A Broadband LNA Setup
For the FDM Out of Band Resonances (OBR)
-FEE ADR, LNA at Room Temperature (RT)

Amin Aminaei, 26 February 2021

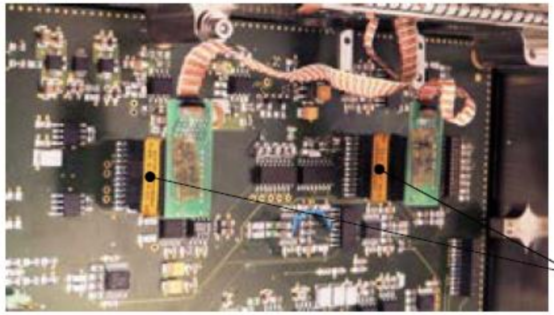
	Loom #1, AC Bias Header on loom PCB Type loom: Cu/Ni - Nb/Ti		Loom #1, AC Bias Header on loom PCB	J11, AC Bias Socket on Filterboard	Labels inhereted from bracket PCB		J1, AC Bias Header on Filterboard	Labels inhereted from FEE	J1, AC Bias Socket (Harwin) on Cu loom PCB	Labels inhereted from FEE	J5, FEE Socket on Cu loom PCB	
	Pin	Signal	Pin	Pin	Signal	Configuration	Pin	Signal	Pin	Signal	Pin	
Pair 1	1	NC	1	1	Magnet I+	← Connected →	1	MAGNET_OUT_B	1	MAGNET_OUT_B	24	MAGNET_OUT_B
	2	NC	2	2	Magnet I-	← Connected →	2	MAGNET_OUT_A	2	MAGNET_OUT_A	23	MAGNET_OUT_A
Pair 2	3	NC	3	3	NC	GND Connection	3	TP1404	3	TP1404	22	TP1404
	4	NC	4	4	NC	GND Connection	4	TP1405	4	TP1405	21	TP1405
Pair 3	5	NC	5	5	NC	GND Connection	5	TP65 SPARE2_B	5	TP65 SPARE2_B	20	TP65 SPARE2_B
	6	NC	6	6	NC	GND Connection	6	TP63 SPARE2_A	6	TP63 SPARE2_A	19	TP63 SPARE2_A
Pair 4	7	NC	7	7	NC	← Connected →	7	PRESQUID_BIAS_B	7	PRESQUID_BIAS_B	18	PRESQUID_BIAS_B
	8	NC	8	8	NC	← Connected →	8	PRESQUID_BIAS_A	8	PRESQUID_BIAS_A	17	PRESQUID_BIAS_A
Pair 5	9	NC	9	9	NC	GND Connection	9	TP62 SPARE1-B	9	TP62 SPARE1-B	16	TP62 SPARE1-B
	10	NC	10	10	NC	GND Connection	10	TP64 SPARE1-A	10	TP64 SPARE1-A	15	TP64 SPARE1-A
Pair 6	11	NC	11	11	NC	← Connected →	11	SQUID_FLUX_B	11	SQUID_FLUX_B	14	SQUID_FLUX_B
	12	NC	12	12	NC	← Connected →	12	SQUID_FLUX_A	12	SQUID_FLUX_A	13	SQUID_FLUX_A
Pair 7	13	NC	13	13	NC	GND Connection	13	GND	13	GND	12	GND
	14	NC	14	14	NC	GND Connection	14	ARRAYSQUID_SIGNAL_RTN	14	ARRAYSQUID_SIGNAL_RTN	11	ARRAYSQUID_SIGNAL_RTN
Pair 8	[illegible]	GND (SQUID Bias/Signal)	[illegible]	[illegible]	GND (SQUID Bias/Signal)	← Connected →	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	16	V- (SQUID Bias/Signal)	16	16	V- (SQUID Bias/Signal)	← Connected →	16	ARRAYSQUID_SIGNAL_A	16	ARRAYSQUID_SIGNAL_A	9	ARRAYSQUID_SIGNAL_A
Pair 9	17	V+ (SQUID Bias/Signal)	17	17	V+ (SQUID Bias/Signal)	GND Connection	17	GND	17	GND	8	GND
	18	NC	18	18	NC	GND Connection	18	GND	18	GND	7	GND
Pair 10	19	SQUID Feedback	19	19	SQUID Feedback	← Connected →	19	FEEDBACK_B	19	FEEDBACK_B	6	FEEDBACK_B
	20	SQUID Feedback	20	20	SQUID Feedback	← Connected →	20	FEEDBACK_A	20	FEEDBACK_A	5	FEEDBACK_A
Pair 11	21	NC	21	21	NC	GND Connection	21	GND	21	GND	4	GND
	22	NC	22	22	NC	GND Connection	22	GND	22	GND	3	GND
Pair 12	23	AC Bias	23	23	AC Bias	← Connected →	23	ACSUM1_B	23	ACSUM1_B	2	ACSUM1_B
	24	AC Bias	24	24	AC Bias	← Connected →	24	ACSUM1_A	24	ACSUM1_A	1	ACSUM1_A

Modifications on PCB (red

Bias resistor 1R between pin 23 en 24 removed

Filterboard to FEE Looms

Loom #1 connected via extension cord



NOTE: Installed mirror-connectors, see note below.

