

**2N2893-2N2967**

| TYPE    | MATERIAL | POLARITY | REPLACE-<br>MENT | PAGE<br>NUMBER | USE  | MAXIMUM RATINGS |           |                |                 |                   | ELECTRICAL CHARACTERISTICS |                 |                  |                                       |                 |           |                |           |      |   |
|---------|----------|----------|------------------|----------------|------|-----------------|-----------|----------------|-----------------|-------------------|----------------------------|-----------------|------------------|---------------------------------------|-----------------|-----------|----------------|-----------|------|---|
|         |          |          |                  |                |      | P <sub>D</sub>  | Ref Point | T <sub>J</sub> | V <sub>CB</sub> | V <sub>CE</sub> — | Subscript                  | h <sub>FE</sub> | @ I <sub>C</sub> | V <sub>CE(SAT)</sub> @ I <sub>C</sub> | h <sub>FE</sub> | Subscript | f <sub>T</sub> | Subscript |      |   |
|         |          |          |                  |                |      | @ 25°C          | °C        | (volts)        | (volts)         | (min)             | (max)                      | Units           | Units            | Units                                 | Units           | Units     | Units          |           |      |   |
| 2N2893  | S        | N        |                  | 8-165          | PMS  | 30W             | C         | 200            | 100             | 80                | 0                          | 50              | 150              | 1.0A                                  | 0.5             | 1.0A      | 50             | E         | 30M  | T |
| 2N2894  | S        | N        | MSS              |                | 360M | A               | 200       | 12             | 12              | 0                 | 40                         | 150             | 30M              | 0.15                                  | 10M             |           |                | 400M      | T    |   |
| 2N2894A | S        | N        | PMS              |                | 360M | A               | 200       | 12             | 12              | S                 | 40                         |                 | 30M              |                                       |                 |           |                | 800M      | T    |   |
| 2N2895  | S        | N        | NSA              |                | 500M | A               | 200       | 120            | 65              | 0                 | 40                         | 120             | 150M             | 0.6                                   | 150M            | 50        | E              | 120M      | T    |   |
| 2N2896  | S        | N        | MSA              |                | 500M | A               | 200       | 140            | 90              | 0                 | 60                         | 200             | 150M             | 0.6                                   | 150M            | 50        | E              | 120M      | T    |   |
| 2N2897  | S        | N        | MSA              | 500M           | A    | 200             | 60        | 45             | 0               | 50                | 200                        | 150M            | 1.0              | 150M                                  | 50              | E         | 120M           | T         |      |   |
| 2N2898  | S        | N        | MSA              | 500M           | A    | 200             | 120       | 65             | 0               | 40                | 120                        | 150M            | 0.6              | 150M                                  | 50              | E         | 120M           | T         |      |   |
| 2N2899  | S        | N        | MSA              | 500M           | A    | 200             | 140       | 90             | 0               | 60                | 200                        | 150M            | 0.6              | 150M                                  | 50              | E         | 120M           | T         |      |   |
| 2N2900  | S        | N        | MSA              | 500M           | A    | 200             | 60        | 45             | 0               | 50                | 200                        | 150M            | 1.0              | 150M                                  | 50              | E         | 120M           | T         |      |   |
| 2N2901  | S        | N        | CHP              | 0.36W          | A    | 200             | 20        | 10             | 0               | 30                |                            | 10M             | 0.15             | 10M                                   | 300M            | T         |                |           |      |   |
| 2N2902  | S        | N        | LPA              | 40W            | C    | 200             | 120       | 120            | 0               | 30                | 90                         | 500M            | 7.5              | 500M                                  | 30              | E         | 2.0M           | T         |      |   |
| 2N2903  | S        | N        | 2N2917           | 11-27          | DFA  | 600M            | C         | 200            | 60              | 30                | 0                          | 125             | 625              | 1.0M                                  | 1.0             | 5.0M      | 150            | E         | 60M  | T |
| 2N2903A | S        | N        | 2N2915           | 11-27          | DFA  | 600M            | C         | 200            | 60              | 30                | 0                          | 125             | 625              | 1.0M                                  | 1.0             | 5.0M      | 150            | E         | 60M  | T |
| 2N2904  | S        | N        |                  | 8-169          | HSS  | 3.0W            | C         | 200            | 60              | 40                | 0                          | 120             | 150M             | 0.4                                   | 150M            |           |                | 200M      | T    |   |
| 2N2904A | S        | N        |                  | 8-169          | HSS  | 3.0W            | C         | 200            | 60              | 40                | 0                          | 120             | 150M             | 0.4                                   | 150M            |           |                | 200M      | T    |   |
