

APPLICATION NOTE

AN141

Using the NE/SA592 video amplifier

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VIDEO AMPLIFIER PRODUCTS

NE/SA/SE592 Video Amplifier

The 592 is a two-stage differential output, wide-band video amplifier with voltage gains as high as 400 and bandwidths up to 120MHz.

Three basic gain options are provided. Fixed gains of 400 and 100 result from shorting together gain select pins G_{1A}-G_{1B} and G_{2A}-G_{2B}, respectively. As shown by Figure 1, the emitter circuits of the differential pair return through independent current sources. This topology allows no gain in the input stage if all gain select pins are left open. Thus, the third gain option of tying an external resistance across the gain select pins allows the user to select any desired gain from 0 to 400V/V. The advantages of this configuration will be covered in greater detail under the filter application section.

Three factors should be pointed out at this time:

1. The gains specified are differential. Single-ended gains are one-half the stated value.
2. The circuit 3dB bandwidths are a function of and are inversely proportional to the gain settings.
3. The differential input impedance is an inverse function of the gain setting.

In applications where the signal source is a transformer or magnetic transducer, the input bias current required by the 592 may be passed directly through the source to ground. Where capacitive coupling is to be used, the base inputs must be returned to ground through a resistor to provide a DC path for the bias current.

Due to offset currents, the selection of the input bias resistors is a compromise. To reduce the loading on the source, the resistors should be large, but to minimize the output DC offset, they should be small—ideally 0Ω. Their maximum value is set by the maximum allowable output offset and may be determined as follows:

1. Define the allowable output offset (assume 1.5V).
2. Subtract the maximum 592 output offset (from the data sheet). This gives the output offset allowed as a function of input offset currents (1.5V-1.0V=0.5V).
3. Divide by the circuit gain (assume 100). This refers the output offset to the input.
4. The maximum input resistor size is:

$$R_{MAX} = \frac{\text{Input Offset Voltage}}{\text{Max Input Offset Current}} \quad (1)$$

$$= \frac{0.005V}{5\mu A}$$

$$= 1.00k\Omega$$

Of paramount importance during the design of the NE592 device was bandwidth. In a monolithic device, this precludes the use of PNP transistors and standard level-shifting techniques used in lower frequency devices. Thus, without the aid of level shifting, the output common-mode voltage present on the NE592 is typically 2.9V. Most applications, therefore, require capacitive coupling to the load.

Filters

As mentioned earlier, the emitter circuit of the NE592 includes two current sources.

Since the stage gain is calculated by dividing the collector load impedance by the emitter impedance, the high impedance contributed by the current sources causes the stage gain to be zero with all gain select pins open. As shown by the gain vs. frequency graph of Figure 2, the overall gain at low frequencies is a negative 48dB.

Higher frequencies cause higher gain due to distributed parasitic capacitive reactance. This reactance in the first stage emitter circuit causes increasing stage gain until at 10MHz the gain is 0dB, or unity.

Referring to Figure 3, the impedance seen looking across the emitter structure includes small r_e of each transistor.

Any calculations of impedance networks across the emitters then must include this quantity. The collector current level is approximately 2mA, causing the quantity of $2r_e$ to be approximately 40Ω. Overall device gain is thus given by

$$\frac{V_O(s)}{V_{IN}(s)} = \frac{1.6 \times 10^4}{Z_{IN}(s) + 40} \quad (2)$$

where $Z(s)$ can be resistance or a reactive impedance. Table 2 summarizes the possible configurations to produce low, high, and bandpass filters. The emitter impedance is made to vary as a function of frequency by using capacitors or inductors to alter the frequency response. Included also in Table 2 is the gain calculation to determine the voltage gain as a function of frequency.

