Figs and Tables in Color

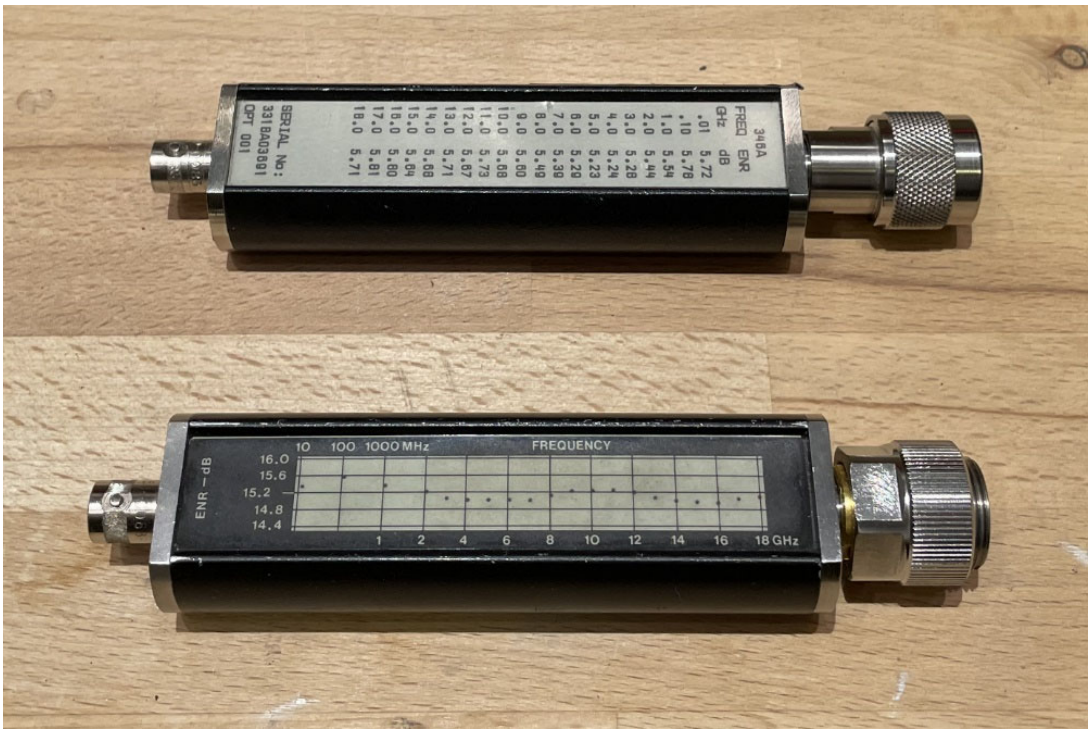

Fig 1 ENR-Noise Sources, HP 436A (upper), HP 436B (lower), each with calibration data.

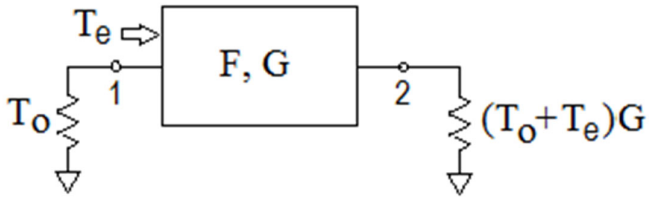

Fig 2 Definition of noise temperatures with a 2-port device with noise factor F and absolute gain G.

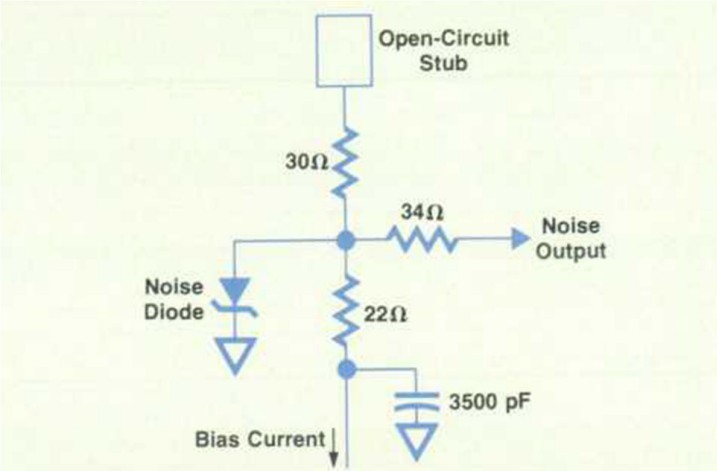

Fig. 2. *Schematic diagram of the broadband impedance-matching imbedding circuit for the 0.01-to-18-GHz noise diode.*

