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AN EIGHT-CHANNEL HIGH VOLTAGE BIAS SUPPLY

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AGS DIVISION TECHNICAL NOTE

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Introduction

A high voltage power supply has been developed for use with the new 240-detector ring loss monitor system. The supply may be used with other systems, so this note is offered to announce availability of the present unit and to provide a basis for new designs. The present circuit is described and recommendations offered for various conditions of use.

Application

Loss monitors, ionization chambers and many devices presently identified by four letter acronyms require in-line bias supplies ranging from 50 to 300 volts. The voltage sensitivity of the ring loss monitors, gas-filled coaxial cables, flattens over 100 volts and remains relatively constant to over 300 volts. Centered in this range, the present supply, packaged in a one inch wide NIM module, provides eight isolated sources of 200 volts dc replacing series battery connections previously used. The circuit dissipates four watts (330 mA at 12 volts), with an additional watt dissipated in the on-board regulator.

Oscillator and Buffer

The circuit diagram is shown in Fig. 1. The power supply has been designed to be powered by a negative 15 volt supply with on-board regulation by a single TO-3 can, which accommodates any supply from -13.5 to -35 volts. Polarity of the circuit is, however, unimportant and is easily altered for other package realizations.

The RCA CD4047 CMOS multivibrator ($1.12 ea.) is connected directly to the 12-volt rails. Nominal 1 MHz operation (middle of the AM broadcast band) is set by a film resistor and epoxy capacitor, and the multi provides complementary outputs which, in this two-output "push-pull" package, permits supply bypassing easily. Our 15-volt supply sees only a resistive load with no rf.

Frequency response of the North-Hills N-11802 bias supply is band-limited to a few kHz about 1 MHz. Frequency sensitivity over this band is only slightly positive, so stability of the CD4047 is more than adequate and expensive crystals or crystal oscillators are not required. A note about circuit layout is appropriate. Our prototype circuits caused severe noise in a portable radio which was on a nearby workbench. Our final single-sided ground-plane type circuit board, shown in Figs. 2 and 3, radiated no rf even without complete NIM case closure. The circuit is nearly symmetrically divided on the board, with all upper components applying to one half the circuit and all lower components applying to the other half.

The CMOS oscillator is buffered by a CMOS hex buffer ($.55), also connected directly to the supply rails. A single gate would suffice for each line, and the triple gates provide redundancy. Both CMOS devices are completely safe from static electricity and transients once mounted on the card. The sixteen units we have built were inserted and retracted from an energized connector many times indiscriminately with no failures.

Output Stage

Each final drive consists of a series connection of the transformer coil, a Siliconix 2N6657 VMOS power FET ($5.00) and an adjustment resistor. Like an automative ignition coil, the transformer is "charged" with current when the output FET is switched ON. Current is determined by the controlled bus voltage and the adjustment resistor. When the FET is switched OFF, the ringing voltage is peak-rectified.

For various reasons, design criteria for the present circuit included driving two transformer assemblies with a single power bus. Adjustment is then effected by a variable resistance in series with the transformer primary. When driving a single assembly, the bus voltage may be varied and the series resistor eliminated. A single assembly requires about 175 mA at 12 volts. This technique can also be used with two push-pull circuits on one board.

The VMOS power FETs were an excellent drive device. The units selected were those packaged in a TO-3 can in anticipation of Class A operation and the need to dissipate a fair amount of heat. In the switched-mode chosen for final operation, units are available with identical specifications in TO-39 three-lead top-hat cans, which can be mounted directly on the circuit board. Our present devices dissipate virtually no power, with two VMOS units and the regulator running 2° C above ambient.

From cold turn-on at 215 volts, the unit will settle at a constant 200 volts within 10 minutes and maintain unloaded voltage stability of better than 0.01%. The NIM package output has a temperature coefficient of about -0.1% per degree C. Each North Hills N-11802 Bias Supply provides four outputs with 10^{12} ohm isolation. Each assembly of four outputs is independent of loading of the other assembly. Each assembly of four outputs will, however, experience common loading effects. The unit may be viewed as a Thevenin voltage source in series with a Thevenin resistance of about 60 kohms feeding all four outputs in parallel, except that each output is isolated from the others and only common loading current decreases common voltage. With the maximum anticipated 15 μA current on each output, all four outputs will fall by about 3.6 volts from the nominal 200 volts, a drop of less than 2%. As mentioned previously, the low voltage sensitivity of the ring loss monitors at this voltage level indicates that a 2% variation is insignificant. Single circuits driving single transformers driving single bridges would provide greater voltage-isolation in future circuits.