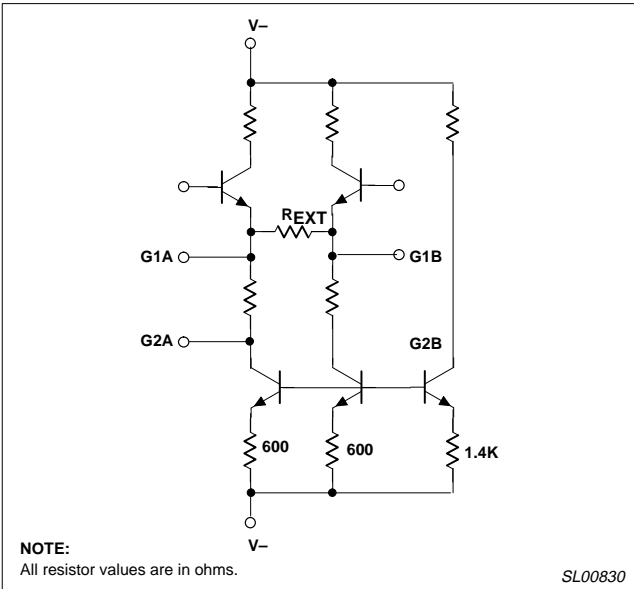


Figure 1. 592 Input Structure




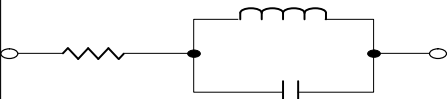
Table 1. Video Amplifier Comparison File

PARAMETER	NE/SA/SE592	733
Bandwidth (MHz)	120	120
Gain	0,100,400	10,100,400
R _{IN} (k)	4-30	4-250
V _{P-P} (V _S)	4.0	4.0

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Table 2. Filter Networks

Z Network	Filter Type	$\frac{V_O(s)}{V_I(s)}$ TRANSFER FUNCTION
	Low Pass	$\frac{1.6 \times 10^4}{L} \frac{1}{s + R L}$
	High Pass	$\frac{1.6 \times 10^4}{R} \frac{S}{s + 1 RC}$
	Band Pass	$\frac{1.6 \times 10^4}{L} \frac{S}{s^2 + R L s + 1 LC}$
	Band Reject	$\frac{1.6 \times 10^4}{R} \frac{S^2 + 1 LC}{s^2 + 1 LC + s RC}$

NOTES:

In the networks above, the R value used is assumed to include $2 r_e$, or approximately 40Ω .

$S = j\Omega$

$\Omega = 2\pi f$

Differentiation

With the addition of a capacitor across the gain select terminals, the NE592 becomes a differentiator. The primary advantage of using the emitter circuit to accomplish differentiation is the retention of the high common mode noise rejection. Disc file playback systems rely heavily upon this common-mode rejection for proper operation.

Figure 4 shows a differential amplifier configuration with transfer function.

Disc File Decoding

In recovering data from disc or drum files, several steps must be taken to precondition the linear data. The NE592 video amplifier, coupled with the 8T20 bidirectional one-shot, provides all the signal conditioning necessary for phase-encoded data.

When data is recorded on a disc, drum or tape system, the readback will be a Gaussian shaped pulse with the peak of the pulse corresponding to the actual recorded transition point. This readback signal is usually $500\mu V_{P-P}$ to $3mV_{P-P}$ for oxide coated disc files and 1 to $20mV_{P-P}$ for nickel-cobalt disc files. In order to accurately reproduce the data stream originally written on the disc memory, the time of peak point of the Gaussian readback signal must be determined.

The classical approach to peak time determination is to differentiate the input signal. Differentiation results in a voltage proportional to the slope of the input signal. The zero-crossing point of the differentiator, therefore, will occur when the input signal is at a peak. Using a zero-crossing detector and one-shot, therefore, results in pulses occurring at the input peak points.

A circuit which provides the preconditioning described above is shown in Figure 5. Readback data is applied directly to the input of the first NE592. This amplifier functions as a wide-band AC-coupled amplifier with a gain of 100. The NE592 is excellent for this use because of its high phase linearity, high gain and ability to directly

couple the unit with the readback head. By direct coupling of readback head to amplifier, no matched terminating resistors are required and the excellent common-mode rejection ratio of the amplifier is preserved. DC components are also rejected because the NE592 has no gain at DC due to the capacitance across the gain select terminals.

The output of the first stage amplifier is routed to a linear phase shift low-pass filter. The filter is a single-stage constant K filter, with a characteristic impedance of 200Ω . Calculations for the filter are as follows:

$$L = \frac{2R}{C}$$

where

R = characteristic impedance (Ω)

$$C = \frac{1}{C}$$

where

C = cut off frequency (radians/sec)

The second NE592 is utilized as a low noise differentiator/amplifier stage. The NE592 is excellent in this application because it allows differentiation with excellent common-mode noise rejection.

