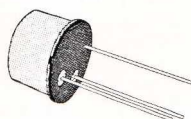


## HIGH SPEED SWITCHES

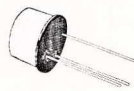
### DESCRIPTION

The 2N2218A, 2N2219A, 2N2221A and 2N2222A are silicon planar epitaxial NPN transistors in Jedec TO-39 (for 2N2218A and 2N2219A) and in Jedec TO-18 (for 2N2221A and 2N2222A) metal cases. They are designed for high-speed switching applications at collector currents up to 500 mA, and feature useful current gain over a wide range of collector current, low leakage currents and low saturation voltages.

☞ 2N2218A/2N2219A approved to CECC 50002-100, 2N2221A/2N2222A approved to CECC 50002-101 available on request.

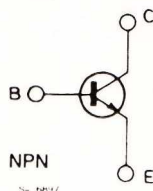


TO-39



TO-18

### INTERNAL SCHEMATIC DIAGRAM



### ABSOLUTE MAXIMUM RATINGS

| Symbol    | Parameter                                                  | Value       | Unit             |
|-----------|------------------------------------------------------------|-------------|------------------|
| $V_{CBO}$ | Collector-base Voltage ( $I_E = 0$ )                       | 75          | V                |
| $V_{CEO}$ | Collector-emitter Voltage ( $I_B = 0$ )                    | 40          | V                |
| $V_{EBO}$ | Emitter-base Voltage ( $I_C = 0$ )                         | 6           | V                |
| $I_C$     | Collector Current                                          | 0.8         | A                |
| $P_{tot}$ | Total Power Dissipation at $T_{amb} \leq 25^\circ\text{C}$ |             |                  |
|           | for 2N2218A and 2N2219A                                    | 0.8         | W                |
|           | for 2N2221A and 2N2222A                                    | 0.5         | W                |
|           | at $T_{case} \leq 25^\circ\text{C}$                        |             |                  |
|           | for 2N2218A and 2N2219A                                    | 3           | W                |
|           | for 2N2221A and 2N2222A                                    | 1.8         | W                |
| $T_{stg}$ | Storage Temperature                                        | - 65 to 200 | $^\circ\text{C}$ |
| $T_j$     | Junction Temperature                                       | 175         | $^\circ\text{C}$ |

## THERMAL DATA

|                  |                                     |     | 2N2218A<br>2N2219A | 2N2221A<br>2N2222A |
|------------------|-------------------------------------|-----|--------------------|--------------------|
| $R_{th\ j-case}$ | Thermal Resistance Junction-case    | Max | 50 °C/W            | 83.3 °C/W          |
| $R_{th\ j-amb}$  | Thermal Resistance Junction-ambient | Max | 187.5 °C/W         | 300 °C/W           |

ELECTRICAL CHARACTERISTICS ( $T_{amb} = 25\text{ °C}$  unless otherwise specified)