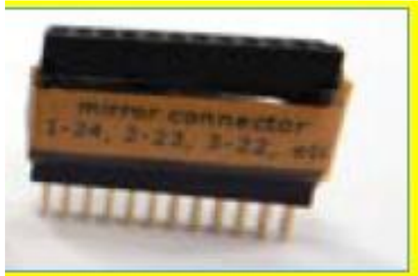
J5, FEE
Socket on Cu loom PCB

Pin	
24	MAGNET_OUT_B
23	MAGNET_OUT_A
22	TP1404
21	TP1405
20	TP65 SPARE2_B
19	TP63 SPARE2_A
18	PRESQUID_BIAS_B
17	PRESQUID_BIAS_A
16	TP62 SPARE1-B
15	TP64 SPARE1-A
14	SQUID_FLUX_B
13	SQUID_FLUX_A
12	GND
11	ARRAYSQUID_SIGNAL_RTN
10	ARRAYSQUID_SIGNAL_B
9	ARRAYSQUID_SIGNAL_A
8	GND
7	GND
6	FEEDBACK_B
5	FEEDBACK_A
4	GND
3	GND
2	ACSUM1_B
1	ACSUM1_A

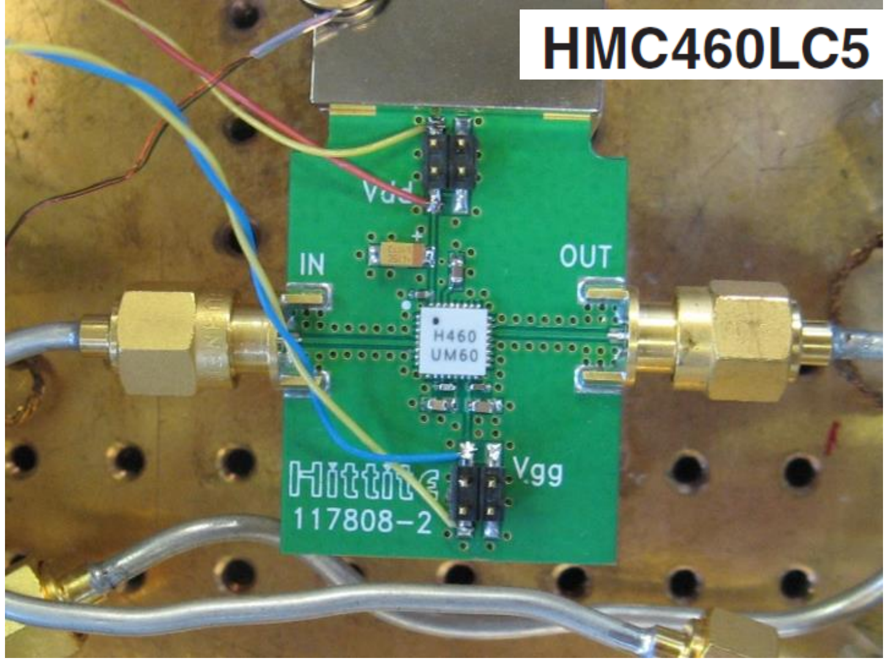
uF decouple (DC Bypass) capacitor
e.g. 4,7 µF, 35 V

Short SMA cable

2-pin header



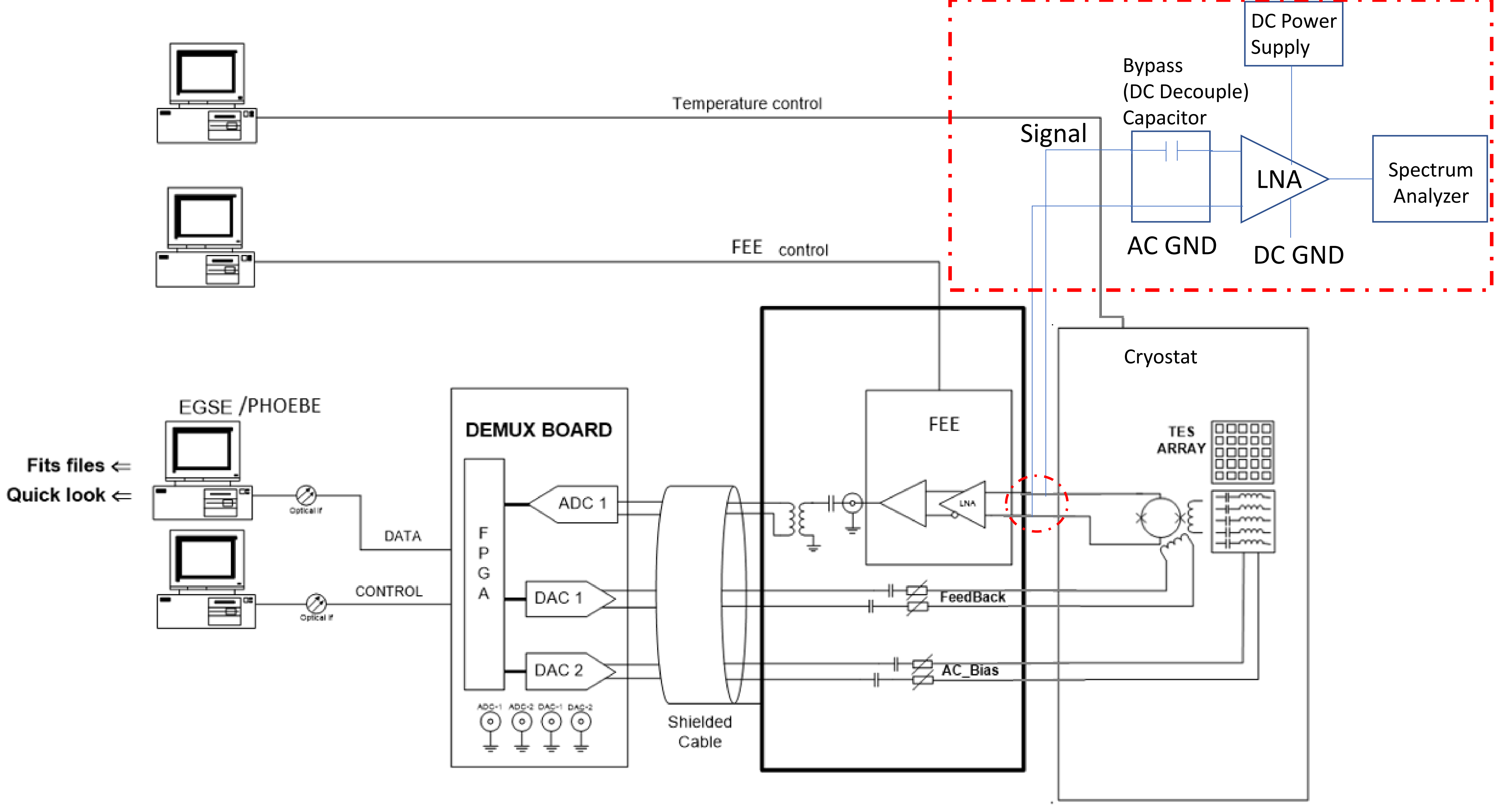
(considering
mirror connectors)



