LANGER
EMV-TECHNIK

Operating instructions

VM 251
Disturbance emission model

The VM 251 test board shows the effect of
EMC measures on electronic devices.

CE

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1 Use

The VM 251 test board shows the effect of EMC measures on electronic devices. The test board contains an 8051 micro-controller in the form of an integrated circuit (IC). The micro-controller emits electro-magnetic waves in different ways (disturbance emissions). The type and quantity of the disturbances emitted can be examined and changed by various measures on the test board. These measures include:

- the different use of rod aerials
- the use of filters on the power supply
- the use of ground planes on the printed circuit board
- the dependency on the 8051 micro-controller programming

The test board can be used for teaching at universities and other institutions of higher education, for the presentation of EMC measuring and testing devices as well as for seminars and workshops in industry.

2 Components

Figure 2.1: Components of the VM 251 model

- Test board with 8051 micro-controller (DS89C450 or P89C668)
- Two telescopic rod aerials
- Two cover plates for the conductor runs
- Two 1.5 V AA batteries as a power supply

3 Commissioning and overview

Two 1.5 V batteries have to be placed in the appropriate compartment on the rear of the VM 251 test board before commissioning. The 8051 micro-controller is already pre-programmed with a test program. Please refer to annex A for the test program sequence.

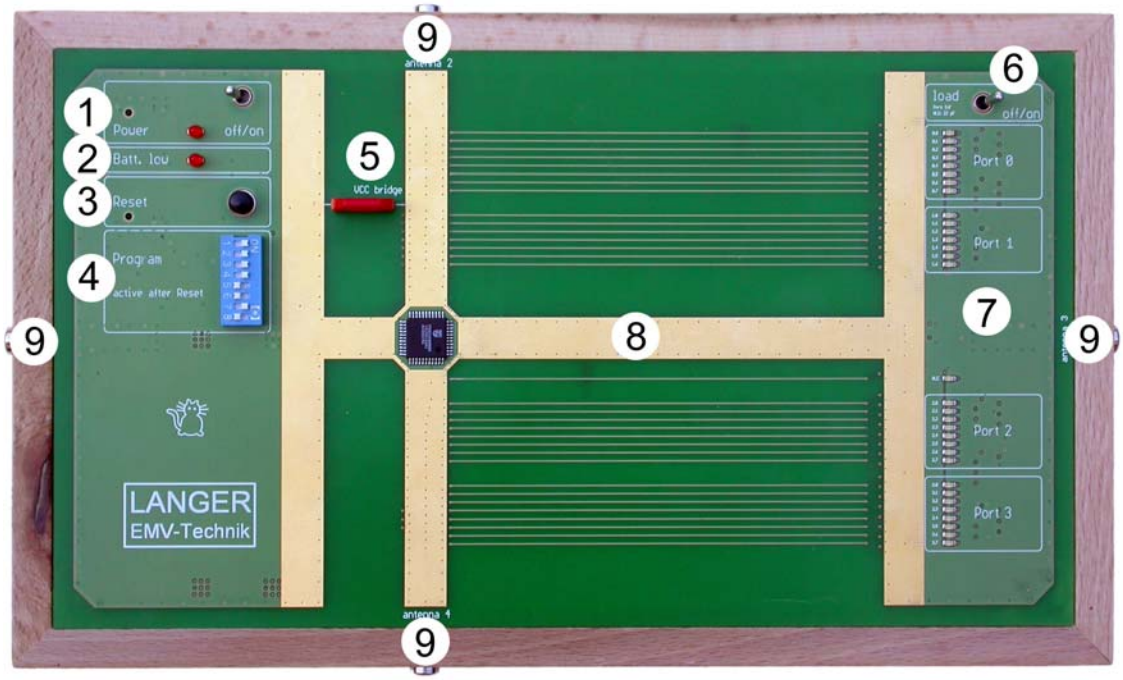


Figure 3.1: VM 251 front

1. Power: to switch the test board on / off
2. Battery indicator: comes on if the battery power is too low
3. Reset the 8051 micro-controller
4. Program selection for the 8051 micro-controller
5. Vcc bridge: the power supply passes through the respective conductor run if the plug is connected
6. Connecting / disconnecting the load to / from the micro-controller's I/O ports
7. LEDs to indicate the status of the individual I/O ports
8. Ground planes to shield the conductor runs using the two cover plates
9. Sockets for the rod aerials