| Symbol            | Parameter                                              | Test Conditions                                                                                                                                                                                                                                                                                                                                                                                               | Min.                                    | Typ. | Max.     | Unit     |
|-------------------|--------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------|------|----------|----------|
| $I_{CBO}$         | Collector Cutoff Current<br>( $I_E = 0$ )              | $V_{CB} = 60\text{ V}$<br>$V_{CB} = 60\text{ V}$ $T_{amb} = 150\text{ °C}$                                                                                                                                                                                                                                                                                                                                    |                                         |      | 10<br>10 | nA<br>μA |
| $I_{CEX}$         | Collector Cutoff Current<br>( $V_{BE} = -3\text{ V}$ ) | $V_{CE} = 60\text{ V}$                                                                                                                                                                                                                                                                                                                                                                                        |                                         |      | 10       | nA       |
| $I_{EBO}$         | Emitter Cutoff Current<br>( $I_C = 0$ )                | $V_{EB} = 3\text{ V}$                                                                                                                                                                                                                                                                                                                                                                                         |                                         |      | 10       | nA       |
| $I_{BEX}$         | Base Cutoff Current<br>( $V_{BE} = -3\text{ V}$ )      | $V_{CE} = 60\text{ V}$                                                                                                                                                                                                                                                                                                                                                                                        |                                         |      | 20       | nA       |
| $V_{(BR)\ CBO}$   | Collector-base Breakdown<br>Voltage ( $I_E = 0$ )      | $I_C = 10\text{ μA}$                                                                                                                                                                                                                                                                                                                                                                                          | 75                                      |      |          | V        |
| $V_{(BR)\ CEO}^*$ | Collector-emitter Breakdown<br>Voltage ( $I_B = 0$ )   | $I_C = 10\text{ mA}$                                                                                                                                                                                                                                                                                                                                                                                          | 40                                      |      |          | V        |
| $V_{(BR)\ EBO}$   | Emitter-base Breakdown<br>Voltage ( $I_C = 0$ )        | $I_E = 10\text{ μA}$                                                                                                                                                                                                                                                                                                                                                                                          | 6                                       |      |          | V        |
| $V_{CE(sat)}^*$   | Collector-emitter Saturation<br>Voltage                | $I_C = 150\text{ mA}$ $I_B = 15\text{ mA}$<br>$I_C = 500\text{ mA}$ $I_B = 50\text{ mA}$                                                                                                                                                                                                                                                                                                                      |                                         |      | 0.3<br>1 | V<br>V   |
| $V_{BE(sat)}^*$   | Base-emitter Saturation<br>Voltage                     | $I_C = 150\text{ mA}$ $I_B = 15\text{ mA}$<br>$I_C = 500\text{ mA}$ $I_B = 50\text{ mA}$                                                                                                                                                                                                                                                                                                                      | 0.6                                     |      | 1.2<br>2 | V<br>V   |
| $h_{FE}^*$        | DC Current Gain                                        | for <b>2N2218A</b> and <b>2N2221A</b><br>$I_C = 0.1\text{ mA}$ $V_{CE} = 10\text{ V}$<br>$I_C = 1\text{ mA}$ $V_{CE} = 10\text{ V}$<br>$I_C = 10\text{ mA}$ $V_{CE} = 10\text{ V}$<br>$I_C = 150\text{ mA}$ $V_{CE} = 10\text{ V}$<br>$I_C = 500\text{ mA}$ $V_{CE} = 10\text{ V}$<br>$I_C = 150\text{ mA}$ $V_{CE} = 1\text{ V}$<br>$I_C = 10\text{ mA}$ $V_{CE} = 10\text{ V}$<br>$T_{amb} = -55\text{ °C}$ | 20<br>25<br>35<br>40<br>25<br>20<br>15  |      | 120      |          |
| $h_{FE}^*$        | DC Current Gain                                        | for <b>2N2219A</b> and <b>2N2222A</b><br>$I_C = 0.1\text{ mA}$ $V_{CE} = 10\text{ V}$<br>$I_C = 1\text{ mA}$ $V_{CE} = 10\text{ V}$<br>$I_C = 10\text{ mA}$ $V_{CE} = 10\text{ V}$<br>$I_C = 150\text{ mA}$ $V_{CE} = 10\text{ V}$<br>$I_C = 500\text{ mA}$ $V_{CE} = 10\text{ V}$<br>$I_C = 150\text{ mA}$ $V_{CE} = 1\text{ V}$<br>$I_C = 10\text{ mA}$ $V_{CE} = 10\text{ V}$<br>$T_{amb} = -55\text{ °C}$ | 35<br>50<br>75<br>100<br>40<br>50<br>35 |      | 300      |          |

\* Pulsed : pulse duration = 300 μs, duty cycle = 1 %.

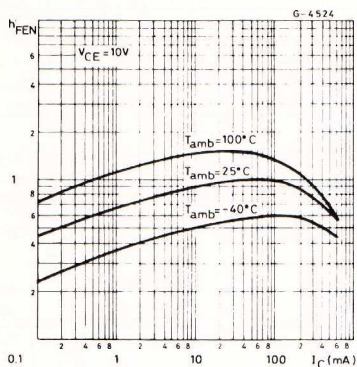
## ELECTRICAL CHARACTERISTICS (continued)

