simulation.

3. Run the simulation. PSpice will generate an output file that contains the values of all voltages and currents in the circuit.

Step3: Displaying the simulation Results

PSpice has a user-friendly interface to show the results of the simulations. Once the simulation is finished a Probe window will open.

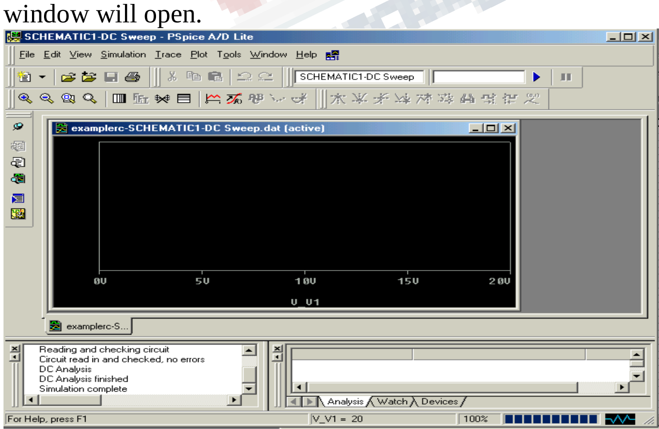

Fig 7: Probe window

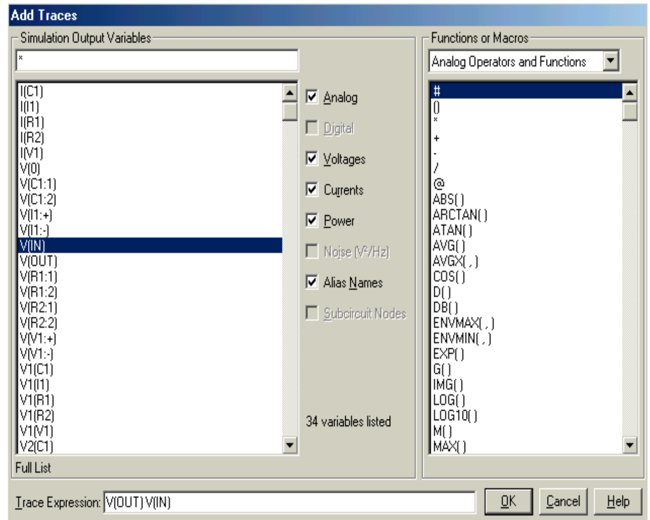

Fig 8: Add trace window

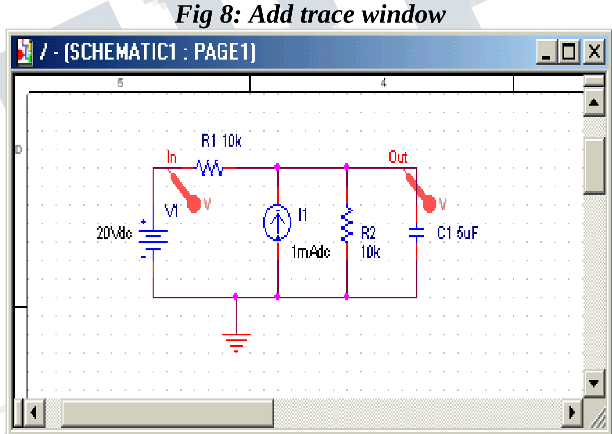

Fig 9: Using Voltage Markers to show the simulation result of V(out) and V(in)

1. menu select MARKERS/VOLTAGE LEVELS. Place the makers on the Out and In node. When done, right click and select End Mode
2. Go to back to PSpice. You will notice that the waveforms will appear.
3. From the PSPICE menu select MARKERS/VOLTAGE LEVELS. Place the makers on the Out and In node. When done, right click and select End Mode
4. Go to back to PSpice. You will notice that the waveforms will appear.
5. You can add a second Y Axis and use this to display e.g. the current in Resistor R2, as shown below. Go to PLOT/Add Y Axis. Next, add the trace for I(R2).
6. You can also use the cursors on the graphs for Vout and Vin to display the actual values at certain points. Go to TRACE/CURSORS/DISPLAY

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7. The cursors will be associated with the first trace, as indicated by the small rectangle around the legend for V(out) at the bottom of the window. Left click on the first trace. The value of the x and y axes are displayed in the Probe window. When you right click on V(out) the value of the second cursor will be given together with the difference between the first and second cursor.