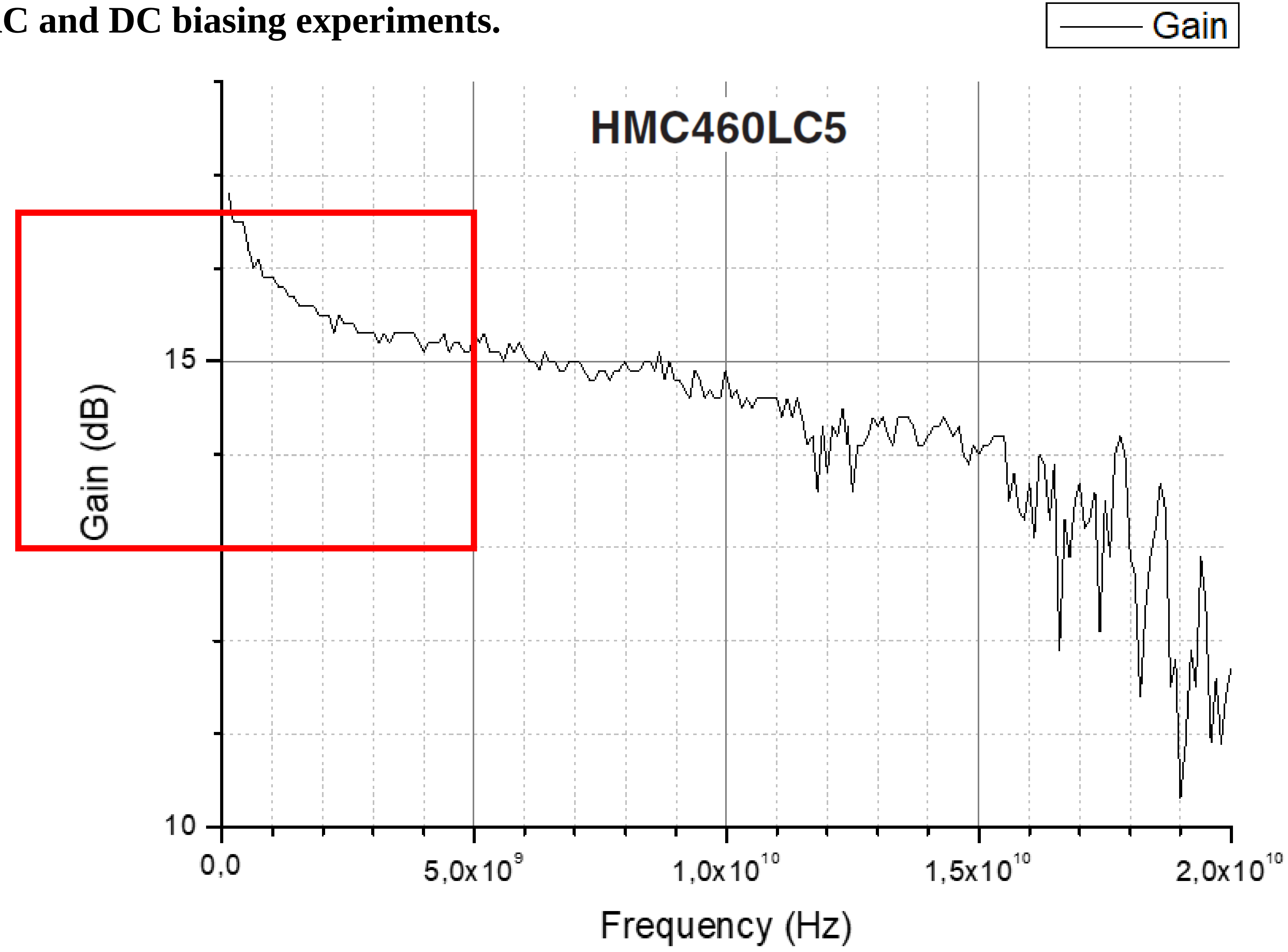
Supply Current (Idd) (Vdd= 8V, Vgg= -0.9V Typ.)		75	

**Adjust Vgg between -2 to 0V to achieve Idd= 75 mA typical.*

Spectrum Analyzer



DC Power Supply
Bypass (DC Decouple) Capacitor
Temperature control
Signal
LNA
Spectrum Analyzer
AC GND
DC GND
FEE control
Cryostat
EGSE /PHOEBE
DEMUX BOARD
FEE
TES ARRAY
Fits files ⇐
Quick look ⇐
Optical if
DATA
ADC 1
FPGA
LNA
CONTROL
DAC 1
FeedBack
DAC 2
AC_Bias
ADC-1 ADC-2 DAC-1 DAC-2
Shielded Cable



