Measuring technology for new EMC design
EMC trouble-shooting in microelectronics

LANGER
EMV-Technik

Everybody's talking about the advantages of micro-technology or the introduction of nano-technology nowadays. The latest scientific insights have put the world of science-fiction within reach of electronics developers. And wouldn't every developer like to use these technologies himself to help shape the future? Optimum board packing and almost complete lack of screening material are striking examples of the miniaturization of electronic modules in today's industry. Saving space and costs and providing more and more functionalities are the requirements that have to be met by companies.

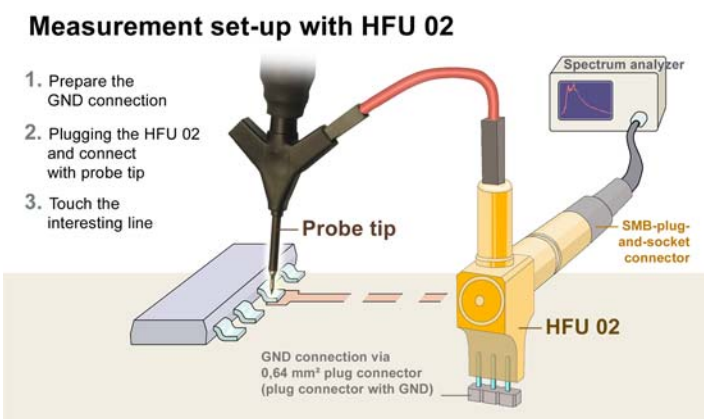
1. Description of the problem
The developer is responsible for troubleshooting and interference suppression should electromagnetic emissions occur when a new module is developed or an existing one improved. He is familiar with a variety of solutions for critical signal pins, quartz connections or sensitive signal lines. High board-packing densities, conductor bundles closely spaced at around 200 µm, applications featuring extremely high EMC requirements (e.g. the automotive industry) together with complicated measuring methods that sometimes even cause disturbances themselves often result in helplessness when it comes to analysing the module.
Important insights into the electromagnetic conditions that prevail on the module can be gained by measuring its RF magnetic or electrical fields with near-field probes. The RF fields responsible for the emissions are sought at the critical frequency response to pinpoint the RF emission sources. The developer uses large-format, near-field probes to locate the magnetic fields that generate a voltage difference on the module and thus the RF field currents responsible for this emission. He investigates the position of the presumed RF sources with more specialized probes by determining the field orientation. The information obtained with the miniature probe's measuring head, which is only up to 0.5 cm² in size, is not always sufficient to take the required counter-measures in these confined structures. This is due to the design-related measuring error in the 100 µm range on the module. In addition to the RF fields of a pin, line or component that is of interest, the probes also measure the fields of the neighbouring pins, lines and components. The higher the share of such measuring errors or the less attention paid to these by the developer, the more problematic an analysis of the results becomes and the less likely the chance of the optimum EMC design.

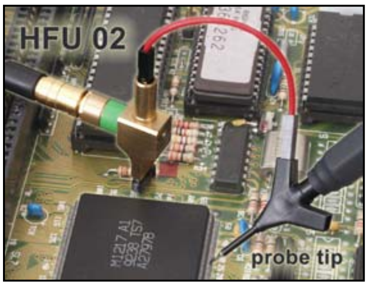
2. How to solve the problem
Langer EMV-Technik (name of company: Langer EMC-technic) offers a special set of RF instrument transformers for measurements in the design stage to enable direct measurement of even low RF currents and RF voltages in microelectronic modules. The RF current transformer (HFI 02) and the RF voltage transformer (HFU 02) makes it much easier for the developer to locate the RF source that is responsible for emissions from the module and to optimise the module with regard to EMC.

Due to its high resolution and special measuring contact via a probe tip, the measuring method based on RF transformers enables error-free evaluation of the RF voltage in the µm range and thus supplements near-field probe measurements. The measuring methods of these RF transformers will be explained in more detail in the following.

RF measurements in the most confined structures

3. HFU measuring methods
The HFU is designed for RF voltage measurements on IC pins of micro-controllers, for example, quartz connections and metallic structural parts. The voltage transformer is connected to GND of the equipment under test (EUT). The developer picks up the voltage difference between the IC pin and GND of the EUT by contacting the pin in question with the probe tip. The influence on the EUT by the probe tip is minimised thanks to the RF transformer's low coupling capacitance. The transformer couples the input voltage to the 50 Ω SMB output at a transformation ratio of 5:1. The measured values are transferred to a spectrum-analyser or oscillograph via a screened cabled. The probe tip that is connected to the transformer via a cable functions optimally up to approx. 500 MHz in such a measurement set-up. At higher frequencies the HFU is connected by CuL wire over a short distance.

