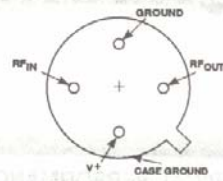


### 3 stufiger UHF - Breitbandverstärker mit Avantek Bausteinen

In diesem Artikel beschreibe ich einen Breitbandverstärker aus 3 Stück Verstärkermodulen der Firma Avantek. Es handelt sich um eine Kaskade der Bausteine GPD-1061, GPD-1062 und GPD-1063. Alle diese Verstärker decken einen Frequenzbereich von 5-1000 MHz ab und weisen eine Verstärkung von ca. 13dB auf. In der nächsten Übersicht sehen Sie die wesentlichen Daten dieser Produktlinie:

**GPD Series Selection Guide**



TO-12, p. 16-50

**GPD SERIES LOW COST AMPLIFIERS, TO-12 PACKAGE**  
 Guaranteed Specifications at 0° to 50°C Case Temperature

Model	Frequency Response (MHz) Minimum	Gain (dB) Minimum	Gain <sup>2</sup> (dB) Minimum	Noise Figure (dB) Typical	Power Output for 1 dB Gain Compression (dBm)		Gain Flatness (±dB) Typical	3rd-Order Intercept Point (dBm) Typical	Input Power (±1% Reg.)		Page Number
					Typical	Typical			Voltage (VDC)	Current (mA) Typical	
GPD-1001/-1061 <sup>1</sup>	5-1000	12	11	6.0	0	1.0	+12	+15	15	3-247	
GPD-1002/-1062 <sup>1</sup>	5-1000	12	11	7.0	+6	1.0	+16	+15	27	3-248	
GPD-1003/-1063 <sup>1</sup>	5-1000	10	9	7.0	+14	1.0	+25	+15	55	3-249	

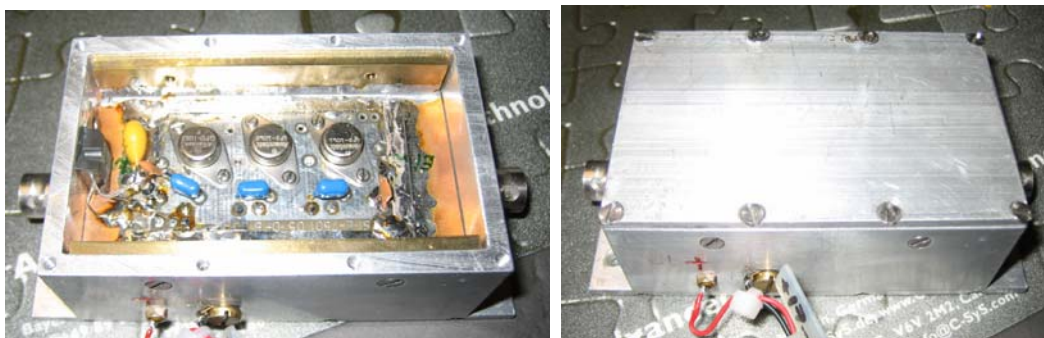
NOTES: 1. The 60 Series is the same as the standard series except that three external capacitors are required to establish low frequency roll-off.  
 2. Military temperature conditions: -55° to +85°C

**MAXIMUM RATINGS AND THERMAL CHARACTERISTICS TABLE**

Model	Maximum Ratings					Thermal Characteristics <sup>1</sup>				
	DC Voltage (Volts)	Continuous RF Input Power (dBm)	Operating Case Temperature (°C)	Storage Temperature (°C)	"R" Series Burn-In Temperature (°C)	$\theta_{JC}$ (°C/W)	Active Transistor Power Dissipation (mW)	Junction Temperature Above Case Temperature (°C)	MTBF MIL-HDBK-217E, A <sub>UP</sub> @ 90°C (Hrs)	Weight (Grams)
GPD-1001/-1061	+17	+13	-55 to +125	-62 to +150	+125	105	37	4	1,639,228 (1001) 1,910,397 (1061)	1.5
GPD-1002/-1062	+17	+13	-55 to +125	-62 to +150	+125	105	81.6	9	1,639,228 (1002) 1,882,476 (1062)	1.5
GPD-1003/-1063	+17	+13	-55 to +125	-62 to +150	+125	75	185	14	869,341 (1003) 2,101,101 (1063)	1.5
GPM-1052	+17	+17	-55 to +125	-62 to +150	+125	130/130	125/175	16/23	—	1.5

NOTES: 1. Values refer to 1st and 2nd stage transistors respectively.  
 2. For further information, see High Reliability section.