5. *The Amplifier characteristic at 4,2 K. Vdd = 8 V, Idd = 77 mA*

LNA Amplifiers

No.	LNA Model	F start MHz	F stop MHz	Noise Figure, dB	Gain, dB	Gain Variation dB	Pout 1dB Min, dBm *	VSWR In Out	Input DC decouple	Type room temp(RT) Cryo	Dimension mm	DC Supply V	Current DC mA	Lead Time Week	Price USD	Supplier
1	BZ-P0010300-150827-152323	1	3000	1.5	26	1.5	8	2.3		RT	30.1x 18.7x 12.3	14-16	95	6-8	1850	B&Z Tech.
2	ASU Cryo LNA	1	2000	0.075 @4-5K	30	0.1			Yes	RT-Cryo	2x 0.625 (+0.325 Vcc pin) x 0.325 Inches	1.6-2.2	19	6-7	2500	ASU
3	HMC460LC5	DC	20000	2.5	14		16.5@10GHz			RT-Cryo	5X5@ IC	8	75	-	available	Analog Dev.
4	LNAM-FBX	1Hz	*20	0.52 nv/root.Hz	400-1000 Voltage G Arb.						41.5 x 10 x 5.9	+-4 +-6	100			Magnicon

- See next slide

2 http://thz.asu.edu/products.html

1 https://www.everythingrf.com/products/microwave-rf-amplifiers/b-z-technology/567-2-bz-p0010300-150827-152323

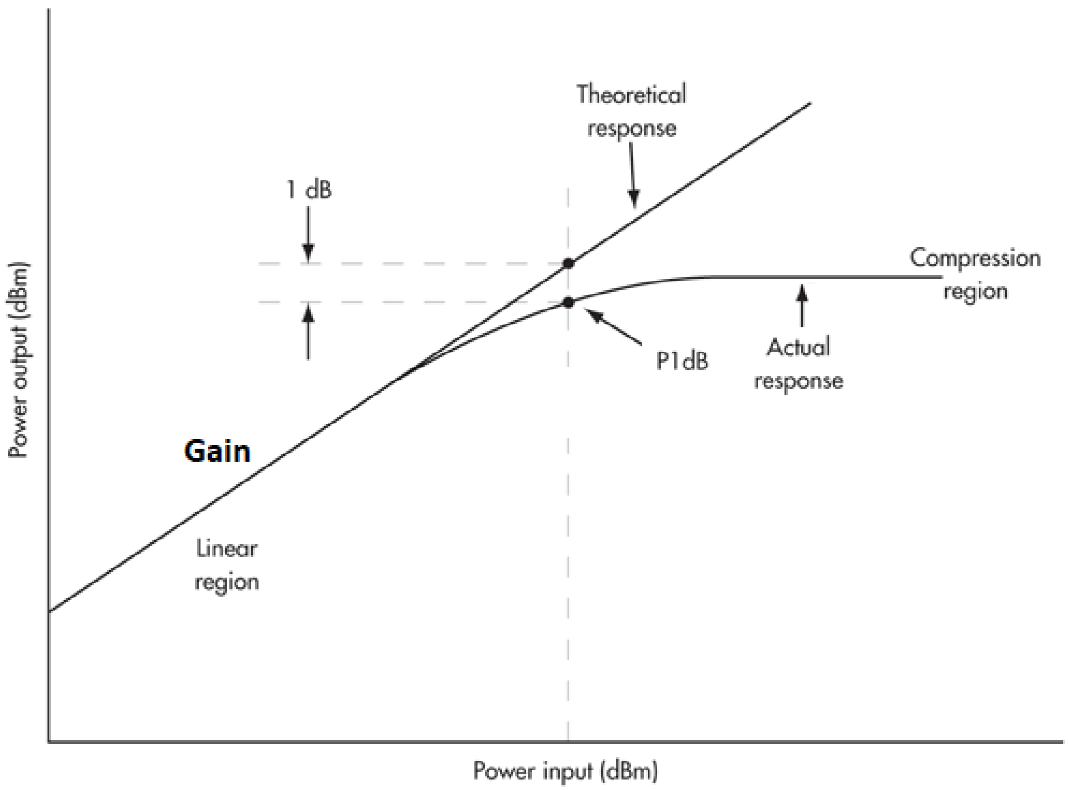
3 https://www.analog.com/media/en/technical-documentation/data-sheets/hmc460lc5.pdf

4 http://www.magnicon.com/amplifier-modules/lnam-lpa

For low-power versions with correspondingly increased voltage noise (e.g., 1 nV/√Hz at 10 mA supply current) or highspeed versions without internal feedback (**80 MHz bandwidth at gain 400), please contact Magnicon GmbH

- **Input and output Impedance: 50 OHM**
- **Input retun loss: < -10dB**
- **Output retun loss: < -10dB**
- **RF connectors: SMA female for Input and output**
- **Unconditionally stable with any input / output impedance**
- **Input 1dB Compression @ 1GHz: -50dBm**
- **Power consumption: 10mW at 10K**

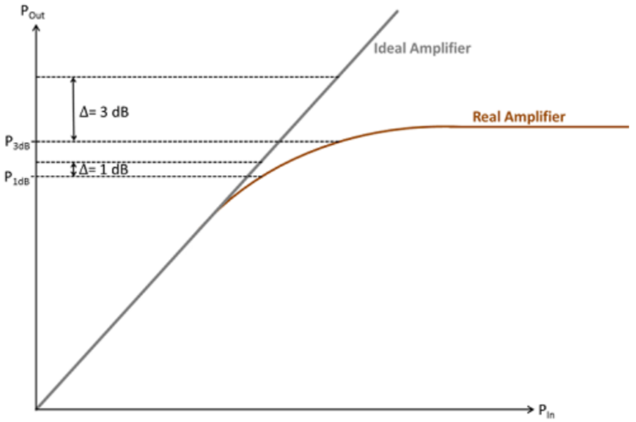
i.e **'output power = input power + Gain'** - so if the gain of an amplifier is 10 dB, then a 1 dBm input signal will result in an 11 dBm output signal and a 10 dBm input signal will result in a 20 dBm output signal.



