Operation amplifier ICs

Measuring the immunity to RF disturbance voltage

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Operation amplifiers (OA) are exposed to electromagnetic disturbances during their use. It is thus important in practice to precisely determine their limit parameters to exclude any subsequent EMC effects.
RF disturbance signals are demodulated during the EMC test procedure at radiated field strengths of more than 100 V/m if a bipolar OA is installed in automobile electronics. These signals are responsible for malfunctions in the electronics. These expected malfunctions can be avoided in the planning phase by the clever selection of an OA with a higher RF compatibility since OA ICs have a different immunity to radiated disturbances depending on the respective IC manufacturer. The IC manufacturers integrate countermeasures in the ICs to increase the IC's immunity to radiated disturbances. Despite these efforts the development engineer must protect the OA against excessively high RF influences on the module. A new measuring method will assist the following two user groups by providing a tool for an optimum planning of RF protection on the one hand and a tool to determine more precise useful development parameters on the other hand.

1. IC manufacturers to improve the ICs

2. IC users to select the proper IC and / or develop EMC compliant IC specific circuits

The following example will demonstrate how these EMC parameters can be determined.

The firm of Langer was faced with the problem of evaluating the immunity of two ASICs with OA to radiated disturbances in the range of up to 3 GHz for their use in automobile technology.
The following measuring method was developed to tackle this task:
The OA circuit was operated as an inverted amplifier. Demodulation at the input base emitter diode is raised to a level that can be easily recorded with measuring devices if the amplification is high enough. The disturbance generator that has the required characteristics is derived from the practical mechanisms of action.

1. In the case of radiated disturbances, the magnetic field of the RF penetrates the existing low-impedance loops. These loops close via the distributed capacitance of the conductor runs if the frequency is high enough.
A low-impedance generator was connected directly to the IC input to simulate this effect. Decoupling relative to the useful signal (negative feedback resistor) had to be provided via a decoupling capacitor. The low-impedance generator could thus be used to evaluate the EMC measures (EMC capacitors) integrated in the IC and their more or less satisfactory implementation in terms of RF technology.

2. An existing external series resistor increases the immunity to conducted disturbances. Integrated EMC capacitors that come off badly in terms of HF technology if tested with a low-impedance generator have a much better effect in connection with this series resistor. A high-impedance generator had to be used to check this described characteristic.

The following generators were developed and used to perform the two measuring tasks described above:

1. Low-impedance generator: 1 R source resistance, frequency range 10 MHz ... 3 GHz

2. High-impedance generator: 1 k source resistance, frequency range 10 MHz ... 3 GHz

The generators were developed by modifying the existing P501 and P502 type probes (automatic P500 probe measurement equipment for the IEC 62132-4 and DPI-BISS (6.8 nF) DPI measuring method from the firm of Langer). These generators were used together with the automatic P500 measurement equipment and the associated XQC-ProbeControl control software to measure and document the frequency response characteristics.

