



# Sense Amplifiers

## LM5520/LM7520 series dual core memory sense amplifiers general description

The devices in this series of dual core sense amplifiers convert bipolar millivolt-level memory sense signals to saturated logic levels. The design employs a common reference input which allows the input threshold voltage level of both amplifiers to be adjusted. Separate strobe inputs provide time discrimination for each channel. Logic inputs and outputs are DTL/TTL compatible. All devices of the series have identical preamplifier configurations, while various logic connections are provided to suit the specific application.

The LM5520/LM7520 has output latch capability and provides sense, strobe, and memory function for two sense lines. The LM5522/LM7522 contains a single open collector output which may be used to expand the number of inputs of the LM5520/LM7520, or to drive an external Memory Data Register (MDR). Intended for small memories, the two channels of the LM5524/LM7524 are independent with two separate outputs. The LM5534/LM7534 is similar to the LM5524/LM7524 but has uncommitted, wire-ORable outputs. The LM5528/LM7528 has the same logic configuration of the LM5524/LM7524 and in addition provides separate low impedance Test Points at each preamplifier output. A similar device having uncommitted, wire-ORable outputs is the LM5538/LM7538.

All critical characteristics are guaranteed for operation within normal system parameter variations of temperature, supply voltages, and output loading.

Features of the series include:

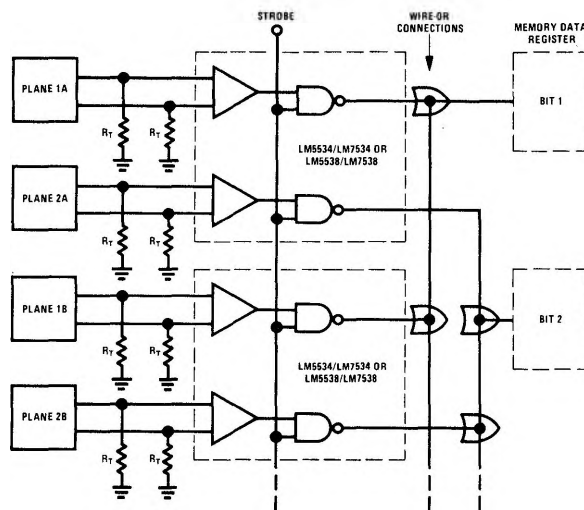
- High speed
- Guaranteed narrow threshold uncertainty including temperature and supply voltage variation
- Adjustable input threshold voltage
- Fast overload recovery times
- Two amplifiers per package
- Molded or cavity dual-in-line package
- Six logic configurations

The part number ending with an even number (e.g., LM5520) designates a tighter guaranteed input threshold uncertainty than the subsequent odd number ending (e.g., LM5521). The remaining specifications for the two are identical. All devices meet or exceed the specifications for the corresponding device (where applicable) in the SN5520/SN7520 series and are pin-for-pin replacements.

### absolute maximum ratings

|                                         |                 |
|-----------------------------------------|-----------------|
| Supply Voltage                          | ±7V             |
| Differential or Reference Input Voltage | ±5V             |
| Logic Input Voltage                     | +5.5V           |
| Operating Temperature Range             |                 |
| LM55XX                                  | -55°C to +125°C |
| LM75XX                                  | 0°C to +70°C    |
| Storage Temperature Range               | -65°C to +150°C |

### typical application



Expanded Small Memory System

## LM5520/LM7520 and LM5521/LM7521

### electrical characteristics

LM5520/LM5521: The following apply for  $-55^{\circ}\text{C} \leq T_A \leq 125^{\circ}\text{C}$ ,  $V^+ = 5\text{V} \pm 5\%$ ,  $V^- = -5\text{V} \pm 5\%$ . (Note 1)

