NATIONAL RADIO ASTRONOMY OBSERVATORY
GREEN BANK, WEST VIRGINIA

ELECTRONICS DIVISION TECHNICAL NOTE NO. 174

Title: The NRAO Type-50A 4-6 GHz SIS Bias-T

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Date: July 11, 1995

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The NRAO Type-50A 4-6 GHz SIS Bias-T

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The BT50A bias-T is for use with SIS mixers with a 4-6 GHz IF. It can be made in six-wire and four-wire versions, compatible with the two SIS bias circuits currently in use at NRAO. Both versions are designed with a degree of electrostatic protection: the amplifier port is internally connected to DC ground, and, following recent OVRO practice all bias leads have built-in series resistors.

The four-wire circuit, shown in Fig. 1, has separate pairs of conductors for voltage monitoring and for the junction bias current. The low-frequency impedance of the bias-T as seen by the SIS mixer is high ($\geq$ 1 kΩ).

The six-wire version, shown in Fig. 2, has separate pairs of conductors for junction voltage and current monitoring and for the source current. The junction bias is developed across the 50-Ω resistor to ground, and the junction current is sensed by the 5-ohm nichrome film resistor. The low-frequency impedance of the bias-T as seen by the SIS mixer is relatively low ($\sim$ 50 Ω).

The IF circuit design is based on the (parallel) self-resonant spiral inductors LS and (series) self-resonant chip capacitors CS. The spiral inductor was designed using an electromagnetic simulator to be self-resonant at 5 GHz. The chip capacitor was chosen empirically to have a minimum impedance at 5 GHz when mounted in this circuit. Details of the IF circuit are shown in Fig. 3. The measured return loss and insertion loss are shown in Fig. 4 (room temperature) and Fig. 5 (at 77 K).

The dimensions of the bias-T are shown in Fig. 6. The male K-connector connects to the SIS mixer, and the female K-connector to the IF circulator and amplifier. The two holes "E" allow a copper heat strap to be attached to the body of the bias-T; this is particularly important if the IF isolator and amplifier are operated above 4 K.

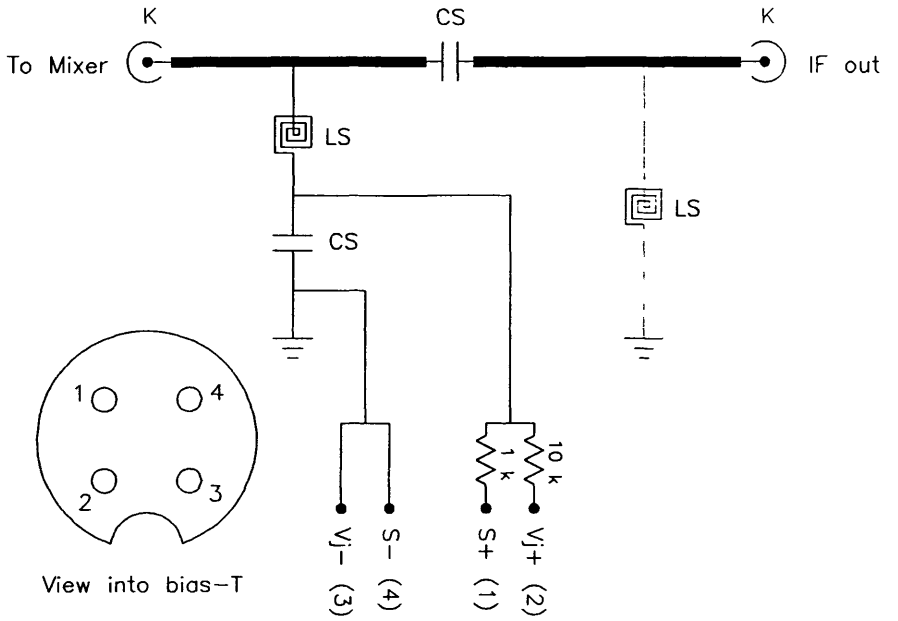

K
CS
K
To Mixer
IF out
LS
LS
CS
1
4
2
3
View into bias-T
1 k
10 k
Vj− (3)
S− (4)
S+ (1)
Vj+ (2)

Fig. 1.

