Automation of EMC tests on ICs

The automated ICT1 IC tester is a positioning system for the evaluation, control and protocol of the measurement of different IC probes. (**Figure 1** ICT1 with P201 probe and test IC). The ICT1 can be used to perform automated immunity and emission tests on individual IC pins and complete ICs. Automatic pin recognition and the highly precise positioning (10 µm) of the measurement systems at the test IC are just two special features of the ICT1. Automated measurements help save time and costs.

The ICT1's design allows direct contact between the measuring tips of the individual probes and the IC pins. The probes are connected to the required measuring and control devices (spectrum analyzer, oscilloscope, RF power amplifier, etc.). The devices are controlled via a PC interface. The test IC is tested in operation and located on a test board for this purpose. This test board is, in turn, connected to the connection board which forms the interface between the test IC and PC. It provides all necessary supply signals for the test IC and forwards the signals to be monitored to the respective measuring devices. The connection board and test IC are located in the ground plane, thus ensuring an optimum measurement environment.

The probe which is needed for the respective measurement objective is connected to the ICT1. Thanks to a dedicated holder, the probes can be changed quickly without any additional tools.

Figure 1 ICT1 with P201 probe and test IC

Contact:

Peter Michak, Head of Sales, *michak@langer-emv.de*

Susanne Kaule, Sales US, *kaule@langer-emv.de*

The pins to be tested in conducted emission measurements such as the 1 Ohm / 150 Ohm method (IEC EN 61967-4) can be chosen in the control software. The ICT1 measures the emissions from the specified pin automatically and creates a measurement log.

In the course of conducted emission investigations such as measurements of the pulse immunity according to IEC 62215-3, the selected pins are approached and tested automatically up to the defined severity and/or until a fault occurs and a measurement log is created (**Figure 2** Measurement log for EMC immunity measurements).

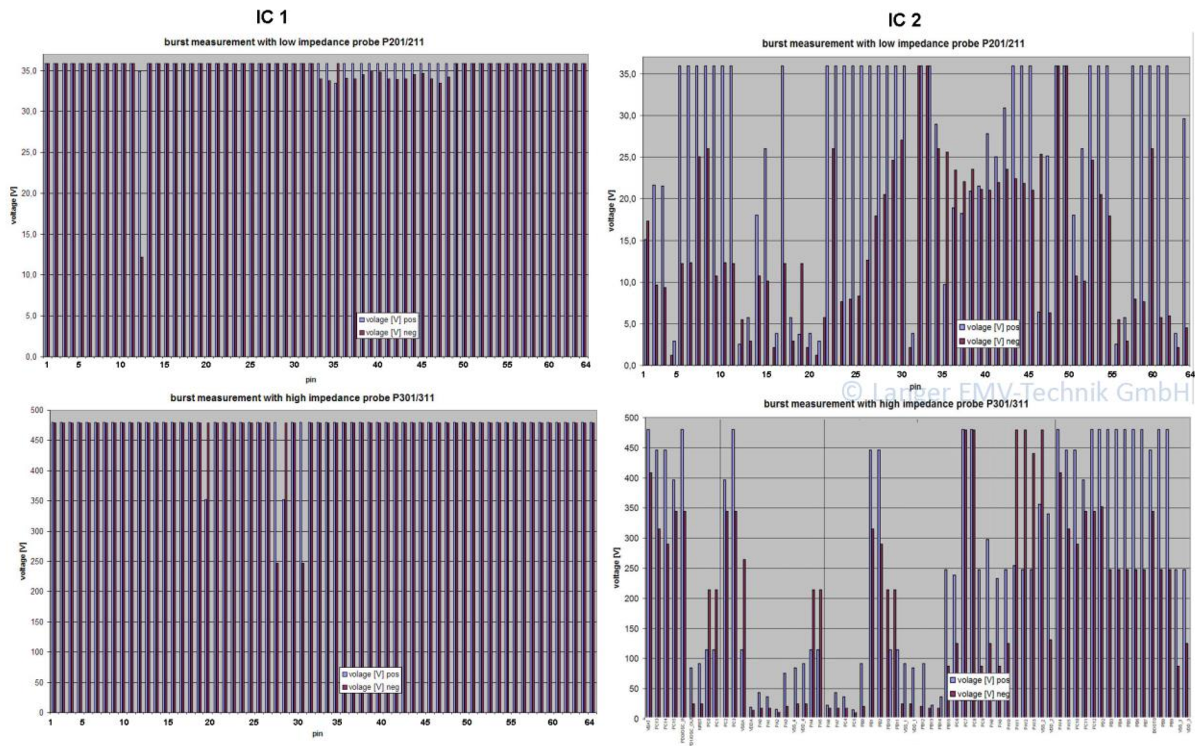

Figure 2 Measurement log for EMC immunity measurements

Near-field probes (e.g. ICR micro-probes) can be used to measure radiated emissions. Apart from measurements at individual IC pins, area or volume scans can be made over the entire test IC (**Figure 3** EMC emission measurement over a test IC).