As the input power level increases, there comes a point where the output power of the amplifier no longer increases by the gain value i.e the amplifier output power starts to saturate.

The **1 dB compression point (P1dB)** is the output power level at which the gain decreases 1 dB from its constant value. Once an amplifier reaches its P1dB it goes into compression and becomes a non-linear device, producing distortion, harmonics and intermodulation products. Amplifiers should always be operated below the compression point.

Sometimes P3dB in data sheet



The **3 dB Compression Point or P3dB** is the power level at which the gain of an amplifier decreases by 3 dB from its ideal linear gain. This is similar to P1dB, where the output power level deviates from the ideal power level by 1 dB.

https://www.everythingrf.com

https://www.everythingrf.com/community/what-is-p1db

Twisted Pair

Cryogenic Cable

https://www.lakeshore.com/products/categories/overview/temperature-products/cryogenic-accessories/cryogenic-cable

	Nominal attenuation (dB/m)		
	C[1]	SC	SS
1 MHz	0.092	0.108	0.569
5 MHz	0.167	0.240	1.272
10 MHz	0.224	0.344	1.799
15 MHz	0.257	0.421	2.850
20 MHz	0.294	0.486	2.545
50 MHz	0.427	0.769	4.031
100 MHz	0.623	1.090	5.694
500 MHz	1.312	2.453	12.749
1 GHz	1.886	3.488	18.048
2 GHz	2.625	—	—
5 GHz	—	7.968	40.526

[1] Type C has a bandwidth to at least 3 GHz — above that, the aluminum/polyester becomes a less effective shield

Coaxial cable frequency response specifications		
Frequency (GHz)	Insertion loss dB/m (dB/ft)	Power CW (20 °C, sea level, W)
0.5	4.43 (1.35)	7.6
1.0	6.27 (1.91)	5.3
5.0	14.09 (4.30)	2.4
10.0	20.01 (6.10)	1.7
20.0	28.45 (8.67)	1.2

This cable transmits and receives high-speed, high-frequency microwave signals. Typically used for transmission lines in cryogenic-vacuum test systems.

Conclusion:

. Cryogenic Cables can operate up to few GHz so OBR are not limited by cables perhaps SQUID filters could limit the upper frequencies.

. Available HMC460LC5 LNA will be used for the OBR test

. ASU Cryo LNA is by far the best product for future investigation

More Products

- Backup Slides

- Other Reference:

- Spietz et al., A Twisted Pair Cryogenic Filter, 2006
- Song et al., Transmission Properties of Cryogenic Twisted Pair Filters, Journal of the Korean Physical Society, Vol. 57, No. 6, December, pp. 1490-1493, 2010.

Products

Show All Amplifiers | Amplifier Search | Amplifier Categories | Custom Amplifiers | In-Stock

Ultra Low Noise Amplifiers

This category of B&Z amplifiers features the industry?s lowest noise figures. The engineers at B&Z have been pioneers, developing new techniques and technologies that drive down amplifier noise figures while maintaining wide pass bands.

957 Models Found:

Sort By: FreqMinMHz Sort

Model	Freq Min (MHz)	Freq Max (MHz)	Gain Min (dB)	Gain Typical (dB)	Gain Flatness (+/-dB)	Noise Figure Typical (dB)	Noise Figure Max (dB)	P1dB Min (dBm)	P1dB Typical (dBm)	Input VSWR	Output VSWR	Datasheet	Qty In Stock	QUOTE
BZY-P00010300-151026-152323	0.1	3000	26	38	1.5	0.9	1.5	10	10	2.3	2.3		0	QUOTE
BZY-P00010600-161027-152323	0.1	6000	25	38	1.7	0.9	1.7	8	10	2.3	2.3		0	QUOTE
BZY-P00010600-170826-172020	0.1	6000	26	38	1.7	0.9	1.7	8	10	2	2		0	QUOTE
BZY-P00010600-201725-172323	0.1	6000	25	38	1.7	0.9	2	17	10	2.3	2.3		0	QUOTE
BZY-P00010300-131026-152020	0.5	3000	26	38	1.5	0.9	1.5	10	10	2.2	2		0	QUOTE
BZY-P00050600-171024-182020	0.5	6000	24	38	1.7	0.9	1.7	8	10	2	2		0	QUOTE
BZY-P00050800-171024-182020	0.5	8000	24	38	1.7	0.9	1.7	8	10	2	2		0	QUOTE
BZP00103UB1	1	3000	27	29	1.8	1.1	1.3	10	11	2.3	2.3	PDF	0	QUOTE
BZT-P00100800-171032-182525-ACIN	1	8000	32	37	1.8	1.3	1.7	5	13	2.5	2.5		0	QUOTE
BZT-P00100800-201032-182323	1	8000	32	37	1.8	1.3	2.3	10	13	2.3	2.3		0	QUOTE
BZT-P0011000-351027-202323	1	22000	27	41	2	1.9	3.5	10	13	2.3	2.3		0	QUOTE
BZT-P011000-301027-202323	1	10000	27	41	2	1.9	3	10	13	2.3	2.3		0	QUOTE
BZY-P00010150-150825-182323	1	1500	25	29	1.8	1.1	1.5	8	11	2.3	2.3		0	QUOTE
BZY-P00010600-151026-152320	1	6000	26	38	1.5	0.9	1.5	10	10	2.3	2		0	QUOTE
BZY-P0010300-102020-152020	1	3000	28		2		1.6	20		2.3	2.3	PDF	1	QUOTE
BZY-P0010600-150826-152020	1	6000	26	38	1.5	0.9	1.5	8	10	2	2		0	QUOTE
BZY-P0010600-201725-172323	1	6000	25	38	1.7	0.9	2	17	10	2.3	2.3		0	QUOTE
BZY-P0010600-201725-172323-HS	1	6000	25	38	1.7	0.9	2	17	10	2.3	2.3		0	QUOTE
BZR-00010200-131350-132020	10	2000	50	60	1.3	0.9	1.3	13	10	2	2		0	QUOTE
BZR-00010200-151050-182020	10	2000	48	60	1.8	0.9	1.5	10	10	2	2		0	QUOTE

http://www.bnztech.com/products.php?Sort=FreqMinMHz&FreqMin=&FreqMax=&FreqUnits=GHz&GainMin=&NoiseFigMax=&P1dBMin=&FreqTol=&SID=19&SearchModel=&SearchMode=1