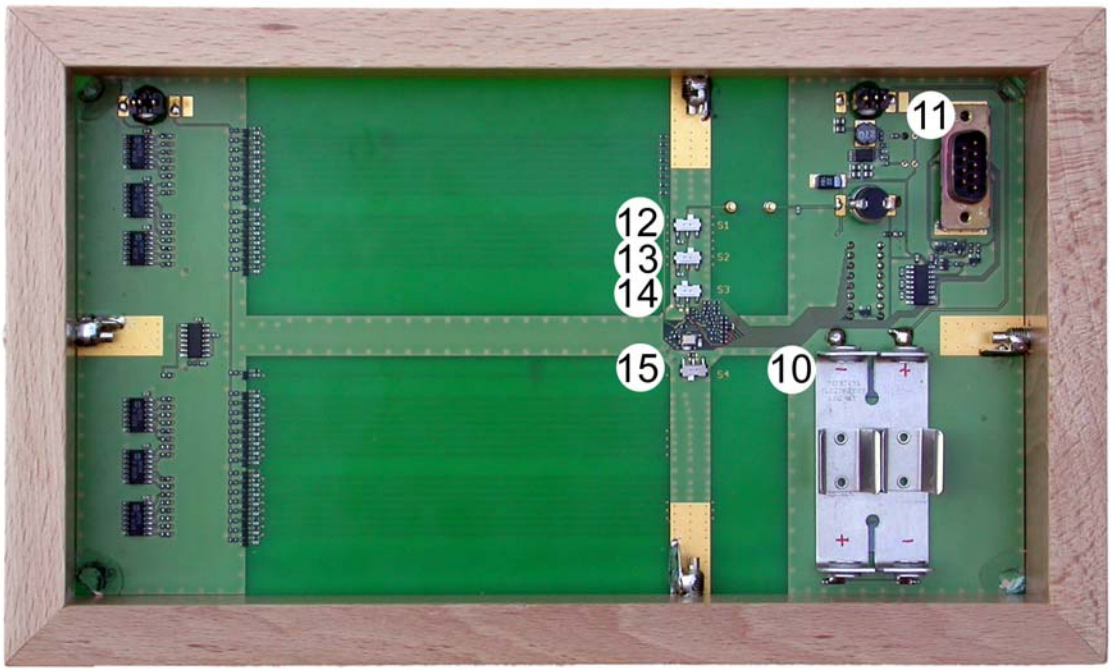


Figure 3.2: VM 251 rear

10. Battery compartment for two 1.5 V AA batteries
11. Programming interface for the 8051 micro-controller (crossed RS232 cable)
12. Blocking capacitor on the power supply of the 8051 micro-controller
13. Blocking capacitor on the power supply of the 8051 micro-controller
14. Blocking capacitor on the power supply of the 8051 micro-controller
15. Chip ferrite between the test board ground and 8051 micro-controller ground

for 12-14: Switch to the left = blocking capacitor (100 nF) is connected
for 15: Switch to the right = chip ferrite (2.2 kΩ@100 MHz) is interconnected

4 Disturbance emission measures

The disturbance emission from the test board can be measured with a receiving aerial. Figure 4.1 shows a possible test set-up for the examination of disturbance emissions.

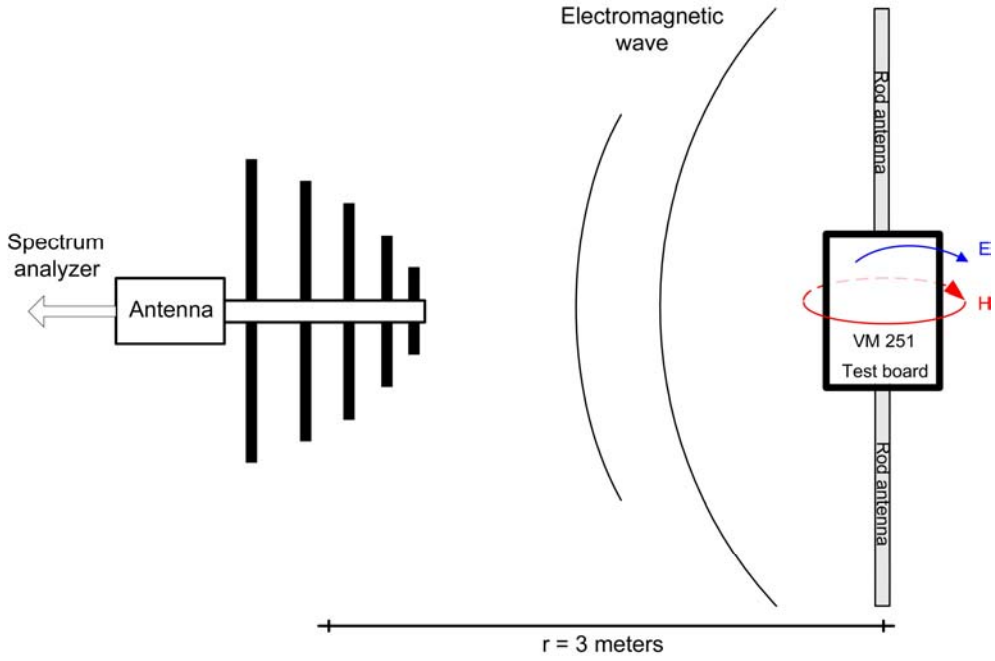


Figure 4.1: Measurement set-up for the examination of disturbance emissions

The effects of different measures taken on the test board such as connecting the blocking capacitors or varying the length of the rod aerials can be examined. The rod aerials simulate the power supply or cable harness of modules.

4.1 Aerials

The rod aerials are plugged into the sockets (9) on the sides of the test board. If both aerials are used they should be arranged opposite each other since the electro-magnetic waves are emitted perpendicular to the rod aerial. The aerials are stimulated to emit disturbances by RF signals on the conductor runs originating from the micro-controller.
The resonance frequencies of the emitted electromagnetic wave are determined by the length of the rod aerial.

4.2 Conductor runs with/without load

The conductor runs on the front of the test board are connected to the 8051 micro-controller ports. The conductor runs are unshielded. They can be terminated either at no load or at a load of 1 nF (6).
The conductor run with the ALE signal[1]. is a special case. The ALE signal is used to control external program memories. The clock frequency of the ALE signals is approx. 1/6 to 1/3 of the oscillator frequency depending on the manufacturer. The oscillator frequency is 20 MHz in this case. The conductor run is terminated at the ALE pin at 22 pF when a load is connected.
The respective LEDs can no longer come on at high-frequency signals if a load is connected. The time constant is too large in this case due to the resistor and capacitor at the conductor run. However, this does not affect the test board's functionality.
If a load is connected, the disturbance emissions increase in the low frequency range since more current flows through the conductor runs. The disturbance emissions remain constant in the upper frequency range since the inductive resistance of the conductor runs is greater at high frequencies.