Fig 3 Internal circuit of a noise source without attenuator [7]

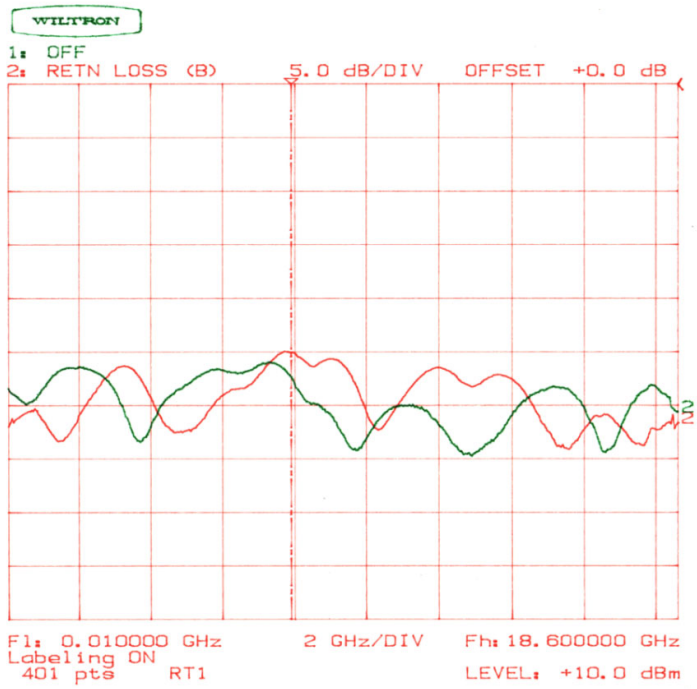

Fig 4 Return loss versus frequency of the HP 346B noise source. Green: ON, red: OFF (Cursor 7.8 GHz, -25 dB).

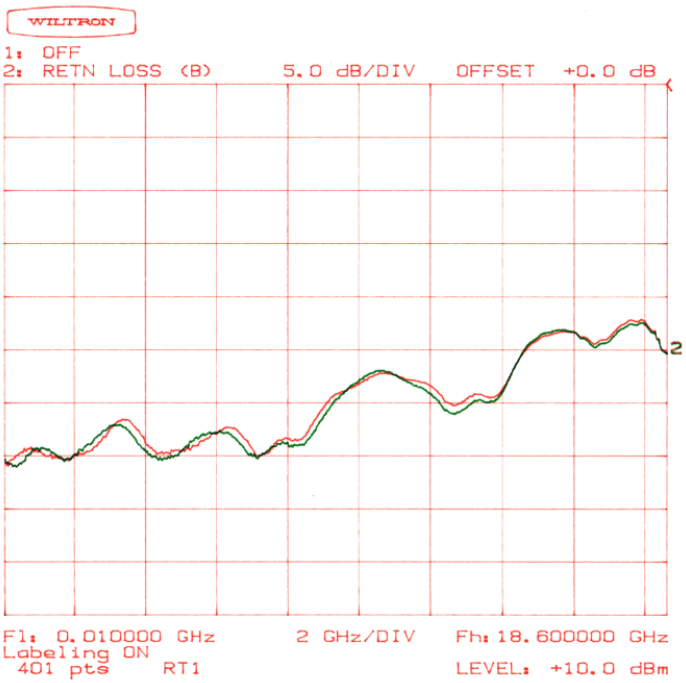

Fig 5 Return loss versus frequency of the HP 346A noise source. Green: ON, red: OFF (with adapter N-to-APC-7).

Fig 6 Noise Figure Meter HP 8970B.

Fig 7 Noise Figure Test Set HP 8971B (part of the Noise Measurement System HP 8970S). At the LO input the HP 8673B is to be connected, at the IF output the HP 8970B respectively.

Fig 8 Synthesized Signal Generator HP 8673B (LO for HP 8971B, all instruments controlled by GPIB by the HP 8970B's system controller).

