SERIES 7520 SENSE AMPLIFIERS

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HIGH-SPEED SENSE AMPLIFIERS FOR CONVERSION OF COINCIDENT-CURRENT MEMORY READOUT TO SATURATED DIGITAL-LOGIC LEVELS

performance features

- high speed and fast recovery time
- time and amplitude signal discrimination
- adjustable input threshold voltage levels
- narrow region of threshold voltage uncertainty
- multiple differential-input preamplifiers
- high d-c noise margin—typically one volt
- good fan-out capability

ease-of-design features

- choice of output circuit function
- TTL or DTL drive capability
- standard logic supply voltages
- plug-in configuration ideal for flow-soldering techniques
- pins on 100-mil grid spacings for industrial-type circuit boards

description

Series 7520 monolithic sense amplifiers are designed for use with high-speed memory systems. These sense amplifiers detect bipolar differential-input signals from the memory and provide the interface circuitry between the memory and the logic section. Low-level pulses originating in the memory are transformed into logic levels compatible with standard transistor-transistor-logic (TTL) and diode-transistor-logic (DTL) circuits.

These sense amplifiers feature multiple differential-input preamplifiers and versatile gating and output circuits, permitting a significant reduction in the circuitry required to accomplish the sensing function. A unique circuit design provides inherent stability of the input threshold level over a wide range of power-supply voltage levels and temperature ranges. Independent strobing of each of the dual sense-input channels ensures maximum versatility and permits detection to occur when the signal-to-noise ratio is at a maximum. The gate and strobe inputs and the outputs are compatible with standard TTL and DTL digital logic circuits.

The SN7520 and SN7521 circuits may be used to perform the functions of a flip-flop or register which responds to the sense and strobe input conditions.

The SN7522 and SN7523 circuits feature a high-fan-out, single-ended, open-collector output stage. In addition, they may be used to expand the inputs to an SN7520 or SN7521 circuit, or to perform the wired-AND function.

The SN7524 and SN7525 circuits provide for independent, dual-channel sensing with separate outputs. SN75234 and SN75235 are similar but have inverted outputs and internal compensation. SN75232 and SN75233 are identical to the SN75234 and SN75235, except that their output gates each feature an open-collector output.

The SN7526 and SN7527 circuits have a D-type flip-flop output with external clear and preset inputs.

The SN7528 and SN7529 circuits are identical to the SN7524 and SN7525 except that the output of each preamplifier is available as a test point. SN75238 and SN75239 are similar to SN7528 and SN7529 but have inverted outputs and internal compensation.

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design characteristics

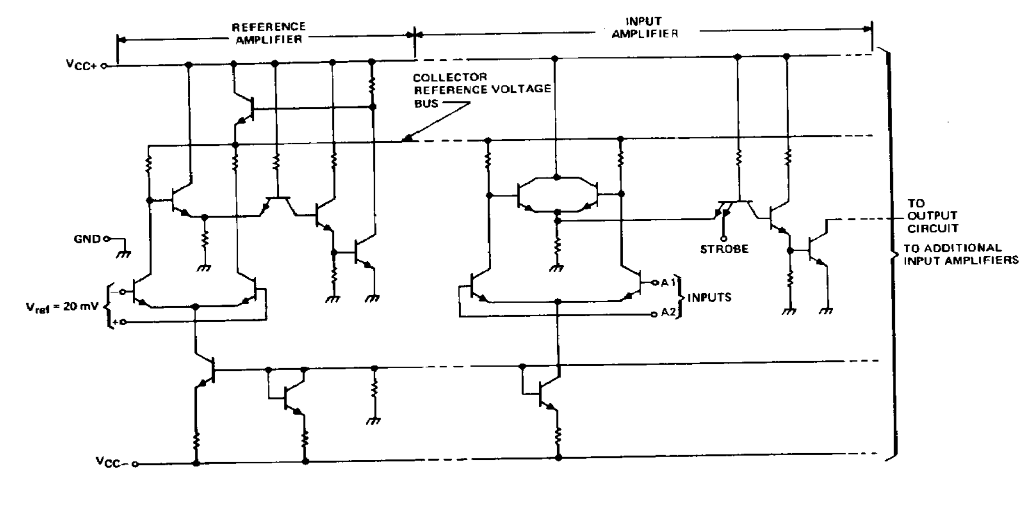
Series 7520 sense amplifiers are completely d-c coupled. Previous designs have resulted in circuits in which the threshold level could not be closely controlled because they were highly sensitive to changes in the d-c levels throughout the amplifier. This was due primarily to the required tolerances on the absolute value of resistors and the resistor temperature coefficients. The "matched-amplifier" design of Series 7520 circuits depends on resistor ratios rather than absolute values. In this design, excellent stability of the threshold level can be maintained despite component variations and changes in bias levels. The capability of multiple-input amplifiers increases the versatility of the design.