Contact:

Peter Michak, Head of Sales, *michak@langer-emv.de*

Susanne Kaule, Sales US, *kaule@langer-emv.de*

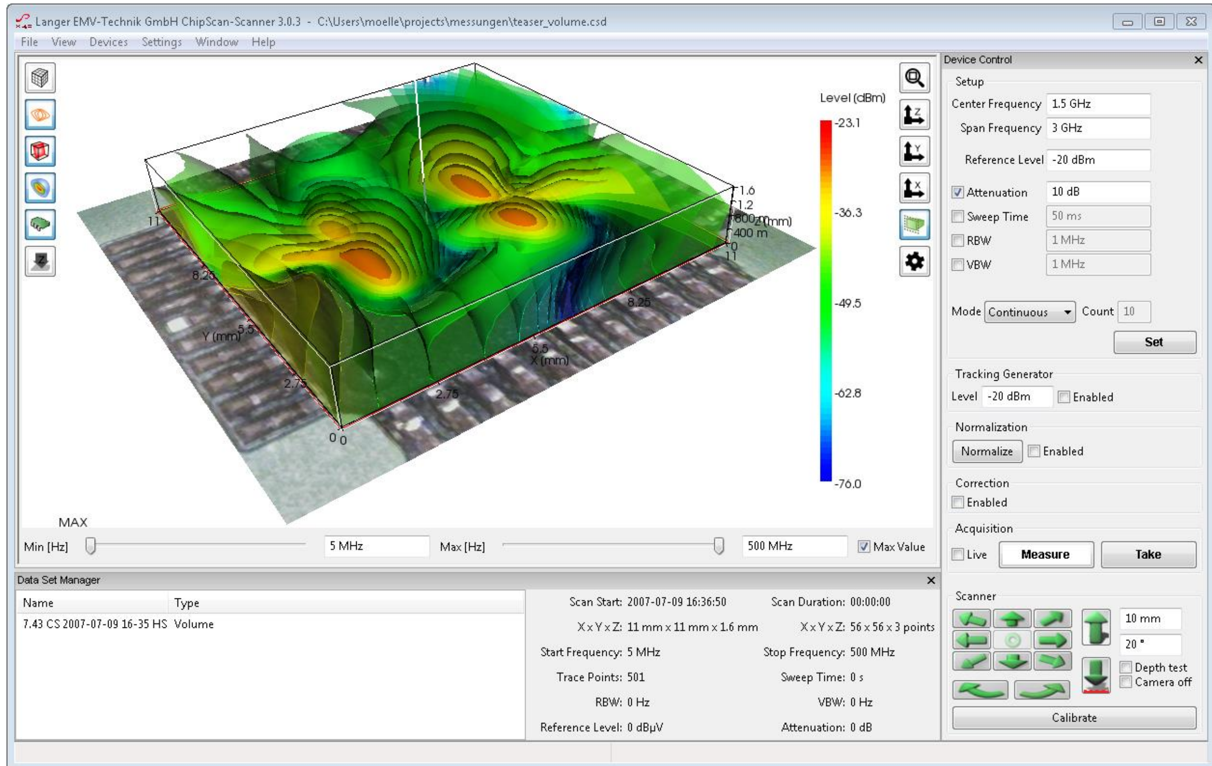

Figure 3 EMC emission measurement over a test IC

Radiated immunity measurements can thus be carried out with a wide variety of field sources. Thanks to the high mechanical resolution, disturbances can be selectively applied to individual areas of the test IC.

The ICT1 is a desktop unit with a footprint of 40 cm by 40 cm. The entire test set-up fits easily on a developer's workplace (**Figure 4** ICT1 test set-up with a P750 probe and external devices.).

Contact:

Peter Michak, Head of Sales, *michak@langer-emv.de*

Susanne Kaule, Sales US, *kaule@langer-emv.de*

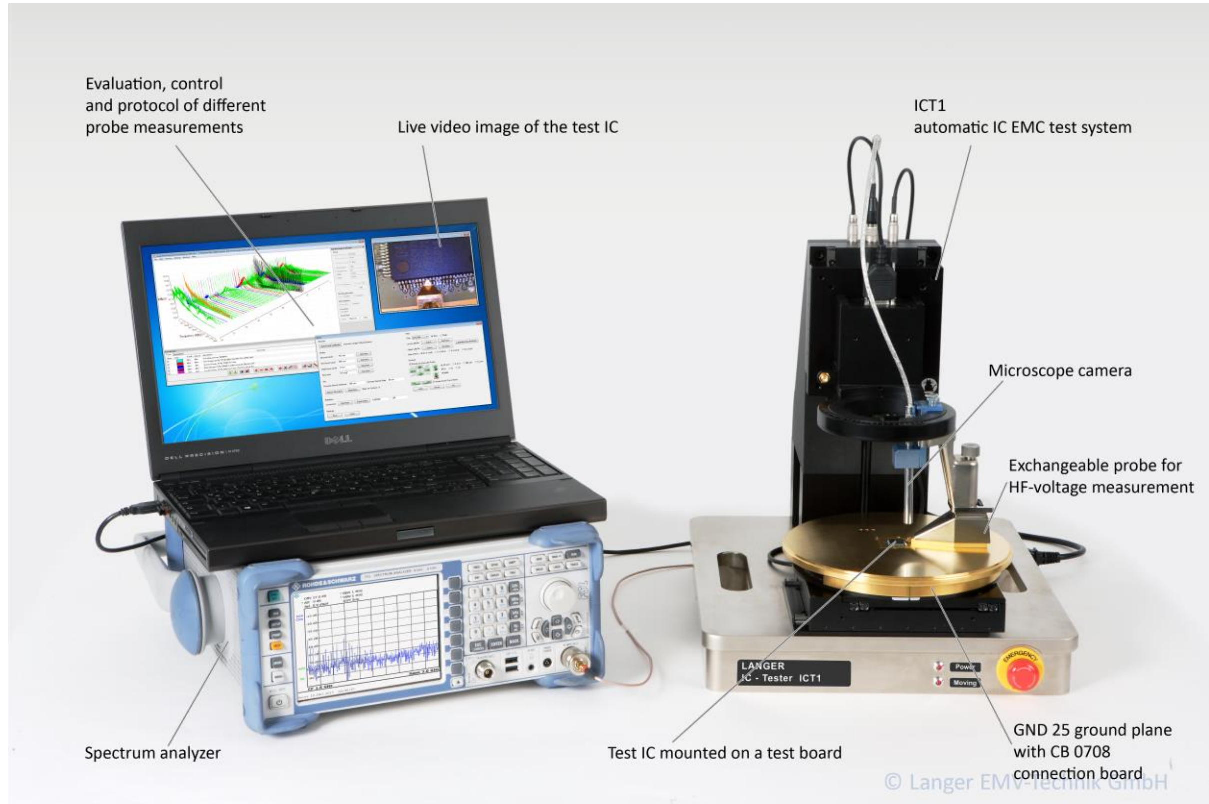

Figure 4 ICT1 test set-up with a P750 probe and external devices.