Die Gesamtschaltung ist in einem geschirmten Aluminiumgehäuse untergebracht welches auch eine genügend gute Wärmeabfuhr gewährleistet. Links wurde der Deckel entfernt um die 3 Verstärker zu zeigen.



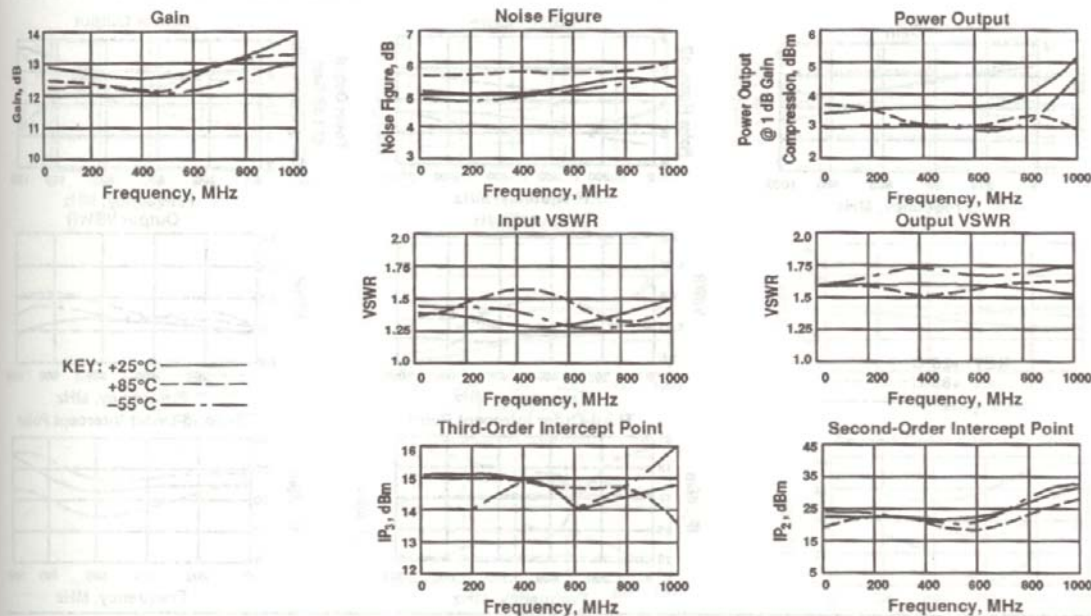
Die Versorgungsspannung der einzelnen Verstärker beträgt 15V. In dem Gehäuse ist ein Spannungsregler 7815 eingebaut, welcher die Versorgungsspannung auf diesen Wert stabilisiert. Die externe Spannung sollte im Bereich 18V bis 24 V liegen. Die gemessene Stromaufnahme bei V<sub>s</sub>=18V beträgt 95 mA. Auf den nächsten Seiten finden Sie jeweils ein Datenblatt der Verstärker GPD-1061, GPD-1062, GPD-1063.