4.3 Cover plates

The conductor runs can be shielded with the two cover plates. The plates can be arranged with the gold-plated side pointing either up or down. Both the electric and magnetic near fields of the conductor runs are shielded when the two plates are put into place. The shielding is more effective if the gold-plated side of the cover plate points down. The disturbance emissions of the test board are thus reduced.

4.4 Vcc bridge

The power supply of the 8051 micro-controller can be led via the respective conductor run by means of the plug. The power is now supplied via a long unshielded conductor run. This increases the disturbance emissions from the test board.

4.5 Filters on the power supply

There are different filters on the underside of the test board which can be used to block the power supply and ground on the micro-controller. The power supply can be blocked by capacitors at different distances to the micro-controller pin (12-14).

[1] ALE: Address Latch Enable

Each of the capacitors has a capacitance of 100 nF. The capacitors are connected if the switch is turned to the left.
The micro-controller ground can be directly connected to the test board ground or led via a chip ferrite. The chip ferrite has a resistance of 2.2 kΩ at a frequency of 100 MHz. The chip ferrite is interconnected between the micro-controller ground and test board ground if the switch is turned to the right.

4.6 Programming

Disturbance emissions also depend on the micro-controller programming. The micro-controller is already pre-programmed. Different program sequences can be selected via the switches on the front of the test board (4). Annex A provides a table which lists a program sequence overview.
The 8051 micro-controller can be reprogrammed via its ISP interface[1]. The programming circuit is located on the test board. A crossed RS 232 cable (zero modem cable) and a PC are needed to program the micro-controller. The micro-controller is programmed using the manufacturer's programming software. The following 8051 micro-controllers can be programmed:

Manu-facturer	**Manufacturer's programming software**	**Settings**
NXP	FlashMagic v. 4.28	Baud rate: 9600 Interface: None(ISP) Oscillator freq.: 20 MHz Options->Advanced Options→Hardware Config: enable "Use DTR and RTS to control RST and PSEN"
Maxim	Microcontroller Toolkit (MTK) v. 2.4.04	Activate the option→"Toggle DTR at connect/disconnect" Baud rate: 9600
Atmel	Flexible In-System Programmer (FLIP) v. 3.3.1	Settings→Preferences→RS 232: enable "ISP Hardware Conditions controlled by Flip", RST: High, PSEN: Low Baud rate: 9600

Annex B shows the circuit diagram of the VM 251 test board including the programming circuit.

[1] ISP: In System Programmable

5 Examples

5.1 Measurements with aerial

The disturbance emissions from the test board are measured with an aerial according to the measurement set-up shown in Figure 4.1. The P89C668 is used as a micro-controller. Each of the rod aerials has a length of approx. 1 meter. The effect of the different EMC measures can then be checked.

Figure 5.1 shows the efficacy of the cover plates on the conductor runs. The yellow curve shows the disturbance emissions measured with no cover on the conductor runs. The red curve shows the disturbance emissions when the conductor runs are covered.

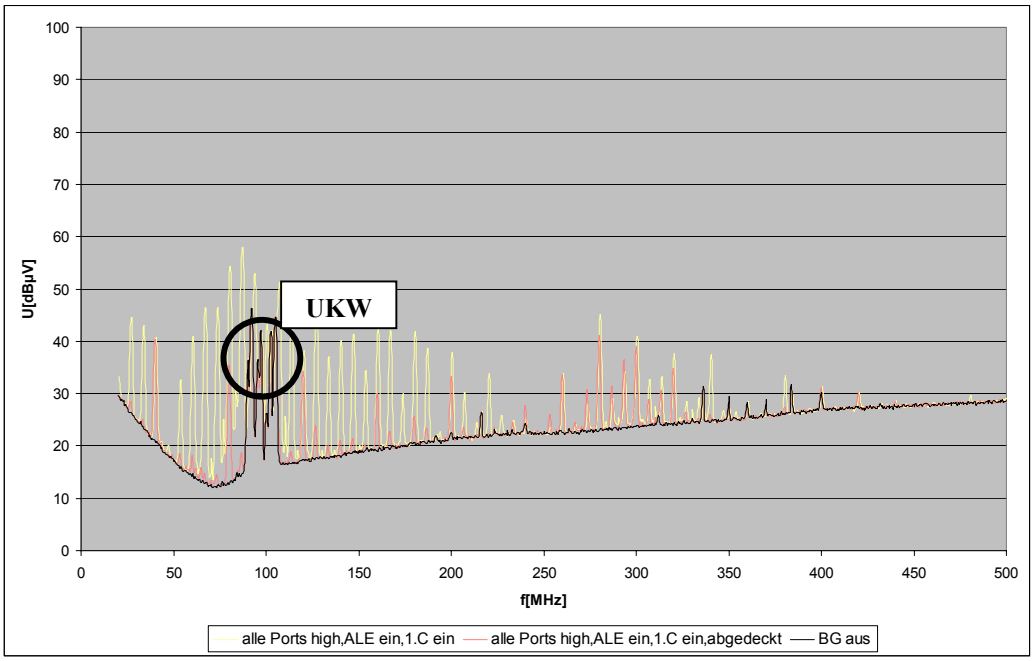


Figure 5.1: Effect of the cover plates on disturbance emissions measured with an aerial

The disturbance emissions are reduced by the cover in all frequency ranges.