General description of probes for RF conducted emissions IEC 61967-4

The ***P603*** and ***P750*** probes have been developed to measure conducted emissions from integrated circuits (ICs) with direct 1 Ohm/150 Ohm coupling. The probes can be used to perform measurements on ICs according to IEC 61967-4 (**Figure 5**). The ***P603*** probe corresponds to the 1 Ohm RF current probe head.

The ***P750*** probe corresponds to the impedance matching network according to IEC 61000-4-6. It has an input impedance of 150 Ohm.

The ***P750*** probe can be used to perform RF voltage measurements and the ***P603*** probe can be used for RF current measurements on IC pins.

Contact:

Peter Michak, Head of Sales, *michak@langer-emv.de*

Susanne Kaule, Sales US, *kaule@langer-emv.de*

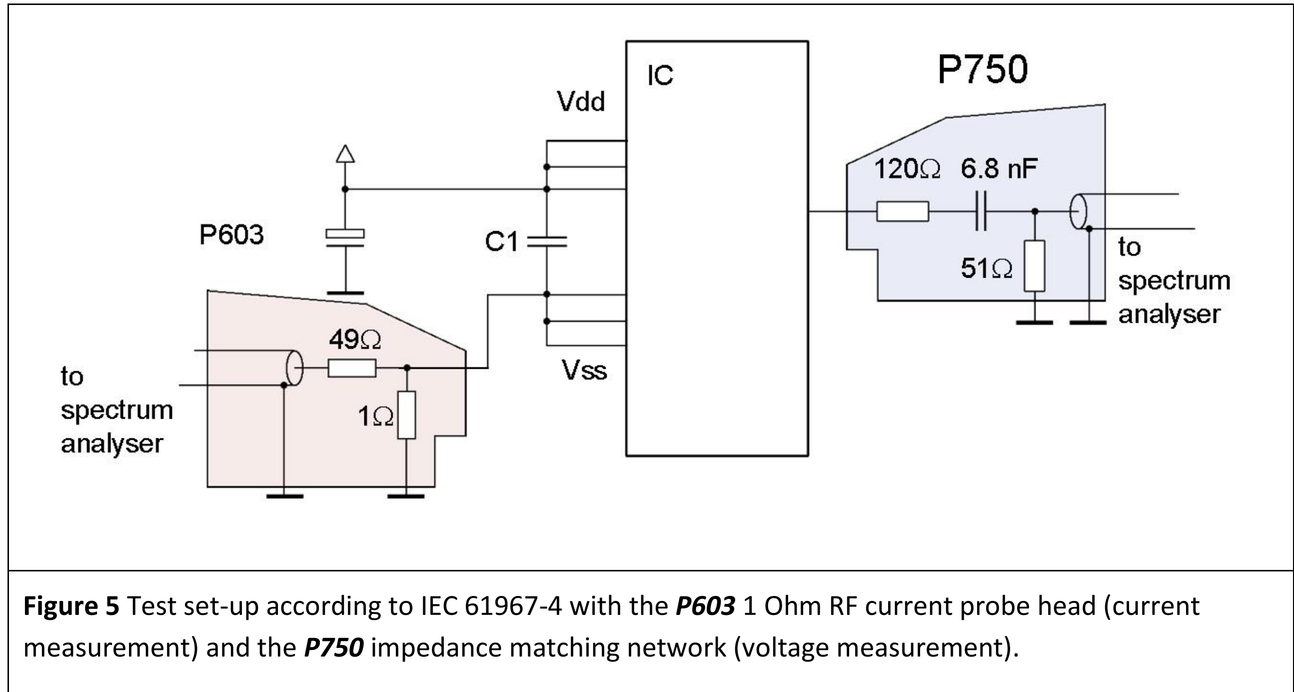

Figure 5 Test set-up according to IEC 61967-4 with the ***P603*** 1 Ohm RF current probe head (current measurement) and the ***P750*** impedance matching network (voltage measurement).

The ***P603*** and ***P750*** probe can also be used for other measurement tasks:

1. Current measurement (***P603***) on concatenated Vdd pins, **Figure 6**
2. Current measurement (***P603***) on a single Vss pin, **Figure 7**
3. Current measurement (***P603***) on a single Vdd pin, **Figure 8**
4. Voltage measurement (***P750***) on a signal pin while this is in operation, **Figure 9**
5. Current measurement (***P603***) on a signal pin while this is in operation, **Figure 10**
6. Voltage measurement (***P750***) on a Vdd or Vss pin, **Figure 11**

Contact:

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Susanne Kaule, Sales US, *kaule@langer-emv.de*