481 COTTONWOOD DRIVE  
MILPITAS, CALIFORNIA 95035  
TEL: 408/955-1000

**GPD-1001/1061**  
Thin-Film Cascadable Amplifier Module  
5 to 1000 MHz

**TYPICAL PERFORMANCE OVER TEMPERATURE (@ +15 VDC unless otherwise noted)**



**AUTOMATIC NETWORK ANALYZER MEASUREMENTS (Typical production unit @ +25°C ambient)**

**NUMERICAL READINGS**

BIAS = 15.00 VOLTS

FREQ MHz	VSWR IN	GAIN dB	PHASE DEG	PHASE DEV	GPDEL ns	VSWR OUT	ISOL dB
100.0	1.29	12.80	175.00	-1.27	.00	1.55	21.19
200.0	1.25	12.70	171.12	-.70	.15	1.57	20.80
300.0	1.20	12.70	165.90	-.76	.13	1.59	20.73
400.0	1.15	12.68	161.70	-.19	.10	1.59	20.57
500.0	1.11	12.69	157.36	.98	.11	1.60	20.31
600.0	1.13	12.82	152.75	1.51	.14	1.58	20.06
700.0	1.18	12.91	148.43	2.34	.14	1.57	19.83
800.0	1.26	13.20	142.15	1.21	.17	1.54	19.55
900.0	1.33	13.44	135.24	-.56	.25	1.48	19.29
1000.0	1.40	13.89	125.84	-4.81	.33	1.48	18.85
1100.0	1.66	14.25	110.43		.49	1.60	18.52
1200.0	2.65	14.09	88.12		.66	1.95	19.60
1300.0	5.16	11.75	67.01		.53	2.26	21.99

**S-PARAMETERS**

BIAS = 15.00 VOLTS

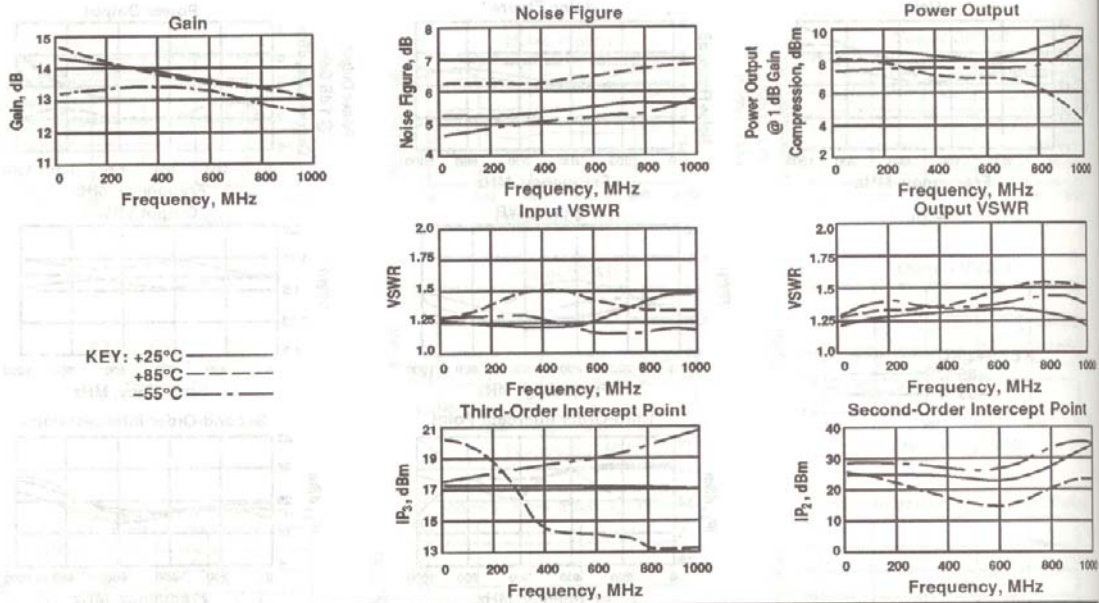
FREQ MHz	S <sub>11</sub>		S <sub>21</sub>		S <sub>12</sub>		S <sub>22</sub>	
	Mag	Ang	dB	Ang	dB	Ang	Mag	Ang
100.00	.126	176.0	12.781	175.4	-20.769	6.5	.216	.8
200.00	.109	170.2	12.735	171.2	-20.961	11.4	.222	3.4
300.00	.090	167.9	12.693	165.9	-20.665	18.5	.228	3.6
400.00	.070	178.0	12.683	161.8	-20.550	24.4	.229	3.1
500.00	.051	-165.9	12.662	157.5	-20.195	28.3	.232	.6
600.00	.059	-137.8	12.787	152.8	-20.108	32.5	.228	-2.0
700.00	.084	-125.1	12.899	148.5	-19.851	36.3	.224	-4.7
800.00	.115	-134.4	13.175	142.2	-19.505	38.1	.213	-8.0
900.00	.145	-153.4	13.447	135.5	-19.210	38.4	.198	-6.6
1000.00	.170	169.8	13.865	126.0	-18.813	37.5	.195	-2
1100.00	.247	112.2	14.251	110.7	-18.550	32.7	.234	7.1
1200.00	.450	52.0	14.090	88.5	-19.649	25.2	.322	-4
1300.00	.675	2.7	11.730	67.1	-21.993	21.1	.390	-19.1
1400.00	.789	-33.2	7.973	53.1	-23.851	29.5	.364	-40.5
1500.00	.831	-54.8	4.163	50.8	-24.626	37.0	.302	-53.1

