Insights into RF-resistant ICs

The exact evaluation of an IC‘s current and voltage characteristics during a radiated RF test allows an investigation of the cause of the IC malfunction.

Linbus systems are used to cross-link vehicle components in automotive engineering. Integrated Lin circuits (Lin ICs) are the systems‘ central communication nodes. Malfunctions in individual vehicle component groups may be the result of radiated RF interferences with the Lin IC function. The Lin IC‘s immunity to radiated RF is thus crucial for a vehicle‘s functional safety. Exact knowledge of the IC characteristics under the influence of radiated RF is valuable from two points of view. IC developers can comprehensively and directly influence the improvement of an IC‘s immunity to RF disturbances. Furthermore, information about the detailed EMC characteristics of a selected IC is also very important during Lin assembly development since it allows the engineers to plan an optimum EMC environment. More and more developers of new products are calling for a more detailed determination of the IC EMC characteristics. This alone allows them to cope with the apparently conflicting demands for faster development cycles and reductions in development costs on the one hand and a high product reliability and functionality on the other. New approaches to finding this information are thus in great demand.

The immunity of ICs to RF disturbances is determined according to the direct RF power injection (DPI) method (IEC 62132-4 standard). RF power is directly injected into the IC pin concerned and the maximum compatible power is determined. The current and voltage are also measured simultaneous to the RF power measurement in order to identify the cause of the fault. The time characteristics of the RF currents and voltages can provide important information on how malfunctions develop in an IC. Thanks to this additional measurement method, the fault causes can be pinpointed much more precisely than in the past. The IC design can thus be made more resistant to EMC disturbances in a selective way.

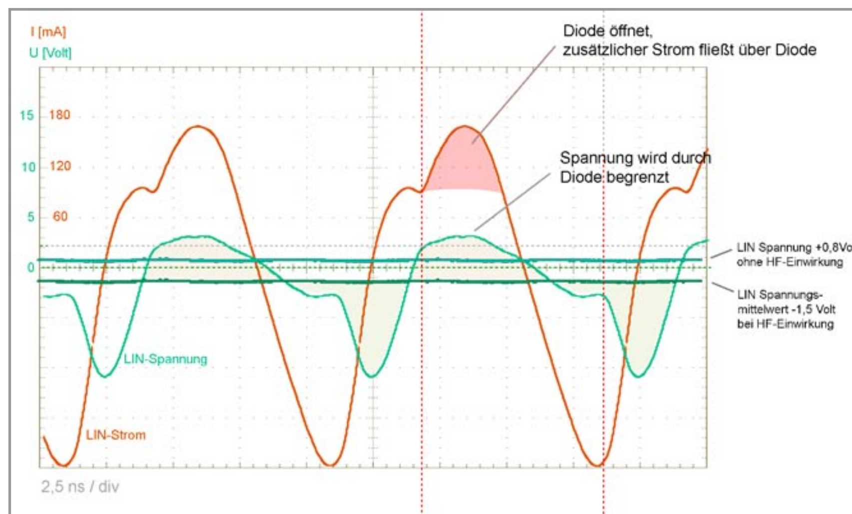

Figure 1 Current and voltage characteristics of a Lin when the damping diode is opened and closed

The control of the damping diode function on the Lin-FET during the injection of disturbances is a typical example. In the event of a fault, the diagnosis is made on the basis of the triggered current peak and the voltage plateau of the diode. The following Figure 1 shows the current and voltage characteristics during this procedure.

As far as the damping diodes are concerned, the most interesting processes occur in the lower frequency range of less than 100 MHz (Figure 2) when the diode is opened. The current and voltage time characteristics are thus monitored in this range with sufficient precision. The challenge in terms of measurement technology is to choose the appropriate current transformer with the corresponding bandwidth. Current transformers generally have a finite bandwidth for the necessary exact measurements on an IC. The transmission of the measured data is generally dampened on the lower frequency band (around 20 MHz) and the current signal in question is thus highly distorted. Non-linear IC effects can falsify the results measured by the current and voltage transformer if the measurement set-up is very complex. In such cases the transmission depends not only on the frequency but also on the current and voltage themselves. The measurement set-up becomes a mismatched network and cannot be considered a 50 Ohm-matched system due to the IC (Figure 3).