| Symbol            | Parameter                    | Test Conditions                                                                                                                                                                                                                                                                                                 | Min.                  | Typ. | Max.                                                                                   | Unit                                                             |
|-------------------|------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|------|----------------------------------------------------------------------------------------|------------------------------------------------------------------|
| $h_{ie}$          | Small Signal Current Gain    | $I_C = 1 \text{ mA}$ $V_{CE} = 10 \text{ V}$<br>$f = 1 \text{ kHz}$<br>for <b>2N2218A</b> and <b>2N2221A</b><br>for <b>2N2219A</b> and <b>2N2222A</b><br>$I_C = 10 \text{ mA}$ $V_{CE} = 10 \text{ V}$<br>$f = 1 \text{ kHz}$<br>for <b>2N2218A</b> and <b>2N2221A</b><br>for <b>2N2219A</b> and <b>2N2222A</b> | 30<br>50<br>50<br>75  |      | 150<br>300<br>300<br>375                                                               |                                                                  |
| $f_T$             | Transition Frequency         | $I_C = 20 \text{ mA}$ $V_{CE} = 20 \text{ V}$<br>$f = 100 \text{ MHz}$<br>for <b>2N2218A</b> and <b>2N2221A</b><br>for <b>2N2219A</b> and <b>2N2222A</b>                                                                                                                                                        | 250<br>300            |      |                                                                                        | MHz<br>MHz                                                       |
| $C_{EBO}$         | Emitter-base Capacitance     | $I_C = 0$ $V_{EB} = 0.5 \text{ V}$<br>$f = 100 \text{ kHz}$                                                                                                                                                                                                                                                     |                       |      | 25                                                                                     | pF                                                               |
| $C_{CBO}$         | Collector-base Capacitance   | $I_E = 0$ $V_{CB} = 10 \text{ V}$<br>$f = 100 \text{ kHz}$                                                                                                                                                                                                                                                      |                       |      | 8                                                                                      | pF                                                               |
| $R_{e(hie)}$      | Real Part of Input Impedance | $I_C = 20 \text{ mA}$ $V_{CE} = 20 \text{ V}$<br>$f = 300 \text{ MHz}$                                                                                                                                                                                                                                          |                       |      | 60                                                                                     | $\Omega$                                                         |
| NF                | Noise Figure                 | $I_C = 100 \mu\text{A}$ $V_{CE} = 10 \text{ V}$<br>$R_g = 1 \text{ k}\Omega$ $f = 1 \text{ kHz}$                                                                                                                                                                                                                |                       | 4    |                                                                                        | dB                                                               |
| $h_{ie}^{**}$     | Input Impedance              | $I_C = 1 \text{ mA}$ $V_{CE} = 10 \text{ V}$<br>for <b>2N2218A</b> and <b>2N2221A</b><br>for <b>2N2219A</b> and <b>2N2222A</b><br>$I_C = 10 \text{ mA}$ $V_{CE} = 10 \text{ V}$<br>for <b>2N2218A</b> and <b>2N2221A</b><br>for <b>2N2219A</b> and <b>2N2222A</b>                                               | 1<br>2<br>0.2<br>0.25 |      | 3.5<br>8<br>1<br>1.25                                                                  | $\Omega$<br>$\Omega$<br>$\Omega$<br>$\Omega$                     |
| $h_{re}^{**}$     | Reverse Voltage Ratio        | $I_C = 1 \text{ mA}$ $V_{CE} = 10 \text{ V}$<br>for <b>2N2218A</b> and <b>2N2221A</b><br>for <b>2N2219A</b> and <b>2N2222A</b><br>$I_C = 10 \text{ mA}$ $V_{CE} = 10 \text{ V}$<br>for <b>2N2218A</b> and <b>2N2221A</b><br>for <b>2N2219A</b> and <b>2N2222A</b>                                               |                       |      | $5 \times 10^{-4}$<br>$8 \times 10^{-4}$<br>$2.5 \times 10^{-4}$<br>$4 \times 10^{-4}$ |                                                                  |
| $h_{oe}^{**}$     | Output Admittance            | $I_C = 1 \text{ mA}$ $V_{CE} = 10 \text{ V}$<br>for <b>2N2218A</b> and <b>2N2221A</b><br>for <b>2N2219A</b> and <b>2N2222A</b><br>$I_C = 10 \text{ mA}$ $V_{CE} = 10 \text{ V}$<br>for <b>2N2218A</b> and <b>2N2221A</b><br>for <b>2N2219A</b> and <b>2N2222A</b>                                               | 3<br>5<br>10<br>25    |      | 15<br>35<br>100<br>200                                                                 | $\mu\text{S}$<br>$\mu\text{S}$<br>$\mu\text{S}$<br>$\mu\text{S}$ |
| $t_d^{***}$       | Delay Time                   | $I_C = 150 \text{ mA}$ $V_{CC} = 30 \text{ V}$<br>$I_{B1} = 15 \text{ mA}$ $V_{BB} = -0.5 \text{ V}$                                                                                                                                                                                                            |                       |      | 10                                                                                     | ns                                                               |
| $t_r^{***}$       | Rise Time                    | $I_C = 150 \text{ mA}$ $V_{CC} = 30 \text{ V}$<br>$I_{B1} = 15 \text{ mA}$ $V_{BB} = -0.5 \text{ V}$                                                                                                                                                                                                            |                       |      | 25                                                                                     | ns                                                               |
| $t_s^{***}$       | Storage Time                 | $I_C = 150 \text{ mA}$ $V_{CC} = 30 \text{ V}$<br>$I_{B1} = -I_{B2} = 15 \text{ mA}$                                                                                                                                                                                                                            |                       |      | 225                                                                                    | ns                                                               |
| $t_f^{***}$       | Fall Time                    | $I_C = 150 \text{ mA}$ $V_{CC} = 30 \text{ V}$<br>$I_{B1} = -I_{B2} = 15 \text{ mA}$                                                                                                                                                                                                                            |                       |      | 60                                                                                     | ns                                                               |
| $r_{bb'} C_{D'C}$ | Feedback Time Constant       | $I_C = 20 \text{ mA}$ $V_{CE} = 20 \text{ V}$<br>$f = 31.8 \text{ MHz}$                                                                                                                                                                                                                                         |                       |      | 150                                                                                    | ps                                                               |

