Noise Figure Measurement Results
3 rd Int EME Conference
Thorn, The Netherlands

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1. Measurement Setup

1.1. Equipment:

Noise Source: AIL7615 (S/N:4044) with Isolator

432 MHZ: Isolation: 26 dB; $|S_{22}|$=0.045; Loss = 0.26 dB; ENR = 15.8 dB

1296 MHZ: Isolation: 50 dB; $|S_{22}|$=0.051; Loss = 0.25 dB; ENR = 15.4 dB

PANFI: HP8970B

432 MHz: Front-End-LNA + Isolator (System Noise Figure = 1.2 dB)

1296 MHz: Solo (System Noise Figure = 6.9 dB)

Relative Accuracy: ±0.05 dB typ. / ±0.13 dB max.

Absolute Accuracy: ±0.16 dB typ. / ±0.48 dB max.

1.2. ENR-Calibration

Five different noise sources have been used on 432 MHz to establish a picture of differences in ENR-Calibration.

Type	Serial-No.	Nominal ENR [dB]	Real ENR: Difference [dB]
AIL7615	4044	15.8	0.0(Reference!)
AIL7615	5212	15.5	-0.22
HP346B	2037A00657	15.46	-0.06
HP346B	2037A0081	15.53	0.0
HP346A	2614A01287	5.30	-0.03

The same picture holds for 1296 MHz.

1.3. Environment Conditions

Place: Thorn, The Netherlands

Temperature: 20.0 - 22.4 ° C (Corrected in PANFI)

Date: 11 th of September, 1988

Responsible: DJ9BV

Measured Noise Figures on 432 MHz (Sorted in ascending order of M+1-Value)								
Claims					Measurements			
Owner	Manuf./Type	Design	Device	NF [dB]	NF [dB]	Gain [dB]	M+1 † [dB]	Remarks
DJ9BV	DJ9BV/Z-1302-2	DJ9BV	MGF1302	0.35	0.28	20.0	0.283	HB
DJ9BV	DJ9BV/Z-101-1	DJ9BV	ATF10135	0.35	0.28	18.0	0.284	HB
DJ9BV	DJ9BV/Z-1302-1	DJ9BV	MGF1302	0.35	0.29	19.6	0.293	HB
PA3AEF	PA3AEF	PA3AEF	MGF1302	?	0.32	23.3	0.321	HB
DL9KR	DL9KR	DL9KR	NE75083	0.4	0.34	44.0	0.34	HB
DJ9BV	DJ9BV/Z-750-1	DJ9BV	NE75083	0.42	0.34	19.7	0.344	HB
DJ9BV	DJ9BV/Z-1402-1	DJ9BV	MGF1402	0.4	0.34	18.8	0.344	HB
I5TDJ	I5TDJ	I5TDJ	2SK571	0.5	0.36	20.8	0.363	HB
DL9KR	DL9KR	DL9KR	NE20283	0.42	0.37	46.4	0.37	HB
SM4GVF	SM4GVF	SM4GVF	MGF1402	0.3	0.38	19.3	0.384	HB
DJ9BV	DJ9BV/Y-2	DJ9BV	NE75083	0.42	0.40	17.2	0.407	HB
LA8AE	SSB/DX432-01	JA6CZD-SSB	MGF1302	0.3	0.40	16.0	0.410	CT
SSB-Electr.	SSB/DX432-01	JA6CZD-SSB	MGF1302	0.3	0.41	21.2	0.413	C
DC3XY	DC3XY	DJ9BV	2SK571	?	0.41	17.6	0.417	HB
SM0PYP	SM0PYP	SM0PYP	NE75083	?	0.43	44.4	0.43	HB
YU1IQ	SSB/DX432-01	JA6CZD-SSB	MGF1303	0.3	0.43	20.0	0.434	C
DL7WX	SSB/DX432-01	JA6CZD-SSB	MGF1412	0.3	0.50	22.2	0.503	C
DC9KK	DJ9BV	DJ9BV	2SK578	0.55	0.50	19.5	0.505	HB
PA3AEF	PA3AEF	PA3AEF	MGF1302	?	0.50	18.0	0.508	HB
PA3DZL	PA3DZL	JA6CZD	MGF1402	0.50	0.56	20.4	0.565	HB
PA3DZL	PA3DZL	JA6CZD	2SK571	0.50	0.61	21.6	0.614	HB
LA8AE	LABE	LABE	MGF1202	0.8	0.90	19.3	0.910	C
YU1IQ	ARR/SP432VDG	ARR	MGF1402	0.50	0.90	14.4	0.931	C
PA3DZL	SSB/DX432A ?	SSB	MGF1402	0.70	0.90	14.2	0.932	CM
PA3AEF	PA3AEF	JA6CZD	MGF1501	0.6	1.27	14.5	1.310	HB
PA3CSG	PA3CSG	PA3CSG	?	?	1.43	12.3	1.506	HB
Measured Noise Figures on 1296 MHz								
DJ6MB	DJ6MB	SSB	NE75083	0.7	0.50	18.4	0.507	HB
VE4MA	VE4MA	VE4MA	NE71084	0.49	0.52	36.2	0.52	HB
DF7VX	SSB/DX1296-S/New	SSB	MGF1402?	0.50	0.53	22.8	0.533	C
DJ9BV	DJ9BV	DJ9BV	2SK569	?	0.72	15.4	0.74	HB
SM4GVF	SM4GVF	SM4GVF	MGF1402	0.4	0.76	16.4	0.776	HB
DC3XY	DC3XY	DC3XY	CFY13	0.7	0.76	15.8	0.779	HB
PA3DZL	SSB/DX1296-S/Old	SSB	MGF1412	0.5	0.82	16.3	0.838	C
DK0IK	SSB/DX1296/Old	SSB	MGF1400	0.8	0.97	17.2	0.987	C
PE1KXH	PE1KXH	DD9DU	MGF1302	1.0	1.0	10.5	1.087	HB
PA3CSG	PA3CSG	SSB	MGF1400	?	1.48	10.9	1.59	HB
PA3DZL	PA3DZL	PA3DZL	MGF1402	1.0	1.65	12.1	1.739	HB
DF9CY	DF9CY	DF9CY	MGF1402	3.0	2.9	10.2	3.118	HB
YU1IQ	SSB/DX1296-S/Old	SSB	MGF1402	0.5	??	Oscill.	??	C