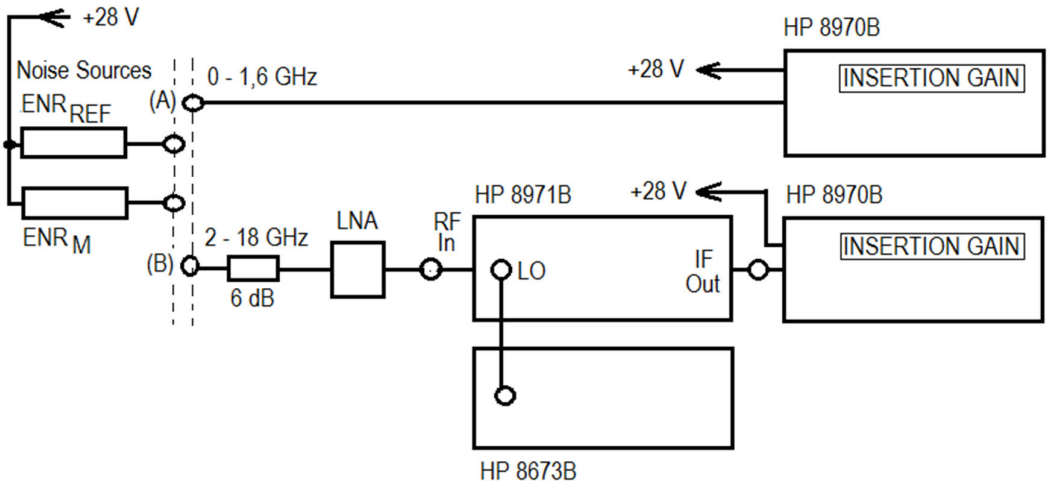

Fig 9 Measurement setup for the ENR calibration by comparison with reference ENR noise source.

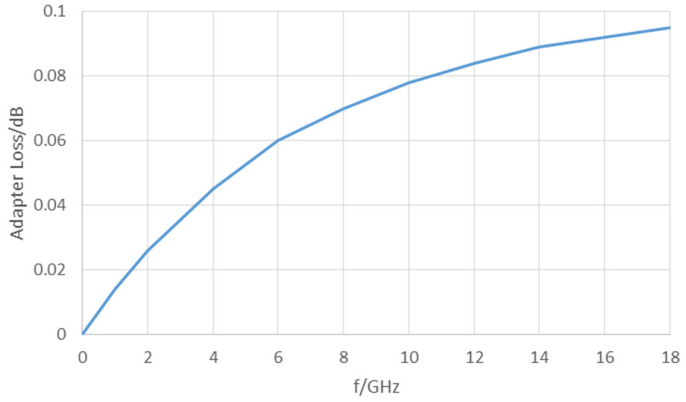

Fig 10 Attenuation versus frequency of an N-to-APC-7 adapter.

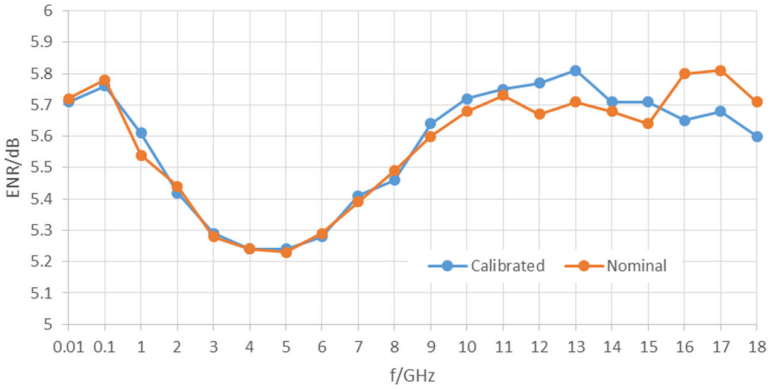

Fig 11 Calibration results and nominal ENR versus frequency of a 6 dB ENR noise source (non-linear frequency axis). Method: Comparison with reference noise source.