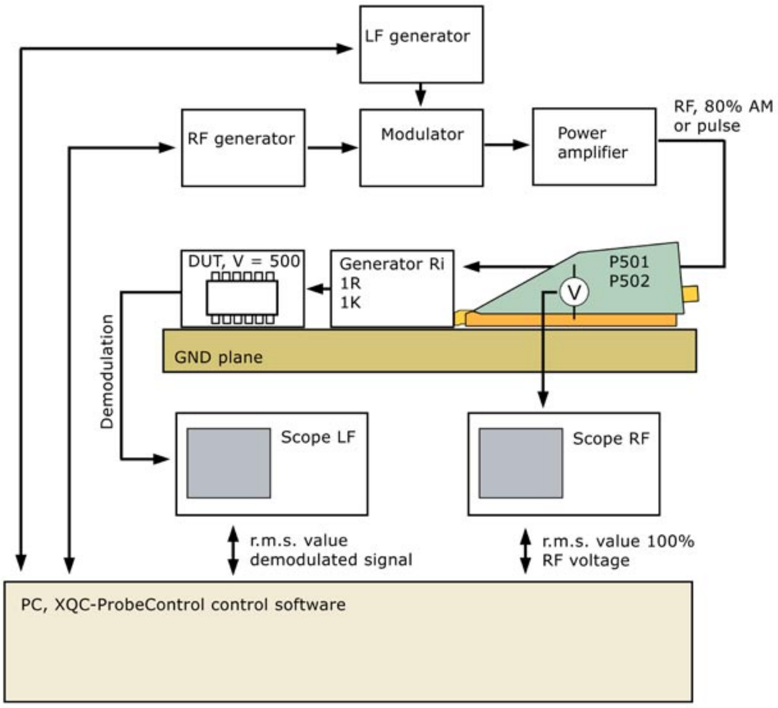


Figure 1, Block diagram of the set-up to measure the immunity to RF on OA

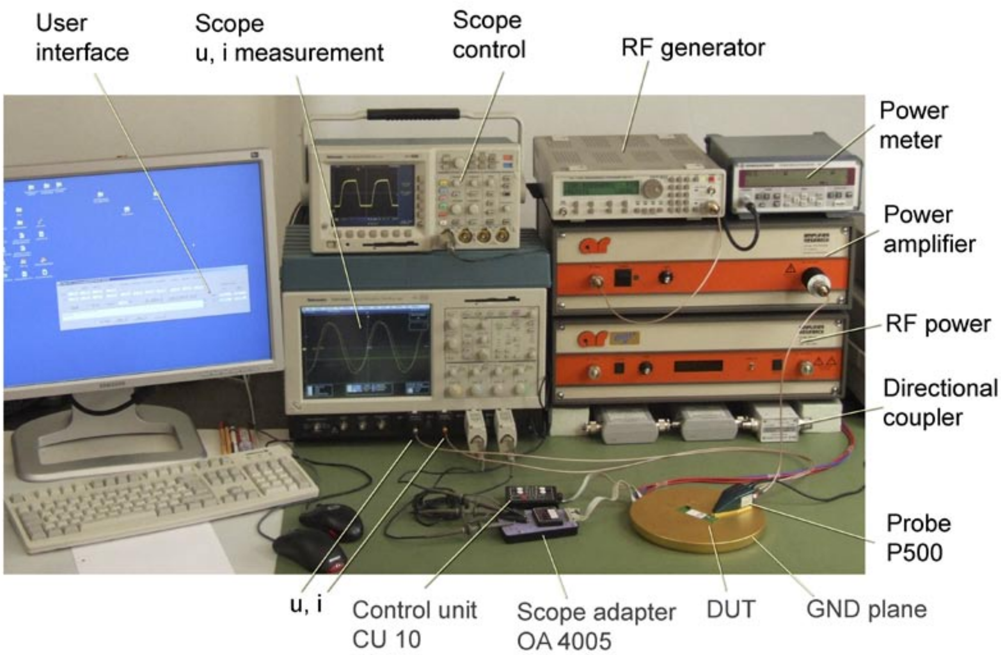
