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# APPLICATION NOTE

Demonstration Board  
**OQ2538HP**  
SDH/SONET main amplifier

May 1996

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**SDH/SONET main amplifier****OQ2538HP**

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**FEATURES**

- Full functional testing capability
- 4-Layer Epoxy FR4 PCB
- Differential microstrip lines with 50  $\Omega$  odd mode impedance
- SMA RF Connectors
- Single-ended and differential operation possible
- Assembly Instructions
- Full extended ground and supply voltage layers

**APPLICATIONS**

- Functional Verification
- Performance Evaluation
- Application Tests

**GENERAL DESCRIPTION**

The demonstration board for the OQ2538HP limiting amplifier IC can be supplied assembled or non assembled. This board can be used to evaluate the OQ2538HP, alone, and allows the designer to do extensive testing without having to worry about other external factors. For maximum reliability the IC is fixed to the board. This application note describes the schematic and the layout of the board and contains assembly instructions. A functional test is described in detail.

A data sheet for the IC is available: "Data Sheet OQ2538HP, Preliminary specification, May 1996"

**ORDERING INFORMATION**

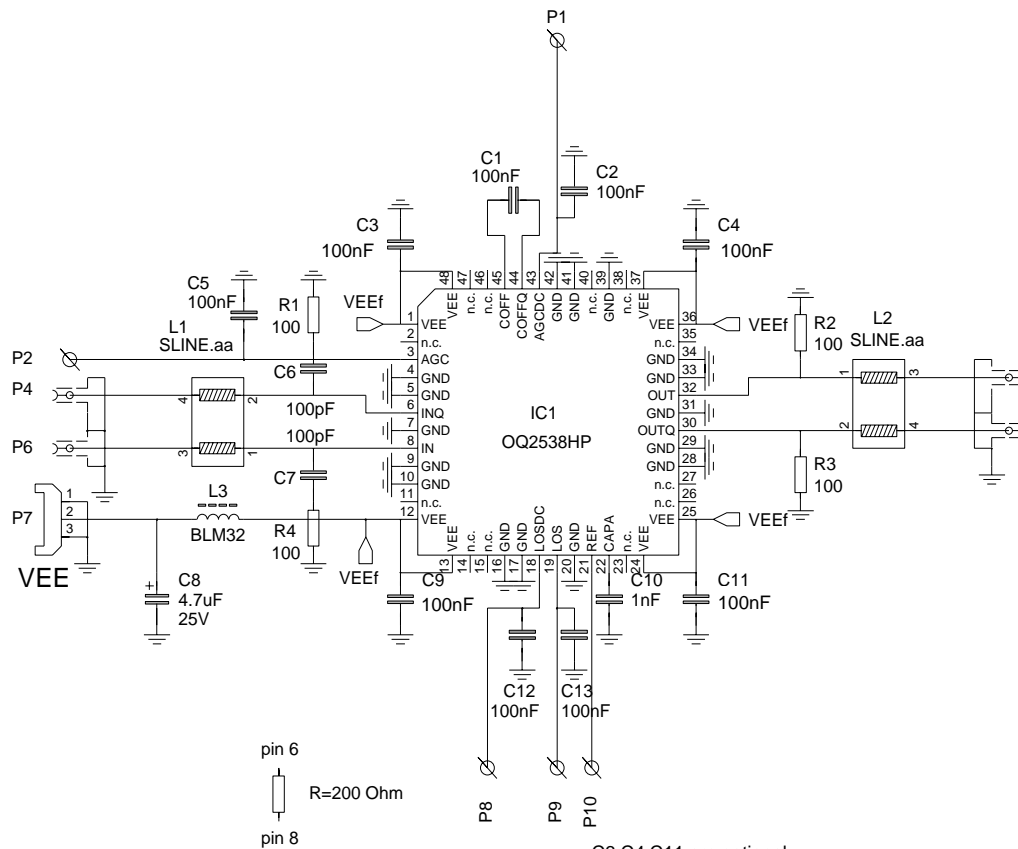
To order demonstration boards, write to:

Philips Semiconductors C&M-N  
Marketing Department  
Gerstweg 2  
6534 AE Nijmegen  
The Netherlands