| PARAMETER                                                  | MIN    | TYP | MAX    | UNIT          | TEST CONDITIONS (EACH AMPLIFIER) |            |              |              |                      |                             |                         | COMMENTS            |
|------------------------------------------------------------|--------|-----|--------|---------------|----------------------------------|------------|--------------|--------------|----------------------|-----------------------------|-------------------------|---------------------|
|                                                            |        |     |        |               | DIFF. INPUT                      | REF. INPUT | STROBE INPUT | GATE Q INPUT | GATE $\bar{Q}$ INPUT | LOGIC OUTPUT (NOTE 3)       | SUPPLY VOLT.            |                     |
| Differential Input Threshold Voltage ( $V_{TH}$ ) (Note 2) | 10(8)  | 15  |        | mV            | $\pm V_{TH}$                     | 15 mV      | +5V          | +5V          |                      | +16 mA(Q)                   | $\pm 5\text{V} \pm 5\%$ | Logic Output < 0.4V |
|                                                            |        | 15  | 20(22) | mV            | $\pm V_{TH}$                     | 15 mV      | +5V          | +5V          |                      | -400 $\mu\text{A}(\bar{Q})$ | $\pm 5\text{V} \pm 5\%$ | Logic Output > 2.4V |
|                                                            | 35(33) | 40  |        | mV            | $\pm V_{TH}$                     | 40 mV      | +5V          | +5V          |                      | +16 mA(Q)                   | $\pm 5\text{V} \pm 5\%$ | Logic Output < 0.4V |
|                                                            |        | 40  | 45(47) | mV            | $\pm V_{TH}$                     | 40 mV      | +5V          | +5V          |                      | -400 $\mu\text{A}(\bar{Q})$ | $\pm 5\text{V} \pm 5\%$ | Logic Output > 2.4V |
| Differential & Reference Input Bias Current                |        | 30  | 100    | $\mu\text{A}$ | 0V                               | 0V         | +5.25V       | +5.25V       | +5.25V               |                             | $\pm 5.25\text{V}$      |                     |

LM7520/LM7521: The following apply for  $0^{\circ}\text{C} \leq T_A \leq 70^{\circ}\text{C}$ ,  $V^+ = 5\text{V} \pm 5\%$ ,  $V^- = -5\text{V} \pm 5\%$

|                                                            |        |    |        |               |              |       |        |        |        |                             |                         |                     |
|------------------------------------------------------------|--------|----|--------|---------------|--------------|-------|--------|--------|--------|-----------------------------|-------------------------|---------------------|
| Differential Input Threshold Voltage ( $V_{TH}$ ) (Note 4) | 11(8)  | 15 |        | mV            | $\pm V_{TH}$ | 15 mV | +5V    | +5V    |        | +16 mA(Q)                   | $\pm 5\text{V} \pm 5\%$ | Logic Output < 0.4V |
|                                                            |        | 15 | 19(22) | mV            | $\pm V_{TH}$ | 15 mV | +5V    | +5V    |        | -400 $\mu\text{A}(\bar{Q})$ | $\pm 5\text{V} \pm 5\%$ | Logic Output > 2.4V |
|                                                            | 36(33) | 40 |        | mV            | $\pm V_{TH}$ | 40 mV | +5V    | +5V    |        | +16 mA(Q)                   | $\pm 5\text{V} \pm 5\%$ | Logic Output < 0.4V |
|                                                            |        | 40 | 44(47) | mV            | $\pm V_{TH}$ | 40 mV | +5V    | +5V    |        | -400 $\mu\text{A}(\bar{Q})$ | $\pm 5\text{V} \pm 5\%$ | Logic Output > 2.4V |
| Differential & Reference Input Bias Current                |        | 30 | 75     | $\mu\text{A}$ | 0V           | 0V    | +5.25V | +5.25V | +5.25V |                             | $\pm 5.25\text{V}$      |                     |

LM5520/LM5521: The following apply for  $-55^{\circ}\text{C} \leq T_A \leq 125^{\circ}\text{C}$ ,  $V^+ = 5\text{V} \pm 5\%$ ,  $V^- = -5\text{V} \pm 5\%$

