RX62T

Immunity Test

Results

September 08, 2010

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1 Immunity test of RX62T

1.1 Parameters

DUT: RENESAS RX62T

Part Number: R5F562TAANFP

Package: LQFP1414-100: plastic low profile quad flat package; 100 leads; body 14 x 14 x 1.7 mm

Package Code: PLQP0100KB-A [14x14mm]

Supply voltage level: 5 V
Current consumption
- with external oscillator: 28 mA

Burst frequency: 10 kHz
Number of pulses: 65500
Duration: 6.55 s

Heartbeat LED on port: P71; pin 56
Failure LED on port: P72; pin 55
Tristate LED on port: P33; pin 58
I/O LED on port: P73; pin 54
Switch on port: PB4; pin 30

Heartbeat frequency: 100 Hz

1.2 Test - Equipment

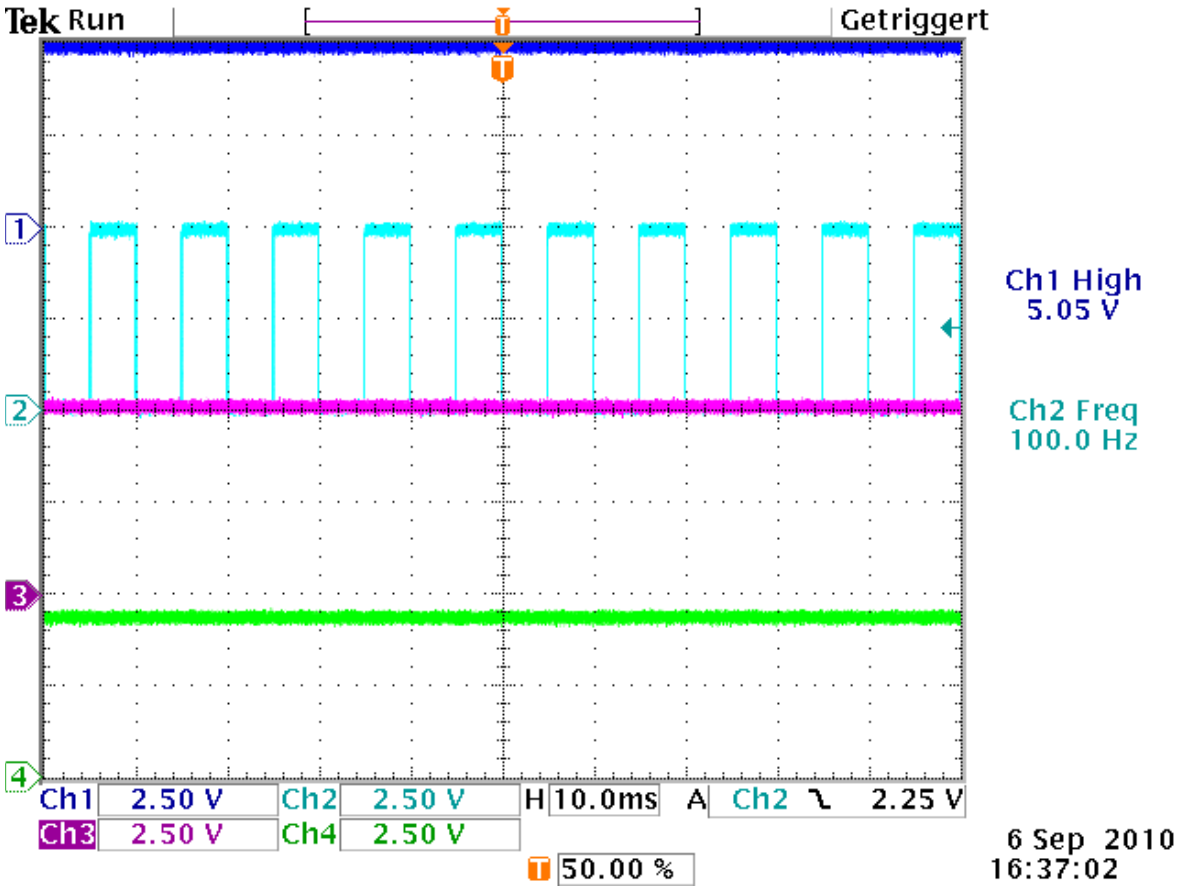
Instrument	Vendor	Model	Comment
Power supply	STATRON	Type 2229	2 x 0-40V / 0-2.5 A
Oscilloscope	Tektronix	TDS3054	4 Channel colour digital phosphor Oscilloscope
IC-Test system	Langer	Set 200/300	EFT injection set for IC
Connection Board	Langer	CB02	
Oscilloscope Adapter	Langer	OA 4005	4 Channel
Control Unit	Langer	CU 22	
Ground Plane	Langer	GND 20	TB1020-02

1.3 Oscillograms normal operation mode

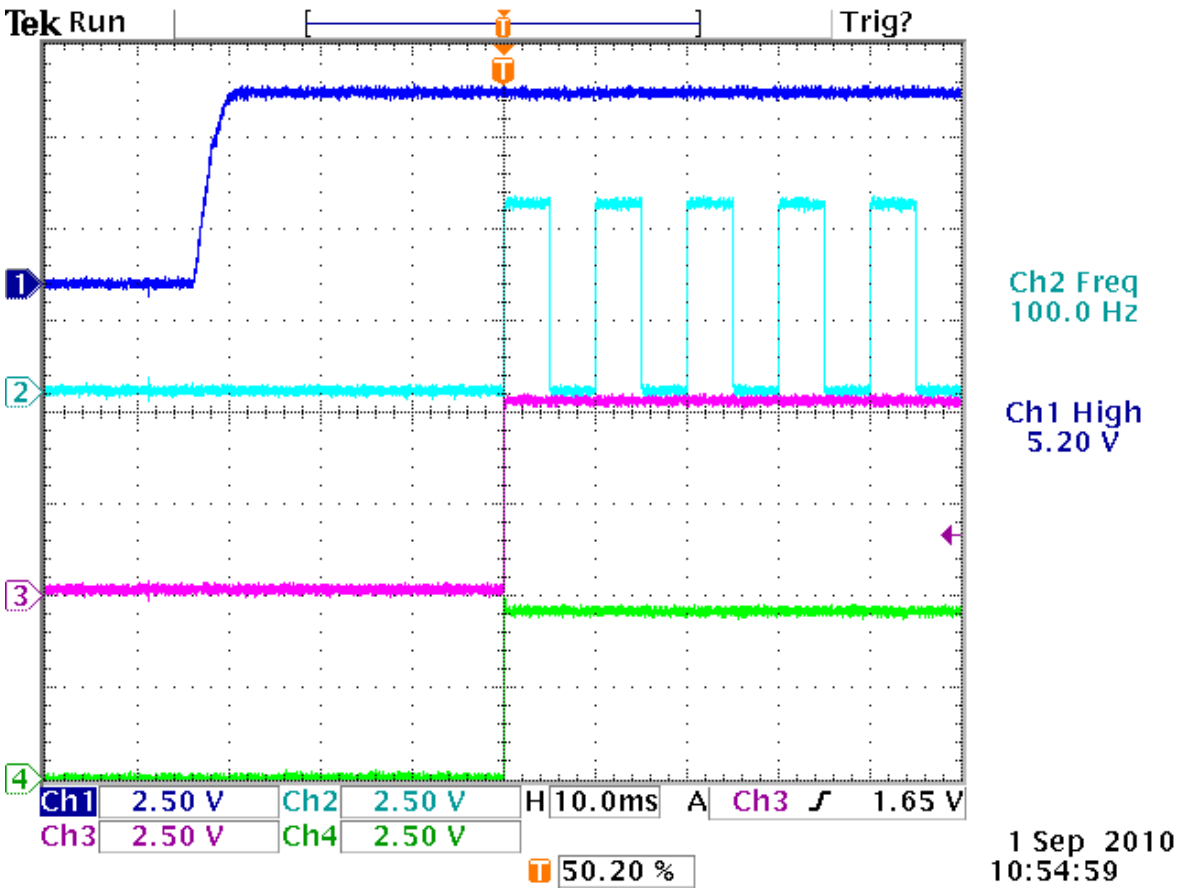
Legend:

Oscilloscope Channel:	Colour:	Signal name:
1	Blue	VDD
2	Cyan	Heartbeat LED
3	Red	Failure LED
4	Green	Tristate LED

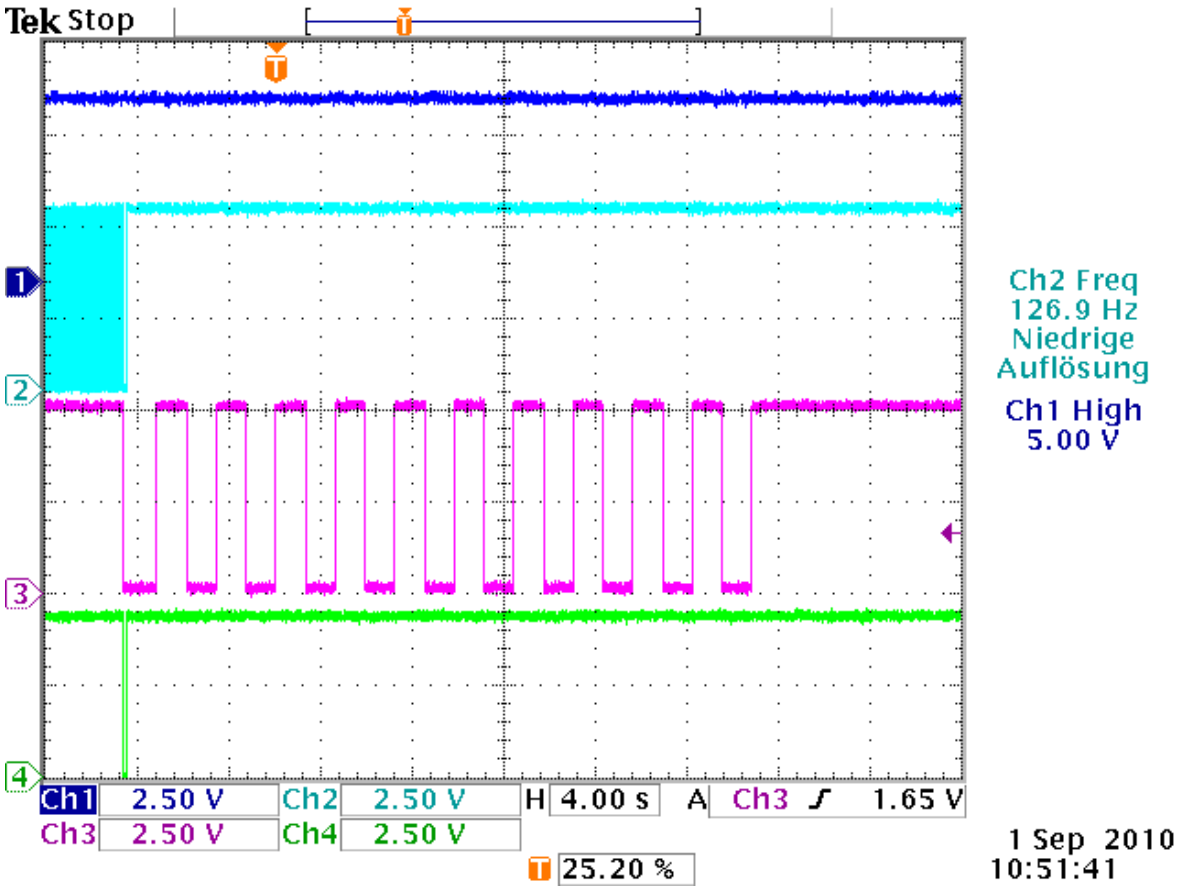
Normal mode:



Power on reset (POR):



External Reset (PUC):



1.4 Fault description

Fault classification:

F1.X function failure, self recoverable without reset

F2.X function failure, self recoverable with reset

F3.X function failure, requires a manual reset

F4.X function failure, requires a power off/on

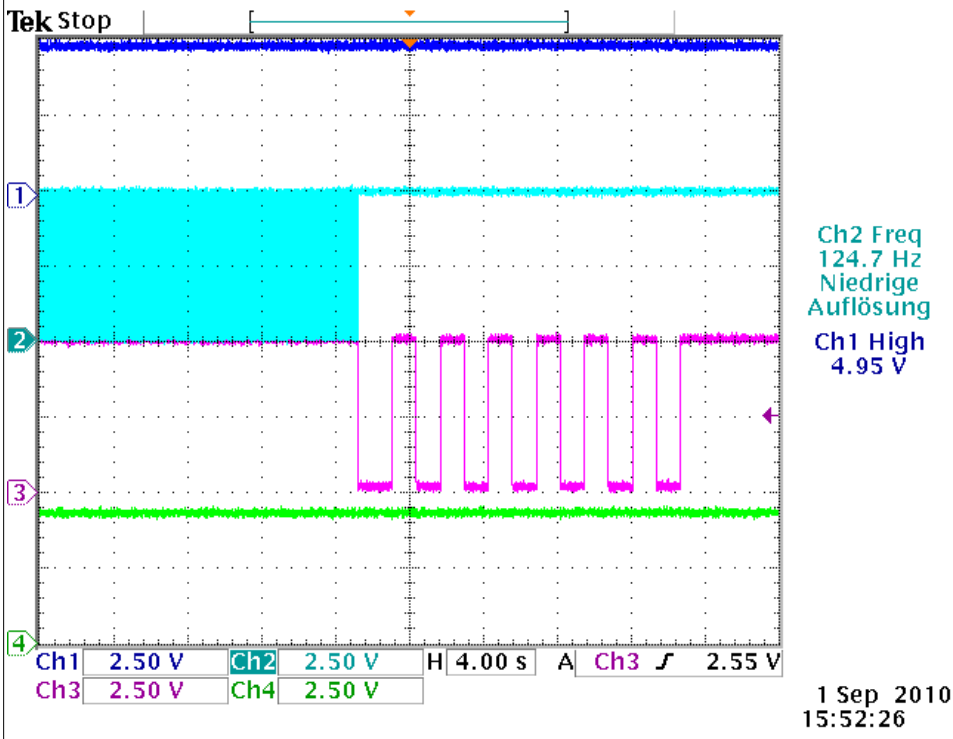
F5.X permanent damage

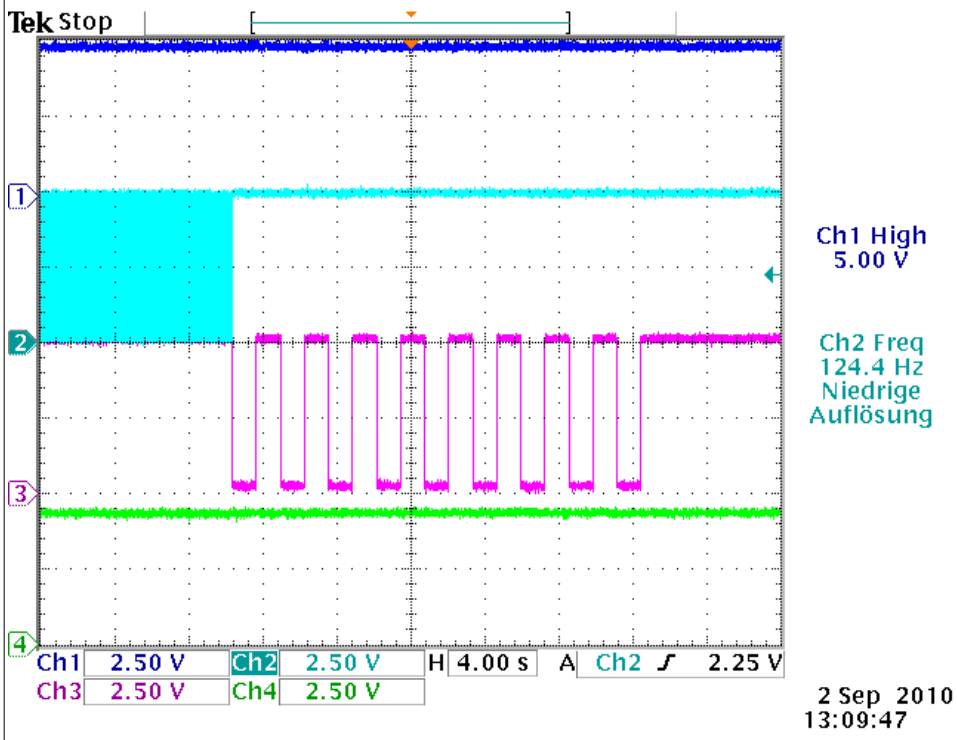
Failure codes of special software:

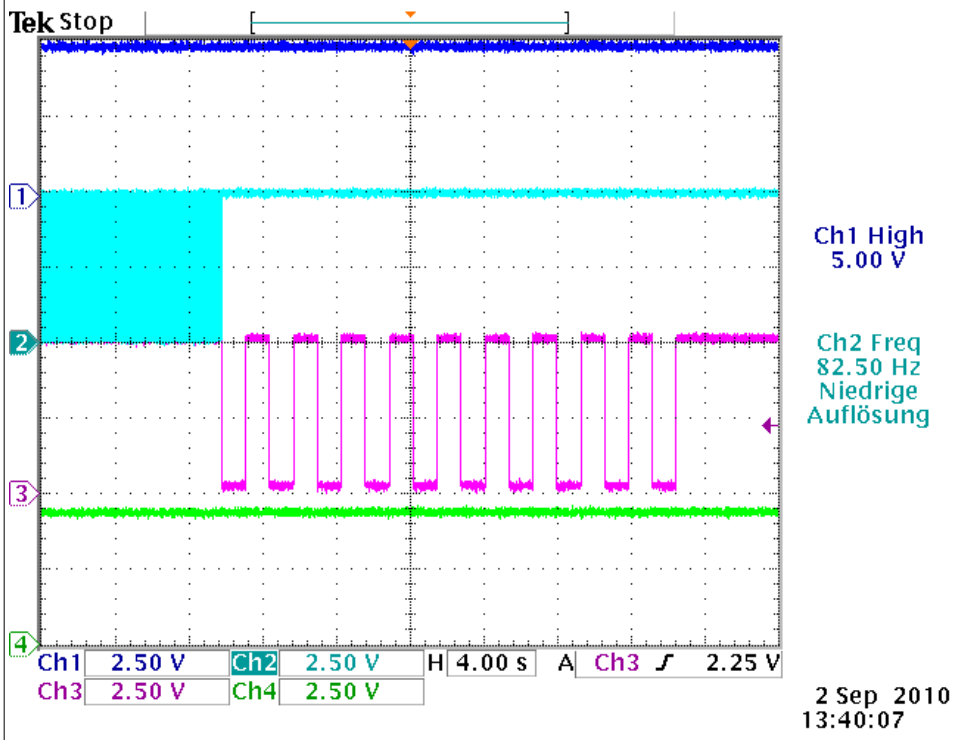
The failure LED is blinking the times you see below, do a short break and do the blinking again.

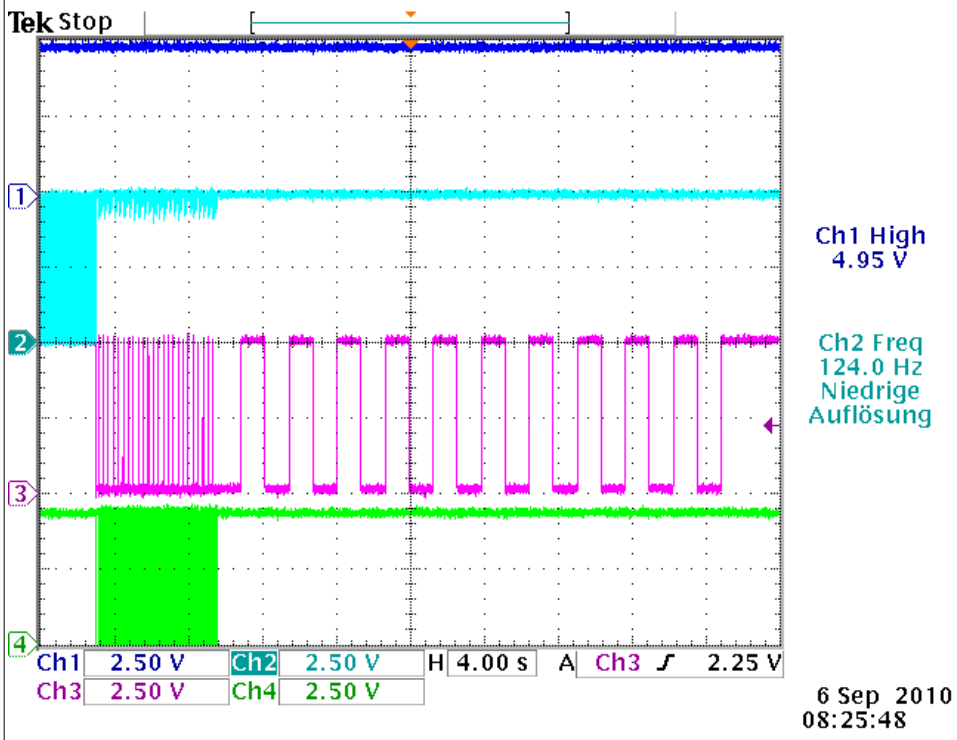
number of blinks	**failure description**	
1	timer ra error	(#define ERR_TRA)
2	cpu register test error	(#define ERR_GPRS)
3	stack test error	(#define ERR_STACK)
4	flags test error	(#define ERR_FLAG)
5	test interrupt base reg.	(#define ERR_INTREG)
6	unexpected HW int error	(#define ERR_HWI)
7	unexpected Peri int error	(#define ERR_PEI)
8	WDT error	(#define ERR_WDT)
9	RAM error	(#define ERR_RAM)
10	CRC error	(#define ERR_CRC)
11	Software Reset	(#define ERR_Swreset)

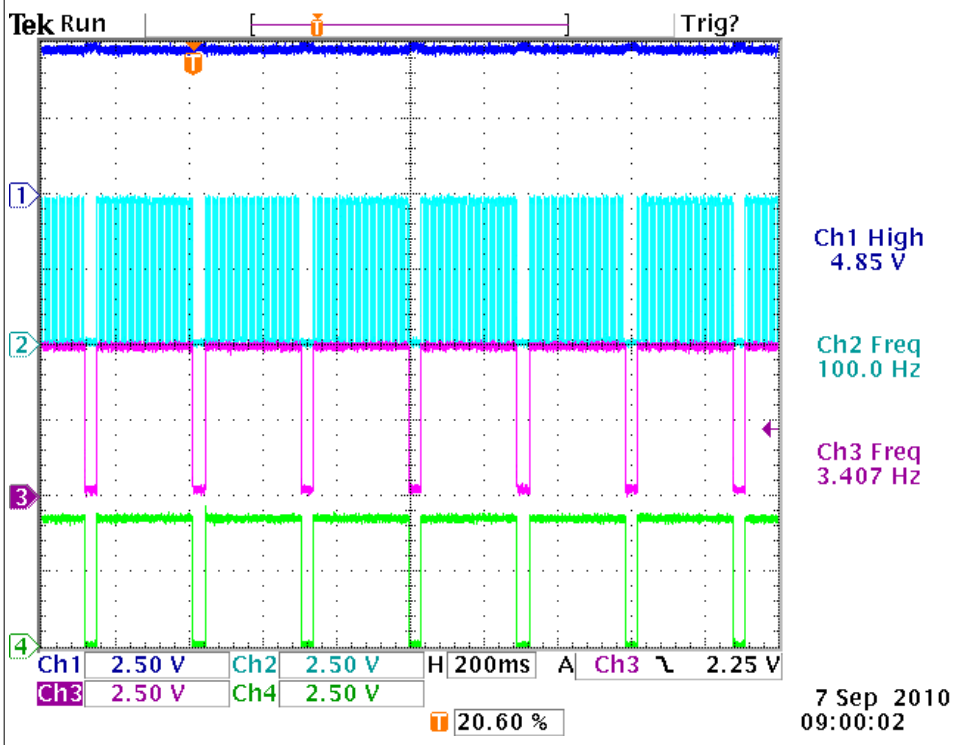
Fault list:

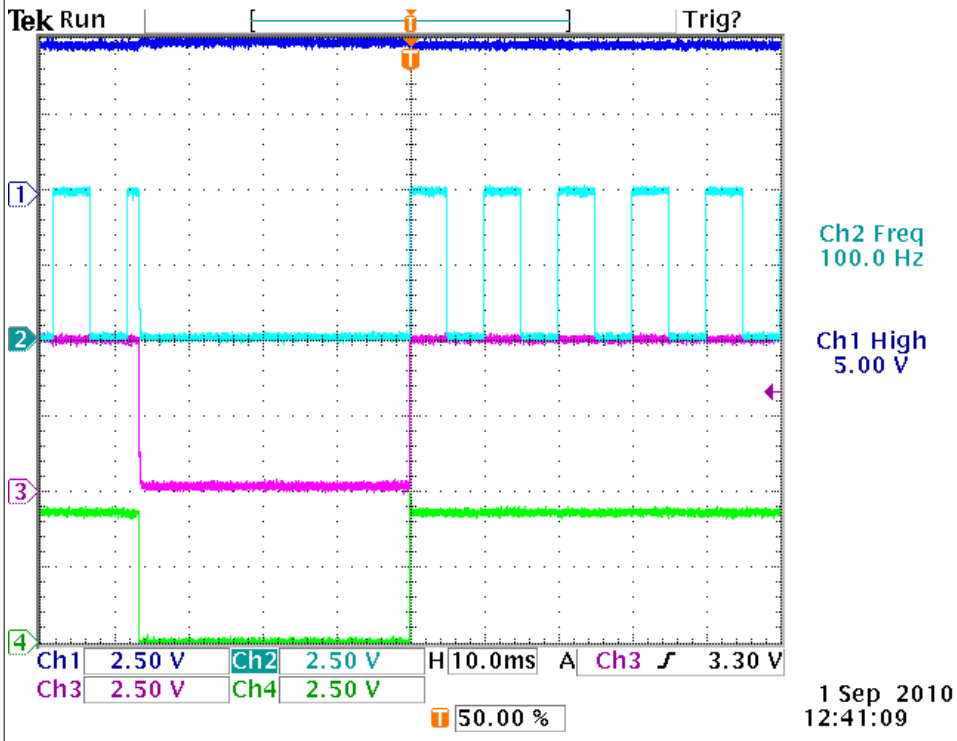
	current	
F1.1	26 mA	 burst on → function stops, error LED flashes 7 times (unexpected Peripherie error) burst off → error LED flashes 7 times (unexpected Peripherie error) POR → normal function

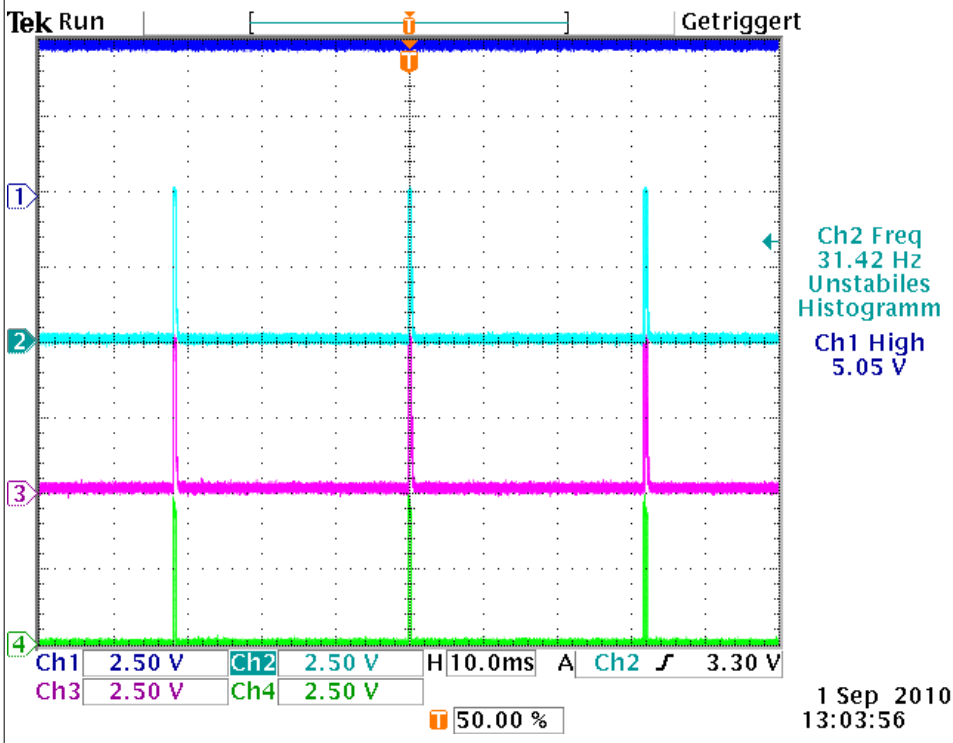
F1.2	26 mA	 burst on → normal function stops, error LED flashes 9 times (RAM error) burst off → error LED flashes 9 times (RAM error) POR → normal function

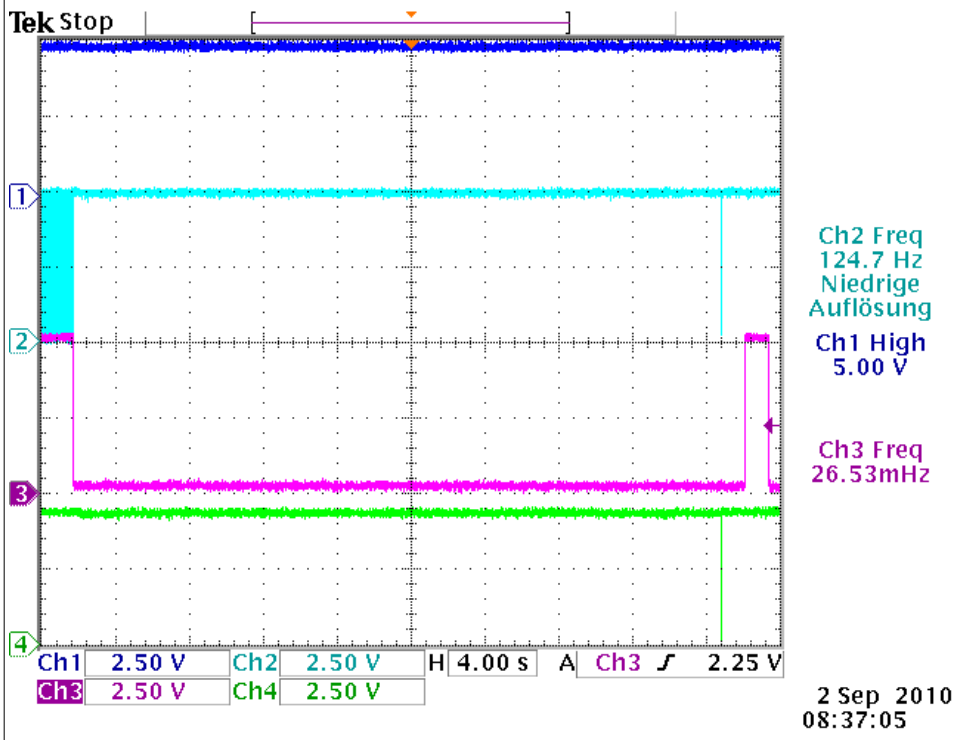
F1.3	26 mA	 burst on → normal function stops, error LED flashes 10 times (CRC error) burst off → error LED flashes 10 times (CRC error) POR → normal function

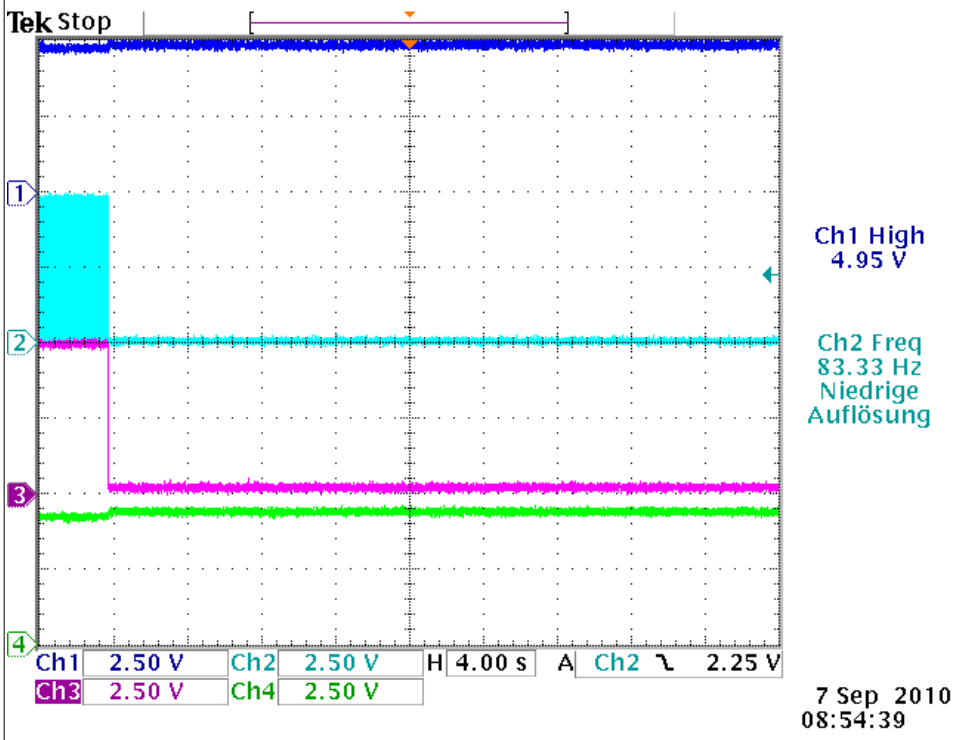
F1.4	26 mA	 burst on → normal function stops, all outputs blinking irregular burst off → error LED flashes 10 times (CRC error) POR → normal function

F2.1	28 mA	 burst on → Function failure, all Outputs blinking irregular burst off → Normal function, Reset LED is high POR → normal function

F2.2	13 mA	 burst on → Function failure, all Outputs are low burst off → Normal function, Reset LED is high POR → normal function