The output of the differentiator/amplifier is connected to the 8T20 bidirectional monostable unit to provide the proper pulses at the zero-crossing points of the differentiator.

The circuit in Figure 5 was tested with an input signal approximating that of a readback signal. The results are shown in Figure 7.

AUTOMATIC GAIN CONTROL

The NE592 can also be connected in conjunction with a MC1496 balanced modulator to form an excellent automatic gain control system.

The signal is fed to the signal input of the MC1496 and RC-coupled to the NE592. Unbalancing the carrier input of the MC1496 causes the signal to pass through unattenuated. Rectifying and filtering one of the NE592 outputs produces a DC signal which is proportional to the AC signal amplitude. After filtering; this control signal is applied to the MC1496 causing its gain to change.

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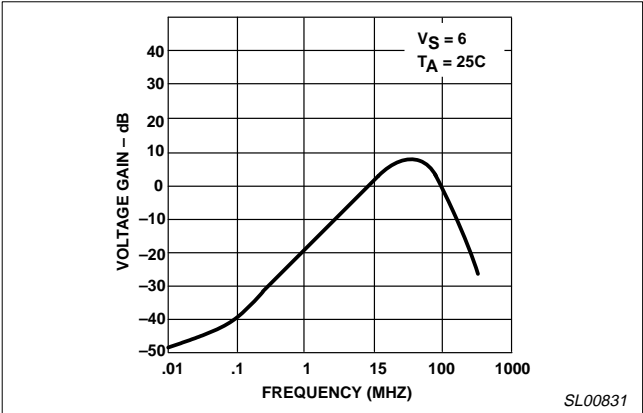


Figure 2. Voltage Gain as a Function of Frequency (All Gain Select Pins Open)