LM7520/LM7521: The following apply for  $0^{\circ}\text{C} \leq T_A \leq 70^{\circ}\text{C}$ ,  $V^+ = 5\text{V} \pm 5\%$ ,  $V^- = -5\text{V} \pm 5\%$

|                                                    |      |      |      |               |       |       |        |        |        |                             |                    |                     |
|----------------------------------------------------|------|------|------|---------------|-------|-------|--------|--------|--------|-----------------------------|--------------------|---------------------|
| Differential Input Offset Current                  |      | 0.5  |      | $\mu\text{A}$ | 0V    | 0V    | +5.25V | +5.25V | +5.25V |                             | $\pm 5.25\text{V}$ |                     |
| Logic "1" Input Voltage (Strobes)                  | 2    |      |      | V             | 40 mV | 20 mV | +2V    | +4.75V |        | -400 $\mu\text{A}(\bar{Q})$ | $\pm 4.75\text{V}$ | Logic Output > 2.4V |
| (Gate Q)                                           | 2    |      |      | V             | 40 mV | 20 mV | 0V     | +2V    |        | +16 mA(Q)                   | $\pm 4.75\text{V}$ | Logic Output < 0.4V |
| (Gate $\bar{Q}$ )                                  | 2    |      |      | V             | 40 mV | 20 mV | 0V     | 0V     | +2V    | +16 mA( $\bar{Q}$ )         | $\pm 4.75\text{V}$ | Logic Output < 0.4V |
| Logic "0" Input Voltage (Strobes)                  |      |      | 0.8  | V             | 40 mV | 20 mV | +0.8V  | +4.75V |        | +16 mA(Q)                   | $\pm 4.75\text{V}$ | Logic Output < 0.4V |
| (Gate Q)                                           |      |      | 0.8  | V             | 40 mV | 20 mV | 0V     | +0.8V  |        | -400 $\mu\text{A}(\bar{Q})$ | $\pm 4.75\text{V}$ | Logic Output > 2.4V |
| (Gate $\bar{Q}$ )                                  |      |      | 0.8  | V             | 40 mV | 20 mV | 0V     | 0V     | +0.8V  | -400 $\mu\text{A}(\bar{Q})$ | $\pm 4.75\text{V}$ | Logic Output > 2.4V |
| Logic "0" Input Current                            | -1   | -1.6 |      | mA            | 40 mV | 20 mV | +0.4V  | +0.4V  | +0.4V  |                             | $\pm 5.25\text{V}$ | Each Input          |
| Logic "1" Input Current (Strobe & Gate $\bar{Q}$ ) | 5    | 40   |      | $\mu\text{A}$ | 0V    | 20 mV | +2.4V  | +5.25V | +2.4V  |                             | $\pm 5.25\text{V}$ | Each Input          |
| (Gate Q)                                           | .02  | 1    |      | mA            | 0V    | 20 mV | +5.25V | +5.25V | +5.25V |                             | $\pm 5.25\text{V}$ | Each Input          |
|                                                    | 5    | 40   |      | $\mu\text{A}$ | 40 mV | 20 mV | +5.25V | +5.25V | +2.4V  |                             | $\pm 5.25\text{V}$ |                     |
|                                                    | .02  | 1    |      | mA            | 40 mV | 20 mV | +5.25V | +5.25V |        |                             | $\pm 5.25\text{V}$ |                     |
| Logic "1" Output Voltage (Strobe)                  | 2.4  | 3.9  |      | V             | 40 mV | 20 mV | +2.0V  | +5.25V |        | -400 $\mu\text{A}(\bar{Q})$ | $\pm 4.75\text{V}$ |                     |
| (Gate Q)                                           | 2.4  | 3.9  |      | V             | 40 mV | 20 mV | 0V     | +0.8V  |        | -400 $\mu\text{A}(\bar{Q})$ | $\pm 4.75\text{V}$ |                     |
| (Gate $\bar{Q}$ )                                  | 2.4  | 3.9  |      | V             | 40 mV | 20 mV | +4.75V | 0V     | +0.8V  | -400 $\mu\text{A}(\bar{Q})$ | $\pm 4.75\text{V}$ |                     |
| Logic "0" Output Voltage (Strobe)                  |      | 0.25 | 0.40 | V             | 40 mV | 20 mV | +0.8V  | +4.75V |        | +16 mA(Q)                   | $\pm 4.75\text{V}$ |                     |
| (Gate Q)                                           |      | 0.25 | 0.40 | V             | 0V    | 20 mV | 0V     | +2V    |        | +16 mA(Q)                   | $\pm 4.75\text{V}$ |                     |
| (Gate $\bar{Q}$ )                                  |      | 0.25 | 0.40 | V             | 0V    | 20 mV | 0V     | 0V     | +2V    | +16 mA( $\bar{Q}$ )         | $\pm 4.75\text{V}$ |                     |
| Q Output Short Circuit Current                     | -3   | -4   | -5   | mA            | 0V    | 20 mV | 0V     | 0V     |        | 0 V(Q)                      | $\pm 5.25\text{V}$ |                     |
| $\bar{Q}$ Output Short Circuit Current             | -2.1 | -2.8 | -3.5 | mA            | 0V    | 20 mV | 0V     | 0V     | 0V     | 0 V( $\bar{Q}$ )            | $\pm 5.25\text{V}$ |                     |
| V+ Supply Current                                  |      | 21   | 35   | mA            | 0V    | 20 mV | 0V     | 0V     | 0V     |                             | $\pm 5.25\text{V}$ |                     |
| V- Supply Current                                  |      | -13  | -18  | mA            | 0V    | 20 mV | 0V     | 0V     | 0V     |                             | $\pm 5.25\text{V}$ |                     |