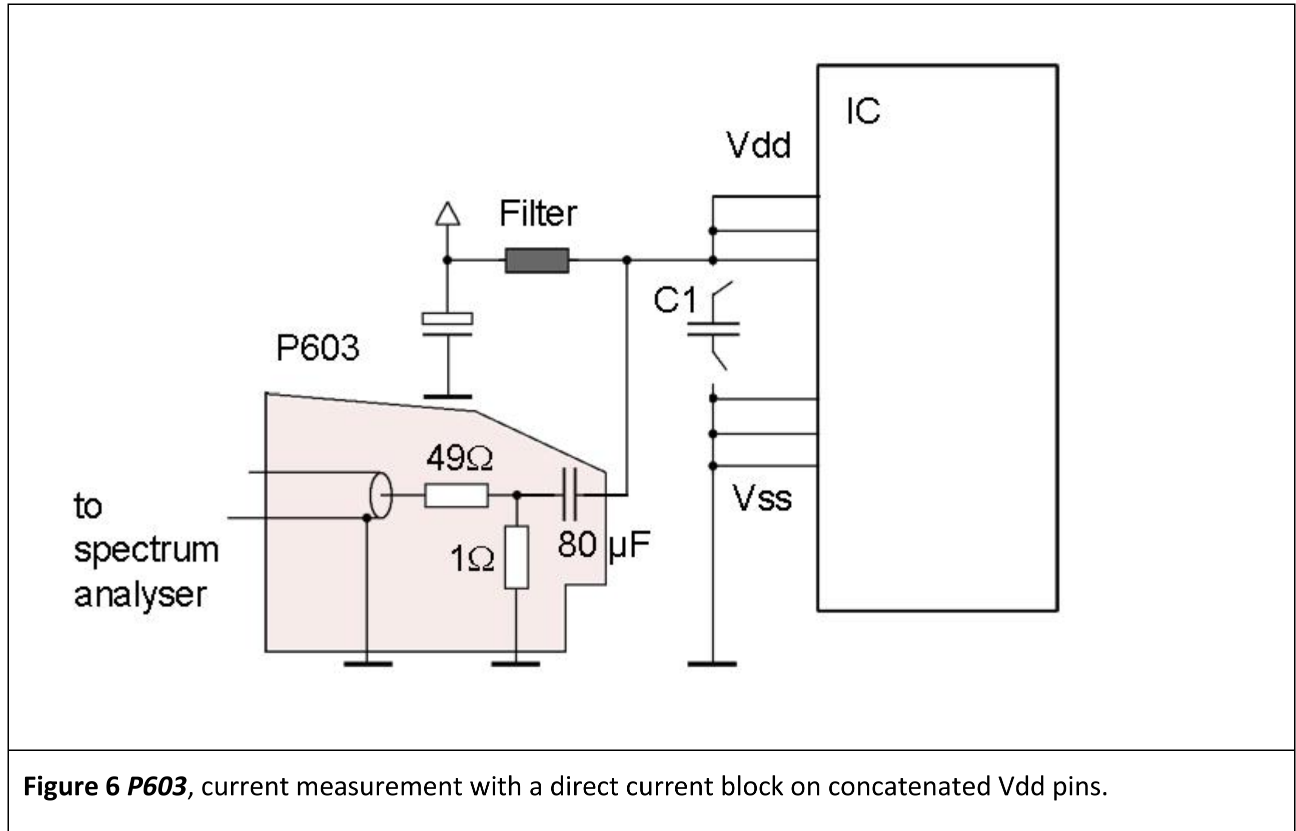


Figure 6 ***P603***, current measurement with a direct current block on concatenated Vdd pins.

An 80 µF capacitor is integrated into the ***P603*** probe as a direct current block. It backs up the IC in the circuit diagrams **Figure 6** and **Figure 8**.

Contact:

Peter Michak, Head of Sales, *michak@langer-emv.de*

Susanne Kaule, Sales US, *kaule@langer-emv.de*

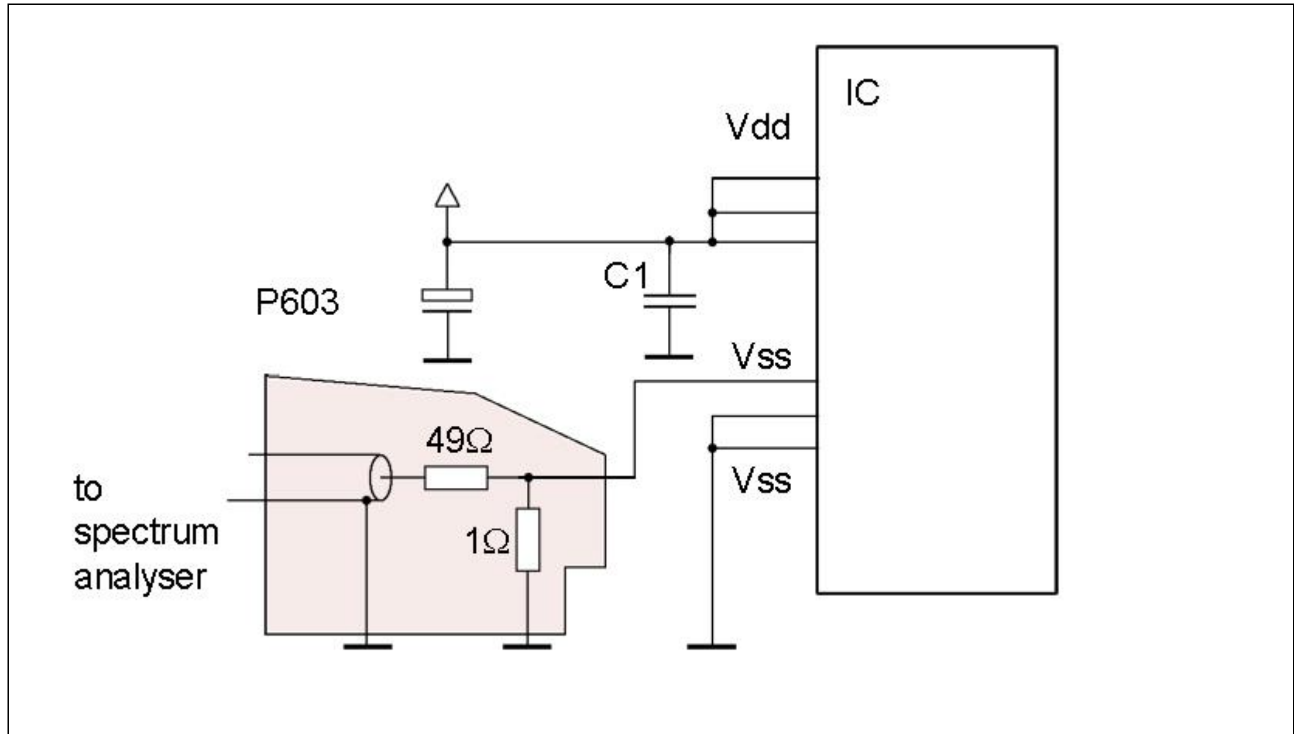
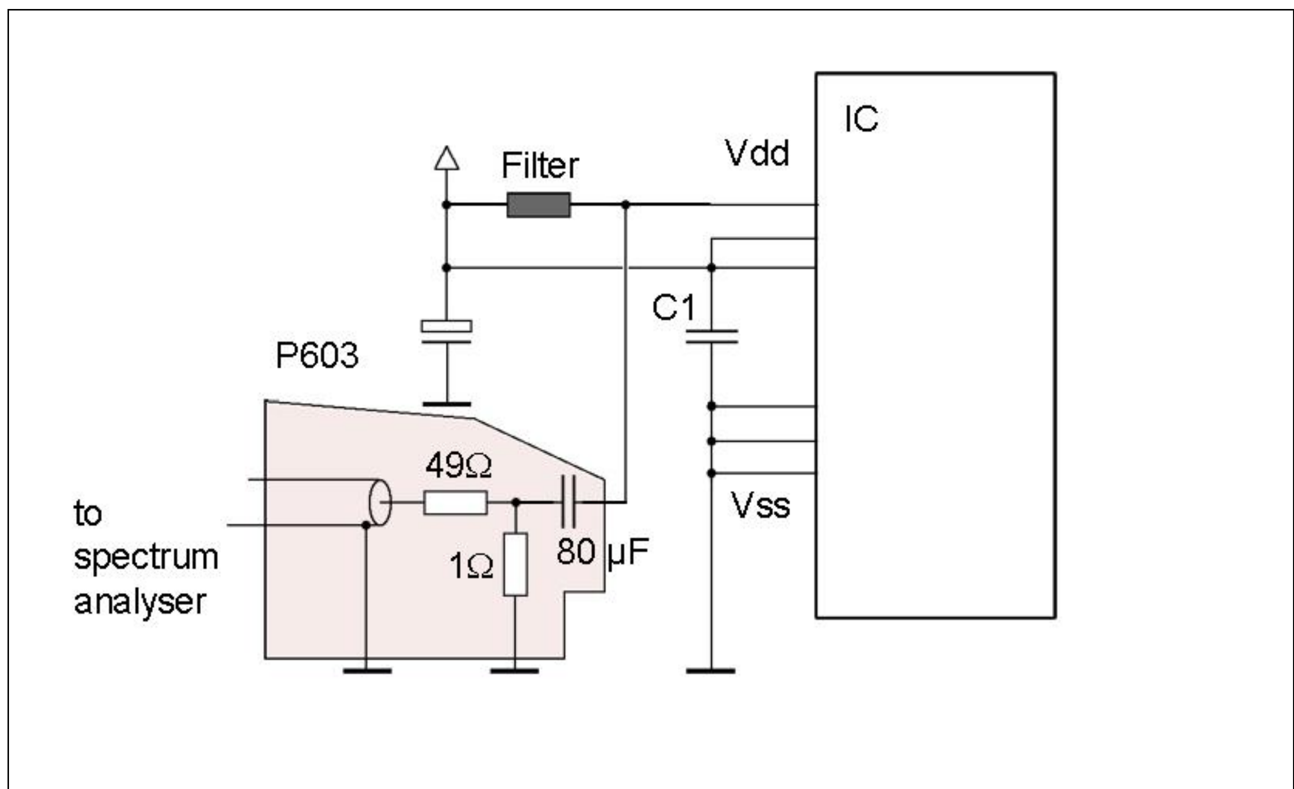


Figure 7 ***P603***, current measurement on a single Vss pin.



Contact:

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Susanne Kaule, Sales US, *kaule@langer-emv.de*

Figure 8 ***P603***, current measurement on a single Vdd pin.