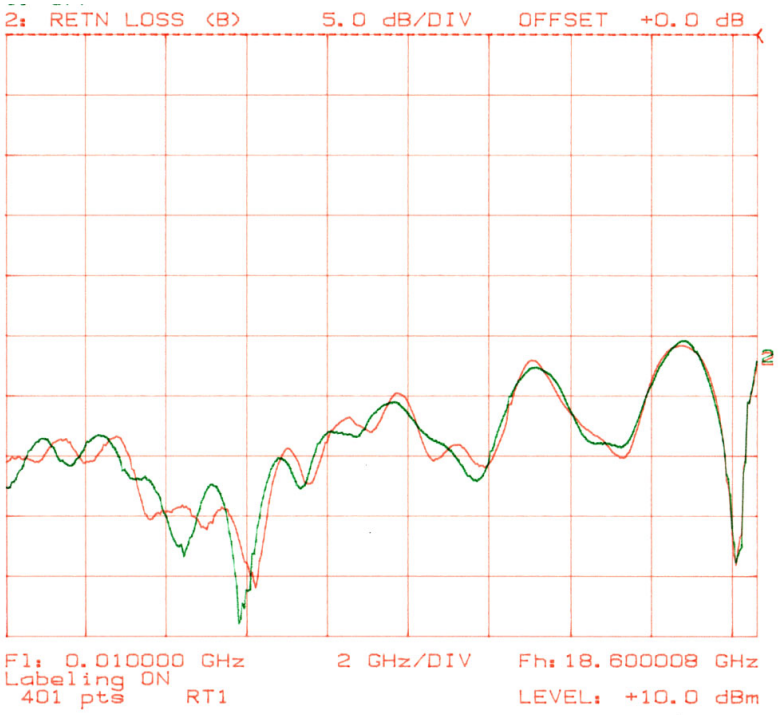

Fig 12 Return loss versus frequency of the modified 5 dB ENR noise source. Green: ON, red: OFF.

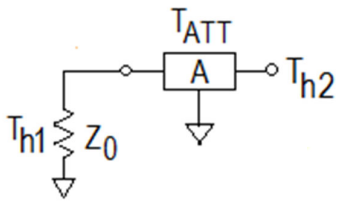

Fig 13 Noise temperatures for a hot source followed by an attenuator.

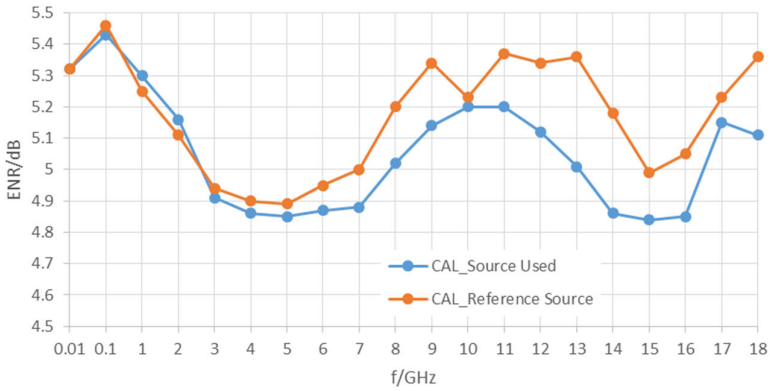

Fig 14 ENR of the modified source (15 dB ENR source (HP 346B) with additional 10-dB attenuator (HP 8492A)). The blue data points show the calibration with the used source (HP 346B). The orange data points show the calibration with a 6 dB ENR source (HP 346A) as a reference source.