0

Remarks:

C: Commercial entry, original condition

CT: Commercial entry, retuned

CM: Commercial entry, modified and retuned

HB: Home built

† $M = \frac{F-1}{1-\frac{1}{G}}$

2. Comments

2.1. 70 cm Measurements

1. Quality of design

   The JA6CZD design and its clones - beside the fact that it leads to instability even for 50 Ohms load impedance - is about 0.15 dB worse in noise figure than designs with High-Q input circuits with the same type of device used.

2. Quality of devices

   The MGF1302 apparantly is the first choice for the transistor and gives a very good cost/performance ratio. Suspected 'good' devices like the NE75083 are inferiour on 432 MHz but better on 1296 MHz.

2.2. 23 cm Measurements

1. Quality of design

   The old DJ8QL-design (PI-Circuit with stripline) is still going strong, but has problems with stability (K < 1). The SSB-DX1296-S/Old is patternd after this design. The DC8UG-design, which incorporates lossless source feedback, has been used for the input stage of the SSB-DX1296-S/New. Noise figure seems to be better than normal, but the low number of measured units prevents further judgements. VE4MA uses high-Q quarter wave air lines in the input and achieves a good noise figure with a medium quality device.

2. Quality of devices

   The NE75083 seems to be very good device on 23 cm. The MGF1402/1412 variety seems to be second to this. But the low number of preamps in this group prevents further judgements.

2.3. Quality of claims

Concerning the claims of commercial preamps there is nearly always a difference between claim and results to the disadvantage of the buyer. To change this unprofessional attitude to data sheets and performance claims some proposals, how to specify a commercial product, are given:

1. On each preamp there should be a unique serial number and the type designation.
2. Each value for a quality feature in a data sheet should be specified:
   1. as a guaranteed value: Minimum or Maximum value dependent on what direction of better quality is expected - i.e. Maximum for noise figure, because the better quality is given by a small value or Minimum for gain, because the better value is given by a large value. The guaranteed value is what the customer buys and must be valid for all units in a series for which the data sheet is given.
   2. Optional a typical value can be specified for each feature. It should be the mean value of the stated feature for at least 100 units, so the statistical error for this mean value is less than 10 %. The typical value is what the customer hopes for and the producer whants to suggest.
3. The following quality features should be covered by the data sheet:

Sample Data Sheet:432 Preamp YYY						
Parameter	Symbol	Condition	Min.	Typ.	Max.	Units
Supply Voltage	V_{SUP}	Total Temp. Range	10	12	25	[Volts]
Ambient Temp.	T_A	-	-20	25	45	[° C]
Operating Frequency	F_{OP}	Total Temp. Range	430	435	440	[MHz]
Noise Figure	NF	F_{OP} = 435 MHz	-	0.4	0.5	[dB]
Gain	G	F_{OP} = 435 MHz	18	20	-	[dB]

4. Optional quality features for preamps are:

Parameter	Symbol	Condition	Min.	Typ.	Max.	Units
3 rd Order Intercpt. @ Input	IP_3	$T_A = 25\,°C$	-10	-5	-	[dBm]
Stability Factor †	K	$T_A = 25\,°C$	1.2	2.0	-	[dB]
Supply Current	I_{SUP}	$T_A = 25\,°C$	20	30	100	[mA]

$$\dagger\ K = \frac{1 + |S_{11} \cdot S_{22} - S_{12} \cdot S_{21}|^2 - |S_{11}|^2 - |S_{22}|^2}{2 \cdot |S_{12} \cdot S_{21}|}$$

The third order intercept point IP_3 should always be referenced to the input of a preamp, so nobody has to know the gain for calculating the input figure for comparison. The K-Factor tells, wether the preamp is unconditionally stable ($K>1$) or not. If $K \leq 1$, the user must be aware of potential instabilities (oscillations) dependent on the actual load and source impedances.