| 2N2905  | S        | N        |                  | 8-169          | HSS  | 3.0W            | C         | 200            | 60              | 40                | 0                          | 100             | 300              | 150M                                  | 0.4             | 150M      |                |           | 200M | T |
| 2N2905A | S        | N        |                  | 8-169          | HSS  | 3.0W            | C         | 200            | 60              | 40                | 0                          | 100             | 300              | 150M                                  | 0.4             | 150M      |                |           | 200M | T |
| 2N2906  | S        | N        |                  | 8-169          | HSS  | 1.8W            | C         | 200            | 60              | 40                | 0                          | 120             | 150M             | 0.4                                   | 150M            |           |                | 200M      | T    |   |
| 2N2907  | S        | N        |                  | 8-169          | HSS  | 1.8W            | C         | 200            | 60              | 40                | 0                          | 100             | 300              | 150M                                  | 0.4             | 150M      |                |           | 200M | T |
| 2N2907A | S        | N        |                  | 8-169          | HSS  | 1.8W            | C         | 200            | 60              | 40                | 0                          | 100             | 300              | 150M                                  | 0.4             | 150M      |                |           | 200M | T |
| 2N2908  | S        | N        |                  |                | LPA  | 75W             | C         | 200            | 80              | 80                | R                          | 12              | 60               | 1.0A                                  | 1.0             | 1.0A      | 10             | E         | 1.0M | T |
| 2N2909  | S        | N        |                  |                | HSA  | 0.4W            | A         | 200            | 60              | 40                | 0                          | 40              | 120              | 0.15A                                 | 0.25            | 0.15A     | 50             | E         | 50M  | T |
| 2N2910  | S        | N        | 2N3409           | 11-33          | DFA  | 0.3W            | A         | 200            | 45              | 25                | 0                          | 70              |                  | 0.1M                                  | 1.0             | 10M       | 50             | E         | 11M  | T |
| 2N2911  | S        | N        | 2N3766           | 7-142          | PMS  | 5.0W            | C         | 200            | 150             | 125               | 0                          | 20              | 60               | 1.0A                                  | 0.3             | 1.0A      |                |           | 1.0M | T |
| 2N2912  | G        | P        |                  | 7-97           | PMS  | 75W             | C         | 110            | 15              | 6.0               | 0                          | 75              |                  | 10A                                   | 0.5             | 25A       |                |           | 20M  | T |
| 2N2913  | S        | N        |                  | 11-27          | DFA  | 300M            | A         | 200            | 45              | 45                | 0                          | 60              | 240              | 10*                                   | 0.35            | 1.0M      |                |           | 60M  | T |
| 2N2914  | S        | N        |                  | 11-27          | DFA  | 300M            | A         | 200            | 45              | 45                | 0                          | 150             | 600              | 10*                                   | 0.35            | 1.0M      |                |           | 60M  | T |
| 2N2915  | S        | N        |                  | 11-27          | DFA  | 300M            | A         | 200            | 45              | 45                | 0                          | 60              | 240              | 10*                                   | 0.35            | 1.0M      |                |           | 60M  | T |
| 2N2915A | S        | N        |                  |                | AFA  | 300M            | A         | 200            | 45              | 45                | 0                          |                 |                  |                                       |                 |           | 240            | E         | 60M  | T |
| 2N2916  | S        | N        |                  | 11-27          | DFA  | 300M            | A         | 200            | 45              | 45                | 0                          | 150             | 600              | 10*                                   | 0.35            | 1.0M      |                |           | 60M  | T |
| 2N2916A | S        | N        |                  |                | AFA  | 300M            | A         | 200            | 45              | 45                | 0                          |                 |                  |                                       |                 |           | 600            | E         | 60M  | T |
| 2N2917  | S        | N        |                  | 11-27          | DFA  | 0.3W            | A         | 200            | 45              | 45                | 0                          | 60              | 240              | 10*                                   | 0.35            | 1.0M      |                |           | 60M  | T |
| 2N2918  | S        | N        |                  | 11-27          | DFA  | 0.3W            | A         | 200            | 45              | 45                | 0                          | 150             | 600              | 10*                                   | 0.35            | 1.0M      |                |           | 60M  | T |
| 2N2919  | S        | N        |                  | 11-27          | DFA  | 0.3W            | A         | 200            | 60              | 60                | 0                          | 60              | 240              | 10*                                   | 0.35            | 1.0M      |                |           | 60M  | T |
