

## Quality Semi-Conductors

# TYPES 2N1302, 2N1304, 2N1306, AND 2N1308

## N-P-N ALLOY-JUNCTION GERMANIUM TRANSISTORS

electrical characteristics at 25°C free-air temperature

| PARAMETER                                                           | TEST CONDITIONS                                               | 2N1302 |                    |      | 2N1304 |                    |      | 2N1306 |                    |      | 2N1308 |                    |      | UNIT      |
|---------------------------------------------------------------------|---------------------------------------------------------------|--------|--------------------|------|--------|--------------------|------|--------|--------------------|------|--------|--------------------|------|-----------|
|                                                                     |                                                               | MIN    | TYP                | MAX  | MIN    | TYP                | MAX  | MIN    | TYP                | MAX  | MIN    | TYP                | MAX  |           |
| $BV_{CBO}$ Collector-Base Breakdown Voltage                         | $I_C = 100 \mu A, I_E = 0$                                    | 25     | —                  | —    | 25     | —                  | —    | 25     | —                  | —    | 25     | —                  | —    | v         |
| $BV_{EBO}$ Emitter-Base Breakdown Voltage                           | $I_E = 100 \mu A, I_C = 0$                                    | 25     | —                  | —    | 25     | —                  | —    | 25     | —                  | —    | 25     | —                  | —    | v         |
| $^*V_{PT}$ Punch Through Voltage†                                   | $V_{EBI} = 1 \text{ v}$                                       | 25     | —                  | —    | 20     | —                  | —    | 15     | —                  | —    | 15     | —                  | —    | v         |
| $^*I_{CBO}$ Collector Cutoff Current                                | $V_{CB} = 25 \text{ v}, I_E = 0$                              | —      | 3                  | 6    | —      | 3                  | 6    | —      | 3                  | 6    | —      | 3                  | 6    | $\mu A$   |
| $^*I_{EBO}$ Emitter Cutoff Current                                  | $V_{EB} = 25 \text{ v}, I_C = 0$                              | —      | 2                  | 6    | —      | 2                  | 6    | —      | 2                  | 6    | —      | 2                  | 6    | $\mu A$   |
| $^*h_{FE}$ Static Forward Current Transfer Ratio                    | $V_{CE} = 1 \text{ v}, I_C = 10 \text{ ma}$                   | 20     | 100                | —    | 40     | 115                | 200  | 60     | 130                | 300  | 80     | 160                | —    | —         |
|                                                                     | $V_{CE} = 0.35 \text{ v}, I_C = 200 \text{ ma}$               | 10     | 100                | —    | 15     | 110                | —    | 20     | 125                | —    | 20     | 140                | —    | —         |
| $^*V_{BE}$ Base-Emitter Voltage                                     | $I_B = 0.5 \text{ ma}, I_C = 10 \text{ ma}$                   | 0.15   | 0.22               | 0.40 | 0.15   | 0.22               | 0.35 | 0.15   | 0.22               | 0.35 | 0.15   | 0.22               | 0.35 | v         |
| $^*V_{CE(sat)}$ Collector-Emitter Saturation Voltage                | $I_B = 0.5 \text{ ma}, I_C = 10 \text{ ma}$                   | —      | 0.07               | 0.20 | —      | —                  | —    | —      | —                  | —    | —      | —                  | —    | v         |
|                                                                     | $I_B = 0.25 \text{ ma}, I_C = 10 \text{ ma}$                  | —      | —                  | —    | —      | 0.07               | 0.20 | —      | —                  | —    | —      | —                  | —    | v         |
|                                                                     | $I_B = 0.17 \text{ ma}, I_C = 10 \text{ ma}$                  | —      | —                  | —    | —      | —                  | —    | —      | 0.07               | 0.20 | —      | —                  | —    | v         |
|                                                                     | $I_B = 0.13 \text{ ma}, I_C = 10 \text{ ma}$                  | —      | —                  | —    | —      | —                  | —    | —      | —                  | —    | —      | 0.07               | 0.20 | v         |
| $h_{ib}$ Small-Signal Common-Base Input Impedance                   | $V_{CB} = 5 \text{ v}, I_E = -1 \text{ ma}, f = 1 \text{ kc}$ | —      | 20                 | —    | —      | 20                 | —    | —      | 20                 | —    | —      | 20                 | —    | ohm       |
| $h_{rb}$ Small-Signal Common-Base Reverse Voltage Transfer Ratio    | $V_{CB} = 5 \text{ v}, I_E = -1 \text{ ma}, f = 1 \text{ kc}$ | —      | $5 \times 10^{-4}$ | —    | —      | $5 \times 10^{-4}$ | —    | —      | $5 \times 10^{-4}$ | —    | —      | $5 \times 10^{-4}$ | —    | —         |
| $h_{ob}$ Small-Signal Common-Base Output Admittance                 | $V_{CB} = 5 \text{ v}, I_E = -1 \text{ ma}, f = 1 \text{ kc}$ | —      | 0.34               | —    | —      | 0.34               | —    | —      | 0.34               | —    | —      | 0.34               | —    | $\mu mho$ |
| $h_{fe}$ Small-Signal Common-Emitter Forward Current Transfer Ratio | $V_{CE} = 5 \text{ v}, I_C = 1 \text{ ma}, f = 1 \text{ kc}$  | —      | 105                | —    | —      | 120                | —    | —      | 135                | —    | —      | 170                | —    | —         |
| $^*f_{hfb}$ Common-Base Alpha-Cutoff Frequency                      | $V_{CB} = 5 \text{ v}, I_E = -1 \text{ ma}$                   | 3      | 12                 | —    | 5      | 14                 | —    | 10     | 16                 | —    | 15     | 20                 | —    | mc        |
| $^*C_{ob}$ Common-Base Open Circuit Output Capacitance              | $V_{CB} = 5 \text{ v}, I_E = 0, f = 1 \text{ mc}$             | —      | 14                 | 20   | —      | 14                 | 20   | —      | 14                 | 20   | —      | 14                 | 20   | pf        |
| $C_{ib}$ Common-Base Open-Circuit Input Capacitance                 | $V_{EB} = 5 \text{ v}, I_C = 0, f = 1 \text{ mc}$             | —      | 13                 | —    | —      | 13                 | —    | —      | 13                 | —    | —      | 13                 | —    | pf        |