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## DEMO BOARD SCHEMATIC



Optional (instead of R1,R4, C6 and C7)

C3,C4,C11 are optional  
Mount R2 and R3 only if 50Ω matching is required

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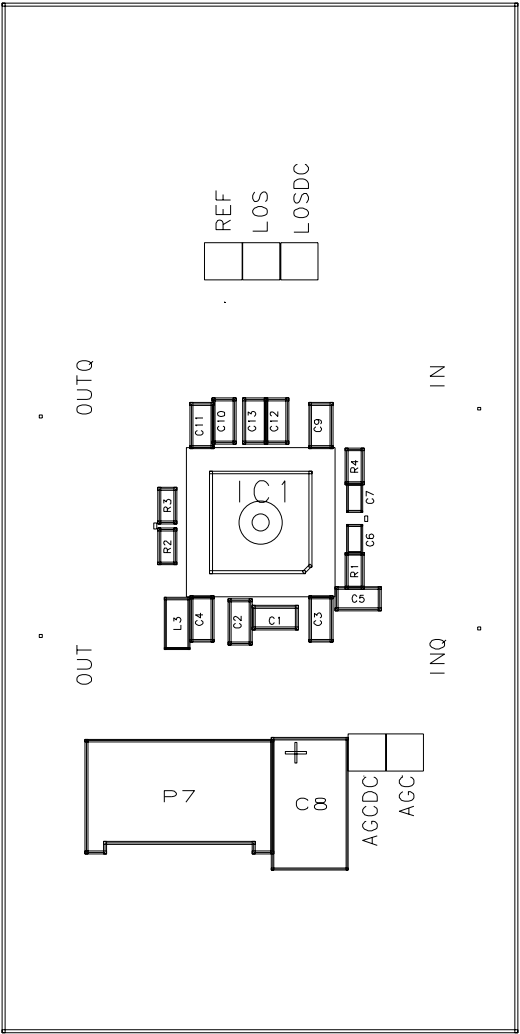
## BILL OF MATERIALS

item no	count	company part no	component	series	vendor	tolerance	rating	geometry	reference
1	1	8222-411-Q2538	Board						
2	1	MKS3733-1-0-303	MKS3730_3p	MKS3730	Stocko			MKS3730_3p	P7
3	5	2422-034-15068	Solder Pin Small		Philips			Solder Pin Small	P1,P2,P8, P9,P10
4	4	2322-704-61001	100	RC21	Philips	1%	0.063 W	R0603_hf	R1,R2,R3, R4
5	9	2222-910-16649	100 nF	C910-X7R	Philips	10%	25 V	C0805_hf	C1,C2,C3, C4,C5,C9, C11,C12, C13
6	2	2222-867-12101	100 pF	C867-NP0	Philips	5%	63 V	C0603_hf	C6,C7
7	1	2222-861-12102	1 nF	C861-NP0	Philips	5%	63 V	C0805_hf	C10
8	1	2222-122-56478	4.7 uF	SAL-RP 122	Philips	20%	25 V	Case_R3	C8
9	1	PN-OQ2538HP	OQ2538HP	IC_Universal	Philips			SOT313	IC1
10	1	BLM32A07	BLM32	CBD	Murata			BLM32	L3
11	4	142-0801-811	SMA Launcher	COAX	EF Johnson			SMA	P3,P4,P5, P6