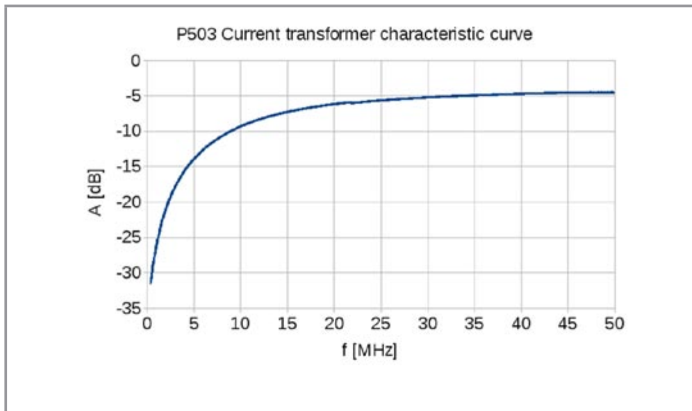

Figure 3 Characteristic curve of the P503 probe's current transformer in the range of up to 50 MHz

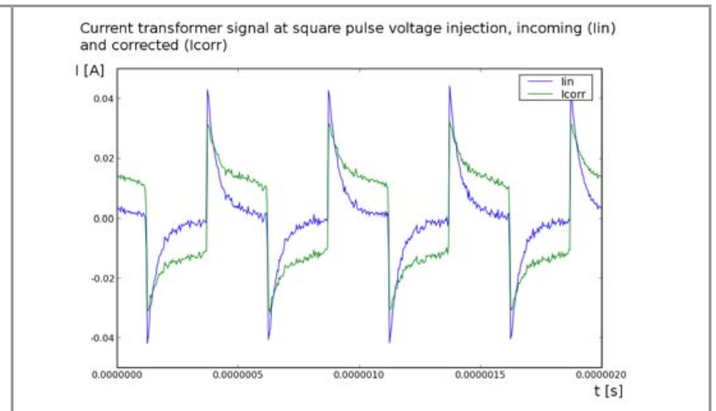

Figure 3 Measurement via a P503 probe with a resistive capacitive load at an induced square-wave voltage

The actual current characteristics at the IC pin have to be reconstructed to nevertheless obtain useful data. The measured curves are thus transmitted from the oscilloscope to the computer and split into the frequency components by discrete Fourier transformation. The frequency components are now determined on the IC on the basis of the measured frequency via equivalent circuits for the measurement set-up. The reconstructed signal is obtained on the IC pin after reverse transformation into a time signal.

The P500 probe has been developed with the probe control 500 software so that current and voltage can be measured without errors at the same time when the RF is injected into the pin (Figure 4). The described problems in terms of measurement technology are solved by an equivalent circuit. The software of the probe 500 automatically corrects all measured results. This automated calculation of the initial curves is the basis for a selective investigation of the cause of IC weak spots to radiated RF. The measurements performed with the P500 probe measurement set-up up to now have allowed developers to save valuable development time and costs and achieve a better immunity to RF disturbances during ongoing IC development.

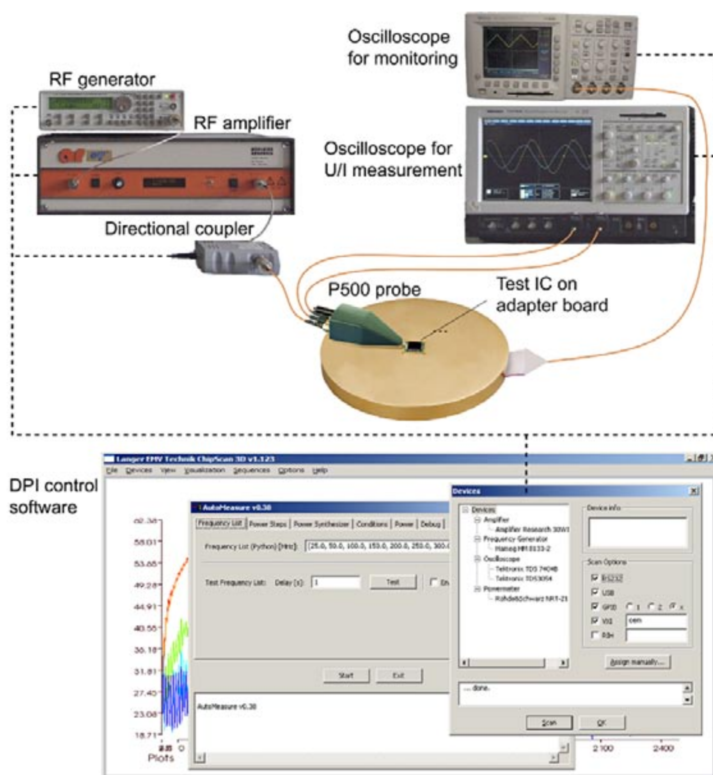

Figure 4 Measuring set-up including P500 and control software

Further information has been published at *http://www.langer-emv.de/en/products/ic-measurement/rf-measurement-on-pin/probes-immunity.*

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