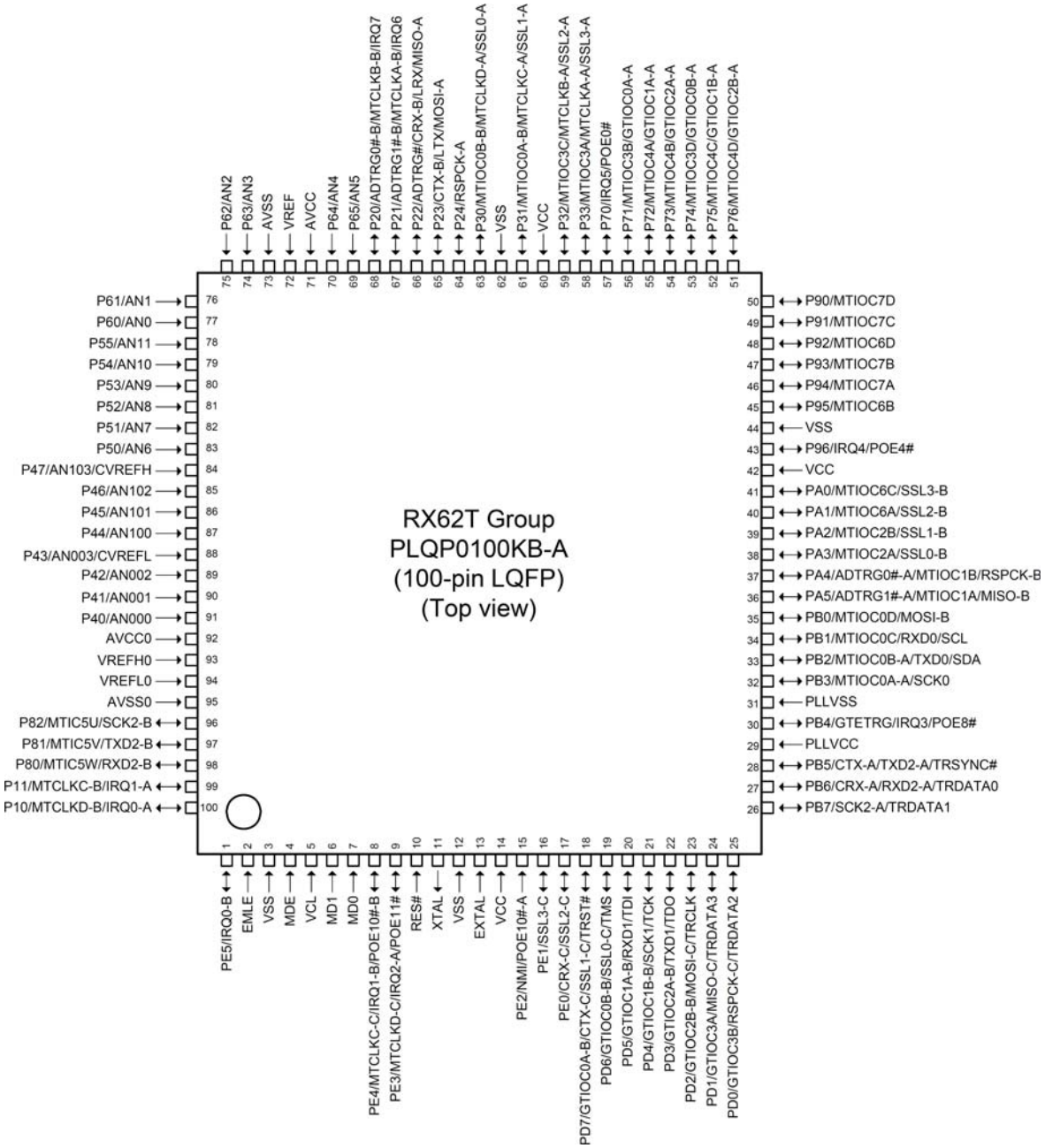
F2.3	14 mA	 burst on → Function failure, Outputs blinking shortly with approx. 32 Hz burst off → Normal function, Reset LED is high POR → normal function

F2.4	32 mA	 burst on → No function, Error led is low or blinking irregular burst off → No function, Error LED is low, after 30 seconds internal reset and error code 8 is blinking POR → normal function

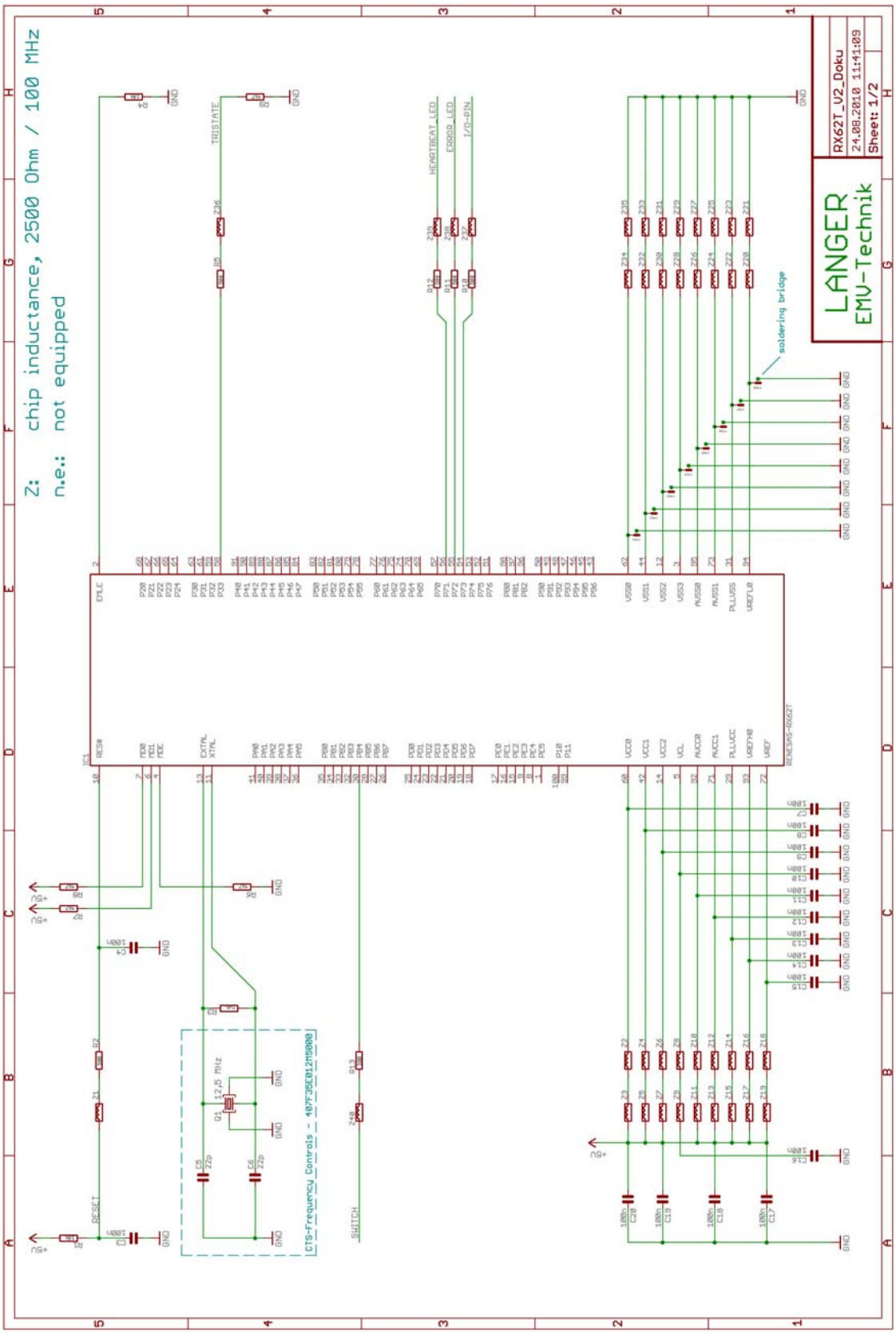
F3.1	16 mA	 burst on → No function, HB and Error LED are low burst off → No function, Error HB and Error LED are low PUC → Reset function, Code 11 is blinking POR → normal function

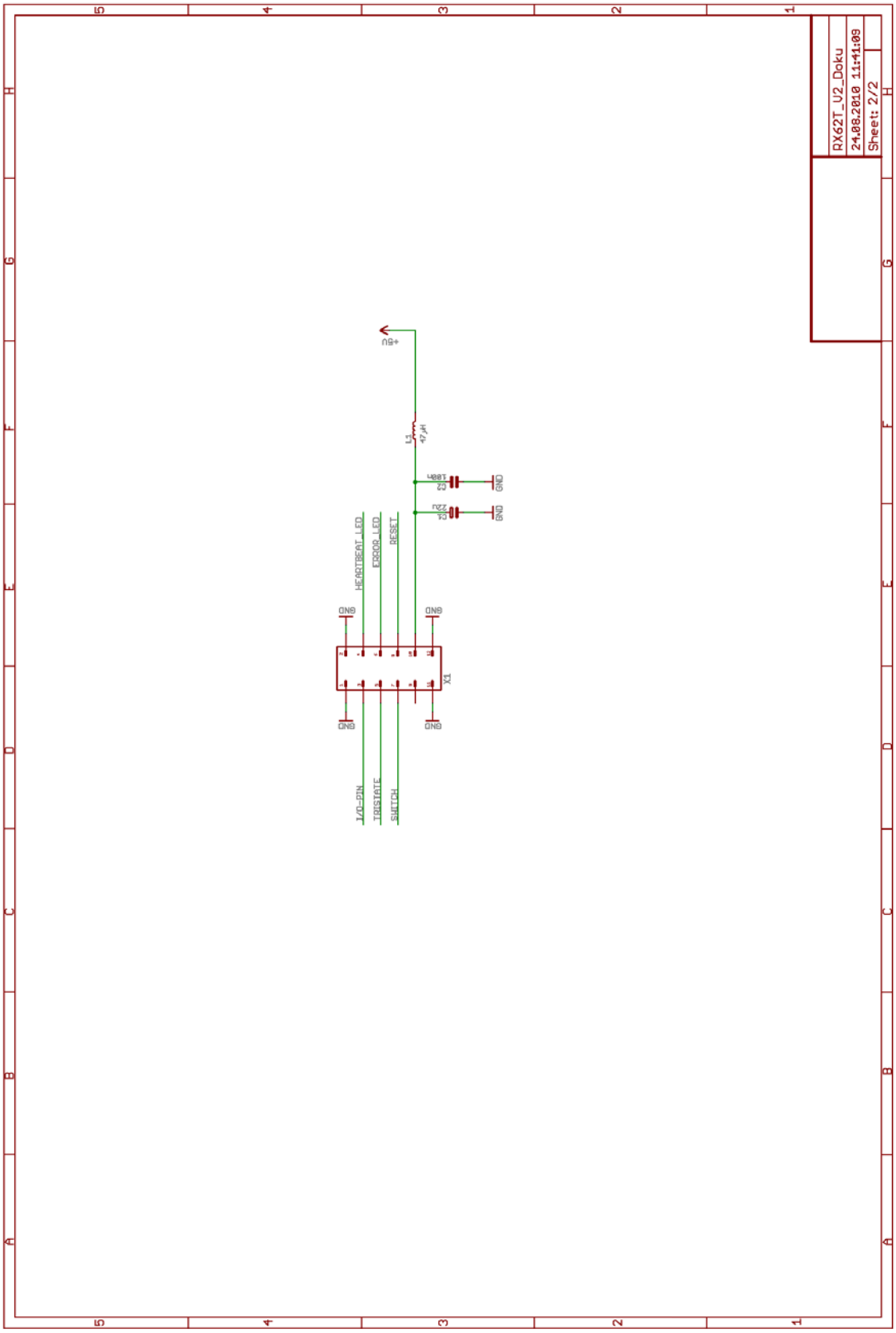
1.5 Pinout RX62T

100-pin LQFP pinout:



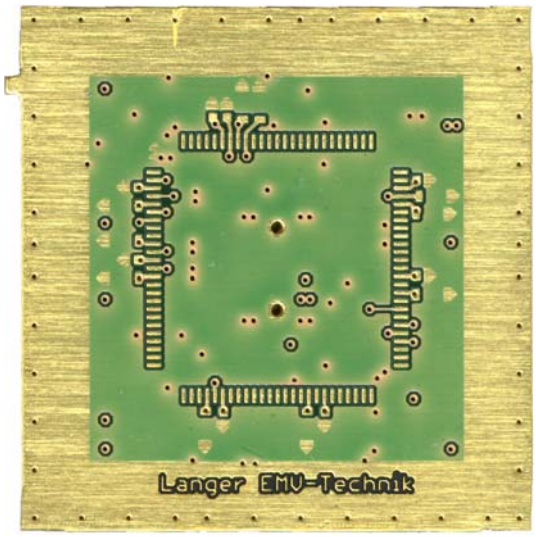
1.6 Test schematic

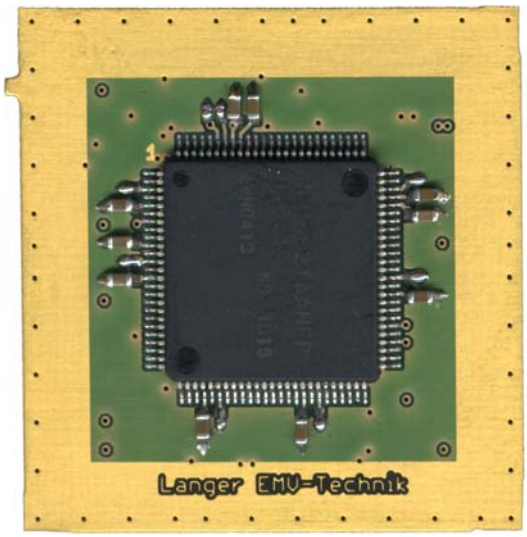



RX62T_V2_Doku
24.08.2010 11:41:09
Sheet: 2/2
+5V
L3
47µH
100n
C2
GND
22µ
C1
GND
HEARTBEAT_LED
EXAMP_LED
RESET
GND
GND
X1
GND
GND
I/O-PIN
TRISTATE
SWITCH

