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TO: SAFIRE AND FIBRE

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SUBJECT: JOHNSON NOISE

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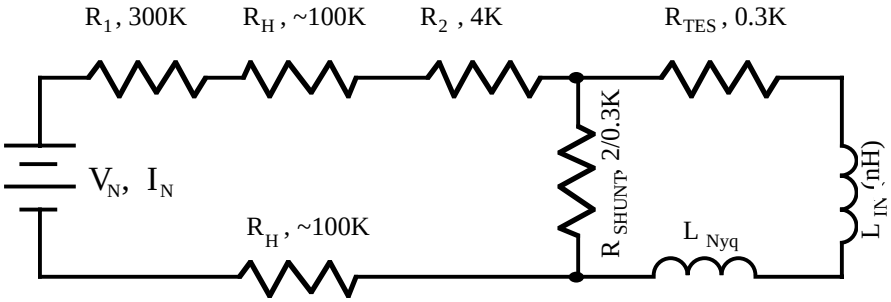
JOHNSON NOISE CALCULATION FOR SAFIRE & FIBRE

With the redesign of the SPIRE bias loop for SAFIRE/FIBRE, it is worth revisiting the calculation of Johnson noise generation from the various components. I present the following model:



I take the following values as standard: R_{TES}=0.1Ω; R_{SHUNT}=3mΩ (SAFIRE/FIBRE), 0.5mΩ (SPIRE); R_H=250Ω.

Calculations:

TES: Current noise is $I_{N,TES} = \mathrm{sqrt}(4kT_{TES}/R_{TES})$=16 pA/√Hz.

Shunt: In SPIRE, $I_{N,SHUNT}=\mathrm{sqrt}(4kT_{SHUNT}R_{SHUNT}/R_{TES}^2)$ = 1 pA/√Hz.

In SAFIRE, $I_{N,SHUNT}=\mathrm{sqrt}(4kT_{SHUNT}R_{SHUNT}/R_{TES}^2)$ = 2 pA/√Hz.

Cold Series: In SPIRE, $I_{N,COLD}=\mathrm{sqrt}(4kT_2/R_2)(R_{SHUNT}/R_{TES})$ = 0.1/√R_2 pA/√Hz.

In SAFIRE, $I_{N,COLD}=\mathrm{sqrt}(4kT_2/R_2)(R_{SHUNT}/R_{TES})$ = 0.4/√R_2 pA/√Hz.

Hot Series: In SPIRE, $I_{N,HOT}=\mathrm{sqrt}(4kT_1/R_1)(R_{SHUNT}/R_{TES})$ = 0.6/√R_1 pA/√Hz.

In SAFIRE, $I_{N,HOT}=\mathrm{sqrt}(4kT_1/R_1)(R_{SHUNT}/R_{TES})$ = 4/√R_1 pA/√Hz.

Supply V_N: $I_{N,SupplyV}=I_{N,SUPPLY}(R_{SHUNT}/R_{TES})$ should be below ≈100 pA/√Hz.

Supply I_N: $I_{N,SupplyI}=V_{N,SUPPLY}(1/(R_1+R_2))(R_{SHUNT}/R_{TES})$ should be below ≈100 nV/√Hz.

Net result: the TES Johnson noise is dominated in all cases by the TES current noise.