Figure 5.2 shows the effect of the filters on the power supply and ground of the micro-controller. The blue curve shows the disturbance emissions with an unblocked power supply and the ground connection led via the chip ferrite. The green curve shows the disturbance emissions with a connected blocking capacitor and bridged chip ferrite.

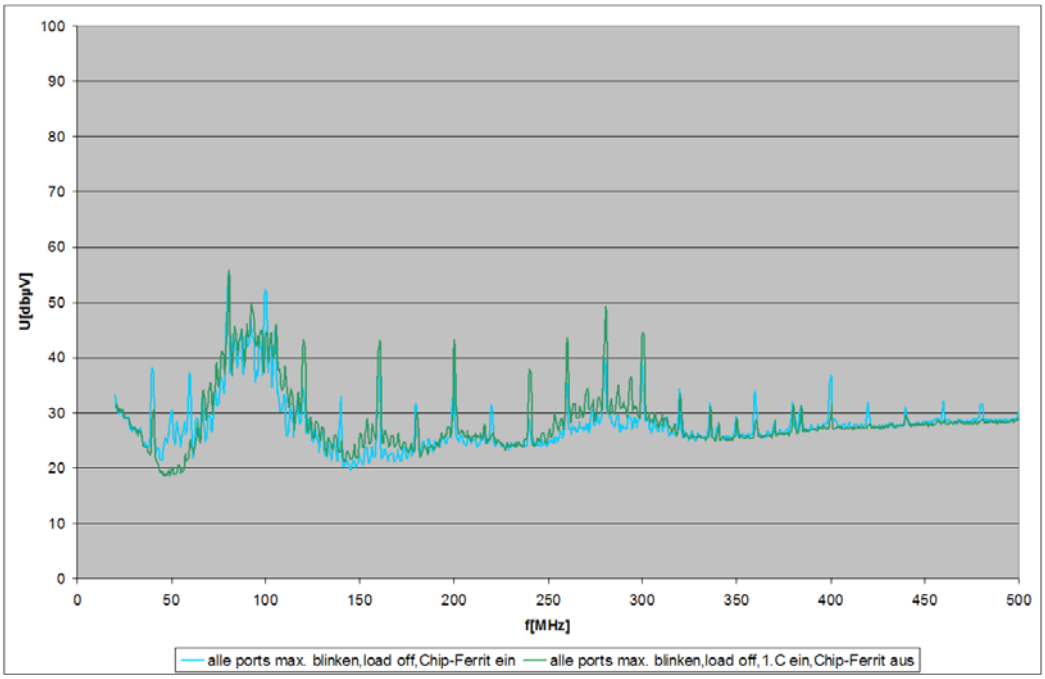


Figure 5.2: Effect of the filters on disturbance emissions measured with an aerial

The disturbance emissions from the test board are reduced by the filters at a frequency of 50 MHz in this example. The disturbance emissions, however, are slightly amplified at 150 MHz and 275 MHz.

5.2 Measurements with ESA

The disturbance emissions from the test boards which were measured with the aerials can also be measured with the ESA "Disturbance emission development system" from Langer EMV Technik GmbH for comparison. Figure 5.3 shows the measurement set-up. Copper adhesive tape or an adapter can also be used instead of the HFA21 with probe tip.

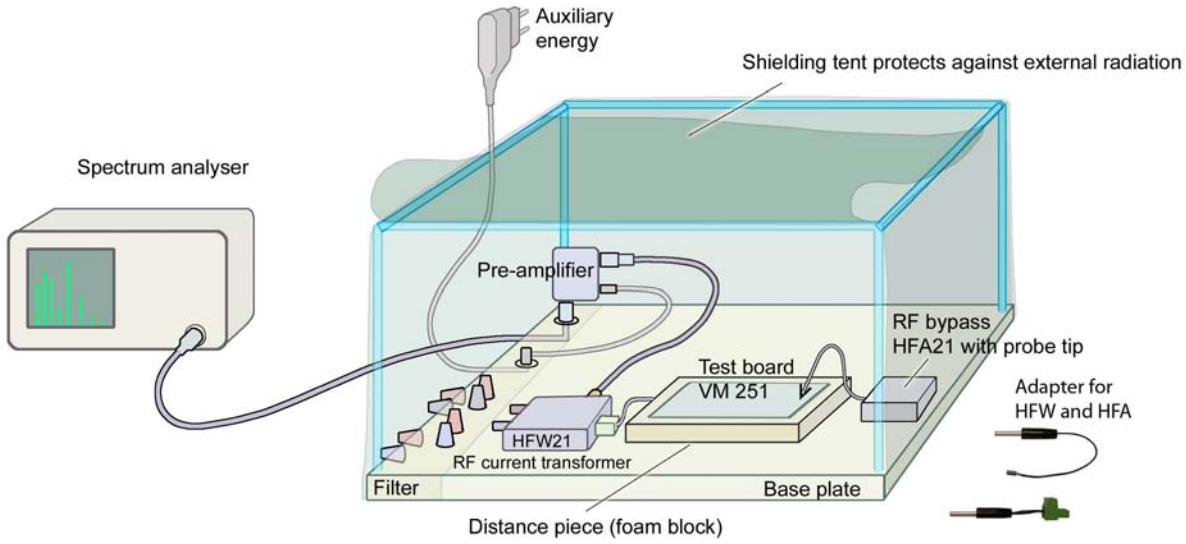


Figure 5.3: Measurement set-up with the ESA

The same test board settings as in the measurements with the aerial are used in the example. Figure 5.4 shows disturbance emissions with and without a cover on the conductor runs.