Note 1: For  $0^{\circ}\text{C} \leq T_A \leq 70^{\circ}\text{C}$  operation, electrical characteristics for LM5520 and LM5521 are guaranteed the same as LM7520 and LM7521, respectively.

Note 2: Limits in parentheses pertain to LM5521, other limits pertain to LM5520.

Note 3: Q or  $\bar{Q}$  in parentheses indicate Q or  $\bar{Q}$  logic output, respectively.

Note 4: Limits in parentheses pertain to LM7521, other limits pertain to LM7520.

Note 5: Positive current is defined as current into the referenced pin.

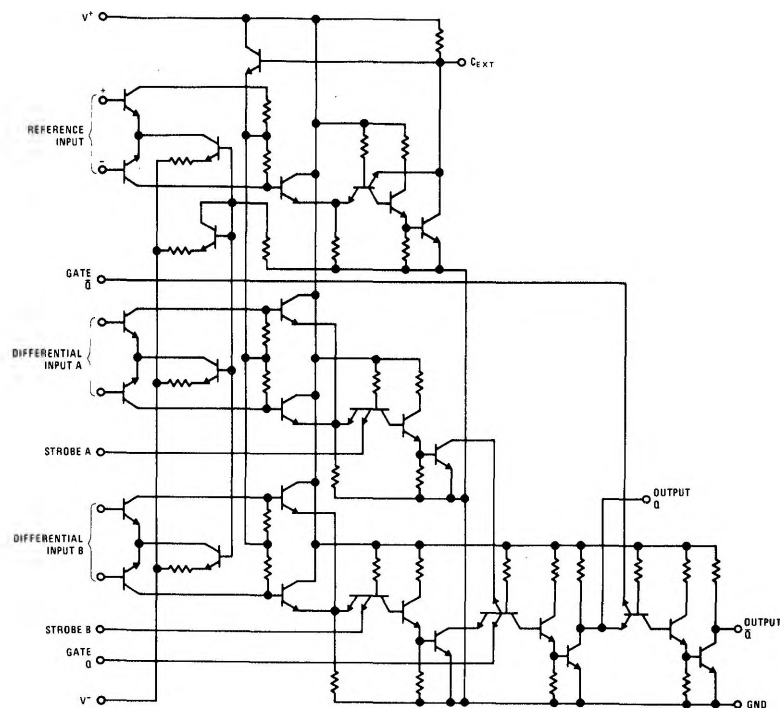
Note 6: Pin 1 to have  $\geq 100$  pF capacitor connected to ground.