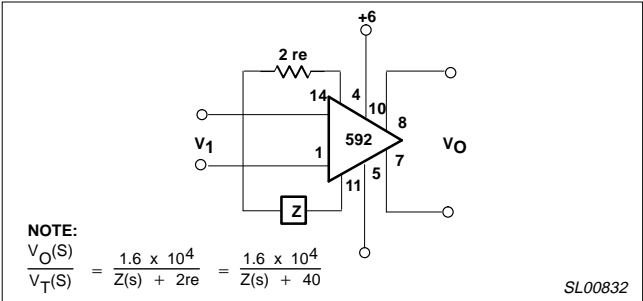


Figure 3. Basic Gain Configuration for NE592, N14

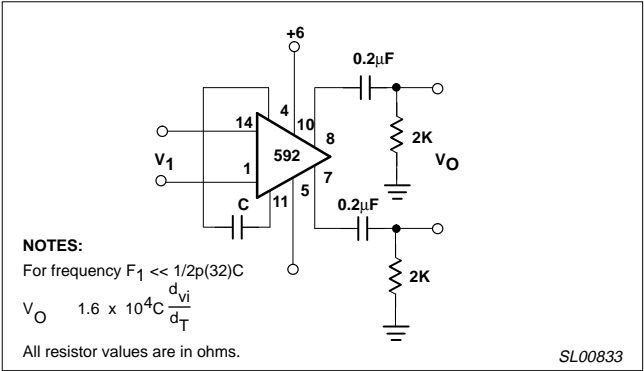


Figure 4. Differential with High Common-Mode Noise Rejection

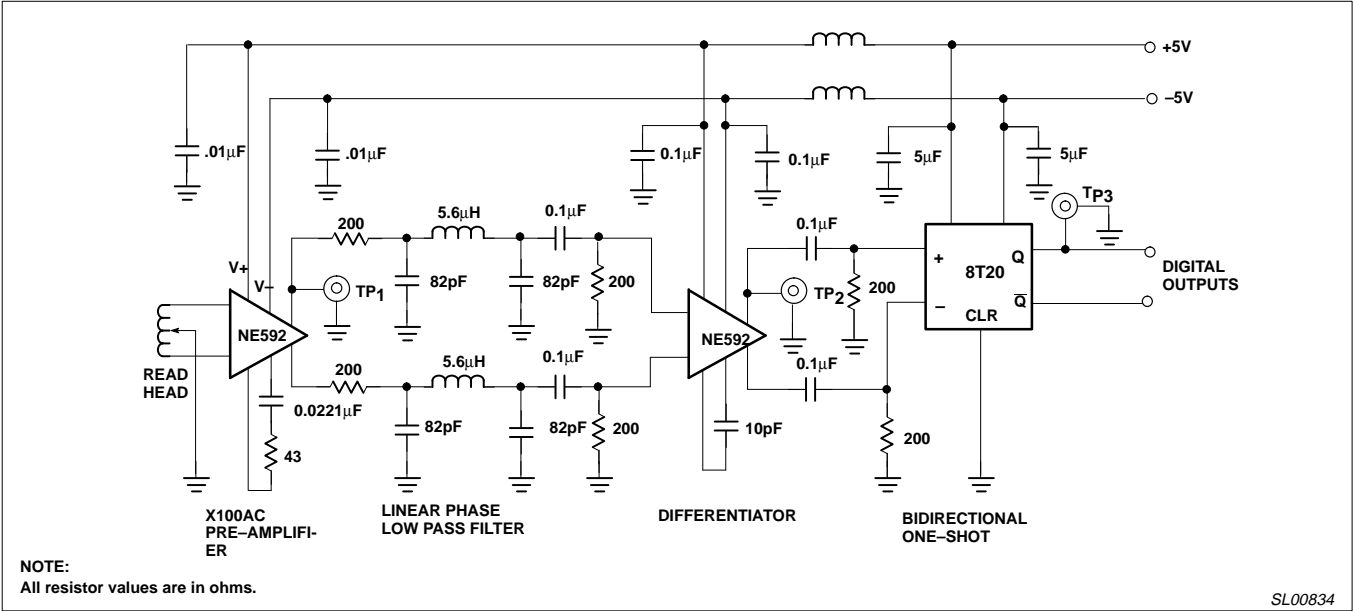


Figure 5. 5MHz Phase-Encoded Data Read Circuitry

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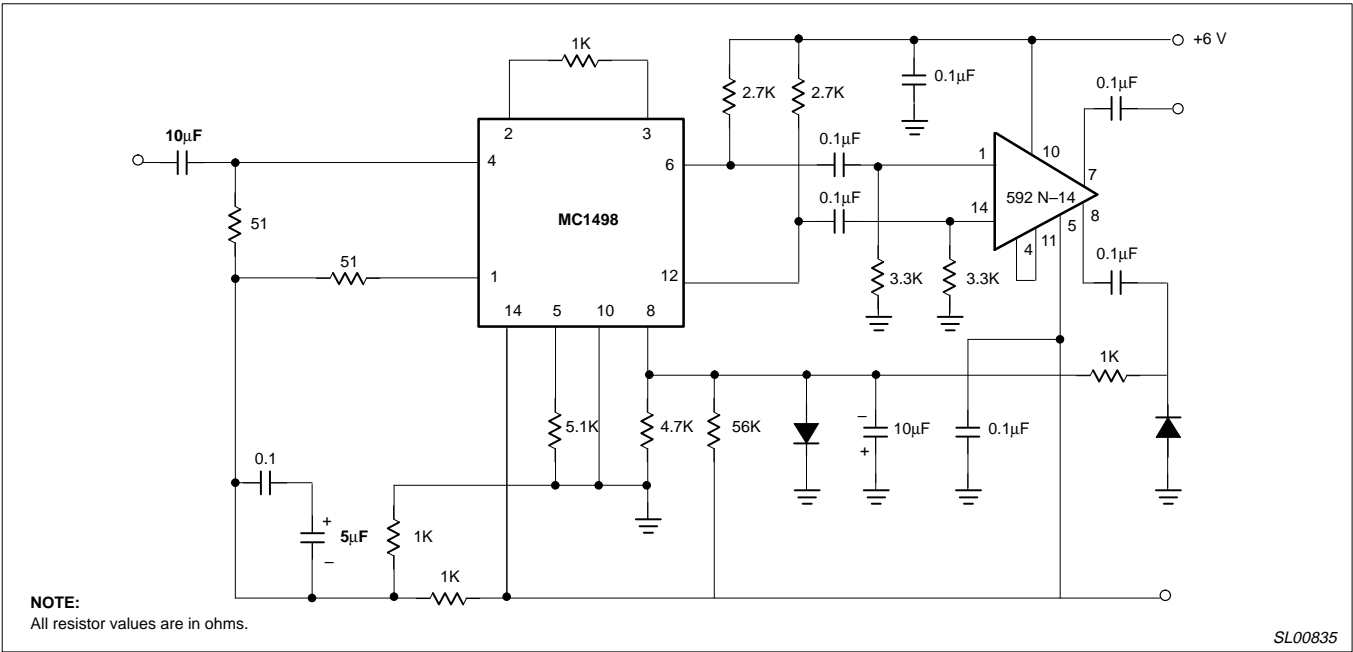