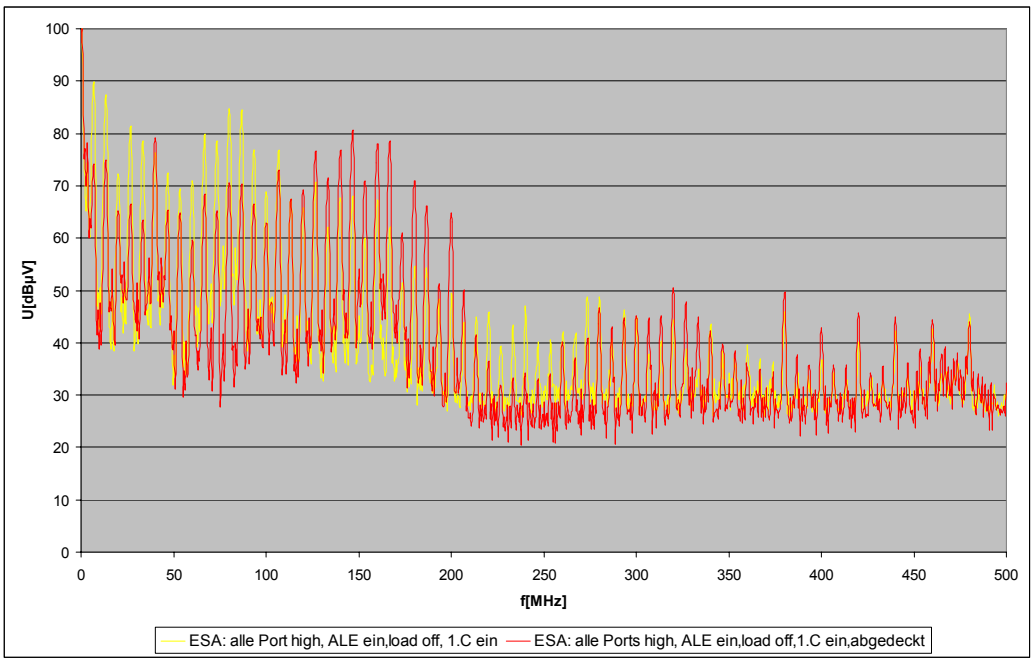


Figure 5.4: Effect of the cover plates on disturbance emissions measured with the ESA

The disturbance emissions are reduced in most of the frequency ranges if the conductor runs are covered and the measurement is performed with the ESA.

The second example shows the effect of the filters (Figure 5.5) as in the measurements with an aerial.

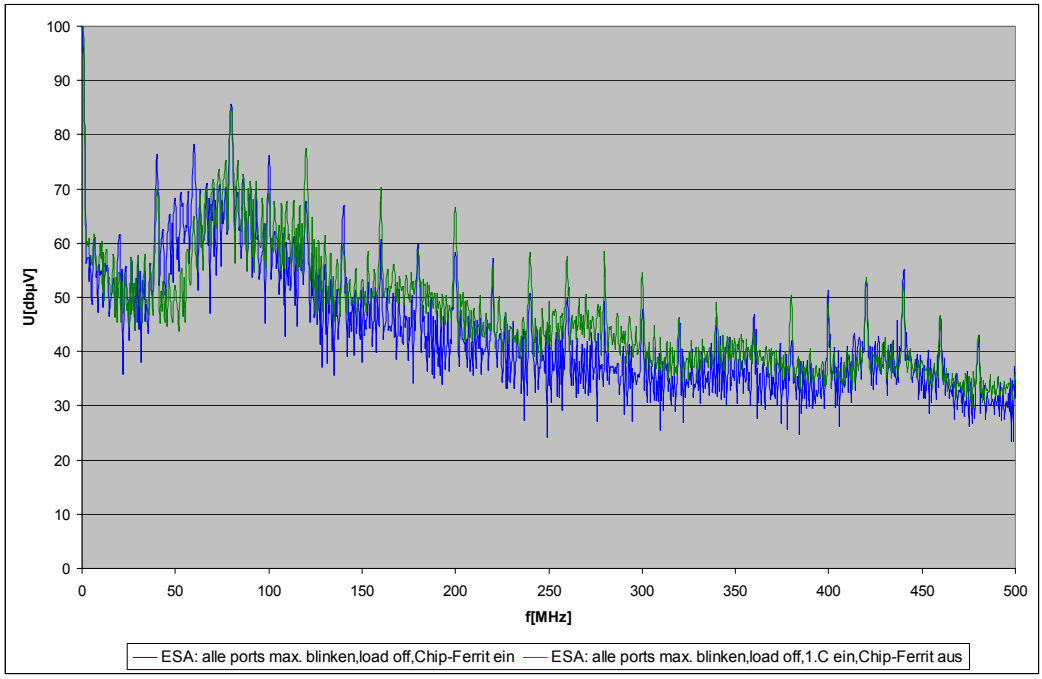


Figure 5.5: Effect of the filters on disturbance emissions measured with the ESA

The disturbance emissions from the test board are reduced at a frequency of 50 MHz by the filters as in the measurements using an aerial. The disturbance emissions, however, are slightly amplified at 150 MHz and 275 MHz.