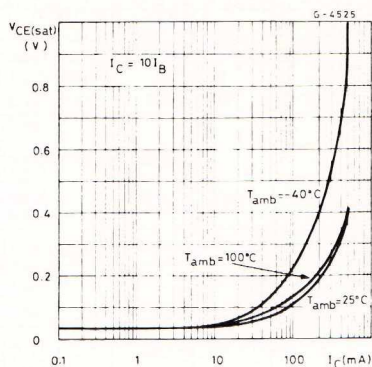
\*\*  $f = 1 \text{ kHz}$ 

\*\*\* see test circuit.

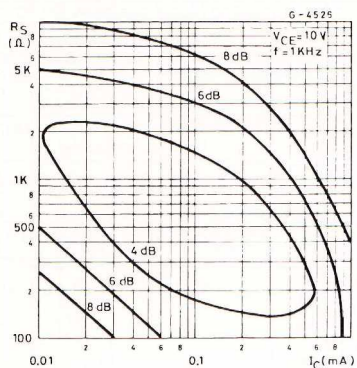
Normalized DC Current Gain.



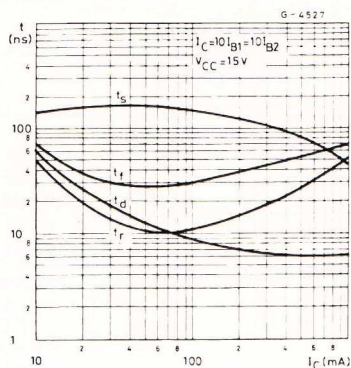
Collector-emitter Saturation Voltage.



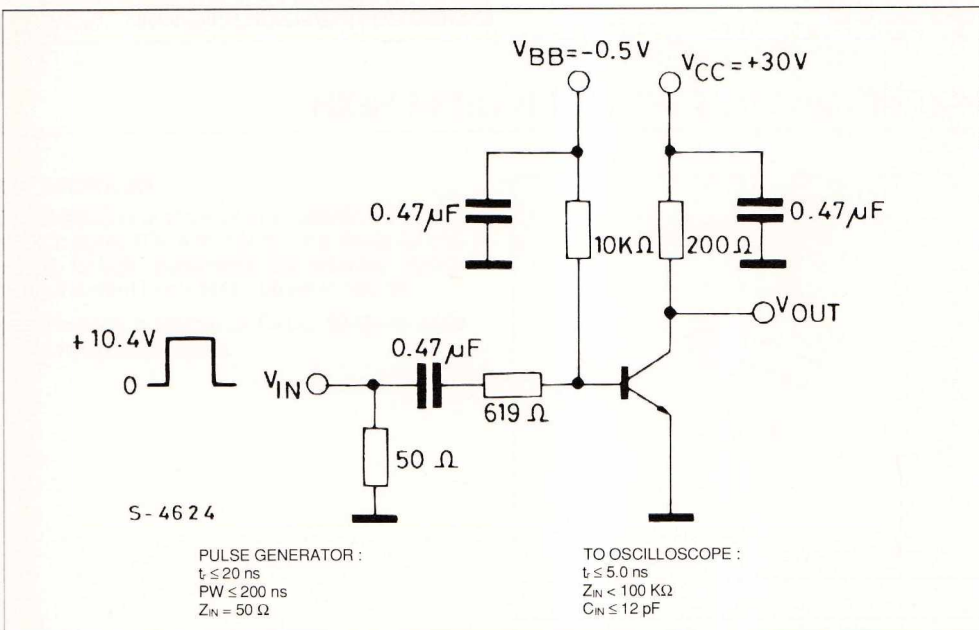
Contours of Constant Narrow Band Noise Figure.



Switching Time vs. Collector Current.





Test Circuit for  $t_d$ ,  $t_r$ .Test Circuit for  $t_d$ ,  $t_r$ .