| 2N2919A | S        | N        |                  |                | AFA  | 300M            | A         | 200            | 60              | 60                | 0                          |                 |                  |                                       |                 |           | 240            | E         | 60M  | T |
| 2N2920  | S        | N        |                  | 11-27          | DFA  | 0.3W            | A         | 200            | 60              | 60                | 0                          | 150             | 600              | 10*                                   | 0.35            | 1.0M      |                |           | 60M  | T |
| 2N2920A | S        | N        |                  |                | AFA  | 300M            | A         | 200            | 60              | 60                | 0                          |                 |                  |                                       |                 |           | 600            | E         | 60M  | T |
| 2N2921  | S        | N        |                  |                | AFA  | 0.2W            | A         | 125            | 25              | 25                | 0                          |                 |                  |                                       |                 |           | 35             | E         |      |   |
| 2N2922  | S        | N        | MPS6512          | 5-109          | AFA  | 0.2W            | A         | 125            | 25              | 25                | 0                          |                 |                  |                                       |                 |           | 55             | E         |      |   |
| 2N2923  | S        | N        | MPS2923          | 5-84           | AFA  | 0.2W            | A         | 125            | 25              | 25                | 0                          |                 |                  |                                       |                 |           | 90             | E         |      |   |
| 2N2924  | S        | N        | MPS2924          | 5-84           | AFA  | 0.2W            | A         | 125            | 25              | 25                | 0                          |                 |                  |                                       |                 |           | 150            | E         |      |   |
| 2N2925  | S        | N        | MPS2925          | 5-84           | AFA  | 0.2W            | A         | 125            | 25              | 25                | 0                          |                 |                  |                                       |                 |           | 235            | E         |      |   |
| 2N2926  | S        | N        | MPS2926          | 5-85           | AFA  | 0.2W            | A         | 125            | 18              | 18                | 0                          |                 |                  |                                       |                 |           | 35             | E         |      |   |
| 2N2927  | S        | P        |                  |                | MNS  | 800M            | A         | 200            | 25              | 25                | 0                          | 30              | 130              | 50M                                   | 0.25            | 50M       |                |           | 100M | T |
| 2N2928  | G        | P        |                  |                | RFA  | 150M            | A         | 100            | 15              | 13                | 0                          | 0.8             | 200              | 2.0M                                  | 0.5             | 50M       | 0.10           | E         | 400M | T |
| 2N2929  | G        | P        |                  | 9-33           | RFA  | 750M            | C         | 100            | 25              | 10                | 0                          | 10              | 100              | 10M                                   | 0.5             | 50M       |                |           | 800M | T |
| 2N2930  | G        | P        | 2N3427           | 6-41           | MSS  | 250M            | A         | 100            | 30              | 12                | 0                          | 60              | 420              | 10M                                   | 0.25            | 100M      |                |           | 4.0M | T |
| 2N2931  | S        | N        |                  |                | AFC  | 50M             | A         | 125            | 5.0             | 5.0               | 0                          | 50              |                  | 50M                                   | 0.45            | 50M       | 30             | E         | 20M  | T |
| 2N2932  | S        | N        |                  |                | AFC  | 50M             | A         | 125            | 5.0             | 5.0               | 0                          | 70              |                  | 50M                                   | 0.45            | 50M       | 70             | E         | 20M  | T |
| 2N2933  | S        | N        |                  |                | AFC  | 50M             | A         | 125            | 45              | 30                | 0                          | 50              |                  | 50M                                   | 0.45            | 50M       | 45             | E         | 20M  | T |
| 2N2934  | S        | N        |                  |                | AFC  | 50M             | A         | 125            | 45              | 30                | 0                          | 70              |                  | 50M                                   | 0.45            | 50M       | 30             | E         | 20M  | T |
| 2N2935  | S        | N        |                  |                | AFC  | 50M             | A         | 125            | 45              | 30                | 0                          | 70              |                  | 50M                                   | 0.45            | 50M       | 70             | E         | 20M  | T |
| 2N2936  | S        | N        |                  |                | LPA  | 300M            | A         | 175            | 60              | 55                | 0                          | 100             | 300              | 10*                                   | 0.3             | 2.0M      | 150            | E         | 30M  | T |
| 2N2937  | S        | N        |                  |                | LPA  | 300M            | A         | 175            | 60              | 55                | 0                          | 100             | 300              | 10*                                   | 0.3             | 2.0M      | 150            | E         | 30M  | T |