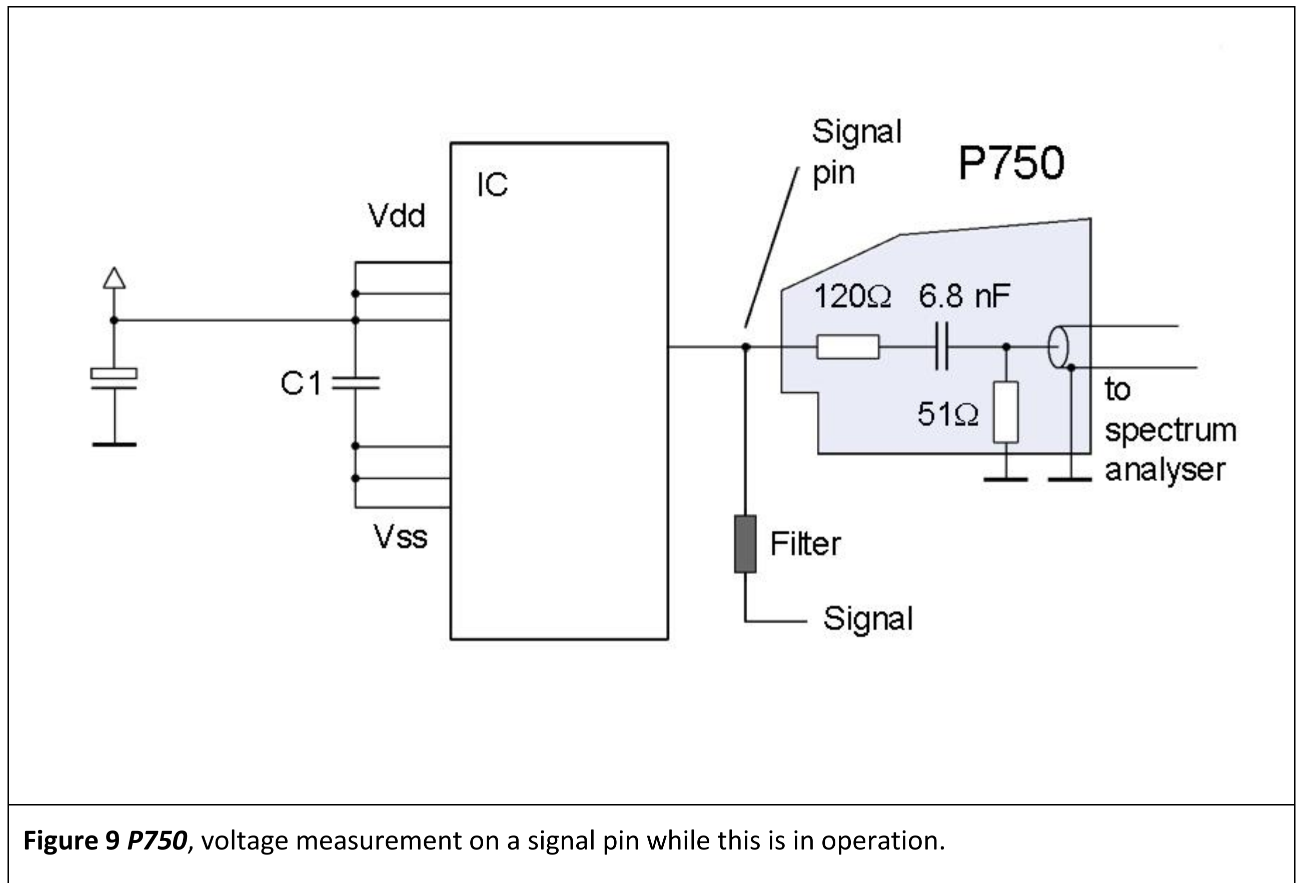

Figure 9 ***P750***, voltage measurement on a signal pin while this is in operation.

Contact:

Peter Michak, Head of Sales, *michak@langer-emv.de*

Susanne Kaule, Sales US, *kaule@langer-emv.de*

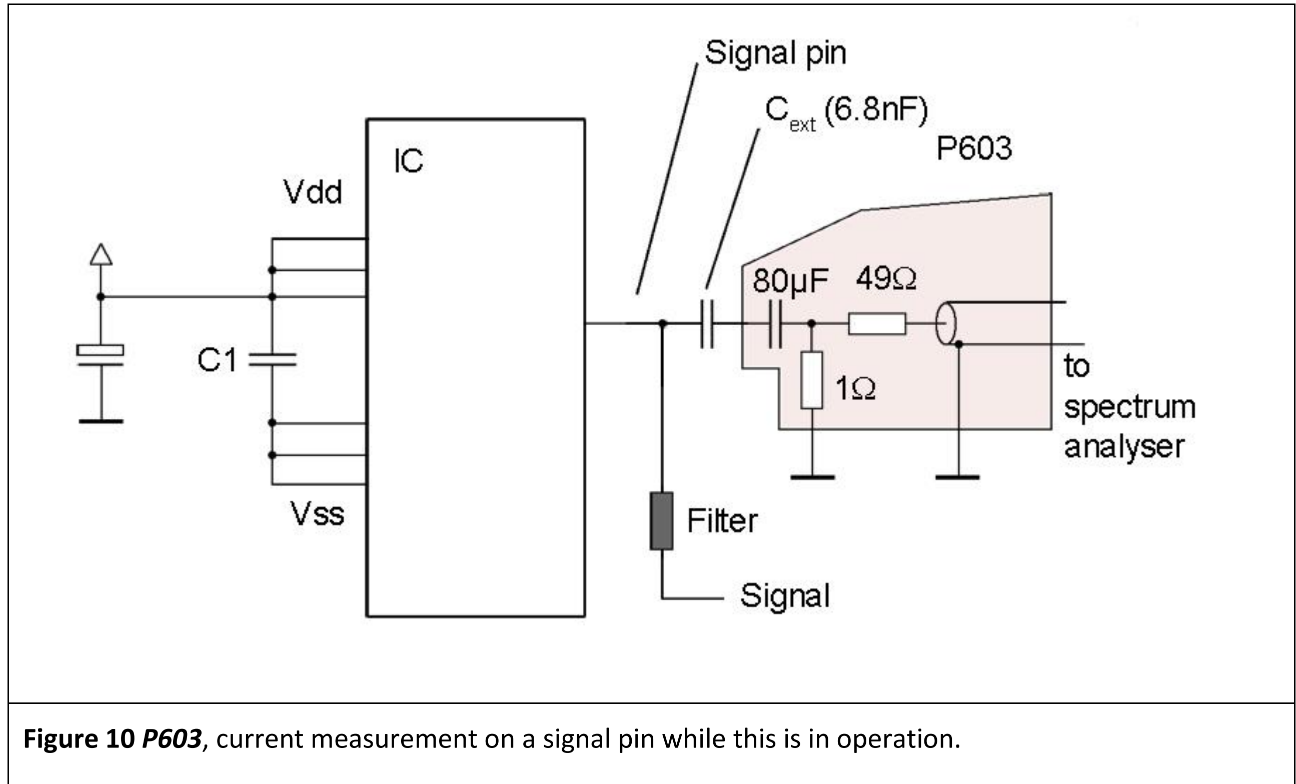

Figure 10 ***P603***, current measurement on a signal pin while this is in operation.