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DEMO BOARD ASSEMBLY DRAWING



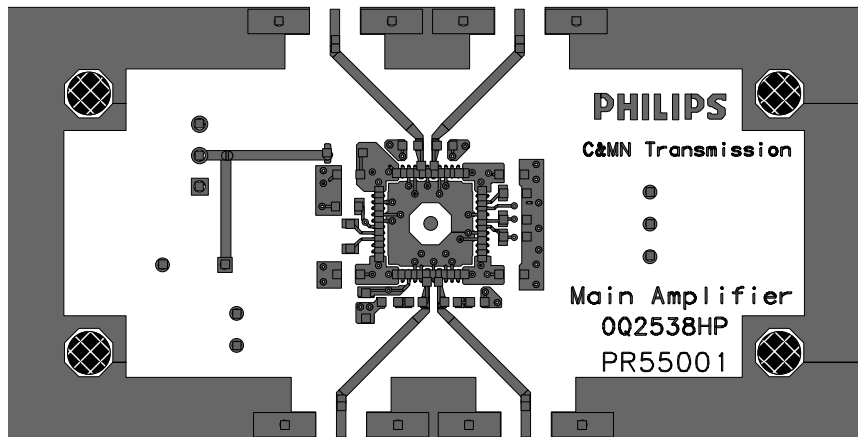
8222 411 55001 2A1C  
PR55001

Assembly-drawing OQ2538

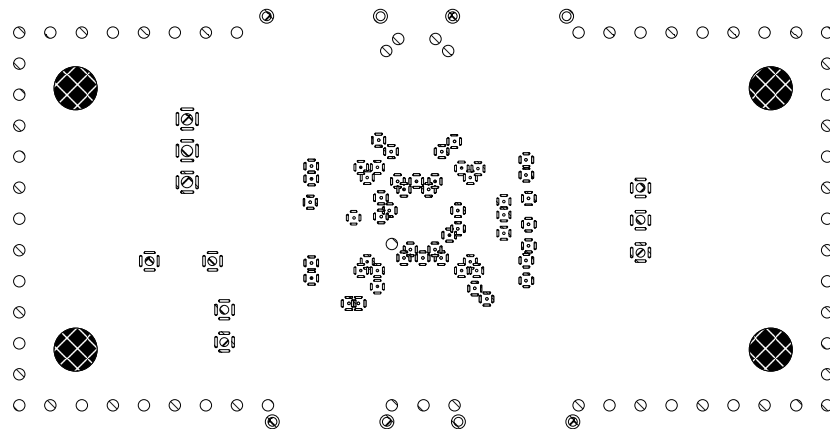
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## LAYOUT: TOP LAYER, SIGNAL LAYER



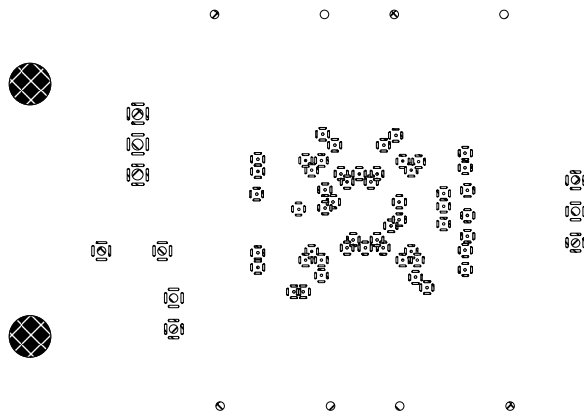
## LAYOUT: 2ND LAYER, GROUND LAYER (NEGATIVE PROJECTION)



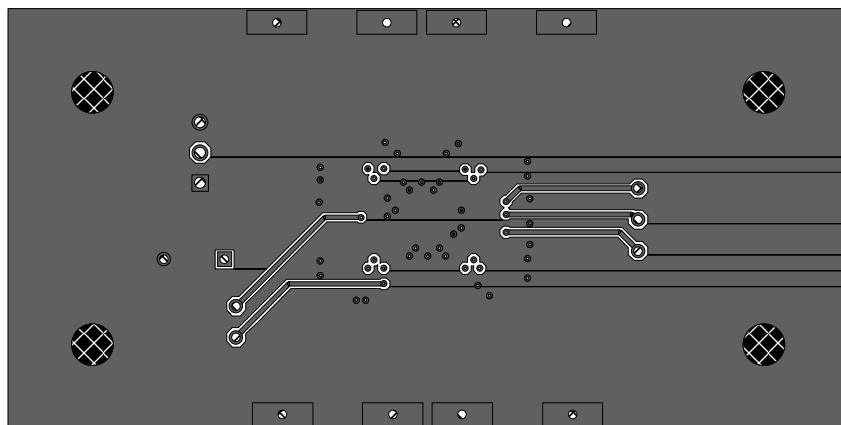
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## LAYOUT: 3RD LAYER, SUPPLY LAYER (NEGATIVE PROJECTION)