8. To place the second cursor on the second trace (for V(in)), right click the legend for V(in). You'll notice the outline around V(in) at the bottom of the window. When you right click the second trace the cursor will snap to it. The values of the first and second cursor will be shown in Probe window.

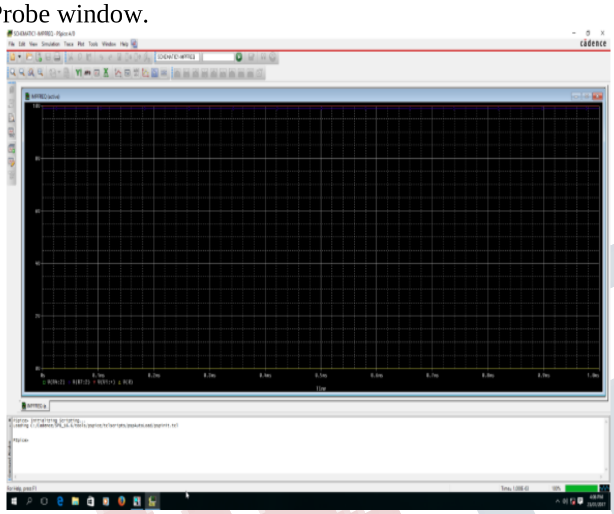

Fig 10: Result of the DC sweep, showing Vout, Vin and the current through resistor R2. Cursors were used for V(out) and V(in).

9. You can chance the X and Y axes by double clicking on them.

10.When adding traces you can perform mathematical calculations on the traces, as indicated in the Add Trace Window to the right of Figure 9.

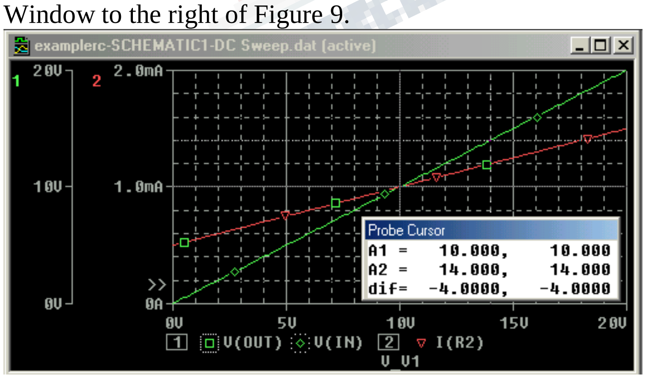

Fig 11: Schematic diagram of LISN

4.2 Schematic Diagram

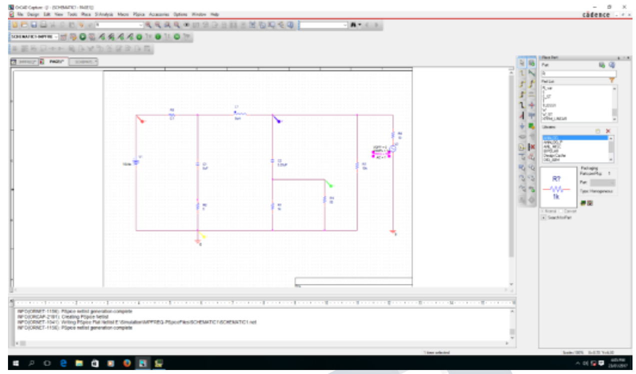

Fig 12: Simulation wave of LISN

V. RESULTS

Specification:
Compliant to MIL-STD-461 E/F
(ii) Voltage - 75 V (Max)
(iii) Current - 10 Amp Cont. (Max)
(iv) Loss - Max. 3 dB (10kHz - 10 MHz)
Comparison of measurement results between 50uH and 5uH LISN