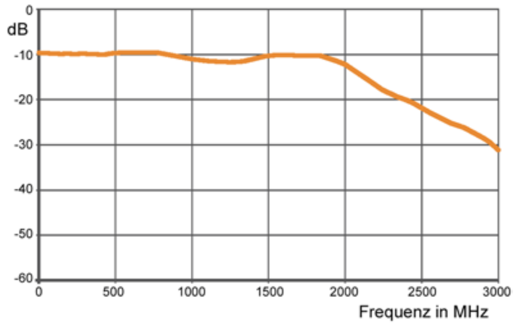




Various types of voltage transformers are available for a frequency range between 150 kHz and 3 GHz depending on the application.
Type A of HFU 02 has a coupling capacitance of approx. 20 pF. This transformer should be used for measurements on oscillator pins at 10 MHz and above or for other high-resistance signals. Due to its sensitivity this type is used for measurements on modules for the automotive industry.
Type B has a coupling capacitance of approx. 3 nF and enables stable measurements in the lower frequency range as of 150 kHz.

The decisive advantages of the HFU 02's for the hardware developer are:

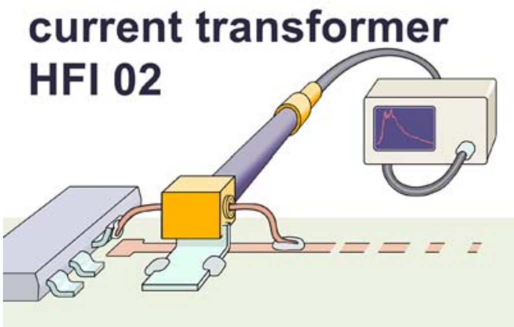
1. Precise and quick measurement
The developer is able to evaluate RF voltages on individual pins of a micro-controller or on individual conductors from a whole bundle of conductors on a board.



2. Low interference with the EUT
The HFU 02 can even monitor sensitive quartz connections without disturbing the quartz signal itself.

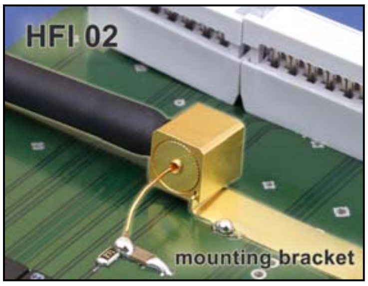
3. Measurement of low RF voltages
Even the lowest RF voltages at low levels can be measured and evaluated successfully under the influence of neighbouring fields.

RF measurement on data lines



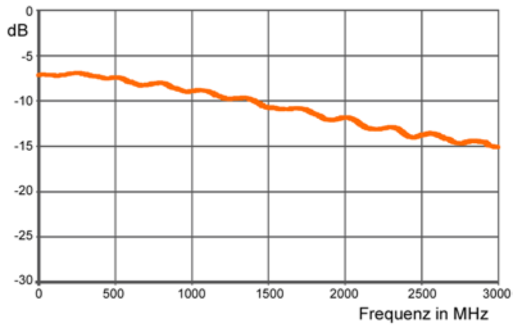
The optimum signal line layout between modules poses a problem, particularly if the throughput is in the Mbit range. Selecting a graphic display is a typical example. The developer has to use as little screening material as possible in EMC optimisation. This is only possible by the optimum dimensioning of filters on data lines. Our practical experience in dimensioning filters on data lines with a throughput of 10 Mbit and more shows that the required screening material can only be significantly reduced by precise measurement. The computational method does not take into account side effects that were possibly not recognised. We recommend the use of the HFI 02 RF current transformer for the required measurements.

4. HFI 02 measuring methods



A small mounting bracket (accessory) is fixed on the GND of the equipment under test and the RF current transformer plugged in. The data line to be evaluated is led through the transformer via a CuL wire with a maximum diameter of 0.45 mm. The transformer couples the voltage to the 50 Ω SMB output. The measurement results are transferred to a spectrum analyser or oscillograph via a screened cable. Filter dimensioning can now begin.
The transformer operates in the measuring range between 100 kHz and 3 GHz and includes special sheath current damping to avoid measuring errors.

The decisive advantages when using a RF current transformer are:



1. Precise RF measurement of low RF currents on data lines
This enables the separate RF evaluation of individual data lines and consideration of side-effects not yet recognized .

2. Reduction of screening material whilst safeguarding signal integrity Additional material costs can thus be saved particularly with products that are manufactured in large quantities.

5. Conclusion
The use of instrument transformers starts on the board with small structures and low RF currents. RF transformers supplement measurements with magnetic and electrical field probes. RF current and RF voltage transformers will become increasingly important in EMC design with progressing miniaturization. Their low cost of acquisition and various fields of application promise fast acceptance by developer's shops.