## LAYOUT: BOTTOM LAYER, GND &amp; SIGNAL LAYER



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**PINNING**

SYMBOL	PIN	DESCRIPTION	TYPE <sup>(1)</sup>
V <sub>EE</sub>	1	negative power supply	S
n.c.	2	not connected	–
AGC	3	rectifier A output	O
GND	4	ground	S
GND	5	ground	S
INQ	6	main amplifier inverting input	I
GND	7	ground	S
IN	8	main amplifier input	I
GND	9	ground	S
GND	10	ground	S
n.c.	11	not connected	–
V <sub>EE</sub>	12	negative power supply	S
V <sub>EE</sub>	13	negative power supply	S
n.c.	14	not connected	–
n.c.	15	not connected	–
GND	16	ground	S
GND	17	ground	S
LOSDC	18	rectifier B reference output	O
LOS	19	rectifier B output	O
GND	20	ground	S
REF	21	band gap reference	O
CAPA	22	band gap reference decoupling	A
n.c.	23	not connected	–
V <sub>EE</sub>	24	negative power supply	S
V <sub>EE</sub>	25	negative power supply	S
n.c.	26	not connected	–
n.c.	27	not connected	–
GND	28	ground	S
GND	29	ground	S
OUTQ	30	main amplifier inverted output	O
GND	31	ground	S
OUT	32	main amplifier output	O
GND	33	ground	S
GND	34	ground	S



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SYMBOL	PIN	DESCRIPTION	TYPE <sup>(1)</sup>
n.c.	35	not connected	–
V <sub>EE</sub>	36	negative power supply	S
V <sub>EE</sub>	37	negative power supply	S
n.c.	38	not connected	–
GND	39	ground	S
n.c.	40	not connected	–
GND	41	ground	S
GND	42	ground	S
AGCDC	43	rectifier A reference output	O
COFFQ	44	automatic offset control capacitance return	A
COFF	45	automatic offset control capacitance	A
n.c.	46	not connected	–
n.c.	47	not connected	–
V <sub>EE</sub>	48	negative power supply	S

**Note**

1. Pin type abbreviations: O = output, I = input, S = power supply, A = analog function.

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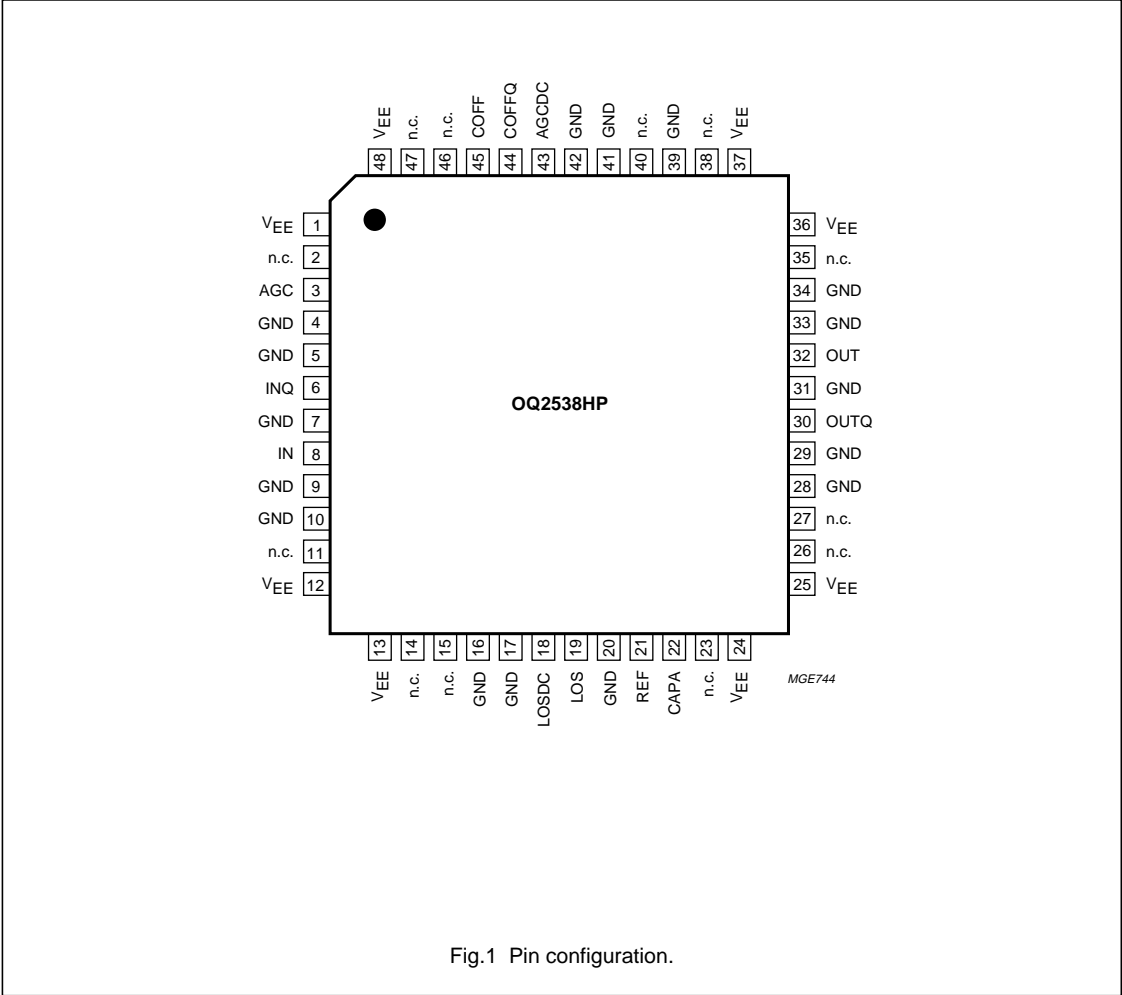