**LM5520/LM7520 and LM5521/LM7521****electrical characteristics**LM5520/LM5521 and LM7520/LM7521: The following apply for  $T_A = 25^\circ\text{C}$ ,  $V^+ = 5\text{V}$ ,  $V^- = -5\text{V}$ 

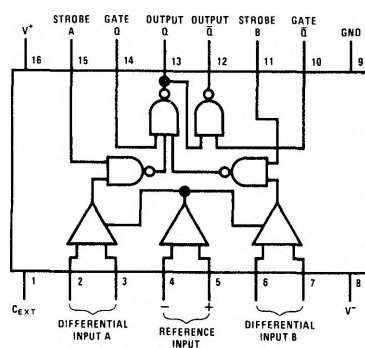
| PARAMETER                                            | MIN | TYP       | MAX | UNIT | TEST CONDITIONS |            |                        |                |                 |
|------------------------------------------------------|-----|-----------|-----|------|-----------------|------------|------------------------|----------------|-----------------|
|                                                      |     |           |     |      | DIFF. INPUT     | REF. INPUT | STROBE AND GATE INPUTS | Q LOGIC OUTPUT | AC TEST CIRCUIT |
| AC Common-Mode Input Firing Voltage                  |     | $\pm 2.5$ |     | V    | PULSE           | 20 mV      | +5V                    | SCOPE          |                 |
| Propagation Delays                                   |     |           |     |      |                 |            |                        |                |                 |
| Differential Input to Logical "1" Q Output           |     | 20        | 40  | ns   |                 | 20 mV      |                        |                | 1               |
| Differential Input to Logical "0" Q Output           |     | 28        |     | ns   |                 | 20 mV      |                        |                | 1               |
| Differential Input to Logical "1" $\bar{Q}$ Output   |     | 36        |     | ns   |                 | 20 mV      |                        |                | 1               |
| Differential Input to Logical "0" $\bar{Q}$ Output   |     | 28        | 55  | ns   |                 | 20 mV      |                        |                | 1               |
| Strobe Input to Logical "1" Q Output                 |     | 10        | 30  | ns   |                 | 20 mV      |                        |                | 1               |
| Strobe Input to Logical "0" Q Output                 |     | 20        |     | ns   |                 | 20 mV      |                        |                | 1               |
| Strobe Input to Logical "1" $\bar{Q}$ Output         |     | 33        |     | ns   |                 | 20 mV      |                        |                | 1               |
| Strobe Input to Logical "0" $\bar{Q}$ Output         |     | 16        | 55  | ns   |                 | 20 mV      |                        |                | 1               |
| Gate Q Input to Logical "1" Q Output                 |     | 12        | 20  | ns   |                 | 20 mV      |                        |                | 2               |
| Gate Q Input to Logical "0" Q Output                 |     | 6         |     | ns   |                 | 20 mV      |                        |                | 2               |
| Gate Q Input to Logical "1" $\bar{Q}$ Output         |     | 17        |     | ns   |                 | 20 mV      |                        |                | 2               |
| Gate Q Input to Logical "0" $\bar{Q}$ Output         |     | 19        | 30  | ns   |                 | 20 mV      |                        |                | 2               |
| Gate $\bar{Q}$ Input to Logical "1" $\bar{Q}$ Output |     | 12        |     | ns   |                 | 20 mV      |                        |                | 2               |
| Gate $\bar{Q}$ Input to Logical "0" $\bar{Q}$ Output |     | 6         | 20  | ns   |                 | 20 mV      |                        |                | 2               |
| Diff. Input Overload Recovery Time                   |     | 10        |     | ns   |                 |            |                        |                |                 |
| Common-Mode Input Overload Recovery Time             |     | 5         |     | ns   |                 |            |                        |                |                 |
| Min. Cycle Time                                      |     | 200       |     | ns   |                 |            |                        |                |                 |

