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LOGARITHMIC AMPLIFIER UP TO 500 MHz WITH AD8307

As a supplement to a good stock of measuring equipment, a logarithmic amplifier is described below with a useful dynamic range of 90 dB. Suitable outputs are provided so that the reading can be displayed, for example, on an oscilloscope. The signal to be measured can likewise be fed out over the serial 3-conductor bus by means of an optional A/D converter for further processing using a micro-controller or a PC.

1. GENERAL

Wobble measurements, for example, using the short-wave synthesiser for the frequency range 1 to 65 MHz [1] need a logarithmic display of the reading with as extensive a dynamic range as possible. Here the AD 8307 logarithmic amplifier from Analog Devices represents an almost ideal component, as a detector with dB linear output. A glance at the specimen circuit shows how few components are required (Fig. 1).

2. CIRCUIT DESCRIPTION

The core of the circuit (Fig. 2) is the AD 8307 logarithmic amplifier from Analog Devices. In the data sheet, the IC is specified as up to 500 MHz, with a dynamic range of approximately 90 dB. This is valid for input levels of + 17 dBm to 75 dBm. The AD8307 can even be used (with restricted accuracy) up to 900 MHz and beyond.

As the frequency increases, the display voltage decreases slightly. The associated characteristics are shown as the frequency response of the AD8307 in Fig. 3. In the interesting frequency range between 1 and 65 MHz, the deviation is negligently slight. Compensation might be necessary, if applicable, with correspondingly broad-band measurement applications.

The dB linear output (pin 4) has a gradient of 20 mV/dB in the given circuit and is high impedance. A type

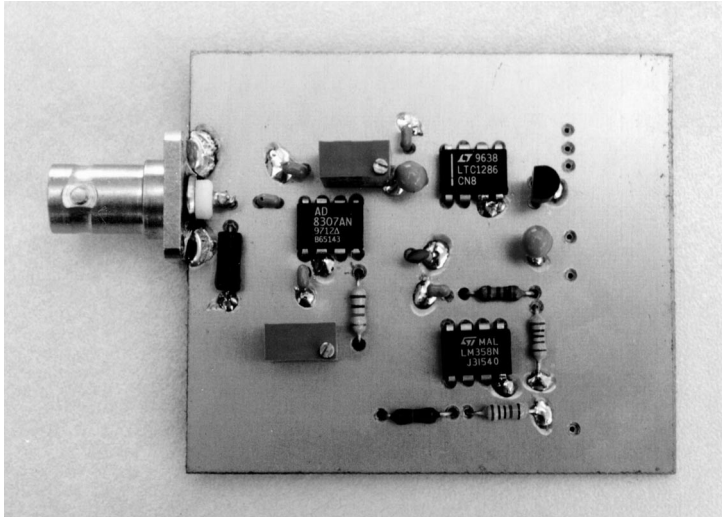


Fig. 1:
Prototype of
logarithmic
amplifier up to
500 MHz

LM358 double OP is downstream as a buffer stage. Thanks to the two different feedback resistances, this makes loadable outputs available with gradients of

50 mV/dB or 100 mV/dB.

The linearity and the offset (in relation to the input power) are set with two 50-Ohm spindle trimmers (see also Section 4: Putting into practise). Table 1 shows the output voltage, plotted against the input power following the balancing.

Ausgangsspannung des
logarithmischen Detektors

	dbm	20mV/dB	50mV/dB	100mV/dB
E i n g a n g	10	2,00	5,01	10,01
	0	1,80	4,50	9,00
	-10	1,59	3,99	7,97
	-20	1,39	3,48	6,96
	-30	1,19	2,99	5,97
	-40	0,99	2,48	4,96
	-50	0,79	1,98	3,95
	-60	0,59	1,49	2,97
	-70	0,40	1,00	2,00
-80	0,24	0,60	1,20	

Table 1: Output voltage plotted
against input power

Ausgangsspannung des logarith-
mischen Detektors = Output voltage of
logarithmic detector, Eingang = Input

As an extension, space was provided on the printed circuit board for a 12-bit type LTC 1286 A/D converter manufactured by Linear Technologies. This makes the signal to be measured available (through a serial 3-conductor bus) for further processing using a micro-controller or PC.

3. ASSEMBLY INSTRUCTIONS

The circuit for the logarithmic amplifier for up to 500 MHz (DJ8ES047) is assembled on a double-sided copper-coated epoxy printed circuit board (Fig.