B&Z TECHNOLOGIES
INNOVATING TO EXCEL

Home | About Us | Careers | Support | Warranty

Products | Custom | In-Stock | Press | Feedback | Contact

Products

Show All Amplifiers | Amplifier Search | Amplifier Categories | Custom Amplifiers | In-Stock

Cryogenic Amplifiers

B&Z Technologies' Cryogenically Cooled Amplifiers are designed and manufactured to be operated at cryogenic temperatures. Amplifiers in this category are normally used in research and scientific applications. B&Z Cryogenically Cooled Amplifiers are being operated at temperatures as low as 12K. Noise temperatures as low as 12K measured at liquid nitrogen temperature can be achieved. The engineers at B&Z technologies have been designing and building amplifiers intended for cryogenic cooling for decades. We have the experience and knowledge required to manufacture amplifiers that can be repeatedly cycled down to cryogenic temperatures with no mechanical or electrical degradation.

125 Models Found:

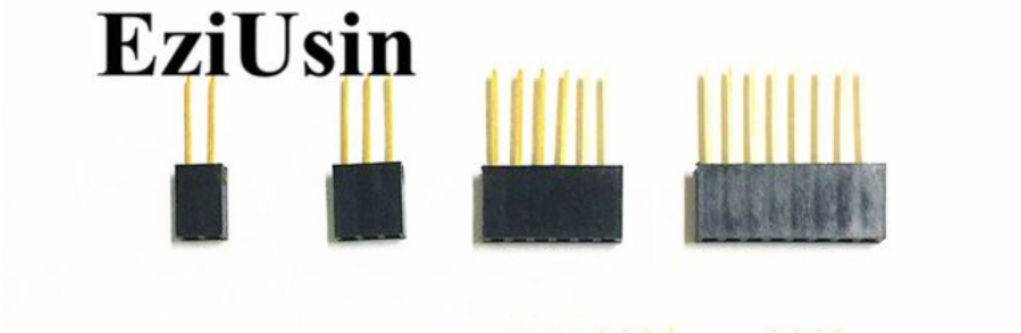
Sort By: FreqMinMHz Sort

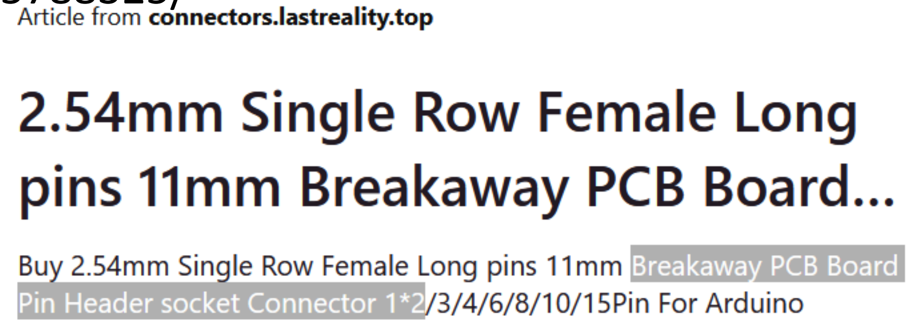
Model	Freq Min (MHz)	Freq Max (MHz)	Gain Min (dB)	Gain Typical (dB)	Gain Flatness (+/-dB)	Noise Figure Typical (dB)	Noise Figure Max (dB)	P1dB Min (dBm)	P1dB Typical (dBm)	Input VSWR	Output VSWR	Datasheet	Qty In Stock	QUOTE
BZY-P0010300-102020-152020	1	3000	28		2		1.6	20		2.3	2.3	PDF	1	QUOTE
BZY-00010300-132030-152323	10	3000	30		1.5		1.3	20		2.3	2.3	PDF	1	QUOTE
BZY-00030300-151730-152323	10	3000	30		1.8		1.5	17		2	2	PDF	1	QUOTE

http://www.bnztech.com/products.php?Sort=FreqMinMHz&FreqMin=&FreqMax=&FreqUnits=GHz&GainMin=&NoiseFigMax=&P1dBMin=&FreqTol=&SID=4&SearchModel=&SearchMode=1

https://www.reichelt.nl/nl/nl/tantaalcondensator-4-7-f-35-v-avx-tap475m035cc-p246466.html?PROVID=2809&gclid=EAIaIQobChMI9oqlgtKH7wIVTrvVCh3XOQbEEAQYBiABEgLWP_D_BwE