Similar results are obtained in the measurements with an aerial and those with the ESA. The disturbance emissions can be examined by both methods.

6 Safety

6.1 Safety precautions

When using a product from LANGER EMV Technik, please observe the following safety instructions to protect yourself from electric shock or the risk of injuries:

- Read and follow the operating instructions.
- Keep the operating instructions in a safe place for later use.
- Observe the safety instructions and warnings provided on the product.
- Visually inspect the product from LANGER EMV-Technik before using it.
- The product from LANGER EMV-Technik may only be used for its intended purposes. Any other use is prohibited.

6.2 Basic safety instructions

1.
The product may only be operated in the operating states described by the manufacturer. Unless otherwise specified in the data sheet: the products are solely for indoor use. A maximum rated voltage tolerance of ±10% and rated frequency tolerance of ±5% is permissible for the power supply.

2.
The local and national safety and accident prevention regulations have to be observed when working on and with the product. The product may only be opened by authorized specialist personnel. The product has to be isolated from the supply mains before any work is performed on the product or this is opened. Only authorized electrical specialists may change any parts and carry out balancing adjustments as well as maintenance or repair work. Only original parts may be used if safety-relevant parts (such as mains switches, mains transformers or fuses) have to be replaced. A safety test has to be performed each time a safety-relevant part has been replaced.

3.
Hazardous substances may be released if products / components are subjected to mechanical and/or thermal treatment beyond their intended use. The product may thus only be dismantled, for example during its disposal, by qualified specialist personnel or LANGER EMV-Technik. Improper dismantling may be harmful. All national regulations pertaining to the disposal must be observed.

4.
Higher functional electromagnetic radiation and near fields occur when the product is operated. In consideration of the fact that unborn children deserve particular protection, pregnant women should be protected by appropriate measures. Furthermore, persons with a pace-maker may be at risk through electromagnetic

radiation. Interference with electronic products outside the EMC environment on site should be prevented by observing the respective safe distances or using shielded rooms. The employer is responsible for assessing work places which are exposed to a special risk of radiation and eliminate hazards if necessary.

5.
Parts or materials may only be added to or removed from a product from LANGER EMV-Technik if this is switched off.

6.
The employer is responsible for choosing the appropriate personnel for operating the products.

7.
Only use the product with the specified type of battery. Make sure before commissioning that the batteries show no signs of damage and are fully charged on fitting.

8.
Never remove a part of the housing whilst the product is in operation. This exposes electrical lines and components and may lead to personal injuries, fire and damage to the product.

9.
Never insert any objects in the openings of the housing which are not intended for this purpose. Never pour any liquids over or into the housing. This may cause short-circuits in the product and/or electric shock, fire or personal injuries.

10.
Never use the product under conditions which may or did lead to condensation in or on the product, for example, after the product was moved from a cold to a warm environment.

11.
Only use neutral detergents for cleaning the product. Never use alcohol, petrol or solvents.

We will remedy each defect which is due to defective materials or defective manufacture, either by repair or supply of spare parts, during the legal warranty period. The warranty period is subject to the applicable law of the country where the product from LANGER EMV-Technik was purchased.

7 Warranty

Warranty is only granted on condition that

- the product from LANGER EMV-Technik is handled with care.
- the operating instructions are observed.
- only original spare parts are used.
- External components such as power supply, connecting cable, etc. have separate warranty terms and conditions which are applicable to the respective manufacturer.

Warranty is forfeited if

- unauthorized repairs have been made on the product from LANGER EMV-Technik.
- the product from LANGER EMV-Technik has been modified.
- the product from LANGER EMV-Technik has been improperly used.

Annex A

Program sequence of the pre-programmed 8051 micro-controller:

The ports are selected with the switches 1 to 3. The programs can be selected with the switches 4 to 6. Switch 7 switches the ALE pin of the micro-controller on or off. Switch 8 has no function.

1	2	3	Port
off	off	off	0
on	off	off	1
off	on	off	2
on	on	off	3
off	off	on	-
on	off	on	-
off	on	off	-
on	on	on	all

4	5	6	Program sequence
off	off	off	-
on	off	off	high
off	on	off	low
on	on	off	Visibly flashing fast
off	off	on	Visibly flashing slowly
on	off	on	-
off	on	on	Flashing at maximum (not visible)
on	on	on	-