Figure 6. Wide-band AGC Amplifier

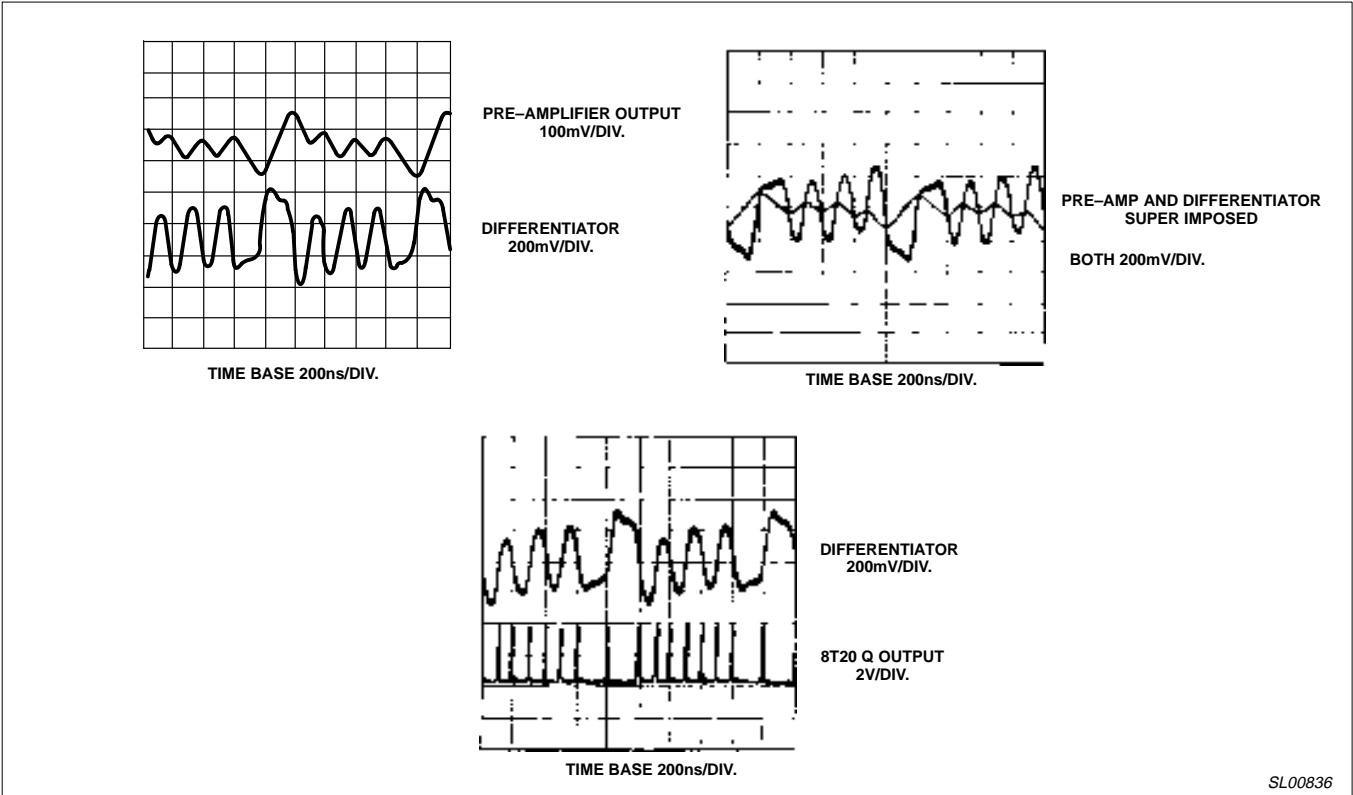


Figure 7. Test Results of Disc File Decoder Circuit