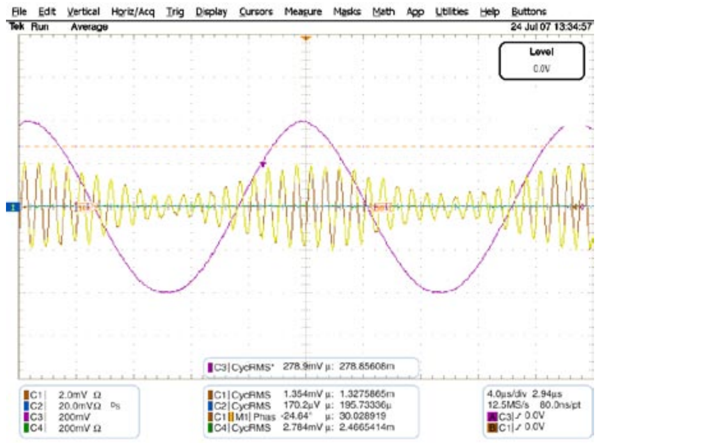
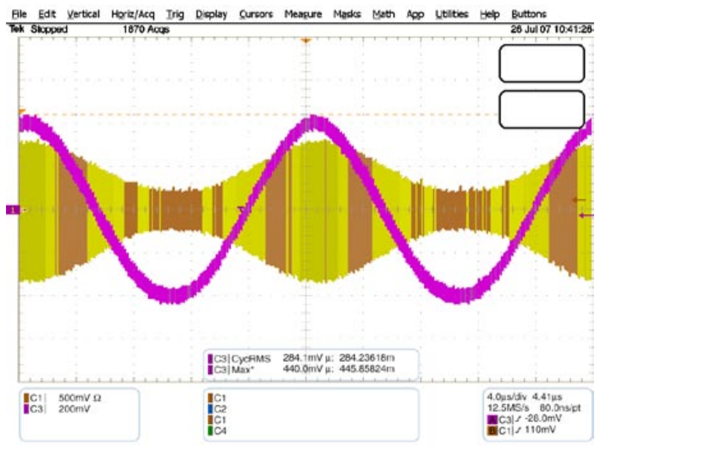
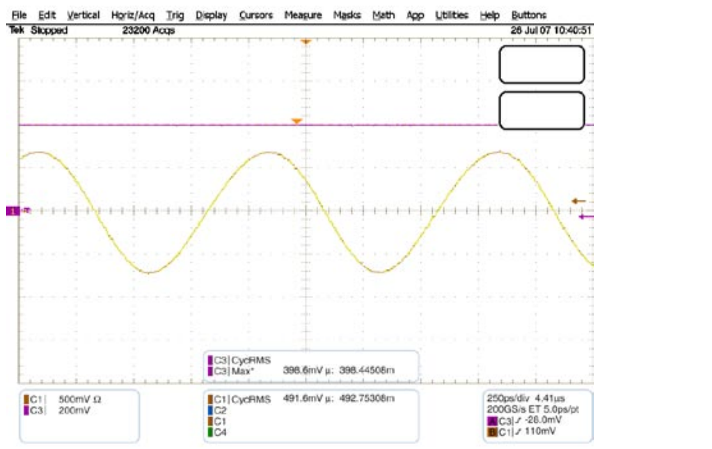
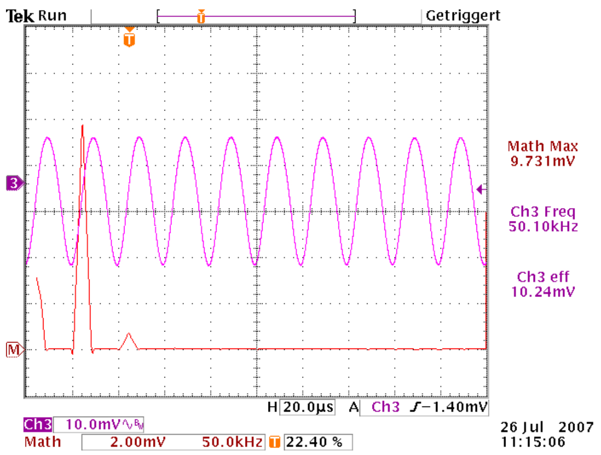