Backup https://www.pinterest.com/pin/716564990695788325/





Vollkupfer

RoHS / REACH KONFORM

In Anlehnung an MIL-C-17

Wärme-beständig

	RG 178 B/U	RG 316 B/U	RG 142 B/U	RG 179 B/U
Aufbau				
Innenleiter	7x0.102 mm Staku AG	7x 0.17 mm Staku AG	1 x 0,94 mm Staku AG	7 x 0,10 mm Staku AG
Dielektrikum (+/- 0.1 mm)	0.84 mm PTFE	1.52 mm PTFE	2,95 mm PTFE	1.55 mm PTFE
Aussenleiter				
a)	Cu-Geflecht versilb.	Cu-Geflecht versilb.	Cu-Geflecht versilb.	Cu-Geflecht versilb.
b)				
c)				
Mantel gesamt +/- 0,2 mm	1,8 mm FEP braun	2,49 mm FEP braun	4,95 mm FEP braun	2,5 mm FEP braun
Elektrische Eigenschaften				
Wellenwiderstand/ Impedanz (Ω)	50 +/-3	50 +/-3	50 +/- 3	75 +/-3
Kapazität (pF/m)	94	91	94	102
Verkürzungsfaktor (v/c)	0,70	0,70	0,70	0,70
Dämpfung bei 20°C (dB 100m)				
1 MHz				3,0
5 MHz				10,0
10 MHz				12,0
20 MHz				
50 MHz	38,0	19,2		15,0
100 MHz	52,5	28,7		21,0
200 MHz	65,3			
300 MHz	81,0			41,0
500 MHz	120,7		35,2	58,0
800 MHz				78,0
1000 MHz	170,0	104,8		90,0
1500 MHz				
2250 MHz				
3000 MHz	308,0	209,2		
Schirmungsmass (dB) – bis 1 GHZ	>	>	>	>
Gleichstromwiderstand (Ohm/km)				
Innenleiter	784	270		784
Aussenleiter	76	40		56
Betriebsspannung (max. V)				
In Anlehung an:				
Mechanische Eigenschaften				
Minimaler Biegeradius (mm)	10	15		10
Temperatur-Bereich	-50 C° bis + 200 C°	-50 C° bis + 200 C°	-50 C° bis + 200 C°	-50 C° bis + 200 C°

https://www.reichelt.nl/nl/nl/coaxkabel-rg-316-u-50-ohm-5m-ring-rg-316-5-p256881.html?PROVID=2809&gclid=EAIaIQobChMIoLCsxKKF7wIVC853Ch10dACkEAQYBSABEgKtgvD_BwE