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**GPD-1002/1062**  
Thin-Film Cascadable Amplifier Module  
5 to 1000 MHz

**TYPICAL PERFORMANCE OVER TEMPERATURE (@ +15 VDC unless otherwise noted)**



**AUTOMATIC NETWORK ANALYZER MEASUREMENTS (Typical production unit @ +25°C ambient)**

**NUMERICAL READINGS**

BIAS = 15.00 VOLTS

FREQ MHz	VSWR IN	GAIN dB	PHASE DEG	PHASE DEV	GPDEL ns	VSWR OUT	ISOL dB
100.0	1.29	14.23	174.38	-16	.00	1.26	24.09
200.0	1.26	14.06	167.94	-52	.19	1.27	23.33
300.0	1.21	13.97	161.47	-93	.16	1.29	23.49
400.0	1.17	13.83	156.06	-27	.14	1.30	23.05
500.0	1.18	13.67	150.80	.53	.14	1.31	22.81
600.0	1.23	13.57	145.27	1.08	.16	1.30	22.14
700.0	1.30	13.44	139.93	1.82	.17	1.29	21.64
800.0	1.39	13.43	133.32	1.29	.18	1.26	21.23
900.0	1.44	13.41	125.77	-18	.26	1.20	20.79
1000.0	1.49	13.53	115.90	-3.99	.33	1.18	19.94
1100.0	1.76	13.51	100.99		.48	1.25	19.43
1200.0	2.74	12.87	80.86		.59	1.43	19.96
1300.0	5.08	10.21	60.92		.44	1.57	21.81