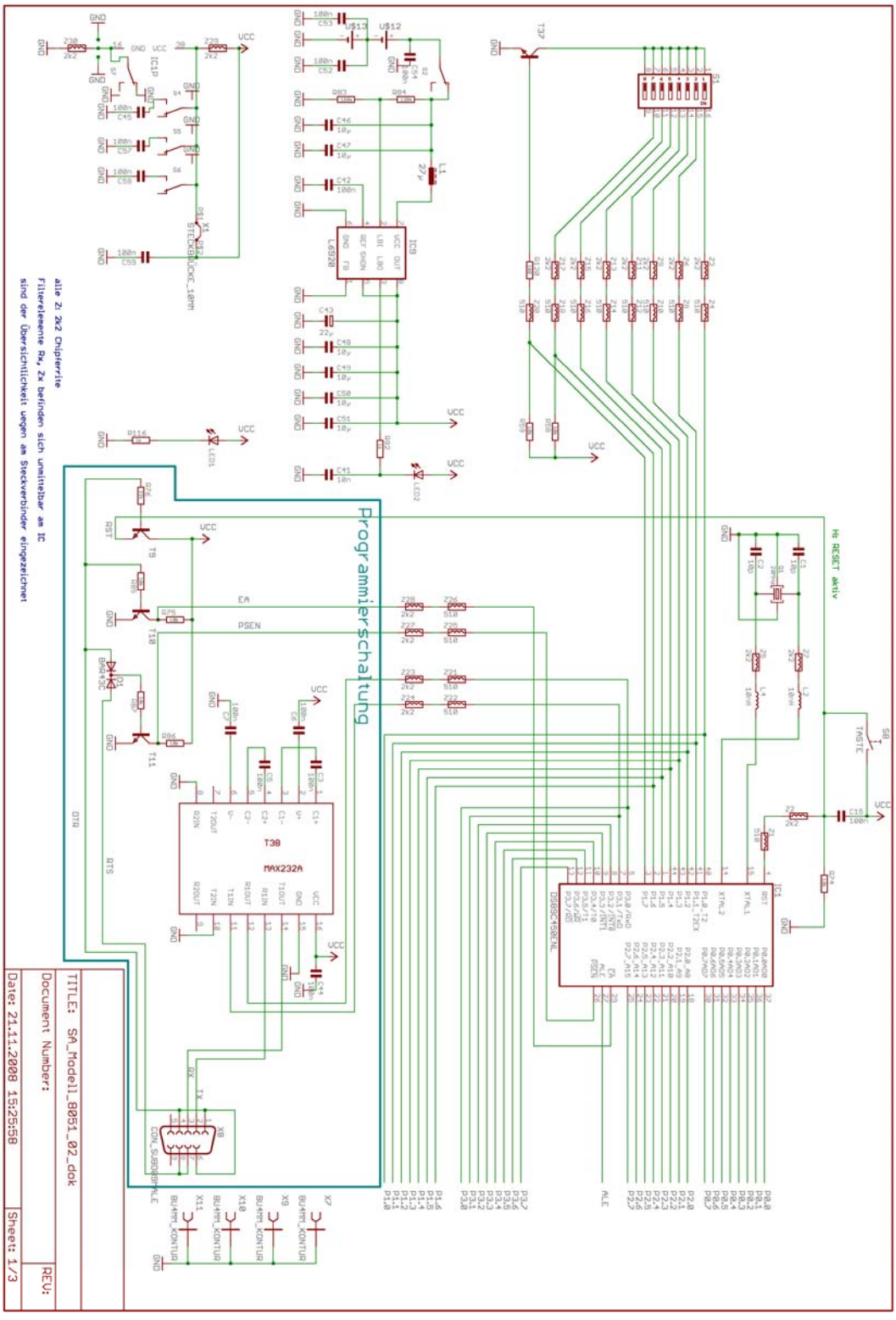
7	ALE
on	ALE on
off	ALE off

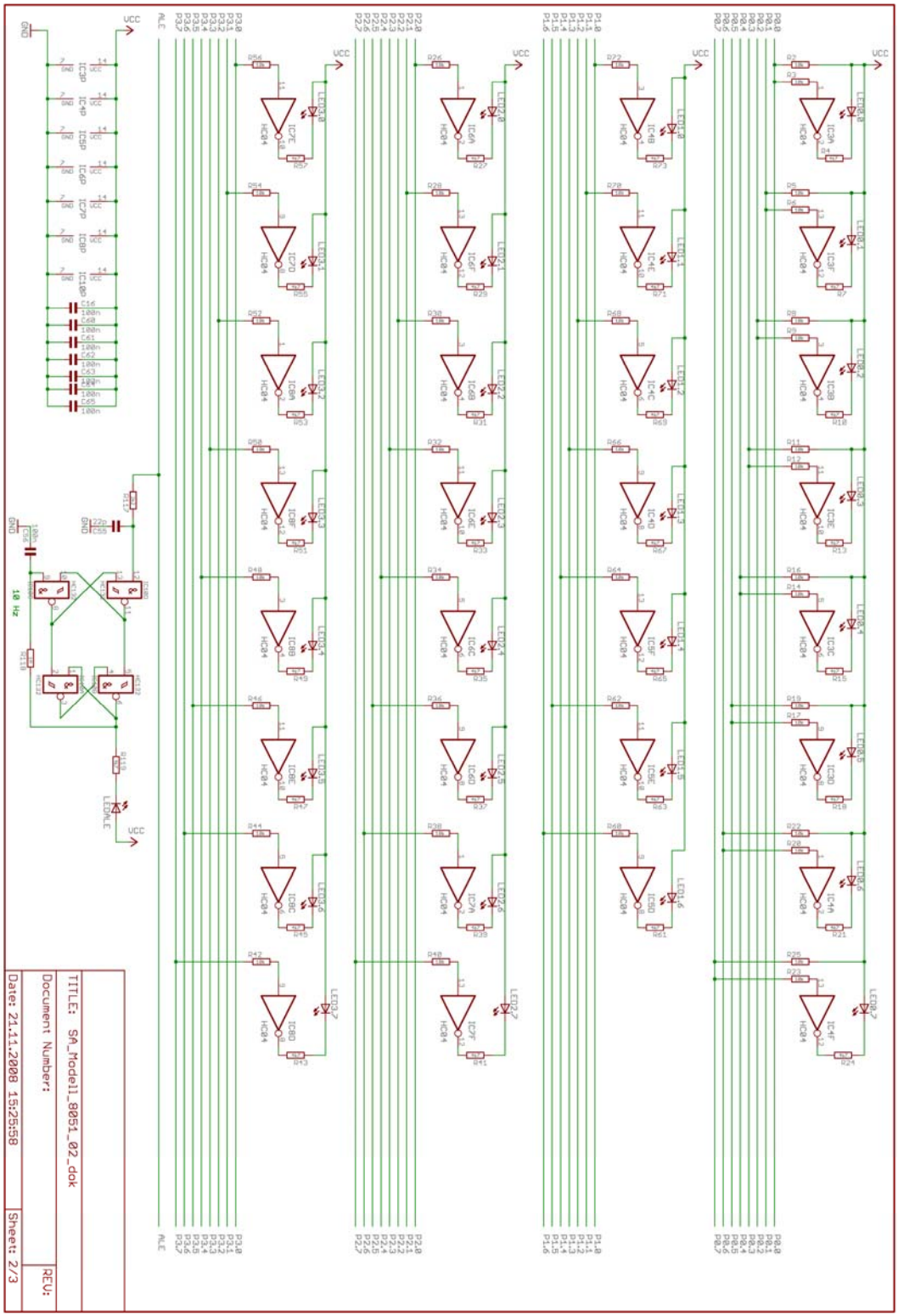
Example:

1	2	3	4	5	6	7	Program selection
on	off	off	off	on	on	off	Port 1 flashes at maximum, ALE off
on	on	on	on	off	off	on	All ports high, ALE on

Annex B

Circuit diagram of the VM 251 test board

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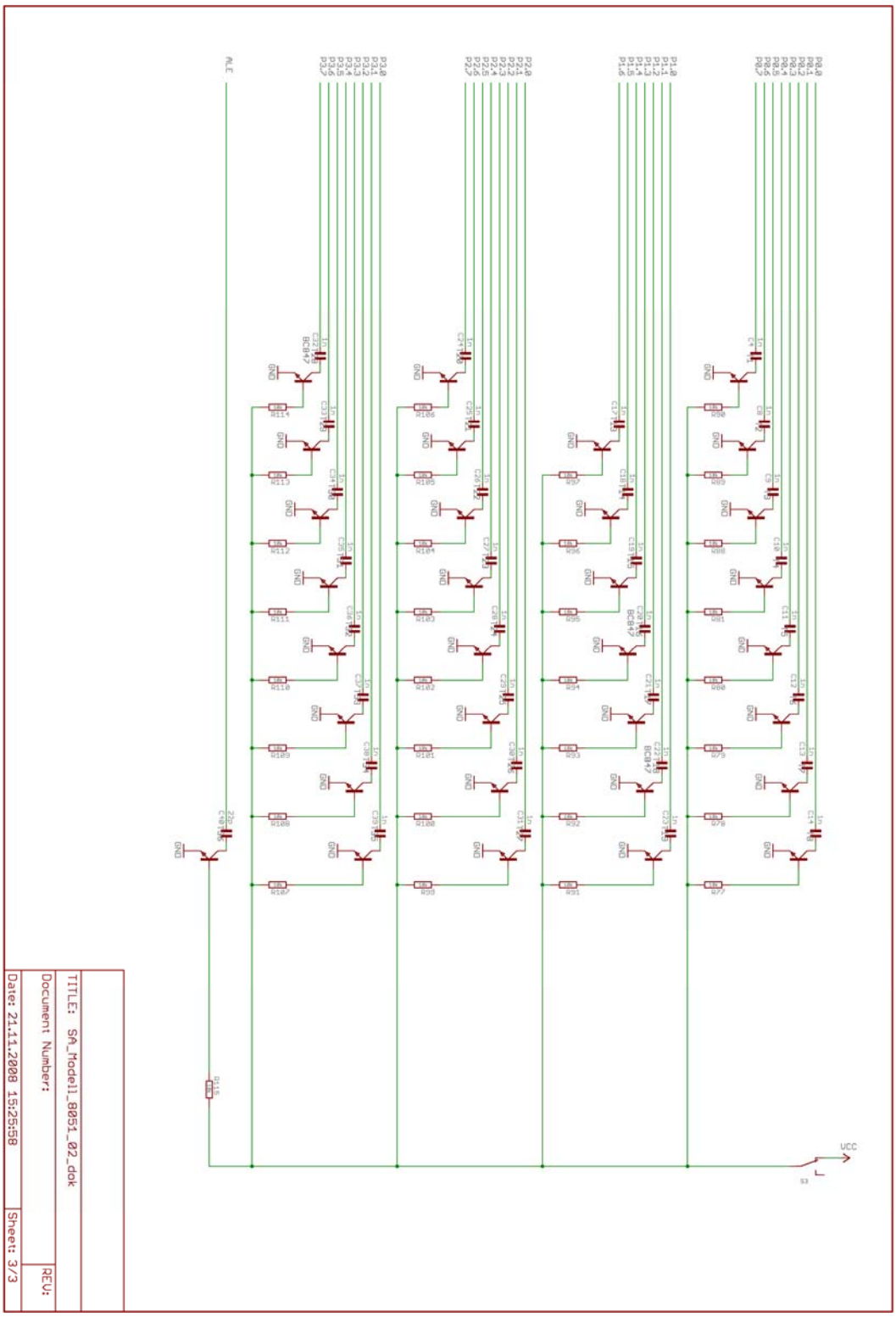
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