RG 316-5 Coaxkabel, RG 316/U, 50 ohm, 5m-ring

Artikel-nr.: RG 316-5

Kabellengte: 5 m

€10,17

€2,03 / m

incl. wettelijke BTW excl. verzendkosten

op voorraad, Levertijd: 4-9werkdagen

- 1 stuks +

in winkelwagen

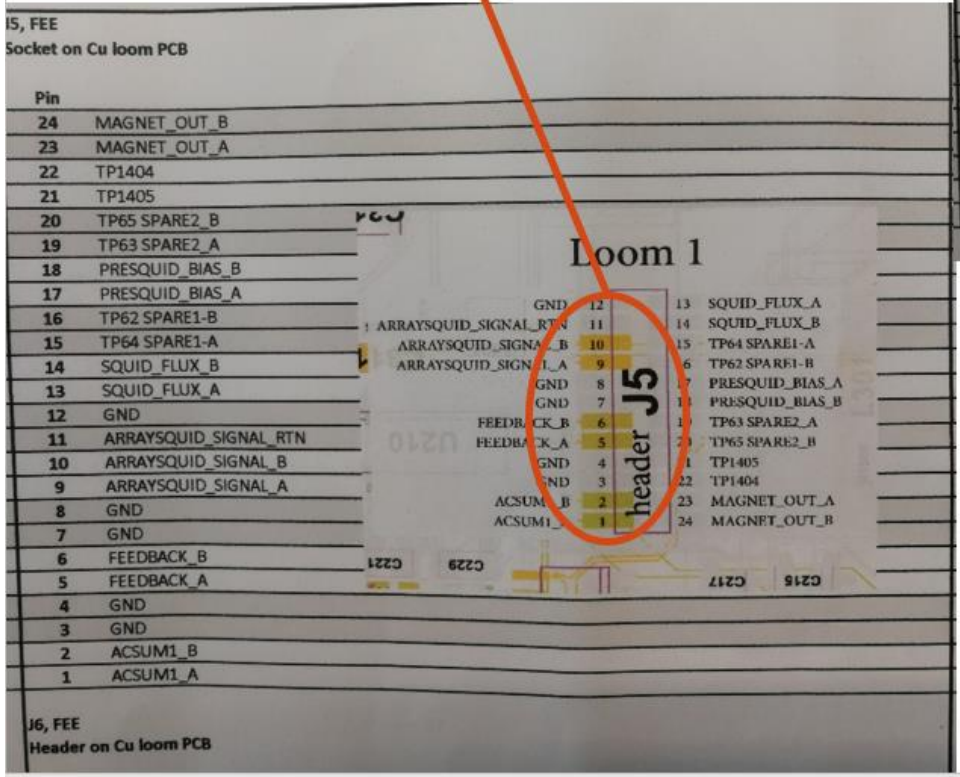
Markeren voor de vergelijking

In lijst overnemen

Typical Attenuation for a Coaxial cable up to 3 GHz

FEE J5 & J6

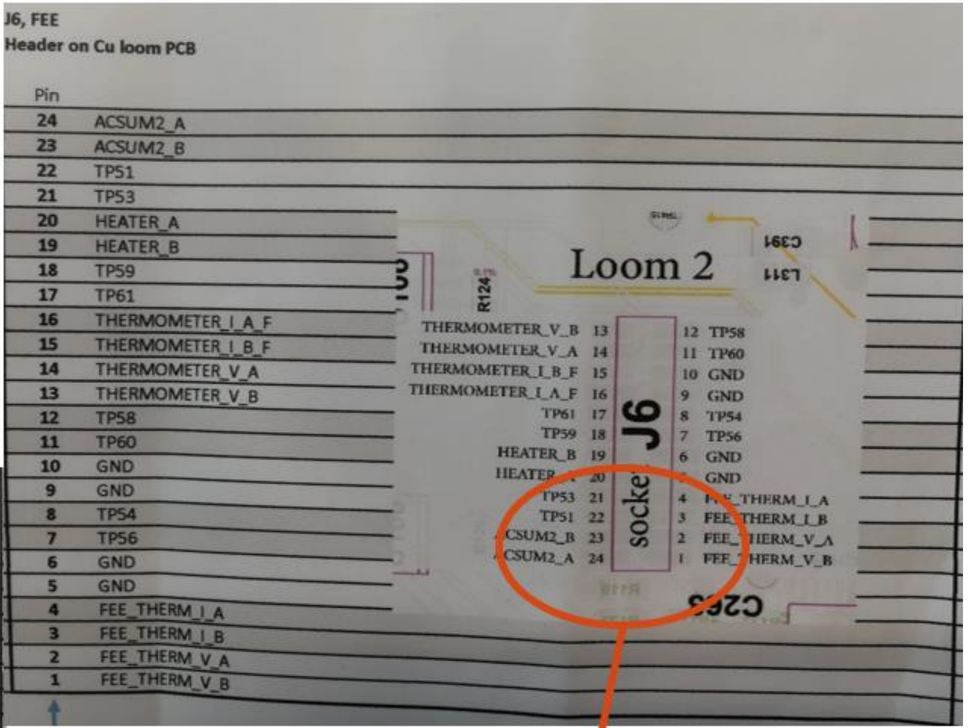
Check values
in 1,2
5,6
9,10



J5, FEE
Socket on Cu loom PCB

Pin	
24	MAGNET_OUT_B
23	MAGNET_OUT_A
22	TP1404
21	TP1405
20	TP65 SPARE2_B
19	TP63 SPARE2_A
18	PRESQUID_BIAS_B
17	PRESQUID_BIAS_A
16	TP62 SPARE1-B
15	TP64 SPARE1-A
14	SQUID_FLUX_B
13	SQUID_FLUX_A
12	GND
11	ARRAYSQUID_SIGNAL_RTN
10	ARRAYSQUID_SIGNAL_B
9	ARRAYSQUID_SIGNAL_A
8	GND
7	GND
6	FEEDBACK_B
5	FEEDBACK_A
4	GND
3	GND
2	ACSUM1_B
1	ACSUM1_A

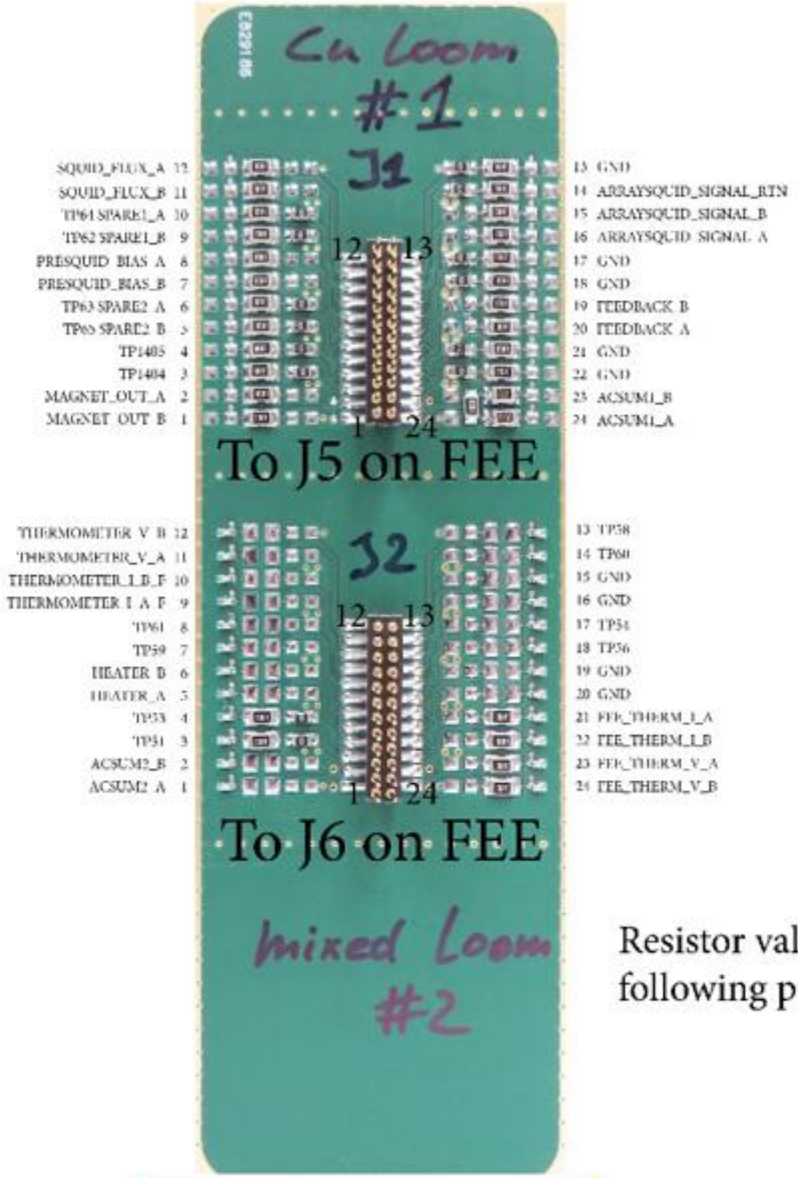
J6, FEE
Header on Cu loom PCB



J6, FEE
Header on Cu loom PCB

Pin	
24	ACSUM2_A
23	ACSUM2_B
22	TP51
21	TP53
20	HEATER_A
19	HEATER_B
18	TP59
17	TP61
16	THERMOMETER_I_A_F
15	THERMOMETER_I_B_F
14	THERMOMETER_V_A
13	THERMOMETER_V_B
12	TP58
11	TP60
10	GND
9	GND
8	TP54
7	TP56
6	GND
5	GND
4	FEE_THERM_I_A
3	FEE_THERM_I_B
2	FEE_THERM_V_A
1	FEE_THERM_V_B

Check values
in 1,2
3,4
21,22



Resistor values on following pages

Note: Labels inhereted from FEE PCB