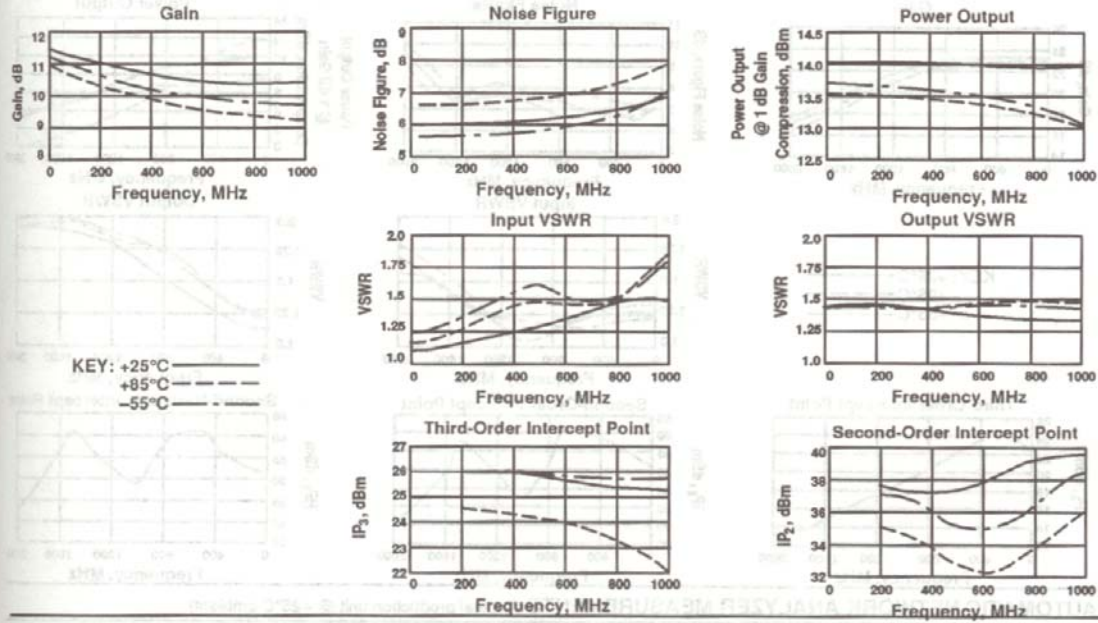
**S-PARAMETERS**

BIAS = 15.00 VOLTS

FREQ MHz	S <sub>11</sub>		S <sub>21</sub>		S <sub>12</sub>		S <sub>22</sub>	
	Mag	Ang	dB	Ang	dB	Ang	Mag	Ang
100.00	.130	177.2	14.212	174.2	-23.883	10.1	.114	1.0
200.00	.115	174.5	14.090	168.1	-23.830	14.4	.118	9.1
300.00	.094	177.6	13.974	161.6	-23.220	23.4	.127	9.4
400.00	.081	-168.4	13.831	156.2	-22.778	31.2	.130	9.0
500.00	.081	-150.6	13.638	150.9	-22.618	36.0	.134	6.5
600.00	.102	-139.1	13.535	145.2	-22.092	41.8	.132	3.1
700.00	.131	-138.6	13.423	139.9	-21.605	45.5	.127	-1.0
800.00	.162	-150.9	13.412	133.3	-21.127	48.1	.115	-6.2
900.00	.178	-171.3	13.416	126.0	-20.662	48.3	.097	-5.4
1000.00	.197	151.2	13.496	116.0	-19.983	47.6	.084	10.0
1100.00	.272	95.7	13.510	101.1	-19.447	42.2	.112	29.1
1200.00	.462	40.7	12.865	81.0	-20.066	34.7	.175	19.4
1300.00	.668	-4.2	10.191	60.9	-21.823	26.8	.225	-4.7
1400.00	.793	-37.1	6.343	51.1	-24.091	28.3	.213	-28.4
1500.00	.837	-58.2	2.570	50.1	-25.353	36.2	.174	-48.3

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**TYPICAL PERFORMANCE OVER TEMPERATURE (@ +15 VDC unless otherwise noted)**



**AUTOMATIC NETWORK ANALYZER MEASUREMENTS (Typical production unit @ +25°C ambient)**

**NUMERICAL READINGS** BIAS = 15.00 VOLTS

FREQ MHz	VSWR IN	GAIN dB	PHASE DEG	PHASE DEV	GPDEL ns	VSWR OUT	ISOL dB
100.0	1.13	11.32	161.40	-60	.00	1.46	22.29
200.0	1.17	11.18	141.34	-1.28	.54	1.43	22.12
300.0	1.23	11.14	122.54	-.68	.51	1.39	21.89
400.0	1.27	10.98	104.21	.36	.51	1.34	21.62
500.0	1.31	10.84	86.05	1.58	.53	1.29	21.29
600.0	1.36	10.72	68.56	1.47	.52	1.26	21.00
700.0	1.41	10.74	47.59	1.88	.57	1.26	21.02
800.0	1.53	10.67	26.70	.98	.56	1.22	19.34
900.0	1.50	10.75	6.68	-.23	.59	1.24	18.98
1000.0	1.54	10.88	-16.41	-3.94	.00	1.28	18.61

LINEARIZATION RANGE: 100.0 to 1000.0 MHz BIAS = 15.00 VOLTS

**S-PARAMETERS**

FREQ MHz	S <sub>11</sub>		S <sub>21</sub>		S <sub>12</sub>		S <sub>22</sub>	
	Mag	Ang	dB	Ang	dB	Ang	Mag	Ang
100.00	.053	-123.2	11.016	171.9	-21.498	11.5	.149	-9.5
200.00	.086	-119.4	11.120	167.0	-22.503	5.8	.125	-16.6
300.00	.082	-127.5	11.249	160.5	-20.865	25.2	.148	-22.0
400.00	.104	-130.2	10.924	154.6	-21.173	25.7	.139	-38.5
500.00	.113	-132.5	10.857	148.1	-21.142	33.8	.141	-49.3
600.00	.137	-146.1	10.755	141.8	-21.214	33.8	.136	-64.1
700.00	.144	-157.4	10.768	135.9	-20.690	39.1	.147	-77.9
800.00	.153	-169.4	10.778	127.8	-20.598	43.3	.156	-93.9
900.00	.186	169.2	10.973	120.2	-19.731	40.8	.157	-109.0
1000.00	.207	136.3	11.218	109.3	-18.887	36.1	.160	-128.3
1100.00	.293	88.5	11.458	95.4	-20.163	40.2	.165	-152.0
1200.00	.455	32.3	10.592	76.2	-19.339	31.5	.144	-175.6
1300.00	.646	-15.4	8.449	55.5	-19.985	24.1	.132	169.3
1400.00	.763	-50.0	5.442	43.9	-21.462	20.9	.133	154.4
1500.00	.820	-75.6	2.652	39.0	-22.083	25.1	.133	138.6
1600.00	.862	-94.2	.174	37.8	-22.710	30.6	.145	117.1
1700.00	.892	-109.5	-2.115	35.7	-24.469	22.8	.163	102.4