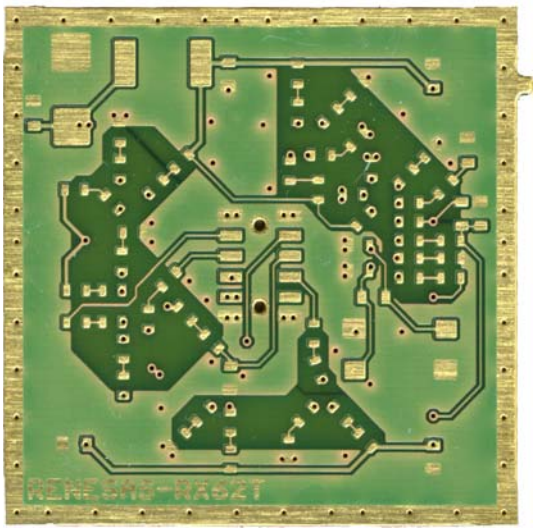
1.7 Adapter board

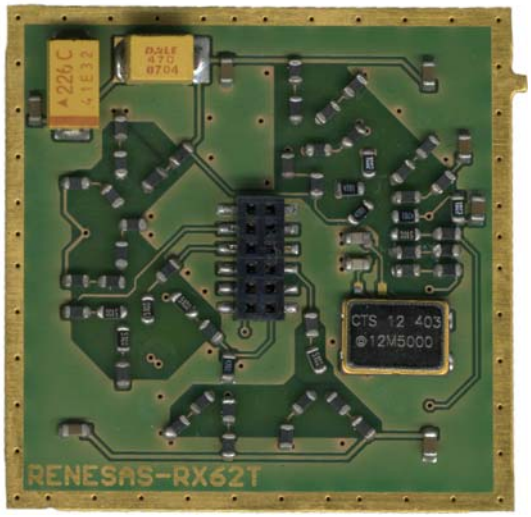
adapter board top:



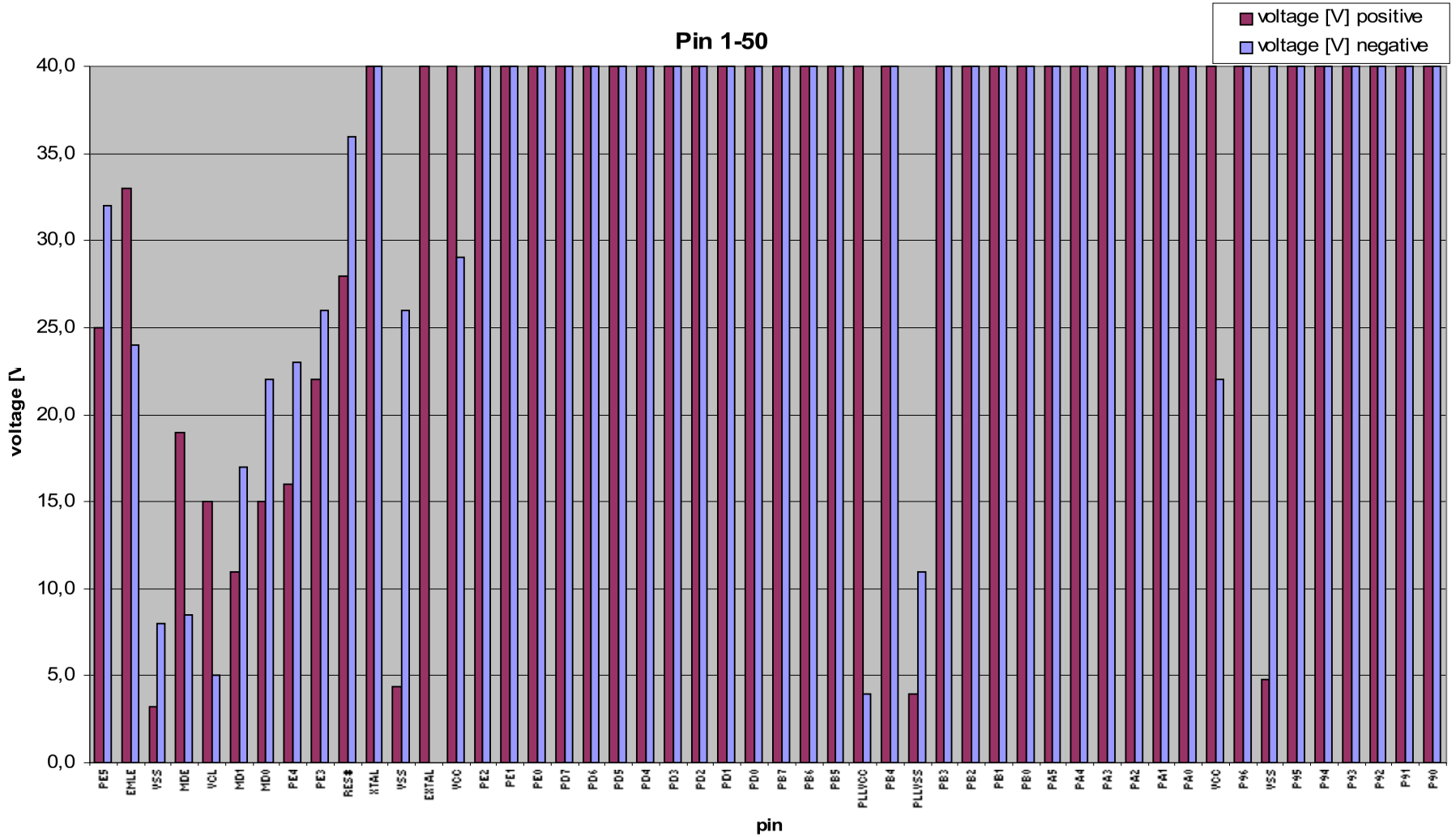


adapter board bottom:





2 Test results diagrams



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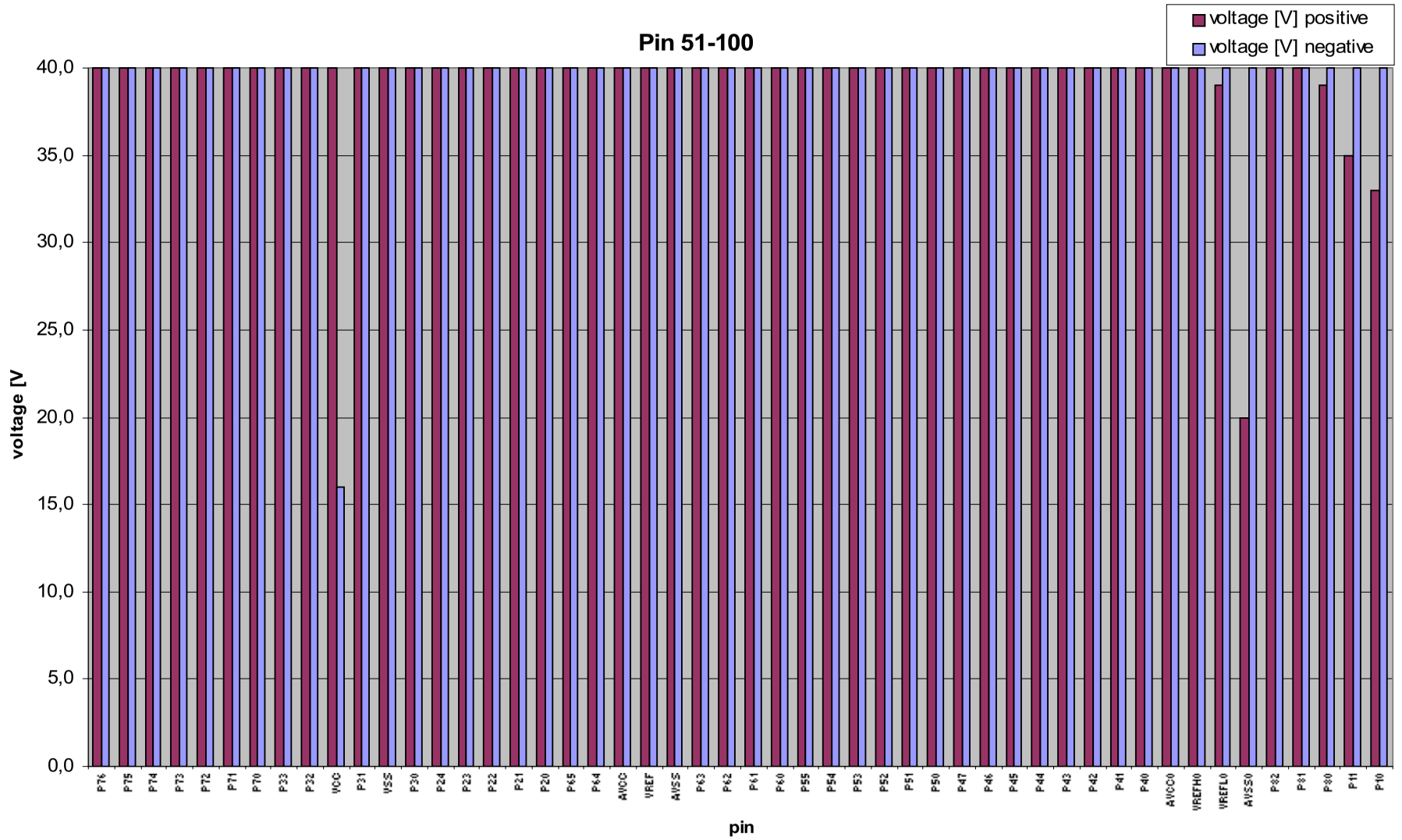

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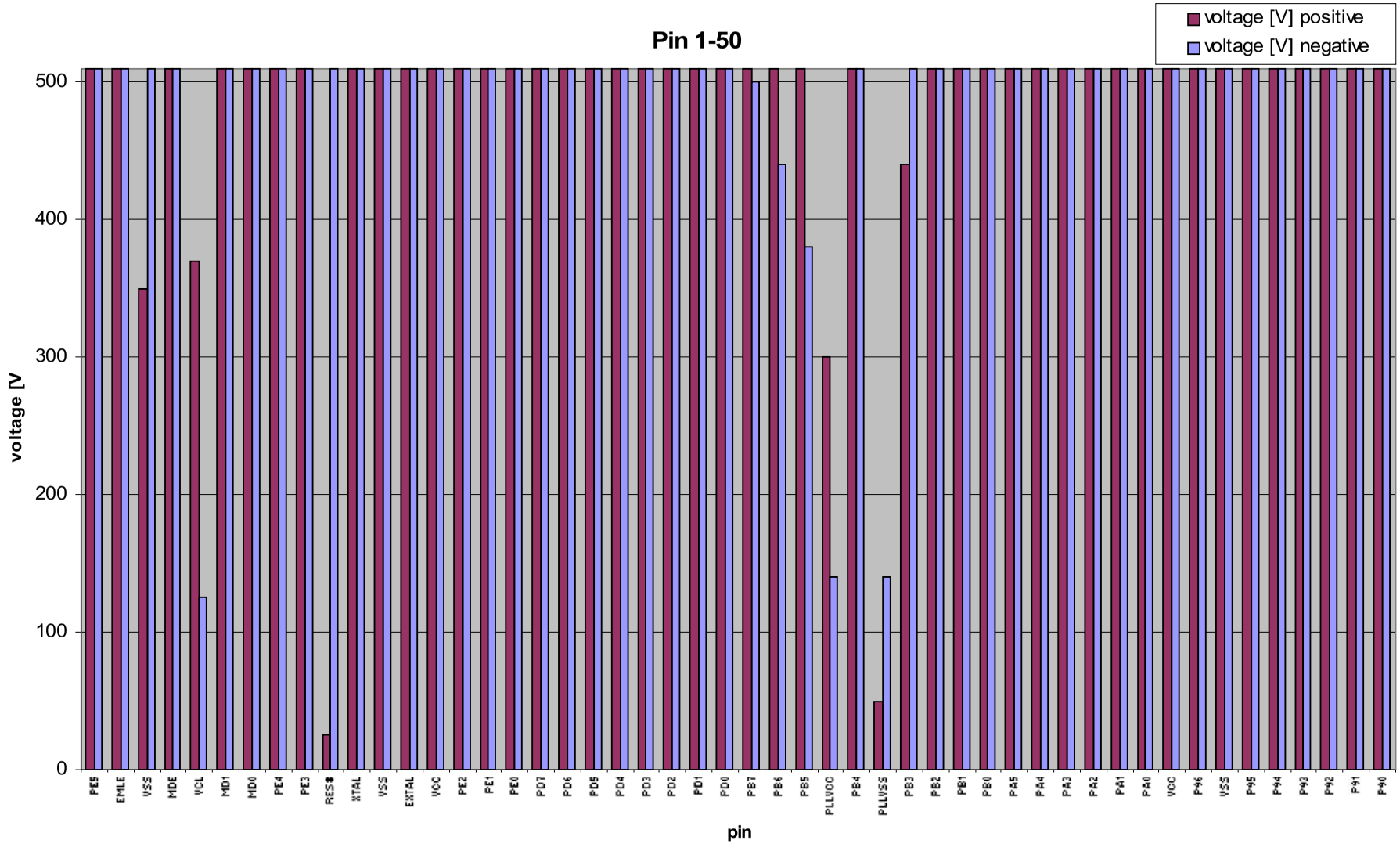