Fig.1 Pin configuration.

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**PREPARING THE DEMO BOARD FOR OPERATION**

**!! WARNING:** THE RF INPUT AND OUTPUT IC PINS ARE **NOT ESD PROTECTED**. HANDLE THE DEMONSTRATION BOARD ACCORDING TO STANDARD ESD HANDLING PROCEDURES!

The IC can be operated in single-ended or differential mode. For single-ended operation the board must be assembled according to the schematic. If the IC is used in a differential application, it is recommended leave the components R1, R4, C6, C7 UNMOUNTED and, in stead, mount a 200Ω resistor with case style 0603 across the differential input lines.

Adjust the supply voltage ( $V_{ee}$ ) to -4.5V before connecting the power cable to the board.

**!! WARNING:** THE INPUTS 'IN/INQ' MUST BE **AC COUPLED** TO ANY INSTRUMENT. USE SMA **DC BLOCKS** AT THE INPUTS BEFORE CONNECTING THE RF SOURCE TO THE DEMO BOARD!

If the IC is tested single-ended, the unused rf input/output must be terminated with 50Ω. All rf connections from the instruments to the demo board should be made with high quality low-loss coaxial RF cable, with 50Ω characteristic impedance.

The 100Ω resistors R2 & R3 at the outputs OUT/OUTQ are placed to have a 50Ω matching of the testboard to a 50Ω cable. These resistors are not essential in an application, where the succeeding IC (e.g. data&clock recovery) is positioned close to the OQ2538 output.

**FUNCTIONAL TEST: DC OPERATING POINT AND OFFSET COMPENSATION**

To verify all DC characteristics both the **inputs** and **outputs** have to remain open. The voltage levels at the pins can be measured with a digital voltmeter. The input DC offset must be lower than 0.6 mV. This should be measured with a voltmeter directly across the input pins.