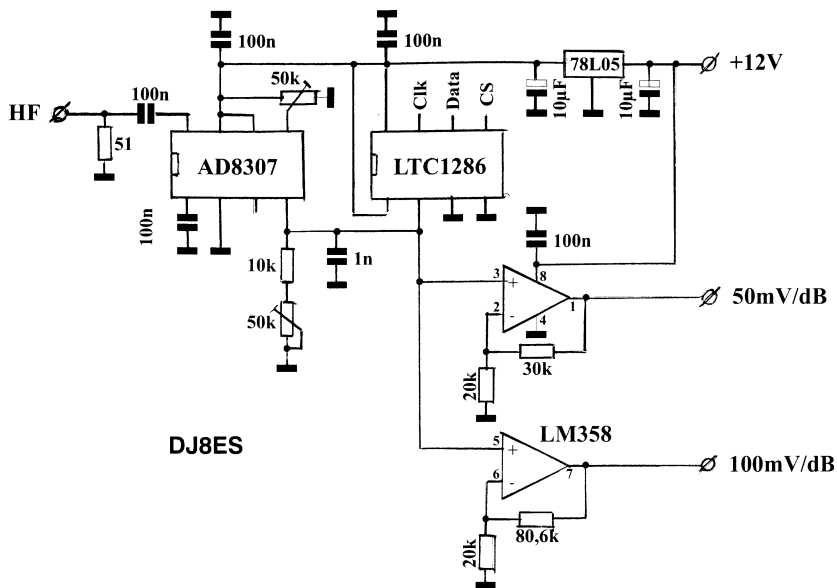


Fig. 2: Circuit for logarithmic amplifier with AD8307

4) with dimensions of 54 mm. x 72 mm.. It should be housed in a suitable tinplate housing.

A BNC socket is provided for the measurement input. The voltage of + 12 V is fed through a 1-nF feedthrough capacitor. Teflon bushings are used for all outputs.

First, all the resistors and capacitors and the voltage regulator are inserted, in

accordance with the component plan (Fig. 5). Before the ICs AD 8307 and, if applicable, LTC 1286 are soldered in, their supply voltage of + 5 V should be tested at the output of the 78L05 fixed voltage regulator.

Because of the high maximum operating frequency, which exceeds 500 MHz, the AD8307 had to be soldered directly onto the printed circuit board i.e. without a socket.



3.1. Component list	1 x 1-nF Df capacitor, solderable
	1 x 4 mm. soldering lug, turned down
1 x DJ8ES 047 printed circuit board	5 x Teflon bushings
1 x tinplate housing 55.5 mm. x 74 mm. x 30 mm.	5 x 100 nF, RM 2.5 mm., ceramic
1 x AD8307 logarithmic amplifier, DIL 8-pole	1 x 1 nF, RM 2.5 mm., ceramic
1 x LM 358 operational amplifier, DIL 8-pole	¼ W resistances, RM 10 mm.:
1 x LTC 1286 A/D converter, DIL (optional)	1 x 51 Ohms
1 x 78L05 fixed voltage regulator	1 x 10 kOhms
2 x 10 µF/35 V, tantalum electrolytic capacitor	2 x 20 kOhms
2 x 50-kOhm vertical spindle trimmer	1 x 30 kOhms
	1 x 80.6 kOhms