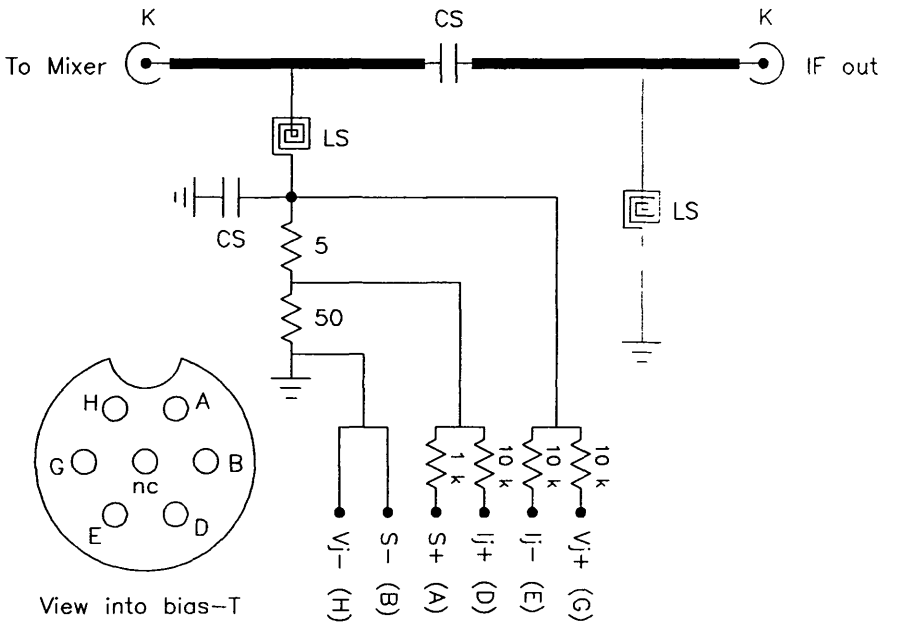
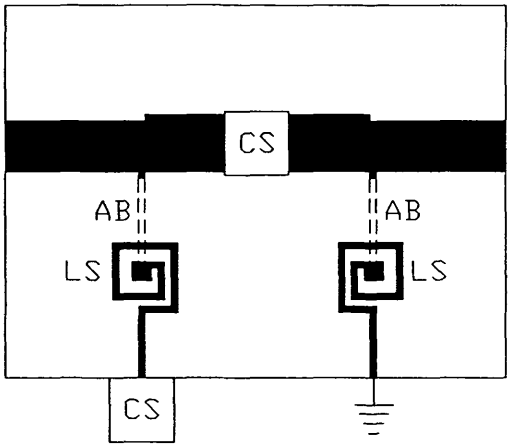

K
CS
K
To Mixer
IF out
LS
LS
CS
5
50
H
A
G
B
nc
E
D
View into bias-T
1 k
10 k
10 k
10 k
Vj− (H)
S− (B)
S+ (A)
Ij+ (D)
Ij− (E)
Vj+ (G)

Fig. 2.



Capacitors CS: ATC-100A 4.7 pF with plates vertical.
Air-bridges AB: 2 mil wire 10-20 mils above substrate.
Resistors: (from MiniSystems Inc.)
1k & 10k: Thick-film MSR10-102E and MSR10-103E, ± 5%
5 ohm: Nichrome WATF-2AN-5R000F ± 1%
50 ohm: Nichrome WATF-2AN-50R00J ± 5%
Substrate: RT Duroid 6010, K=10.5, t=0.050".

Fig. 3.

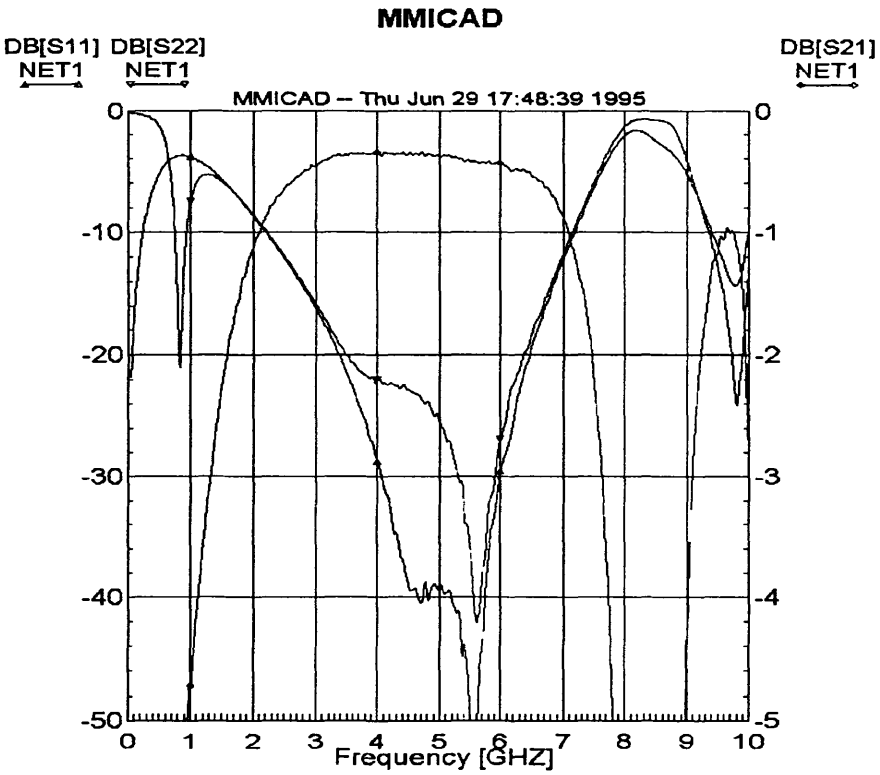


Fig. 4. Measured return loss and insertion loss at room temperature.