## LM5520/LM7520 and LM5521/LM7521

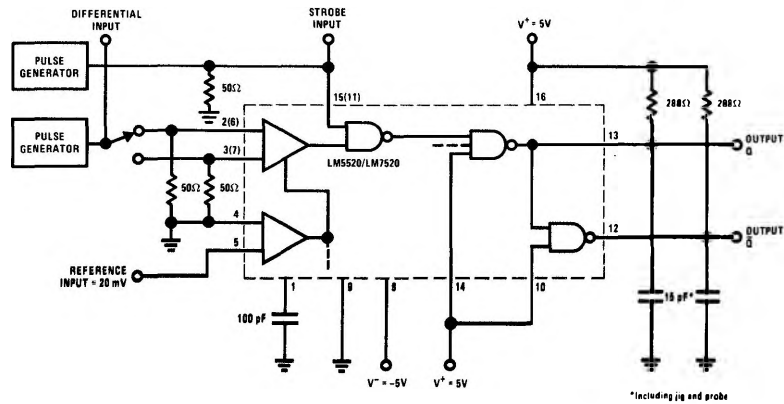
## schematic diagram



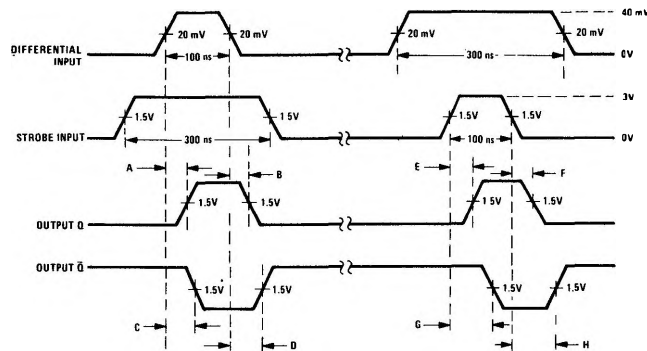
## connection diagram



## LM5520/LM7520 and LM5521/LM7521 AC test circuit (1)

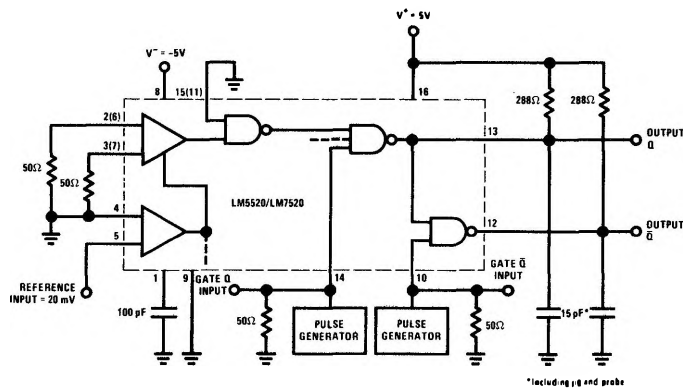


### voltage waveforms (1)

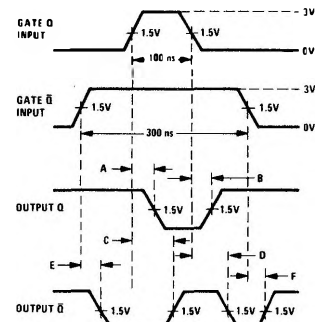


- Pulse generator characteristics:  
 $Z_{OUT} = 50\Omega$ ,  $t_r = t_f = 15 \pm 5$  ns, PRR = 1 MHz
- Propagation delays:  
 A = Differential input to logical "1" output Q  
 B = Differential input to logical "0" output Q  
 C = Differential input to logical "0" output Q-bar  
 D = Differential input to logical "1" output Q-bar  
 E = Strobe input to logical "1" output Q  
 F = Strobe input to logical "0" output Q  
 G = Strobe input to logical "0" output Q-bar  
 H = Strobe input to logical "1" output Q-bar

### AC test circuit (2)



### voltage waveforms (2)



- Pulse generator characteristics:  
 $Z_{OUT} = 50\Omega$ ,  $t_r = t_f = 15 \pm 5$  ns, PRR = 1 MHz
- Propagation delays:  
 A = Gate Q input to logical "0" output Q  
 B = Gate Q input to logical "1" output Q  
 C = Gate Q input to logical "0" output Q-bar  
 D = Gate Q input to logical "1" output Q-bar  
 E = Gate Q-bar input to logical "0" output Q  
 F = Gate Q-bar input to logical "1" output Q