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Die untere Grenze des Frequenzgangs des Gesamtverstärkers wird vor allem durch die externen Koppelkondensatoren bestimmt. Eine Beschreibung hierzu finden Sie im nächsten Bild:

Application Note  
Cascadable Amplifiers

Calculating The Low Frequency Response Of A GPD Amplifier

Neither the 460 nor the 1060 series GPD amplifiers have internal coupling capacitors. These, along with the DC bias bypass capacitor, must be provided in the external circuit. By selecting the values of the capacitors, the low frequency roll-off point may be set as close to DC as required.

The design curves of Figures 8b and 8c can be used to determine the proper input, output and bias bypass capacitor values. Figure 8b provides the required capacitor value for the desired frequency response. Figure 8c will provide the gain roll-off.

For example, to produce a flat frequency response to 200 Hz, from Figure 8b, a capacitive value of 50  $\mu\text{F}$  should be used.

From Figure 8c it can be seen that if 50  $\mu\text{F}$  capacitors are used the gain of the amplifier will only be reduced by 0.05 dB at 200 Hz. At 100 Hz the roll-off would be 0.2 dB, at 50 Hz the roll-off would be 0.85 dB and at 30 Hz the gain would be reduced by 3 dB.

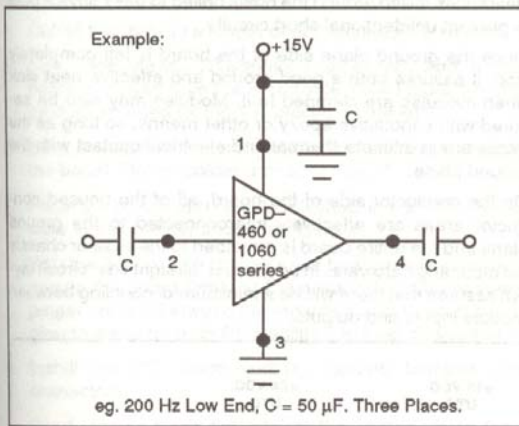