AD8307 - logarithmischer Detektor

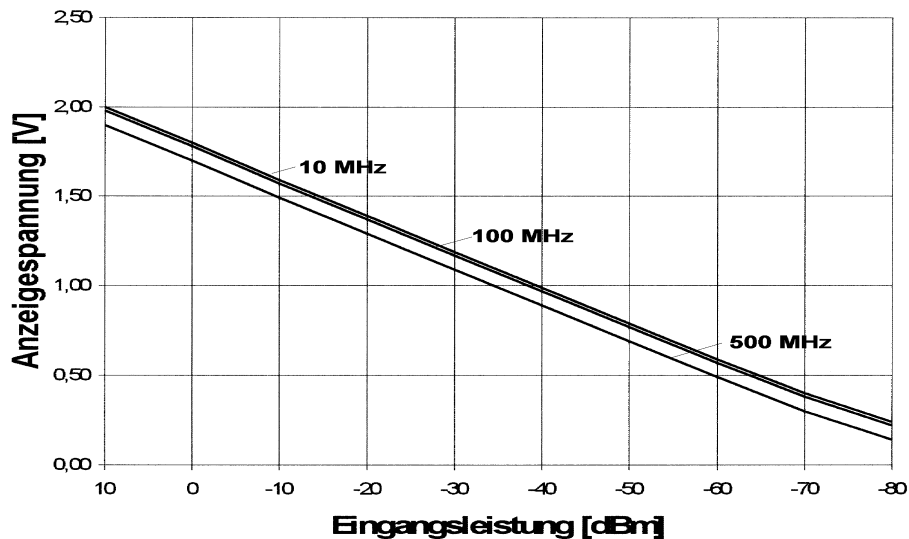


Fig. 3: Frequency response for AD8307

Anzeigespannung = Display voltage, Eingangsleistung = Input power

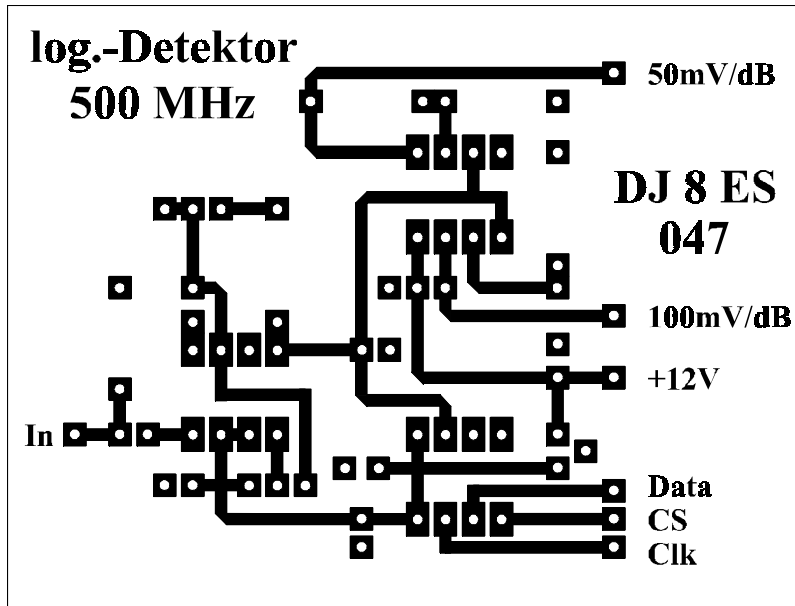


Fig. 4: DJ8ES 047 printed circuit board layout

4. PUTTING INTO OPERATION

Feed in the + 12 V DC power supply and an input signal of e.g. 0 dBm (1 mW). You should already be able to obtain a reading from a measuring instrument connected to the two outputs.

Use the 50-Ohm trimmer (through 10 kOhms to pin 4 of AD8307) to set the linearity of the entire system. The voltage differential between any test signal and a signal weakened by 10 dB must be exactly 1 V.

The simplest way of balancing this is with a switchable attenuator. During the balancing procedure, the absolute value

of the measurement voltage displayed is of no importance. The only thing relevant is the differential of 1 V to be established between the two measurement levels.

Finally, adjust the input signal offset. To do this, feed the test signal into the input at a level of 0 dBm and use the 50-kOhm trimmer at pin 5 of AD8307 to set 100 mV/dB output to precisely 9.0 V.

That completes the balancing. The logarithmic detector now measures outputs between + 10 dBm and 80 dBm in accordance with Table 1 at the beginning of the article. A reading of + 10 dBm (10 mW) thus corresponds to a voltage of 10 V at the 100 mV/dB output or, to put it another way: 1 V per 10 dB.

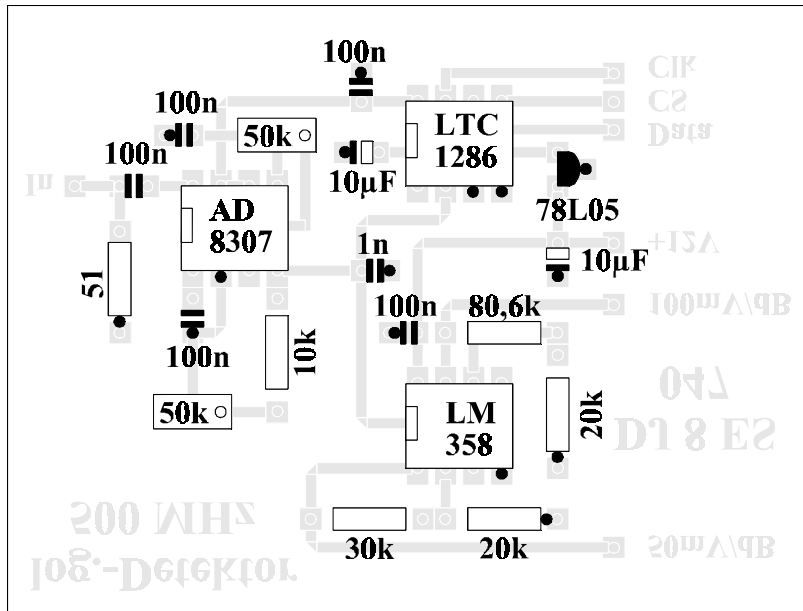


Fig. 5: Component plan for DJ8ES 047 assembly

In wobble measurements with the short-wave synthesiser, the Y input of an oscilloscope is connected up at the same point. Set the oscilloscope to 1 V/cm. for the purpose. The synthesiser supplies the X deflecting voltage. The settings and measurement structure required have already been discussed in [1].

[2] Data sheet AD8307

Analog Devices, Inc., 1997

[3] Data sheet LTC 1286

Linear Technology Corporation, 1994

5. LITERATURE REFERENCES

[1] Kaa, Bernd, DG 4 RBF

1-65 MHz short-wave synthesiser with DDS

VHF Reports, no. 4/99