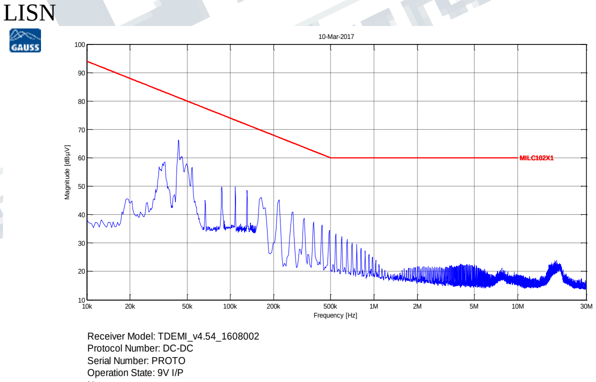

Fig 13:Measurement results with prototype 50 uH LISN

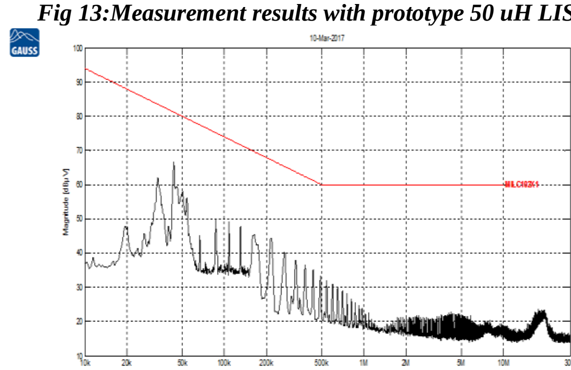

Fig 14: Measurement results with prototype 5 uH LISN

By observing the above results me can say that measurement result with prototype 50uH lisn and 5uH lisn are approximately same expect at 60db magnitude.

Fig 15: When the both terminals are connected

The insertion loss of LISN can be observed by using the spectrum analyzer. In the above figure we can observe that the input port of spectrum is connected to the EUT port of the LISN and the output port of the spectrum analyzer is connected to the positive and negative terminals of LISN. So that we can observe the above graph.

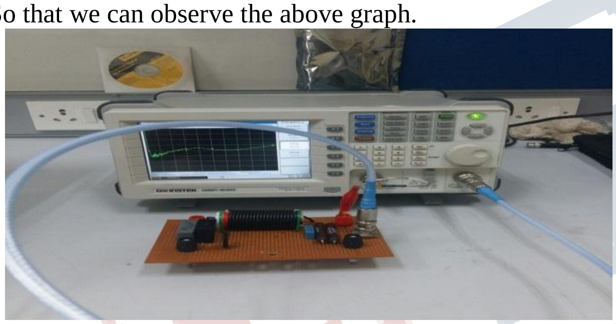

Fig 16: When only positive terminal is connected

When the negative terminal of LISN is removed i.e., ground port, we can observe the above graph. The insertion loss can be found by the difference between the above two graphs i.e.,fig 5.3 and fig 5.4 by observing both the graphs we can conclude that 3db loss.

VI. ADVANTAGES AND DISADVANTAGES

a). ADVANTAGES

1. LISN is a device used in conducted emission
2. Stable line impedance
3. Lisn prevents external noise coupling
4. Suitable connection to the measuring equipment

b).DISADVANTAGES

1. LISN offers losses because of this losses components may get heated
2. For high current LISN forced pulling is required
3. It is a invasive type of measuring instrument.