Figure 2, P500 measurement equipment and XQC ProbeControl

The OA IC (DUT) is located on an adapter PCB which is let into a metal plate (GND plane). The low-impedance or high-impedance generator is placed on the metal plate and connected to the corresponding IC pin contact. The generator probe comprises a voltmeter to determine the RF voltage (generator voltage UG). UG was adjusted to such a high level in the test set-up that a demodulation voltage of up to 10 mV_{eff} was achieved. The measurement results are shown in Figures 3 and 4. The effect of the integrated RF filter capacitors (lower frequency range) improves with an increasing frequency.

Oscillograms in Figure 3:

	Modulation voltage and modulated RF signal Red: modulation voltage Yellow: RF generator voltage
	1 k generator, IC manufacturer 2, Modulation voltage and modulated 1 GHz RF signal
	1 k generator, IC manufacturer 2, 1 GHz RF voltage on the crest of modulation
	1 k generator with 1 GHz RF voltage as above, IC manufacturer 2, demodulation voltage at the IC output

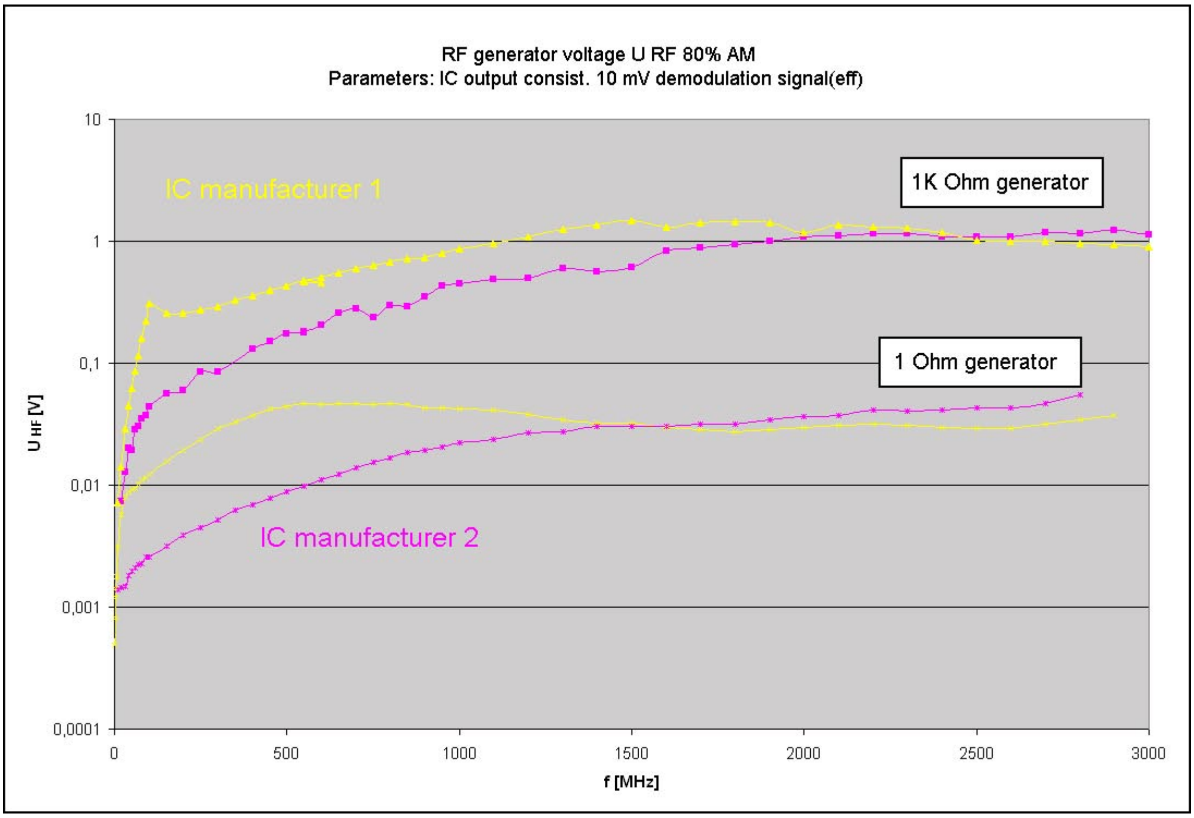


Figure 4, Results of measuring the immunity to RF disturbances of two OA ASICs from different IC manufacturers

The measurement with the 1 R generator shows a better immunity to radiated disturbances up to 1.5 GHz for OA IC no.1. This result indicates that the IC has a greater integrated EMC capacitor or better interconnection. The line inductances determine the current distribution above 1 GHz.
The 1k generator naturally provides better values. The stable RF behaviour of OA IC no. 1 can also be proven at higher frequencies (probably better interconnection of the capacitor).
The EMC test on the installed electronics also confirmed this OA IC behaviour.