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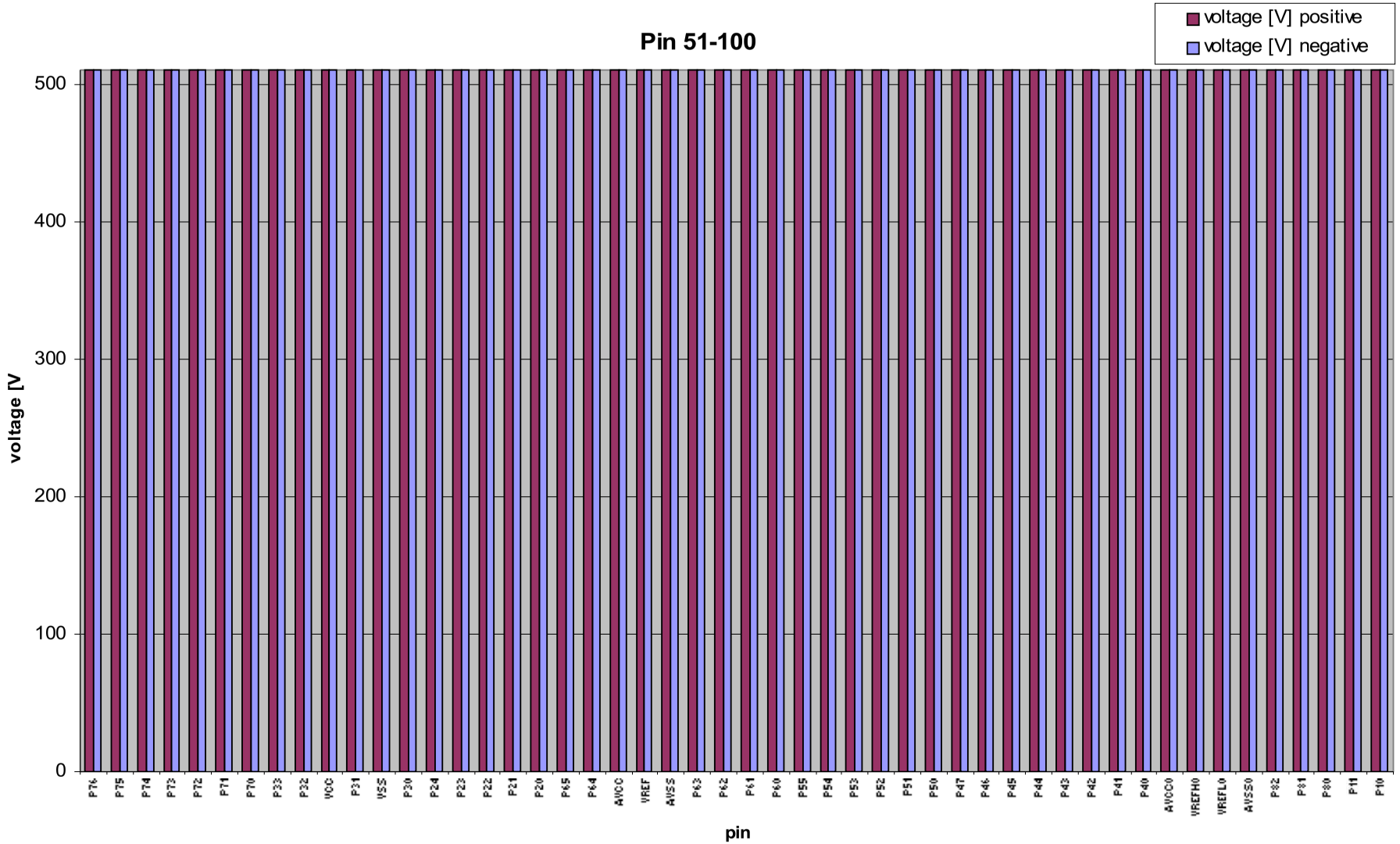

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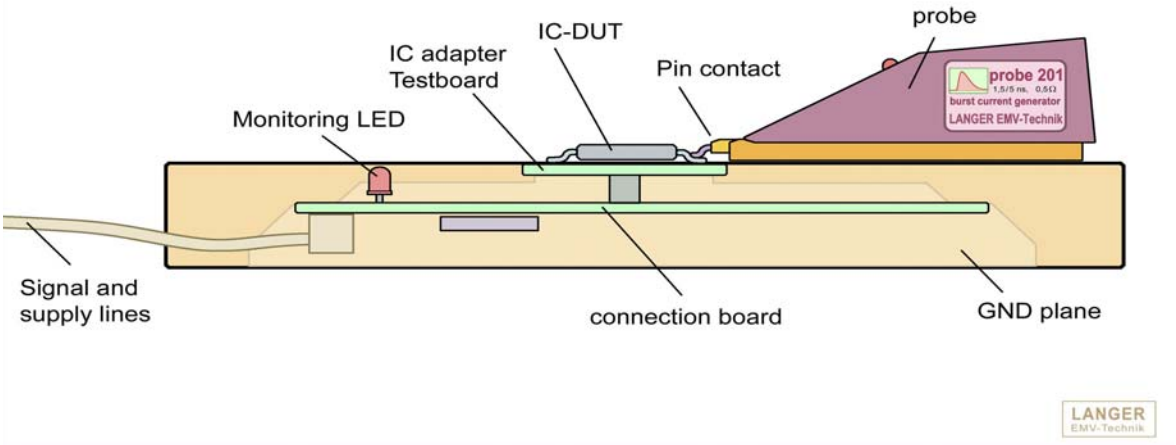
Annex A: General description of the burst test

1 A burst system for the IC level

Up to now there was no measurement system for the IC level available to perform reaction less fast transient testing of ICs. To close this gap a measurement system that satisfies all the requirements at the IC level was developed by Langer EMV-Technik GmbH. To design a burst generator for the IC level, all the corresponding characteristics of an IC, as well as the voltage level which actually occurs at the IC pin have to be considered. A decisive prerequisite for a correct measurement is the right connection to the IC (DUT). Therefore a reference plane (a massive GND plane) is used in which the DUT is placed via a chip adapter board.



Depending on the kind of measurement, different burst generators (probes) can be used. These probes are placed on the reference plane and are electrically connected to it. A pin contact is used to couple the bursts into the IC pin. This measuring setup, especially the usage of a reference plane, guarantees that correct measurements up to the GHz range can be performed.

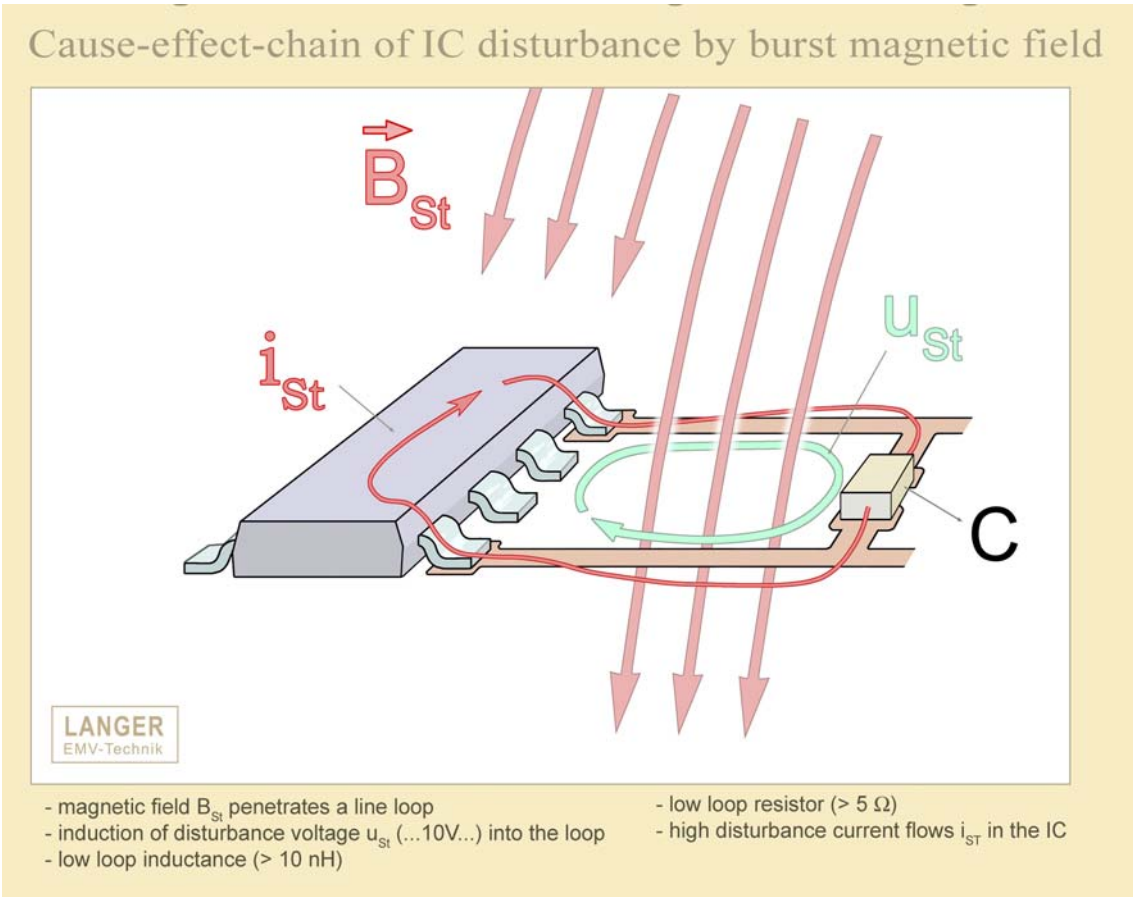
In order to perform burst measurements at the chip level, a chip adapter board has to be fabricated first. This adapter board is than connected to a connection board, which is used to supply the IC and bring it into an adequate operation mode. During the measurement the probe is attached securely to the reference plane by a magnet. This guarantees an excellent ground connection of the probe. The pin of the IC under test, which should be tested, is connected to the probe via the pin contact. The massive GND plane and the small setup allows to measure the operating condition of the IC with an oscilloscope during a burst interference without influencing the measurement results.

To couple burst signals into the IC under test, several burst probes of the series 200 (current injection) and 300 (voltage injection) are available. These probes are supplied by a Burst Power Station BPS 201. A serial interface to a PC is used to control the probes and to set different burst parameters.

