HEMT/FET BIAS STAGE 4 InP version

KANONIUK

Vmax

3.03V

3.4V

4.2V

5.0V

JP1 JP2

OC OC OC OC

Vindex

3.03V

3.4V

4.2V

5.0V

"1" = CLOSED

"0" = OPEN

"1" = LNA STAGE ON

"0" = LNA STAGE OFF

CTRL 4

LM385-1.2

JP15 JUMPER-OPEN

JP16 JUMPER-CLOSED
Introduction.

The F38 HEMT bias card supplies drain and gate bias voltages for a 4 stage HEMT low noise amplifier. It consists of 4 identical driver circuits, with Drain, Gate and Current voltage monitoring and remote on/off control circuits.

Power requirements.

<p>| | |</p>
<table>
<thead>
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</thead>
<tbody>
<tr>
<td>+15V</td>
<td>-15V</td>
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</table>

Principle of operation.

The F38 Bias card consists of 4 identical servo power supplies for N-channel HEMTs. Plus and minus 5 volt references are supplied by on card regulators.

The circuit diagram of one of these servo supplies is shown in Fig 1. Typical voltages are for a HEMT biased at a drain voltage of 2.0 volts and a drain current of 10 milliamps. The bias on the gate bias line should be in the range -1.2 to +0.6 Volts, but the exact value depends on the characteristics of the individual HEMT device used.

HEMT Servo Power supply.

In describing the operation of the bias supply it is assumed that an N-channel HEMT is connected to the supply.

The required drain voltage is set with VR1 and op-amp U4A drives the drain voltage to that value. Each VD ADJUST has a selectable limiting resistor in series to limit the drain voltage to a predetermined maximum voltage. Resistor R51 senses the drain current and the voltage across R51 is amplified by op-amp U4D. The output of this op-amp is 0.1 volts per milliamp of drain current.

The required drain current is set with VR2 (at -0.16 volts per milliamp of drain current). The voltage on the inverting input of op-amp U4C is the output of the voltage divider formed by R49 and R26 + R27. This must be near to zero volts as the op-amp has high gain. If the drain current in the HEMT is greater than required, the input voltage to the op-amp U4C is greater than zero and the output of this op-amp goes negative. This pulls the gate of the HEMT negative and reduces the drain current.

The drain voltage, drain current and gate voltage monitor points are buffered by unity gain op-amps U1A, U1D and U1C respectively. The drain current monitor is 0.1 v/mA.

Drain and Gate over-voltage protection.

Zener diodes on the Drain and Gate bias lines ensure that the absolute drain-gate and gate-source voltage limits of the HEMT cannot be exceeded. All the gate bias lines are limited by 1.2 volt zener diodes, with the Drain-Gate zener diodes are selectable according to the max Drain voltage required for a particular device. See table below.

<table>
<thead>
<tr>
<th>Jumper</th>
<th>Drain V</th>
<th>Zener</th>
<th>Vdg clamping voltage</th>
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<tbody>
<tr>
<td></td>
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</tr>
<tr>
<td>JP4</td>
<td>&lt;2</td>
<td>2V4</td>
<td>2.0 volts</td>
</tr>
<tr>
<td>JP3</td>
<td>&lt;4</td>
<td>5V1</td>
<td>4.8 volts</td>
</tr>
<tr>
<td>None</td>
<td>&lt;5</td>
<td>6V2</td>
<td>5.8 volts</td>
</tr>
</tbody>
</table>
Single Stage HEMT Supply

Drain current limit.

The HEMT drain current is supplied via Q1 and Q2. Normally Q2 is saturated, but when the drain current is about 15 mA the voltage drop across R53 is 0.8 volts and the drop across R54 is 1.5 volts, so that the base-emitter voltage of Q2 is 0.7 volts. At this point the collector current through Q2 can not be increased as it will increase the voltage drop across R53, which will lead to a reduction in base-emitter voltage of Q2.

Power-up and power-down sequence.

Each set of three HEMT bias supplies can be turned on and off independently. The power-up and power-down sequences are designed to avoid damaging the HEMT with excessive voltages and currents during power-up and power-down.

When the HEMT is off, the gate and drain voltages are near zero. When turned on, the gate voltage goes negative, the drain is brought up to the required value then the gate voltage rises to bring the drain current up to the required value. When the HEMT is turned off the sequence is reversed: the gate voltage decreases to reduce the drain current to zero, the drain voltage is reduced to zero and then the gate voltage is brought back up to zero.

When the TTL level on CONTROL 1 is high, the output of U7B is low, CMOS switch U9B is open, switches U12A, U12B and U10C are open and the HEMT servo supply operates as described above.

Turn off sequence. When the CONTROL 1 input goes low, the output of gate U7B goes high and CMOS switch U9B is closed. This connects the +10 volt reference to the power-up, power-down timing circuits. C35 charges up with a time constant of 68 µS, and closes the CMOS switches U12A and U12B after 50 µS. C36 charges up with a time constant of 540 µS, and closes CMOS switch U10C after 200 µS. When CMOS switch U12B closes C20 discharges with a time constant of 40 µS and the servo power supply drives the HEMT drain current to zero. When CMOS switch U12A closes, C13 discharges with a time constant of 100 µS and the HEMT drain voltage goes to Zero. CMOS switch U12C closes 200 µS after the start of the turn off sequence, discharging C22 through R57 with a time constant of 1.2 mS bring the HEMT gate voltage to zero.

Turn on sequence. When CONTROL 1 goes high, the output of gate U11D goes low and CMOS switch U9B is opened. C36 discharges through R103 with a time constant of 1 mS, and opens the CMOS switch U10C after 1.5 mS. C35 discharges through R99 and R100 with a time constant of 55 mS, and opens CMOS switches U12A and U12B after 15 mS. When CMOS switch U12A is opened, C13 charges up with a time constant of 10 mS and the HEMT drain voltage increases to the required value. When CMOS switch U12B is opened, C20 charges up with a time constant of 40 mS and the HEMT gate voltage increases under control of the servo bias circuit to increase the HEMT drain current to the required value.
+/-15 Volt Power Sense

The voltages of the +/-15 volt power supply rails are sensed so that the bias to the HEMTs will be turned off in the sequence described above in the event of a power dropout. When power is restored, this circuit delays the application of biases to the HEMTs until the power supply rails have almost reached +/-15 volts. This allows the servo circuit to stabilize before the HEMT biases are turned on.

When the +/-15 volt supplies are at their nominal value, both inputs to U8A are low, both inputs to U8D are high, the output of U8B (SUPPLY ON) is high and the LNA CONTROL lines are enabled.

If the -15 volt supply is greater than -14.4 volts, both inputs to U8A will be high and one input to U8D will be low. If the +15 volt supply is less than 14.1 volts, the other input to U8D will be low. If either of the inputs to U8D are low, its output will be high and the output of U8B (SUPPLY ON) will be low. When SUPPLY ON is low all four LNA CONTROL lines are disabled and all HEMT supplies are turned off.

Fig 2. Power supply sense circuit.