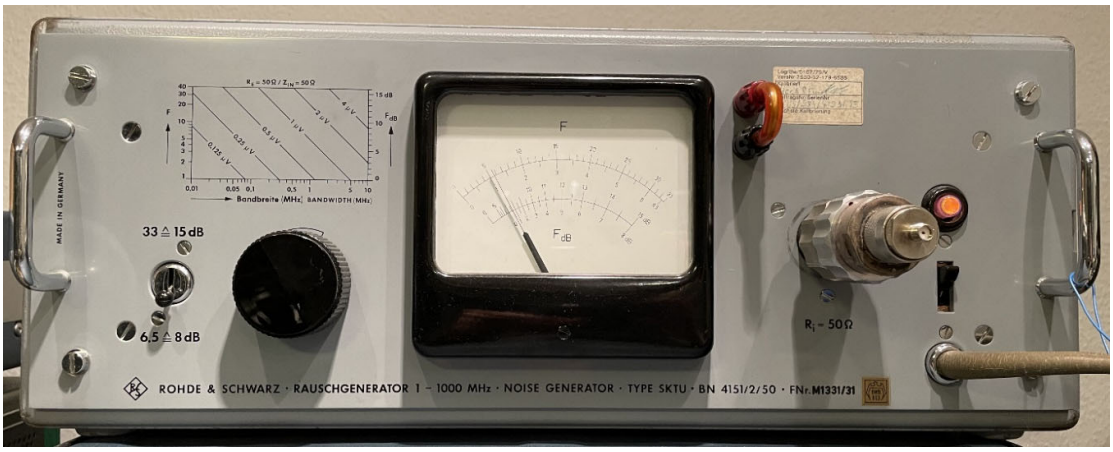

Fig 15 Noise Generator SKTU (Rohde&Schwarz), modification for precision noise calibrations: short circuit plug (upper right corner of meter), multi-turn poti with large knob (left of meter).

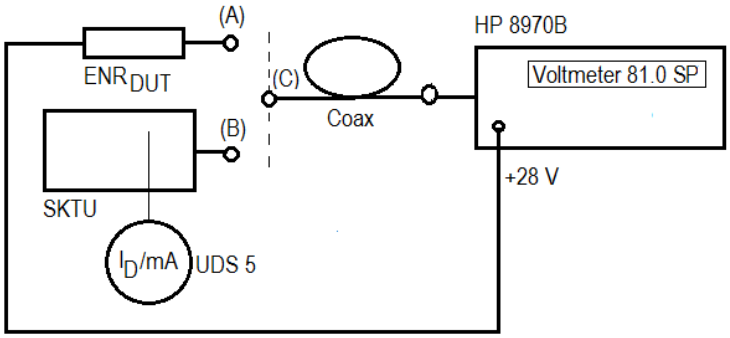

Fig 16 Measurement setup for ENR calibration with the SKTU.

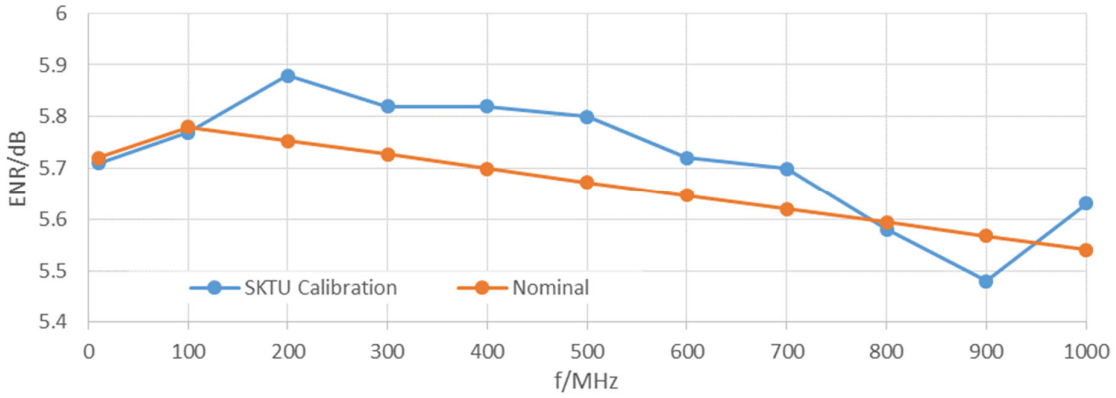

Fig 17 Calibration results and nominal ENR versus frequency of a 6 dB ENR noise source (nominal ENR values linearly interpolated for 200-900 MHz). Method: Comparison with SKTU noise.