VII APPLICATIONS

- The LISN operates over 100KHz to 65KHz range. The network is ideally suited for use in MIL-STD-461AB/C conducted emission testing.
- The LISN is used to provide known impedance from the power line to the equipment under test (EUT) while diverting any RF signals from the power line to a 50-ohm port.
- Military, many civilian organizations also use this document.

VIII CONCLUSION AND FUTURE SCOPE

a. Conclusion

In modern life bit commercial Electronic, industrial are defense electronics problem of electromagnetic interference (EMI) is ever growing problem. Accurate and precision measurement of EMI gives vital information about the characteristics of noise (or) EMI. Which leads to the achievement of electromagnetic comparability.

IX FUTURE SCOPE

A dual 5 uH LISN with built in 50 Ohm loads and RF switches for automatic measurement on positive and negative power supply line.

REFERENCES

[1] Sandeep M. Satav, "Line Impedence Stabilization Network" IEEE Transactions on Electromagnetic Compatibility,2008
[2]https://en.wikipedia.org/wiki/Line_Impedance_Stabilization_Network
[3] https://www.com-power.com/lisns.html
[4] http://www.ets-lindgren.com/manuals/3816-2.pdf

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International Journal of Engineering Research in Electronics and Communication Engineering (IJERECE)
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[5]https://www.google.co.in/search?q=line+impedance+stabilization+network&dcr=0&tbm=isch&tbo=u&source=univ&sa=X&ved=0ahUKEwik_qrs2cnWAhXEOo8KHZmbDN4QsAQISA&biw=1280&bih=645

[6]http://www.feng.pucrs.br/~fdosreis/ftp/publicacoes/Conferencias/IECON/IECON2003/lepuc6elio.PDF

[7] http://www.jdtechsales.com/introduction-to-line-impedance-stabilization-networks

[8]http://www.rfwireless-world.com/Terminology/What-is-LISN-Line-Impedance-Stabilization-Network.html

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Mr. Maddu Srinivasa Rao has obtained Master Degree in ECE specialization in Computers and Communications from JNTU Kakinada and BE degree in ECE from Sri Ramanand Theerth Maratwada University , Nanded, Maharashtra. He is pursuing his Ph.D in JNTUH. His research area is in Communications, Embedded Systems and Computer Networks. He is presently working as Associate Professor & HOD in the Department of ECE in Joginpally B.R. Engineering College, Moinabad, Hyderabad and has an experience of 17 years both in Industry & Teaching.

Dr. D.Nagendra Rao. B.Tech, M.E.,Ph.D., MBA. His carrier spans nearly three decades in the field of teaching, administration, R&D., and other diversified in-depth experience in academics and administration. He has actively involved in organizing various conferences and work-shops. He has published over 70 international journal papers out of his research work. He presented more than 15 research papers at various national and International conferences. He is currently approved reviewer of IASTED International journals and conferences from the year 2006. He is presently working a Professor in the Department of ECE in D.R.K Engineering College, Bowrampet, Hyderabad He is also guiding the projects of P.G. /Ph.D. students of various universities.

Dr.V. Usha Shree, Professor of ECE dept, Joginpally B.R Engineering College, Hyderabad, has an experience of 20 years in teaching and research put together. She obtained her B.Tech(ECE), M.Tech(ECE) and Ph.D(ECE) from Jawaharlal Nehru Technological University, College of Engineering, Ananthapur. She obtained her Ph.D in the area of MEMS sensors and Embedded Systems. She is versatile in multidisciplinary specializations in allied branches. Her laurels include more than 109 publications in the National and International reputed conferences and journals. She is the fellow of IETE, Life member of ISTE. As a Chief coordinator of Industry Institute Partnership Cell (IIPC), her efforts of networking with industry for faculty and student development programs are appreciated. She worked as principal for leading Engineering College, and was responsible for establishing the facilities and nurturing the faculty and student to build managerial competencies. She is guiding 8 Ph.D students. She has guided 1 Ph.D students and more than 10. M.Tech students. She has organized many Conference / Workshops / Seminars at national and international level.