A monitoring circuit is provided by placing an LED across the transformer primary. The LED is driven at 1 MHz, like the transformer, and any failure of the ac drive will extinguish the unit. A series resistor limits current, an additional diode provides LED reverse voltage protection and a series capacitor ensures the LED will extinguish if the FET should develop a drain-source short.

Acknowledgments

We thank Larry Leipuner for requiring the CMOS realization of a previous circuit so that CMOS seemed a natural choice here. We thank Heather Hartmann for assembly and test of the prototype circuits and, with Hue-Anh Pham, assembly of the sixteen initial loss monitor power supplies pictured, all of which worked the first time. We thank Howard Rittenhouse for the excellent circuit board layout and taping. We thank, in addition, many who were directly or indirectly responsible for this circuit.

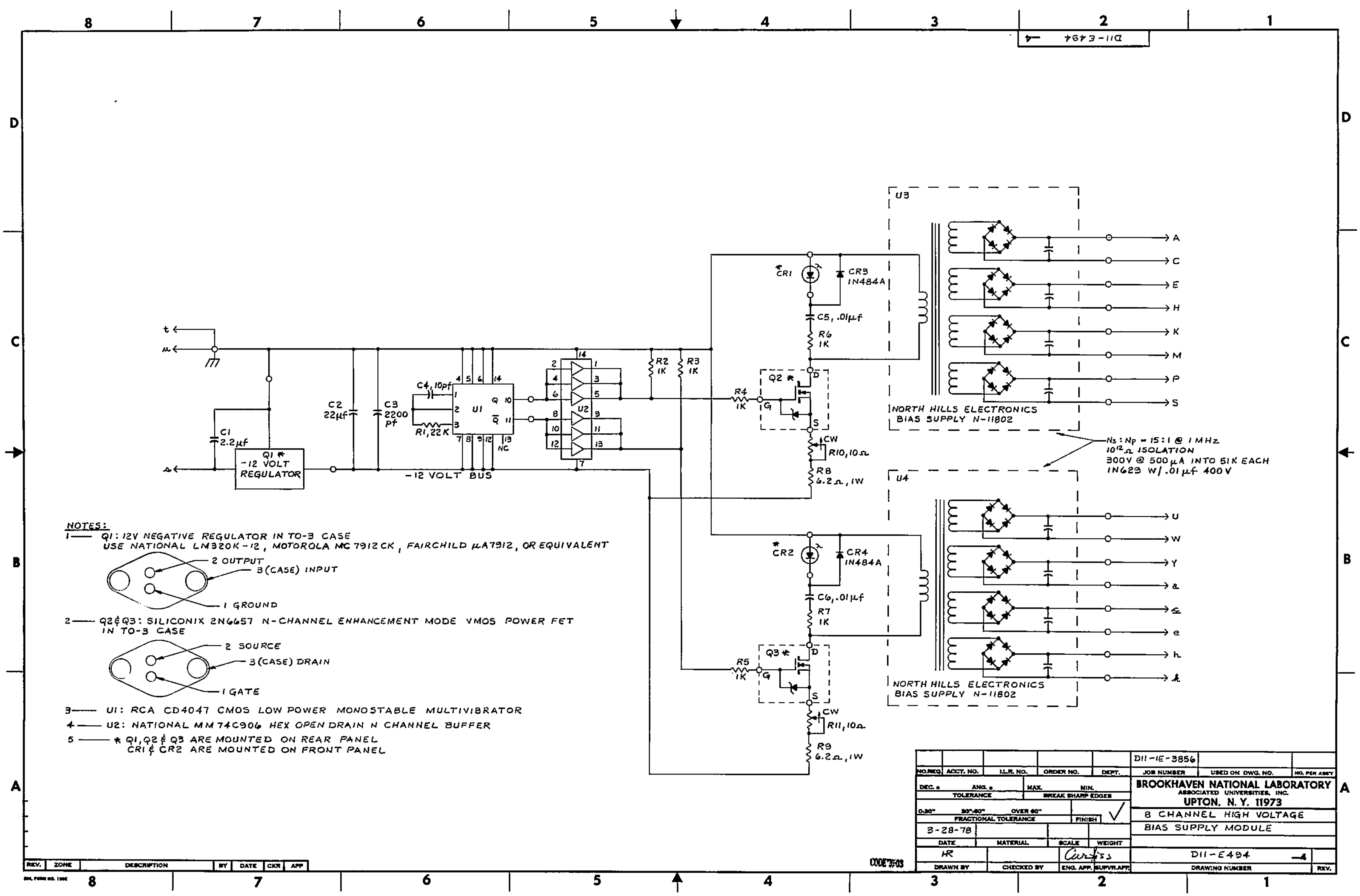

Fig. 1 Eight Channel High Voltage Bias Supply Circuit Diagram