3 How do disturbance couple into the IC under test

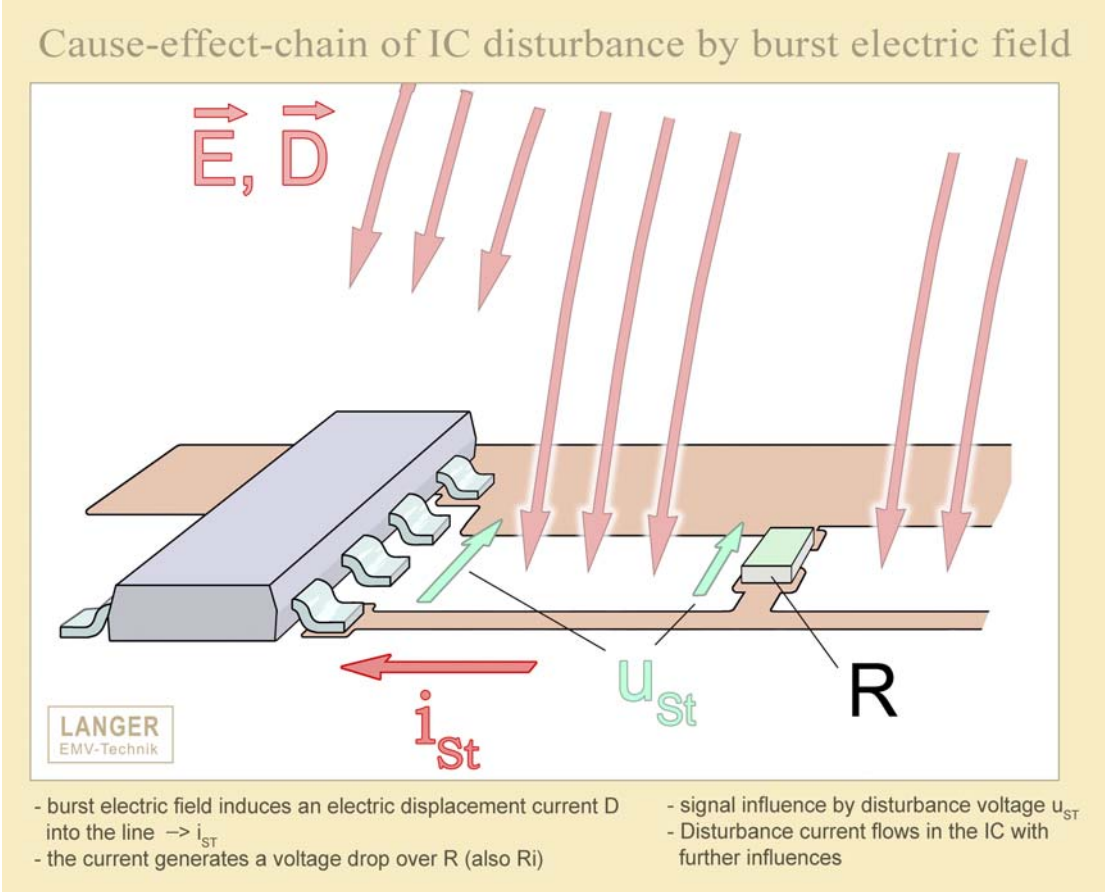
3.1 Magnetic coupling

Current, which is caused by burst pulses, is flowing on PCB traces and causes magnetic fields B_{St}. This magnetic fields than couple into loops on the PCB and induce noise voltages $u_{St.}$ The function of an IC can be interfered in two ways by the magnetic field:
The induced voltage influences the input of the IC. The input circuit can not separate a normal input signal from a noise signal and the IC may consider a noise signal as a logical signal.
The induced voltage drives a noise current i_{St} into the IC pin. If the IC pin is a VDD/VSS-pin, the noise current is flowing directly to the internal V_{DD}/V_{SS}-system of the IC. It can penetrate however also via an input pin for example through internal drivers, the protection diodes, or couple capacitors to the internal VDD/VSS-system of the IC. The VDD/VSS system leads the noise current to further functional parts of the ICs, so that interferences can occur in areas having no direct relation to the interfered pin.



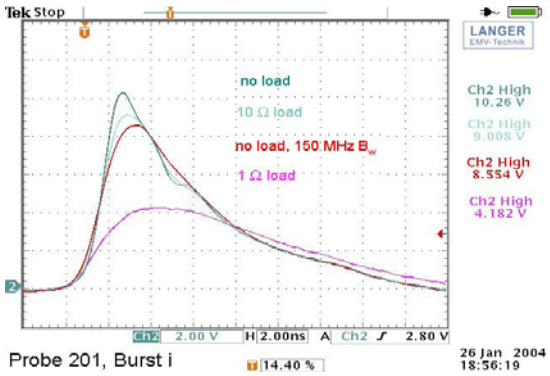
3.2 Electric coupling

The electric fields caused by burst interference's can be up to 10.000V/m. As a burst pulse has a very short rise time with high du/dt an electronic system can be effected by capacitive coupling. In this case a current is generated due to the stray capacitance. Figure 5 shows how electric fields couple into PCBs. Again there are two ways how the function of an IC can be interfered:
On the PCB and insight the IC might be resistors to VDD and to VSS. In the figure these resistors have been summarised by one resistor R. The current generates a voltage drop u_{St} across this resistor. The voltage drop is interpreted by the IC as a logic signal and causes a malfunction.
The current is divided into two parts. A first part flows via the resistor and eventually via an external decoupling capacitor outside of the IC, the second part of the current flows directly into the IC. Protection diodes for example might give a path for the current to flow to several further functional parts and cause similar effects as with magnetic coupling.

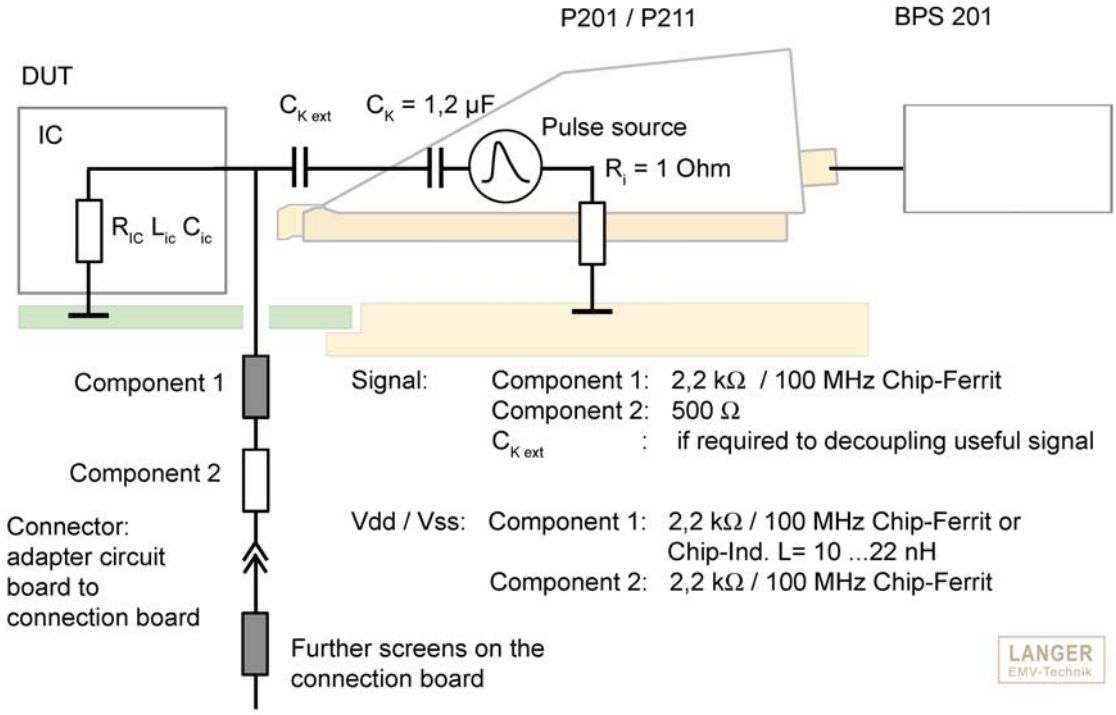


4 Burst probes

4.1 Low impedance probe



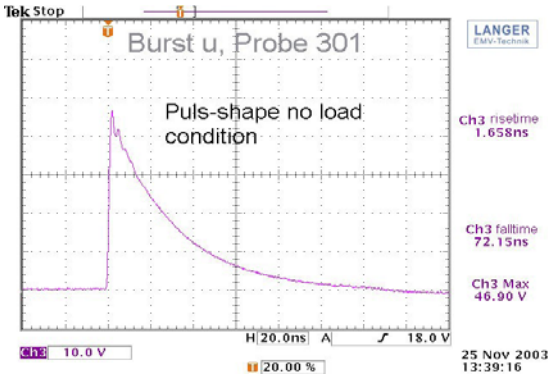
Probes for magnetic coupling have to recreate the induction loops of the PCB. In the worst case this induction loop can only exist because of the internal current path of the IC and the path via the decoupling capacitor connected to the IC pins. In this case the parameters R and L of the current loop can be characterised by the parameters of the IC, which are for the Vdd/Vss pins about 10-100Ohm and 10nH. To keep the probes free from reactions their R and L value was set to be about 10 times smaller. For these measurements, probes of the series 200 are available.

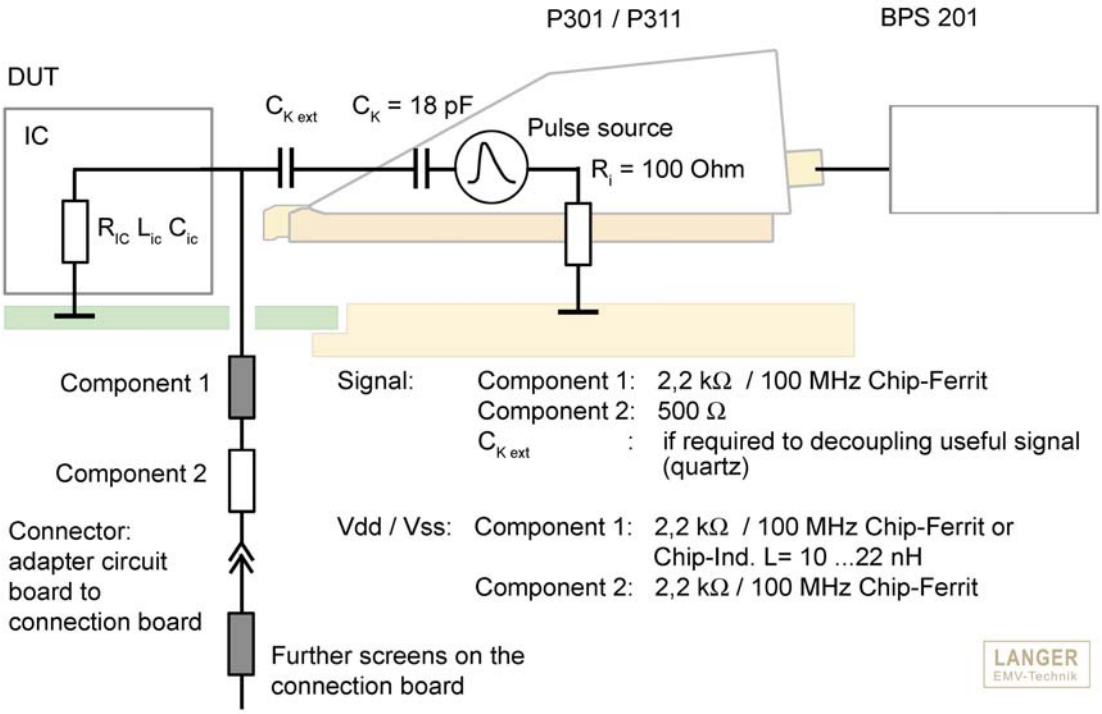


Probes burst-i:	**Probe 201**	**Probe 211**
Pulse shape:	1,5 / 5 ns	1,5 / 5 ns
Coupling capacitance:	1,2 µF	1,2 µF
Internal resistance:	1 Ω	1 Ω
Pulse voltage:	± 5-35 Volt	± 0,5-5 Volt

4.2 High impedance probe

Probes from the 300 series have been designed for electric coupling. The probes inject voltage pulses at a rise time of 1ns via a low coupling capacitance.