The external capacitor C_{ext} can reduce the stress on the signal pin caused by the probe's low impedance (1 Ohm) (**Figure 10**) during current measurements on signal pins.

The impedance of the capacitor C_{ext} should be at least 3 dB smaller than the shunt's 1 Ohm resistance.

Contact:

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Susanne Kaule, Sales US, *kaule@langer-emv.de*

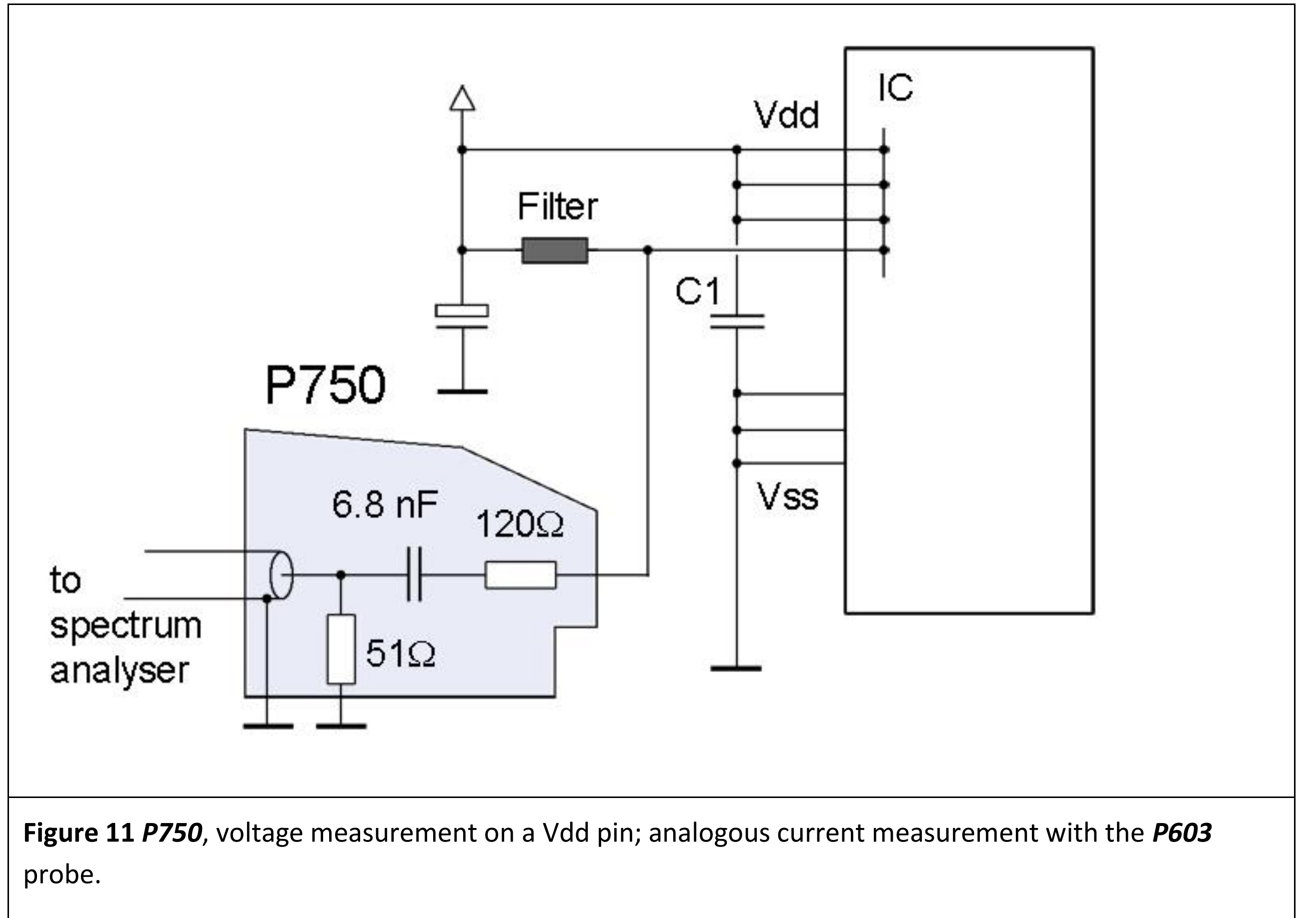

Figure 11 ***P750***, voltage measurement on a Vdd pin; analogous current measurement with the ***P603*** probe.

Contact:

Peter Michak, Head of Sales, *michak@langer-emv.de*

Susanne Kaule, Sales US, *kaule@langer-emv.de*

An IC internal connection to other Vdd supply pins is assumed for a voltage measurement on a Vdd pin (**Figure 11**). This measurement enables the determination of voltage dips on the IC's internal Vdd network.

The test IC is soldered to the test board[1] (**Figure 12**). The ***P603*** and ***P750*** probes can be moved freely on the ***GND 25*** ground plane or ***GNDA*** ground adapter[2] (**Figure 12**). Unlike the measurement set-up according to IEC 61967-4, this set-up ensures that the ***P603*** or ***P750*** probe's pin contact can reach and contact each IC pin. The probes are fixed on the ground plane with magnets. Filter elements and bridges are located on the underside (bottom) of the test board to prepare the measurement set-up for contact with the probe (**Figure 14**).