Figure 8a. GPD Circuit

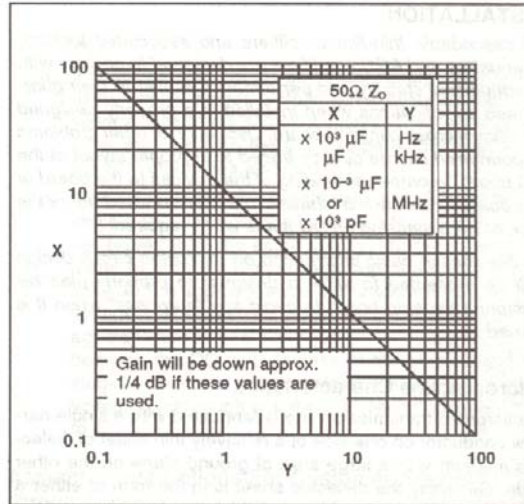


Figure 8b. Capacitor Values for Amplifier Low Frequency Response

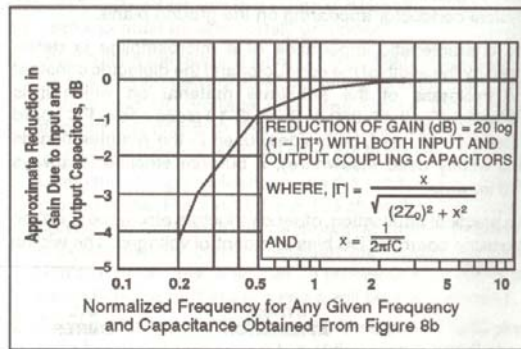
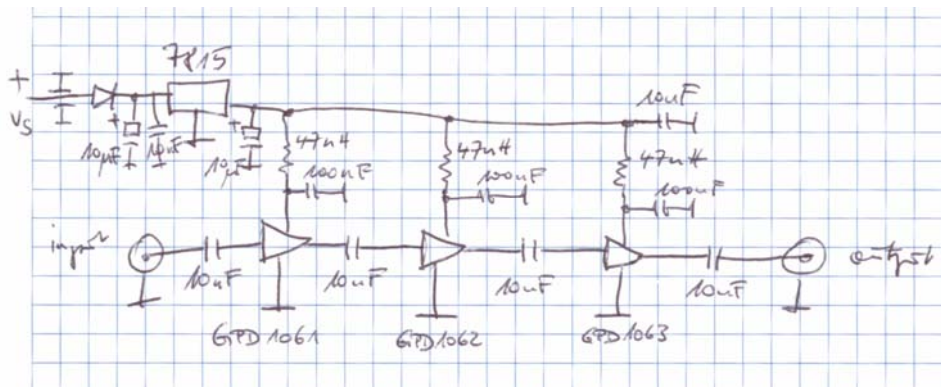
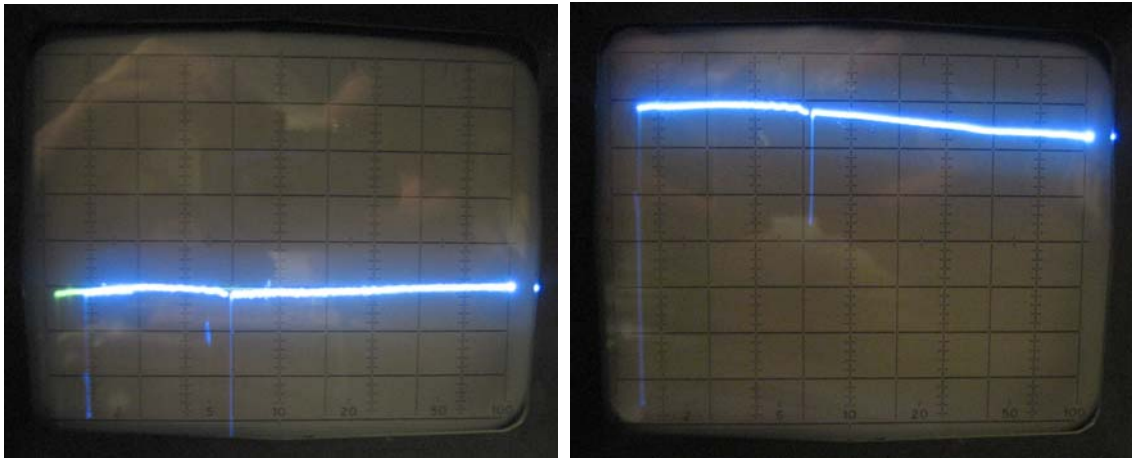


Figure 8c.

Hier die von mir verwendete Gesamtschaltung:



Hier nun ein Frequenzgang, welcher an dem Verstärkermodul gemessen wurde. Links ist jeweils der Frequenzgang des Messaufbaus ohne Verstärker (die Nulllinie), rechts der Frequenzgang des Messaufbaus mit eingeschleiftem Verstärker zu sehen. Die vertikale Skala beträgt 10dB/Teilung. Der Frequenzbereich beträgt 100 bis 1000 MHz.



Die Verstärkung beträgt bei niedrigen Frequenzen also ca. 40dB und fällt nach oben hin ab. Bei 1 GHz beträgt die Gesamtverstärkung noch ca. 33 dB. Die untere Grenzfrequenz ist nicht zu erkennen da mein Netzwerkanalysator erst ab 100 MHz eingesetzt werden kann.

Hier noch einige weitere Daten des Gesamtverstärkers die jedoch nur rechnerisch ermittelt wurden und noch nicht messtechnisch verifiziert wurden: Rauschzahl NF = 6 dB, P1dBout = +14 dBm, OIP3 = +25 dBm

Für Kommentare und Rückfragen stehe ich jederzeit gerne zur Verfügung.

Mit freundlichen Grüßen

Matthias DD1US

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Homepage: <http://www.dd1us.de>