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## FUNCTIONAL TEST: FREQUENCY RESPONSE AND NOISE FIGURE

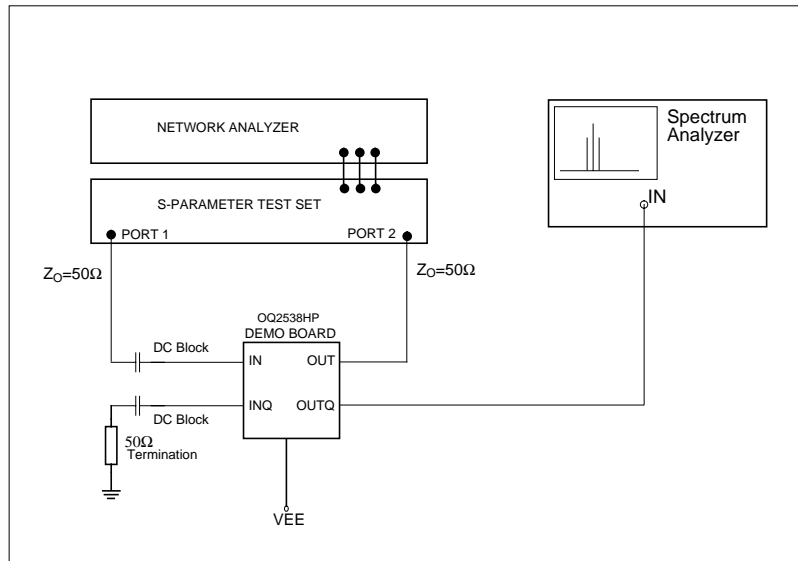


Fig 1. Functional test set up: frequency response and noise figure

**Linear (Small Signal) Gain:** To verify gain and bandwidth, measure the *forward transmission S21* with a 2-port vector network analyser as shown in figure 1. The input power level of the analyser should be set to -50 dBm. Make sure, that the network analyser is calibrated for this power level. The S21 should be around 40dB with a bandwidth of about 3 GHz.

NOTE that the input matching network reduces the overall gain of this configuration by 3dB if compared to the gain of the IC only.

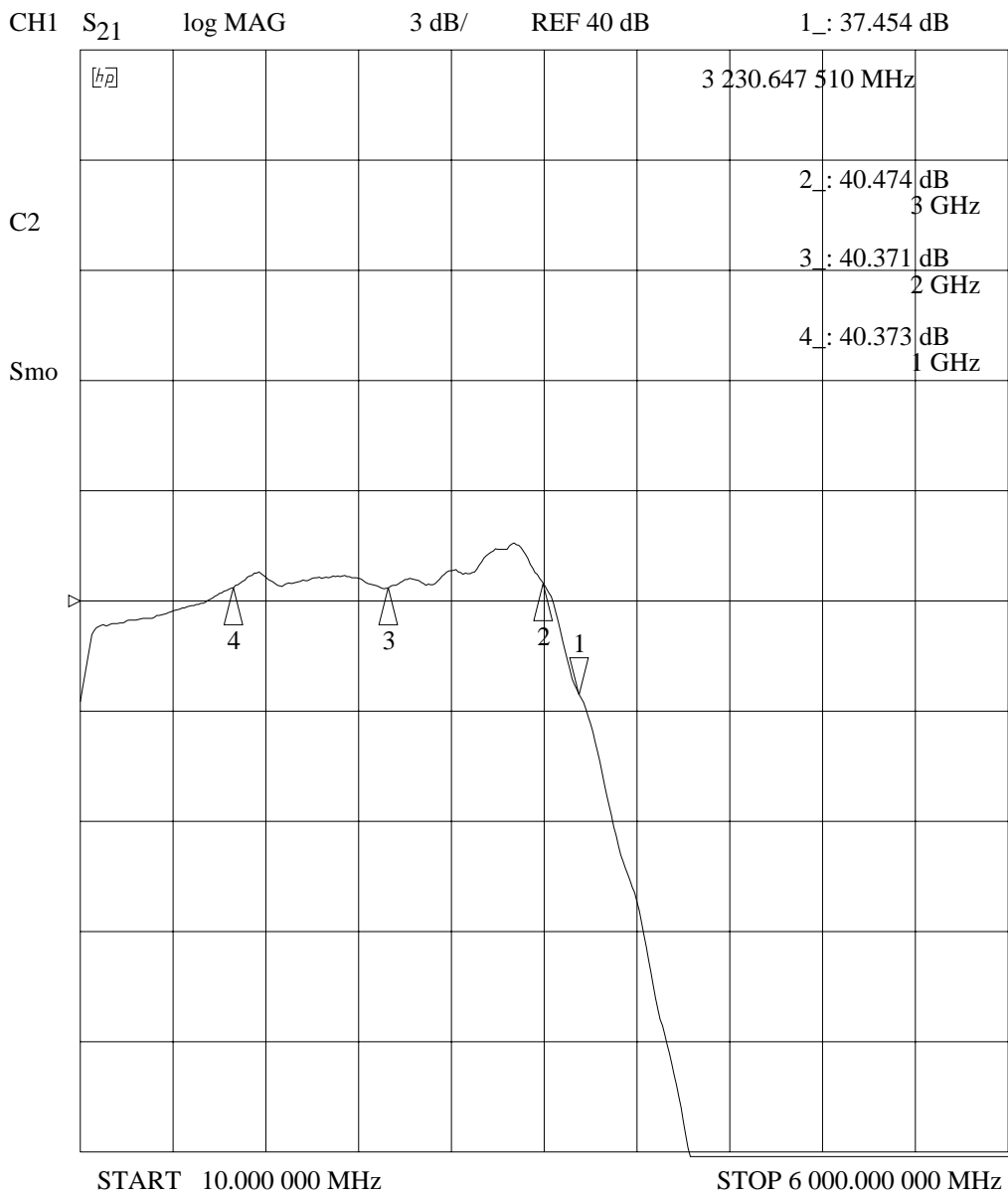
**Noise Figure:** A spectrum analyzer must be connected to the 2nd output (OUTQ) to measure the output noise spectrum. If 'N0' represents the noise level measured by spectrum analyzer in 1Hz bandwidth and expressed in dBm, the noise figure can be evaluated acc. to the equation below.