† $V_{PT}$  is determined by measuring the emitter-base floating potential  $V_{EBI}$ . The collector-base voltage,  $V_{CB}$ , is increased until  $V_{EBI} = 1$  volt; this value of  $V_{CB} = (V_{PT} + 1 \text{ v})$ .

switching characteristics at 25°C free-air temperature

| PARAMETER                   | TEST CONDITIONS††                                                                                                                                          | 2N1302 |      |     | 2N1304 |      |     | 2N1306 |      |     | 2N1308 |      |     | UNIT      |
|-----------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|------|-----|--------|------|-----|--------|------|-----|--------|------|-----|-----------|
|                             |                                                                                                                                                            | MIN    | TYP  | MAX | MIN    | TYP  | MAX | MIN    | TYP  | MAX | MIN    | TYP  | MAX |           |
| $t_d$ Delay Time            | $I_C = 10 \text{ ma}, I_{B(1)} = 1.3 \text{ ma}$<br>$I_{B(2)} = -0.7 \text{ ma}, V_{BE(Off)} = -0.8 \text{ v}$<br>$R_L = 1 \text{ k } \Omega$ (See Fig. 1) | —      | 0.07 | —   | —      | 0.07 | —   | —      | 0.06 | —   | —      | 0.06 | —   | $\mu sec$ |
| $t_r$ Rise Time             |                                                                                                                                                            | —      | 0.20 | —   | —      | 0.20 | —   | —      | 0.18 | —   | —      | 0.15 | —   | $\mu sec$ |
| $t_s$ Storage Time          |                                                                                                                                                            | —      | 0.70 | —   | —      | 0.70 | —   | —      | 0.64 | —   | —      | 0.64 | —   | $\mu sec$ |
| $t_f$ Fall Time             |                                                                                                                                                            | —      | 0.40 | —   | —      | 0.40 | —   | —      | 0.36 | —   | —      | 0.34 | —   | $\mu sec$ |
| $Q_{sb}$ Stored Base Charge | $I_{B(1)} = 1 \text{ ma}, I_C = 10 \text{ ma}$ (See Fig. 2)                                                                                                | —      | 800  | —   | —      | 760  | —   | —      | 720  | —   | —      | 680  | —   | pcb       |

††Voltage and current values shown are nominal; exact values vary slightly with device parameters.

operating characteristics at 25°C free-air temperature

| PARAMETER            | TEST CONDITIONS                                                                                  | 2N1302 |     |     | 2N1304 |     |     | 2N1306 |     |     | 2N1308 |     |     | UNIT |
|----------------------|--------------------------------------------------------------------------------------------------|--------|-----|-----|--------|-----|-----|--------|-----|-----|--------|-----|-----|------|
|                      |                                                                                                  | MIN    | TYP | MAX | MIN    | TYP | MAX | MIN    | TYP | MAX | MIN    | TYP | MAX |      |
| NF Spot Noise Figure | $V_{CB} = 5 \text{ v}$<br>$I_B = -1 \text{ ma}$<br>$f = 1 \text{ kc}, R_G = 1 \text{ k } \Omega$ | —      | 4   | —   | —      | 4   | —   | —      | 3   | —   | —      | 3   | —   | db   |