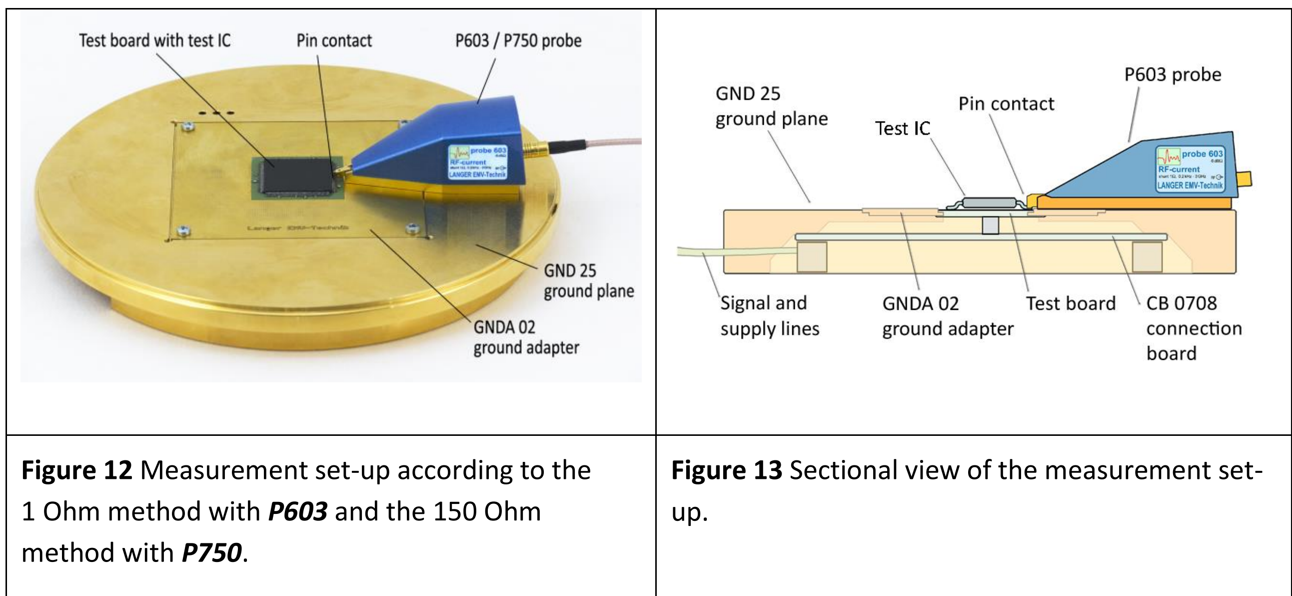

Figure 12 Measurement set-up according to the 1 Ohm method with ***P603*** and the 150 Ohm method with ***P750***.	**Figure 13** Sectional view of the measurement set-up.

The same test board is used for all measurement methods (1 Ohm, 150 Ohm). Bridges are provided to the Vdd / Vss root at the Vss / Vdd pins in the initial state. The associated bridge to the root is removed and the corresponding filter becomes active if a Vdd / Vss pin is measured.

[1] The test board is described in the "IC test instruction manual", mail@langer-emv.de
[2] ***GNDA 02*** ground adapter and ***GND 25*** ground plane are included in the ***ICE1*** IC test environment.

www.langer-emv.de
Contact:

Peter Michak, Head of Sales, *michak@langer-emv.de*

Susanne Kaule, Sales US, *kaule@langer-emv.de*

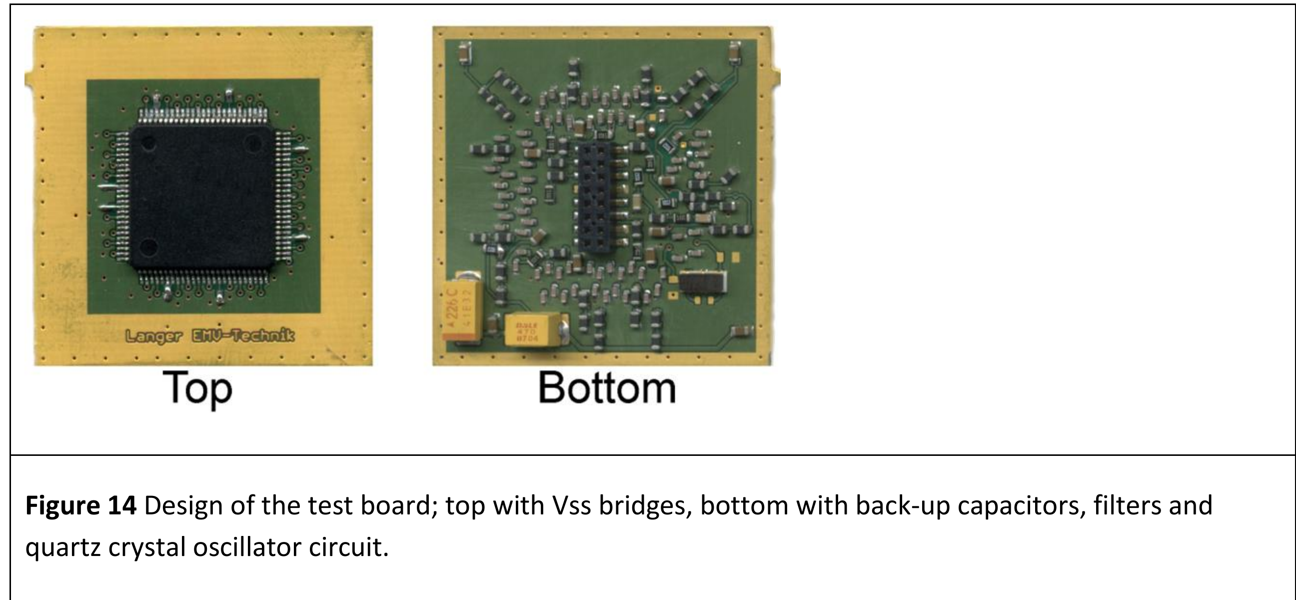

Figure 14 Design of the test board; top with Vss bridges, bottom with back-up capacitors, filters and quartz crystal oscillator circuit.

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Contact:

Peter Michak, Head of Sales, *michak@langer-emv.de*

Susanne Kaule, Sales US, *kaule@langer-emv.de*