The basic circuit is used to implement several sense-amplifier designs. Additional logic circuitry is added to the strobe-gate output to provide versatile sensing functions. The outputs of two or more input amplifiers can be combined to implement multiple-input amplifiers, a function not previously available in integrated form. The d-c coupled design eliminates many of the problems associated with overload recovery time and threshold shift (with high input repetition rates) usually encountered in sense amplifier designs that use reactive coupling components.

circuit operation

The basic Series 7520 sense amplifier strobe and threshold circuit is shown in Figure A. The design uses a "matched-amplifier" concept which takes advantage of the inherent excellent component matching and thermal tracking characteristics of monolithic integrated circuits. A reference amplifier is used to generate the collector reference voltage which is distributed to the input amplifiers. Application of an external reference voltage, V_{ref}, establishes the input-amplifier threshold voltage level, V_T. The design is such that there is 1:1 correspondence between the applied reference voltage, V_{ref}, and the nominal threshold voltage level, V_T. The reference and input amplifiers use identical circuit configurations; therefore, changes in bias levels introduced into the input amplifier through changes in temperature or power-supply voltage levels are compensated by similar changes in the reference amplifier.

The collector reference voltage, supplied by the reference amplifier, can be used to control the threshold-voltage level of more than one input amplifier, thereby establishing equal threshold levels to all of the input sense channels simultaneously.



Patent pending

FIGURE A—BASIC SERIES 7520 SENSE-AMPLIFIER CIRCUIT

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circuit operation (continued)

The second stage of the input amplifier is a TTL gate. This gate provides the threshold action for the input sense channel and provides a convenient point in the circuit to accomplish the strobe function. The differential-input sense signal switches the output of the TTL gate only when the strobe input voltage is higher than the logic input threshold voltage. The strobe input, therefore, provides the sense amplifier with the capability of time discrimination, allowing the input signal to be detected when the signal-to-noise ratio is at a maximum.

The logic inputs (i.e., gate and strobe) of Series 7520 sense amplifiers are designed to be compatible with Series 74 TTL digital integrated circuits. The multiple-emitter transistors are utilized to provide inherent switching-time advantages over other saturated-logic schemes. The same noise margin and logic threshold voltage as guaranteed for Series 74 are assured for each of the gate and strobe inputs. This is accomplished by testing each logic input under standard Series 74 test conditions, i.e., 2 volts for high-level input condition and 0.8 volt for low-level input conditions. Since the guaranteed minimum high-level output voltage is 2.4 volts and the guaranteed maximum low-level output voltage is 0.4 volt, a minimum noise margin of 0.4 volt is assured at each input.

SN7520 and SN7521 circuit

This circuit is a dual-channel sense amplifier with the preamplifiers connected to a common output stage and a complementary output stage. The output circuit is composed of two cascaded NAND gates, each with external gate inputs. External connection of the Z output and the G_Y input results in a flip-flop or register that is set by signals at the differential-input terminals. Reset of the register is performed at the G_Z input. Capacitive coupling from output Z to G_Y results in output pulse stretching. With either connection, complementary output levels are available. The gate and strobe inputs and the outputs are compatible with standard TTL logic. The input function of SN7520/SN7521 can be expanded by connecting the Y output of SN7522/SN7523 to the G_Y input of the circuit being expanded.