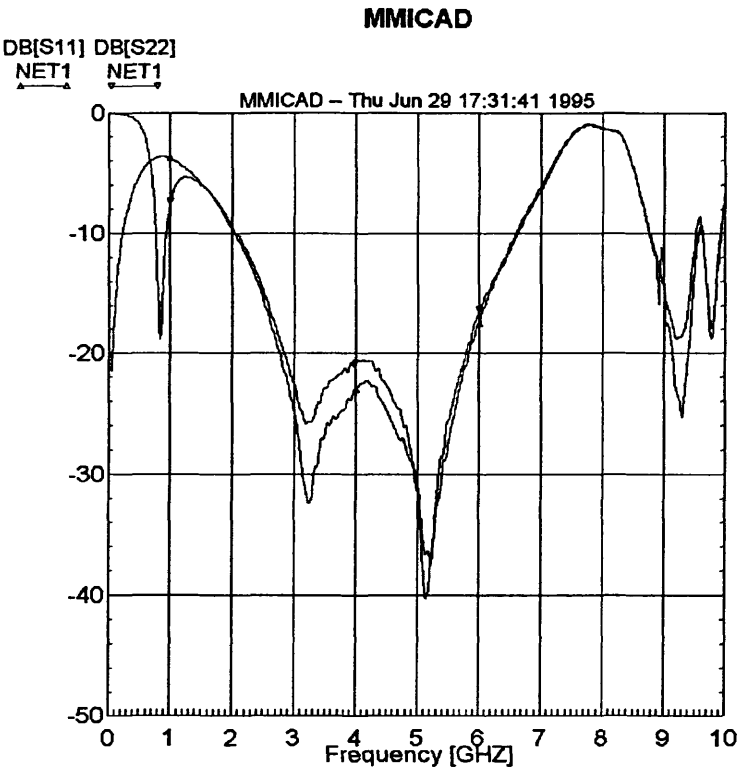


Fig. 5. Measured return loss at 77 K.

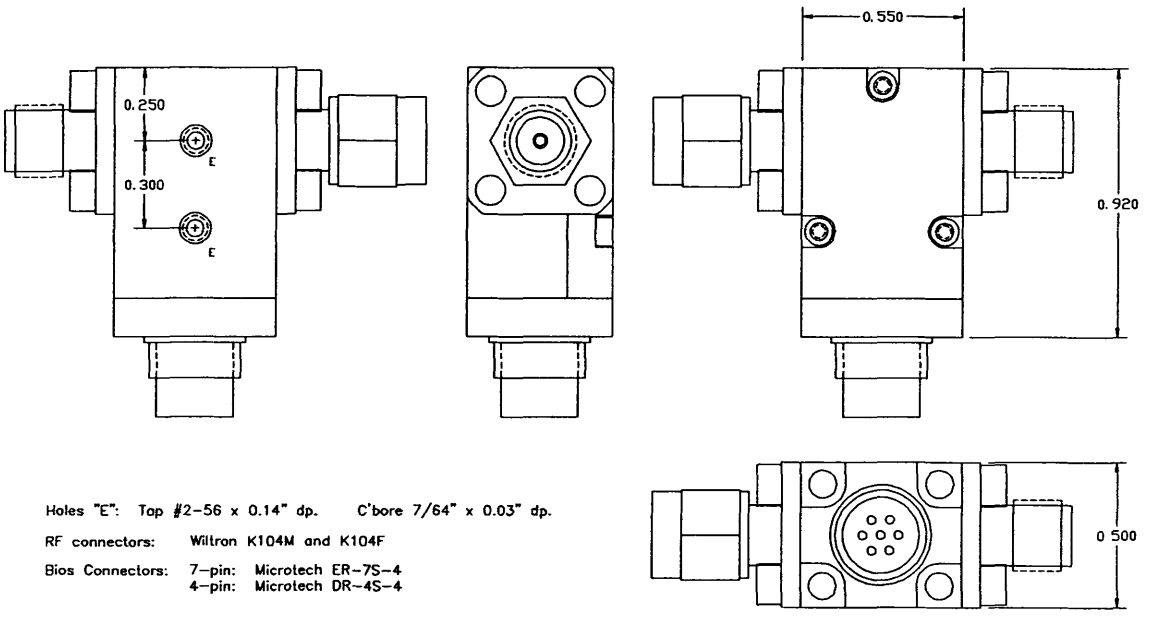


Fig. 6.