$$NF = N0 - (S21 + 3) + 173.8 \text{ dB}$$

Due to the input matching network, the gain that is measured with the network analyzer is 3 dB lower than the real amplifier gain. This must be accounted in the noise figure calculation by adding 3 dB to the measured S21. Note further that  $\log(kT)$  is 173.8 dBm

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Measured S21 vs. frequency

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## FUNCTIONAL TEST: TIME DOMAIN

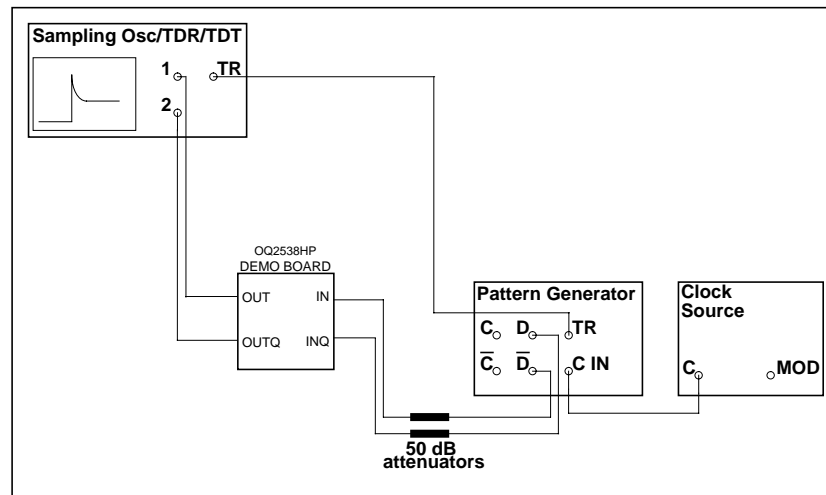


Fig 2. Functional test set up: time response

To test the input sensitivity, output levels, rise/fall times and overshoot, a PRBS pattern generator in combination with an RF clock generator is needed, as depicted in the figure above. With this setup the IC can be tested in differential mode.

The input sensitivity can be determined by starting off with a high input level (100 mV) and then reducing the input signal level until the amplitude of the output waveform starts to diminish. This is an indication that the amplifier is no longer clipping the signal. The input level for this case is equal to the input sensitivity.

In addition to the above measurement also the maximum allowed input signal level range has to be tested. The shape of the wave form should not change under this severe input overload condition.

The rise/fall times (based on 10%-90% crossings) can easily be determined with an oscilloscope. The overshoot and the band averaged jitter is not specified in the data sheet, but can be measured accordingly.

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