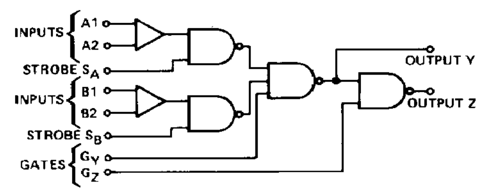

FIGURE B
SN7520/SN7521 LOGIC DIAGRAM

logic: $Y = \bar{G}_Y + A \cdot S_A + B \cdot S_B$

$Z = \bar{G}_Z + \bar{Y}$

$Z = \bar{G}_Z + G_Y\,(\bar{A} + \bar{S}_A)\,(\bar{B} + \bar{S}_B)$

SN7522 and SN7523 circuit

This circuit is a dual-channel sense amplifier with the preamplifiers connected to a common output stage. The output circuit features an open-collector output which permits two or more of these outputs to be connected in the wire-AND configuration. Each package includes a load resistor that may be used as the output pull-up resistor. High sink-current capability is a feature of this design, and a separate ground terminal is used for the output circuitry. These devices can also be used as input expanders for the SN7520/SN7521 circuit.

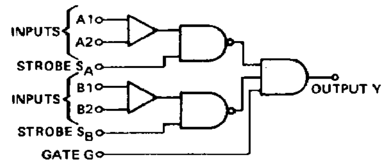

FIGURE C
SN7522/SN7523 LOGIC DIAGRAM

logic: $Y = G\,(\bar{A} + \bar{S}_A)\,(\bar{B} + \bar{S}_B)$

SN7524 and SN7525 circuit

This circuit features two completely independent sense amplifiers in a single package. Each amplifier features high fan-out capability.

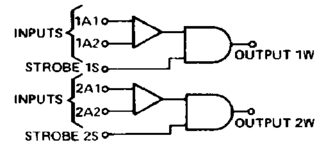

FIGURE D
SN7524/SN7525 LOGIC DIAGRAM
SN75232/SN75233 SAME EXCEPT INVERTED OPEN-COLLECTOR OUTPUT
SN75234/SN75235 SAME EXCEPT INVERTED OUTPUT

logic: $W = AS$ for SN7524 and SN7525

$W = \overline{AS}$ for SN75232, SN75233, SN75234, and SN75235

SN7526 and SN7527 circuit

This circuit is a dual-channel sense amplifier with the preamplifiers connected to a D-type flip-flop with external clear and preset inputs. A delay between the strobe input terminals and the clock input of the flip-flop ensures that data is set up at the D input of the flip-flop prior to clocking.

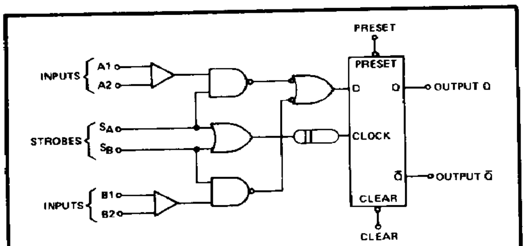

FIGURE E
SN7526/SN7527 LOGIC DIAGRAM

logic: See function table on page 11-16.

SN7528 and SN7529 circuit

This circuit features two separate single-preamplifier sense amplifiers in a single package. The output of each preamplifier is available as a test point. These test points can be used to observe the amplified core signal to facilitate accurate strobe timing. When using this device, care should be taken to avoid coupling the strobe signal or other stray signals to the test point. Excessive loading of the test point is also to be avoided. The result of either coupling or loading will be a change in the threshold voltage of the device. The output circuit of each channel features a simple TTL gate configuration with a high fan-out capability.

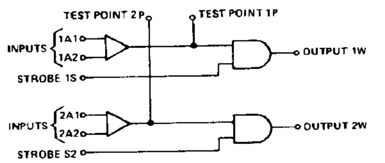

FIGURE F
SN7528/SN7529 LOGIC DIAGRAM
SN75238/SN75239 SAME EXCEPT INVERTED OUTPUT

logic: W = AS for SN7528 and SN7529
W = $\overline{AS}$ for SN75238 and SN75239

SN75232, SN75233, SN75234, SN75235, SN75238, and SN75239 circuits

The SN75234, SN75235, SN75238, and SN75239 dual sense amplifier circuits are the same as SN7524, SN7525, SN7528, and SN7529, respectively, except that an additional stage has been added to the output gate to provide an inverted output and internal compensation has been added. Compared to using a separate gate for inversion, not only is package count reduced, but less propagation delay is added. The need for an external roll-off capacitor has been eliminated. SN75232 and SN75233 are identical to the SN75234 and SN75235, respecitvely, except that their output gates each have an open-collector output. This permits two or more outputs to be connected in wire-AND configuration.