f	$GAIN_R$	$GAIN_M$	$GAIN_{DIF}$	ENR_R	ENR_M	ADAPT	ENR_{DUT}	ENR_N	Δ
GHz	dB	dB	dB	dB	dB	dB	dB	dB	dB
0.01	+0.02	-9.66	-9.68	15.39	5.71	0.00	5.71	5.72	-0.01
0.1	+0.01	-9.82	-9.83	15.59	5.76	0.00	5.76	5.78	-0.02
1	0.00	-9.80	-9.80	15.40	5.60	0.01	5.61	5.54	+0.07
2	+0.02	-9.79	-9.81	15.22	5.41	0.02	5.43	5.44	-0.01
3	0.00	-9.87	-9.87	15.12	5.25	0.04	5.29	5.28	+0.01
4	0.00	-9.88	-9.88	15.07	5.19	0.05	5.24	5.24	0.00
5	0.00	-9.87	-9.87	15.06	5.19	0.05	5.24	5.23	+0.01
6	+0.02	-9.83	-9.85	15.05	5.22	0.06	5.28	5.29	-0.01
7	+0.01	-9.75	-9.76	15.09	5.33	0.07	5.40	5.39	+0.01
8	+0.01	-9.73	-9.74	15.13	5.39	0.07	5.46	5.49	-0.03
9	+0.01	-9.64	-9.65	15.21	5.56	0.08	5.64	5.60	+0.04
10	+0.01	-9.60	-9.61	15.25	5.64	0.08	5.72	5.68	+0.04
11	+0.01	-9.55	-9.56	15.23	5.67	0.08	5.75	5.73	+0.02
12	+0.01	-9.44	-9.45	15.13	5.68	0.09	5.77	5.67	+0.10
13	+0.01	-9.29	-9.30	15.02	5.72	0.09	5.81	5.71	+0.10
14	0.00	-9.27	-9.27	14.89	5.62	0.09	5.71	5.68	+0.03
15	-0.01	-9.27	-9.26	14.88	5.62	0.09	5.71	5.64	+0.07
16	-0.02	-9.34	-9.32	14.88	5.56	0.09	5.65	5.80	-0.15
17	-0.01	-9.46	-9.45	15.04	5.59	0.09	5.68	5.80	-0.12
18	-0.06	-9.64	-9.58	15.08	5.50	0.10	5.60	5.71	-0.11

Table 1 Calibration of a 6 dB ENR noise source by comparison with a 15 dB ENR reference noise source. (Results in blue, nominal in red color).

f	ENR_{346B}	$ATT_{10dB\ NF}$	ENR_{5dB}	$ATT_{10dB\ NWA}$	Δ_{ATT}	ENR_{CAL}
GHz	dB	dB	dB	dB	dB	dB
0.01	15.39	10.07	5.32	10.12	-0.05	5.32
0.1	15.59	10.16	5.43	10.13	+0.03	5.46
1	15.40	10.10	5.30	10.14	-0.04	5.25
2	15.22	10.06	5.16	10.12	-0.06	5.11
3	15.12	10.21	4.91	10.12	+0.09	4.94
4	15.07	10.21	4.86	10.12	+0.09	4.90
5	15.06	10.21	4.85	10.11	+0.10	4.89
6	15.05	10.18	4.87	10.10	+0.08	4.95
7	15.09	10.21	4.88	10.08	+0.13	5.00
8	15.13	10.11	5.02	10.06	+0.05	5.20
9	15.21	10.07	5.14	10.05	+0.02	5.34
10	15.25	10.05	5.20	10.05	+0.00	5.23
11	15.23	10.03	5.20	10.02	+0.01	5.37
12	15.13	10.01	5.12	9.98	+0.03	5.34
13	15.02	10.01	5.01	9.98	+0.03	5.36
14	14.89	10.03	4.86	9.98	+0.05	5.18
15	14.88	10.04	4.84	9.96	+0.08	4.99
16	14.88	10.03	4.85	9.91	+0.12	5.05
17	15.04	9.89	5.15	9.90	-0.01	5.23
18	15.08	9.97	5.11	9.86	+0.11	5.36

Table 2 Calibrated ENR of modified noise source and attenuations versus frequency.

f	V_{DUT}	$I_{D\ SKTU}$	ENR_{DUT}	ENR_N	Δ
MHz	V	mA	dB	dB	dB
10	0.4307	3.721	5.71	5.72	-0.01
100	0.3981	3.788	5.77	5.78	-0.01
200	0.3810	3.877	5.88	(5.75)	(+0.13)
300	0.3638	3.820	5.82	(5.73)	(+0.09)
400	0.3458	3.819	5.82	(5.70)	(+0.12)
500	0.3369	3.798	5.80	(5.67)	(+0.13)
600	0.2930	3.733	5.72	(5.65)	(+0.07)
700	0.2845	3.714	5.70	(5.62)	(+0.08)
800	0.2807	3.617	5.58	(5.59)	(-0.01)
900	0.2821	3.530	5.48	(5.57)	(-0.11)
1000	0.2219	3.585	5.63	5.54	+0.09

Table 3 Calibration of a 6 dB ENR noise source by comparison with the SKTU's noise. (Results in blue, nominal in red color).