Probes burst-u:	**Probe 301**	**Probe 311**
Pulse shape:	1,5 / 20 ns	1,5 / 20 ns
Coupling capacitance:	18 µF	18 pF
Internal resistance:	100 Ω	100 Ω
Pulse voltage:	± 120-500 Volt	± 5-140 Volt

Annex B: Evaluation of immunity

Recommended evaluation of the immunity test results on IC's with burst pobes:

Probe family 200 - Burst current injection

Immunity of supply pins:

Voltage at probe (off-load voltage)	**Evaluation of the immunity**
< 3 Volt	very low
3 ... 10 Volt	low
10 ... 20 Volt	medium
> 20 Volt	high

Immunity of signal pins:

Voltage at probe (off-load voltage)	**Evaluation of the immunity**
< 10 Volt	very low
10 ... 20 Volt	low
20 ... 25 Volt	medium
> 35 Volt	high

Probe family 300 - Burst voltage test

Immunity of signal pins:

Voltage at probe (off-load voltage)	**Evaluation of the immunity**
< 50 Volt	very low
50 ... 150 Volt	low
150 ... 300 Volt	medium
> 300 Volt	high

Annex C: Additional ESD-Field immunity test

1 ESD E-field immunity test

Probe 1301	ESD E-field probe

Application:

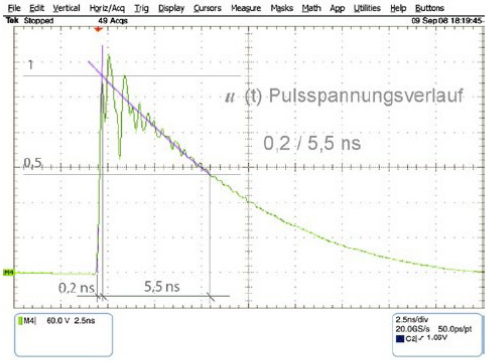
A field source is used to generate an ESD electric field and measure the IC's immunity to ESD electric fields, in particular multi-pole ICs (chip sets).

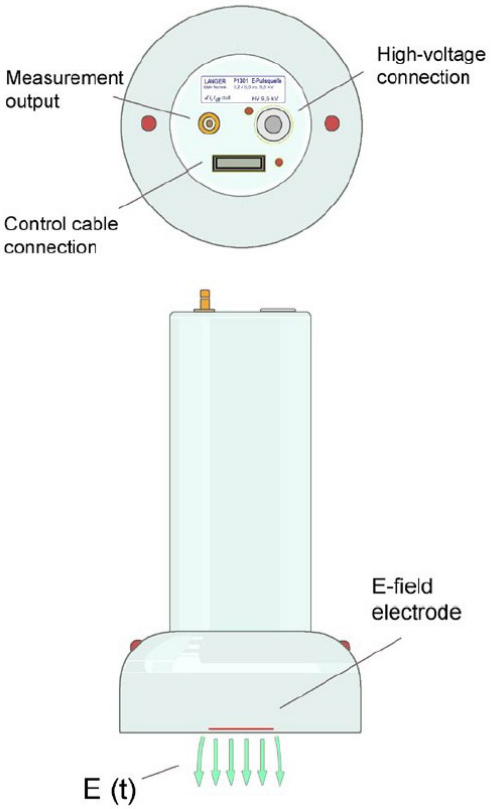
The probe is positioned at a defined distance (3 or 10 mm) above the IC.

Properties:

A pulse voltage is fed into a field electrode within the probe to generate the ESD electric field. This produces an electric field pulse that leaves the probe via its bottom. The slope rate of 200 ps has a similar effect in the IC as ESD transients.

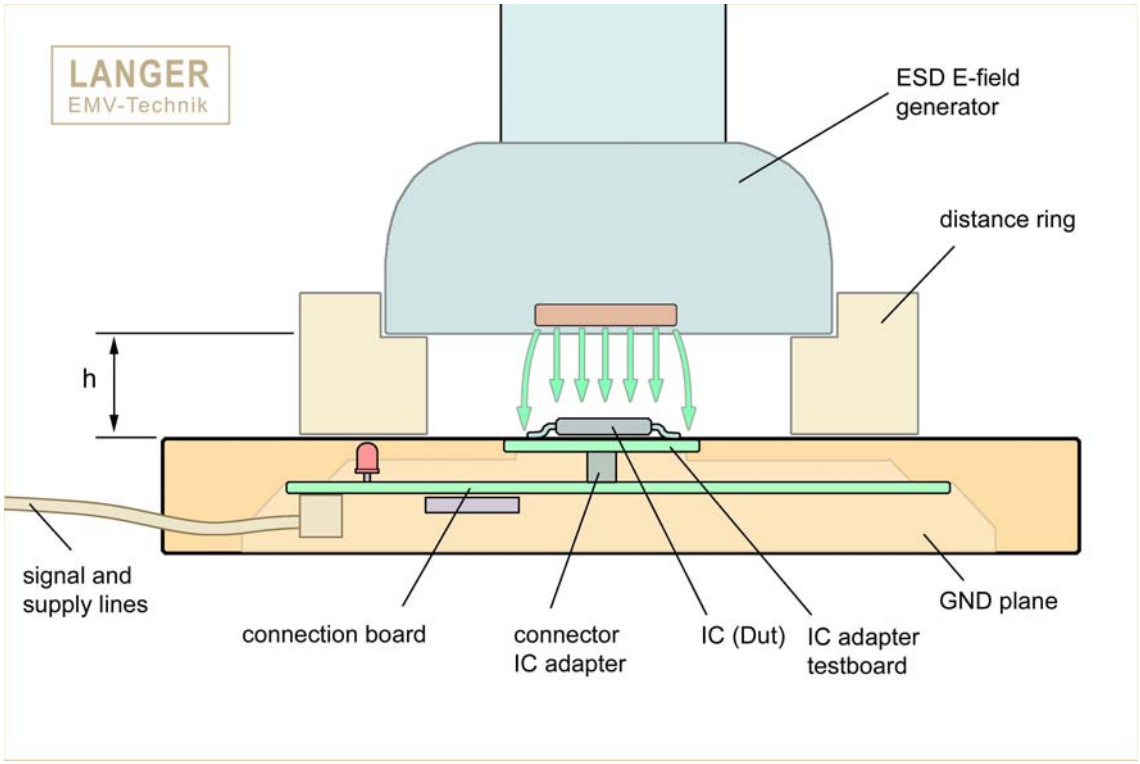
Pulse shape

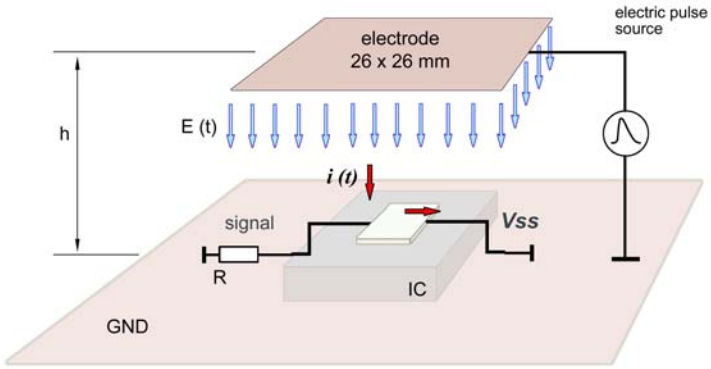




	Probe 1301	
Pulse voltage	0,2... 9,5	kV
Pulse shape	0,2 / 5,5	ns
Frequency	0...10	Hz
High voltage	0,2... 9,5	kV
Control unit	BPS 203	
Internal di / dt meter Measurement output Correction factor	50	Ω, SMB dB
Dimensions	96 x 168	mm

The probe 1301 is operated with the BPS 203 control station. The BPS 203 supplies the high voltage and control signals for the probe. The probe is controlled via a PC user interface.
The probe has an internal di / dt meter. The pulse current flow can be determined through integration.
Furthermore, the measurement set-up also comprises a GND 20/22 ground plane with an IC adapter and spacer rings of 3 mm and 10 mm.


LANGER
EMV-Technik
ESD E-field
generator
distance ring
h
signal and
supply lines
connection board
connector
IC adapter
IC (Dut)
IC adapter
testboard
GND plane


electrode
26 x 26 mm
electric pulse
source
h
E (t)
i (t)
signal
Vss
R
IC
GND

2 ESD H-field immunity test

Probe 1201 | **ESD H-Feld Probe**

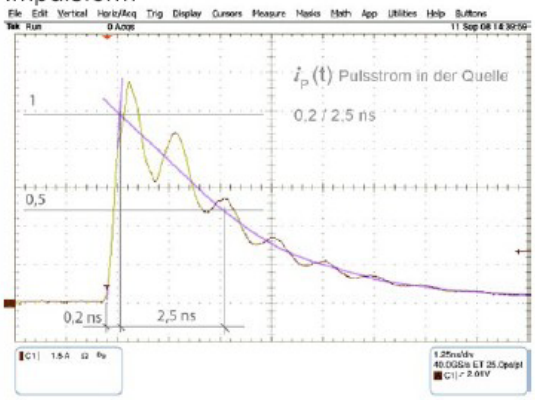
Anwendung:

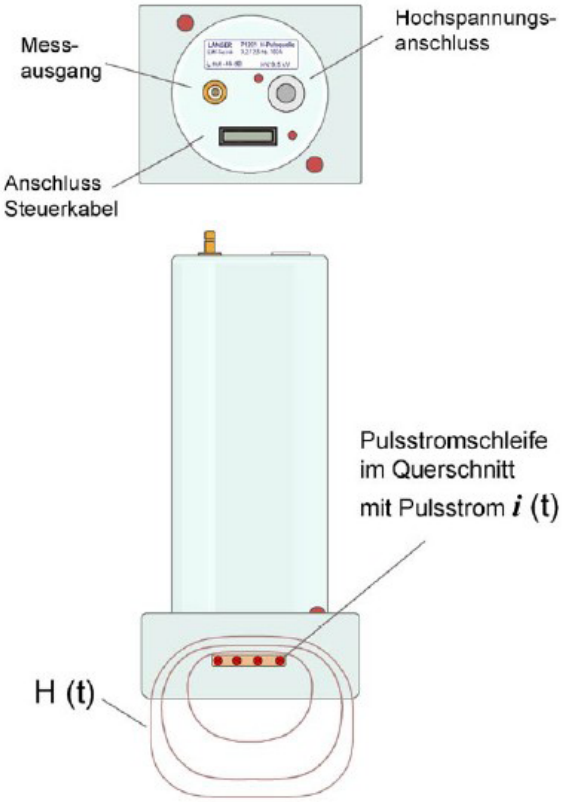
Feldquelle erzeugt ESD-Magnetfeld und dient der Messung der ESD-Magnetfeld-festigkeit von IC, insbesondere hochpolige IC (Chipsätze).
Die Probe wird im definierten Abstand (3 bzw 10 mm) über dem IC angeordnet.

Eigenschaften:

Für die Erzeugung des ESD-Magnetfeldes wird in der Probe eine Pulsstromschleife mit einem Pulsstrom gespeist. Es entsteht ein Magnefeldimpuls der aus dem Boden der Probe austritt. Die Flankensteilheit von 200 ps erzeugt im IC ähnliche Wirkung wie ESD-Einschwingvorgänge

Impulsform





	Probe 1201	
Pulsstrom	± 20 ... 160	A
Pulsform	0,2 / 2,5	ns
Frequenz	0...10	Hz
Hochspannung	0,2... 9,5	kV
Steuergerät	BPS 203	
interner Shunt	0,1	Ω
Shuntanpassung	50	Ω, SMB
Korrekturfaktor	26	dB
Abmessung	78 x 160	mm

3 Test results ESD-Field immunity

P1201	0°	7,9 kV	F2.1
	90°	9,5 kV	No fault
	180°	7,9 kV	F2.1
	270°	9,5 kV	No fault

P1301	+9,5 kV	No fault
	-4,7 kV	F2.1