reference voltage considerations

These sense amplifiers feature a variable-threshold voltage level with simultaneous adjustment of both sense channels or both sense amplifiers by a single reference voltage. The operating threshold voltage level of the input amplifiers is established by and is approximately equal to the applied reference input voltage, V_{ref}. These sense amplifiers are recommended for use in systems requiring threshold voltage levels of ±15 to ±40 mV.

A simple method of generating the reference voltage is the use of a resistor voltage divider from either the positive (V_{CC+}) or negative (V_{CC-}) voltage supplies. See Figure G. This type of voltage divider may be used to supply an individual reference amplifier or to supply a number of paralleled reference amplifiers. The bias current required at the reference amplifier input is low (nominally 30 μA); therefore, voltage dividers of this type may normally be operated with very low current requirements. In noisy environments, the use of a filter capacitor across the inputs is recommended. By locating the capacitor as close to the device terminals as possible, noise and stray signals will be presented common-mode to the reference amplifier and thus be rejected.

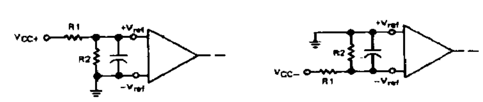

FIGURE G

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input line layout considerations

Input sensitivity and device speed require adequate precautions in the routing of signal input and reference lines to prevent noise pickup. Bypassing of supply and reference inputs at the device with low-inductance disc ceramic capacitors, and use of a good ground plane to separate strobe and output lines from sense and reference input lines, is recommended.

sense-input termination resistor considerations

Termination resistors are intentionally omitted from the sense-input terminals so the designer may select resistor values which will be compatible with the particular application. Matched termination resistors, (R_T, Figure H), normally in the range of 25 Ω to 200 Ω each, are required not only to terminate the sense line in a desired impedance but also to provide a d-c path for the sense-input bias currents. Careful matching of the resistor pairs should be observed or effective common-mode rejection will be reduced.

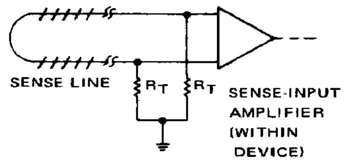

FIGURE H

output drive capability

The output circuits of these sense amplifiers feature the ability to sink or supply load current, This capability permits direct use with both TTL- and DTL-type loads. The open-collector output of the SN7522/SN7523 circuit may be connected to similar outputs to perform the wire-AND function. Load currents (out of the output terminal) are specified as negative values. Arrows on the d-c test circuit indicate the actual direction of current flow.

logic input current requirements

Logic input current requirements are specified at worst-case power-supply conditions over the operating free-air temperature range of 0°C to 70°C. The logic input currents are identical to those of, and compatible with, Series 74 TTL digital integrated circuits. Each logic input of the multiple-emitter input transistors requires no more than a 1.6-mA flow out of the input at a low logic level. Each input emitter requires current into the input when it is at a high-logic level. This current is 40 μA maximum. Currents into the input terminals are specified as positive values. Arrows on the d-c test circuits indicate the actual direction of current flow.

absolute maximum ratings over operating free-air temperature range (unless otherwise noted)

Supply voltages (see Note 1)	
V_{CC+}	7 V
V_{CC-}	−7 V
Differential input voltage, V_{ID} or V_{ref}	±5 V
Voltage from any input to ground (see Note 2)	5.5 V
Off-state voltage applied to open-collector outputs	5.5 V
Operating free-air temperature range	0°C to 70°C
Storage temperature range	−55°C to 150°C

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recommended operating conditions

	MIN	NOM	MAX	UNIT
V_{CC+} (see Note 1)	4.75	5	5.25	V
V_{CC-} (see Note 1)	−4.75	−5	−5.25	V
V_{ref}	15		40	mV

NOTES: 1. These voltage values are with respect to network ground terminal.
2. Strobe and gate input voltages must be zero or positive with respect to network ground terminal.

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