| 2N2938  | S        | N        |                  |                | HSS  | 300M            | A         | 200            | 25              | 13                | 0                          | 30              |                  | 50M                                   | 0.4             | 50M       |                |           | 500M | T |
| 2N2939  | S        | N        |                  |                | HFA  | 0.8W            | A         | 300            | 75              | 60                | 0                          | 60              | 240              | 0.15A                                 | 0.75            | 0.15A     |                |           | 150M | T |
| 2N2940  | S        | N        |                  |                | HFA  | 0.8W            | A         | 300            | 120             | 80                | 0                          | 60              | 240              | 0.15A                                 | 0.75            | 0.15A     |                |           | 150M | T |
| 2N2941  | S        | N        |                  |                | HFA  | 0.8W            | A         | 200            | 150             | 100               | 0                          | 60              | 240              | 0.15A                                 |                 |           |                |           | 150M | T |
| 2N2942  | G        | P        |                  |                | HSS  | 150M            | A         | 100            | 50              | 25                | 0                          | 50              |                  | 10M                                   | 0.15            | 10M       |                |           | 150M | T |
| 2N2943  | G        | P        |                  |                | HSS  | 150M            | A         | 100            | 30              | 15                | 0                          | 30              |                  | 10M                                   | 0.2             | 10M       |                |           | 120M | T |
| 2N2944  | S        | P        |                  |                | CHP  | 400M            | A         | 175            | 15              | 10                | 0                          | 80              |                  | 1.0M                                  |                 |           |                |           | 10M  | T |
| 2N2944A | S        | P        |                  |                | CHP  | 400M            | A         | 200            | 15              | 10                | 0                          | 100             |                  | 1.0M                                  |                 |           |                |           | 15M  | T |
| 2N2945  | S        | P        |                  |                | CHP  | 400M            | A         | 175            | 25              | 20                | 0                          | 40              |                  | 1.0M                                  |                 |           |                |           | 5.0M | T |
| 2N2945A | S        | P        |                  |                | CHP  | 400M            | A         | 200            | 25              | 20                | 0                          | 100             |                  | 1.0M                                  |                 |           |                |           | 10M  | T |
| 2N2946  | S        | P        |                  |                | CHP  | 400M            | A         | 175            | 40              | 35                | 0                          | 30              |                  | 1.0M                                  |                 |           |                |           | 3.0M | T |
| 2N2946A | S        | P        |                  |                | CHP  | 400M            | A         | 200            | 40              | 35                | 0                          | 50              |                  | 1.0M                                  |                 |           |                |           | 5.0M | T |
| 2N2947  | S        | N        |                  | 9-35           | MFA  | 25W             | C         | 175            | 60              | 60                | S                          | 2.5             | 55               | 0.4A                                  | 0.5             | 1.0A      |                |           | 100M | T |
| 2N2948  | S        | N        |                  | 9-35           | MFA  | 25W             | C         | 175            | 40              | 40                | S                          | 2.5             | 100              | 0.4A                                  | 0.5             | 1.0A      |                |           | 100M | T |
| 2N2949  | S        | N        |                  | 9-38           | MFA  | 6.0W            | C         | 175            | 60              | 60                | S                          | 5.0             | 100              | 40M                                   | 0.5             | 0.4A      |                |           | 100M | T |
| 2N2950  | S        | N        |                  | 9-38           | MFA  | 6.0W            | C         | 175            | 60              | 60                | S                          | 5.0             | 100              | 40M                                   | 0.5             | 0.4A      |                |           | 100M | T |
| 2N2951  | S        | N        |                  | 9-40           | MFA  | 3.0W            | C         | 175            | 60              | 60                | S                          | 20              | 150              | 10M                                   | 0.5             | 0.15A     |                |           | 200M | T |
| 2N2952  | S        | N        |                  | 9-40           | MFA  | 1.8W            | C         | 175            | 60              | 60                | S                          | 20              | 150              | 10M                                   | 0.5             | 0.15A     |                |           | 200M | T |
| 2N2953  | G        | P        | 2N1194           | 6-30           | AFC  | 120M            | A         | 100            | 30              | 25                | R                          | 100             |                  | 50M                                   |                 |           | 200            | E         | 300M | T |
| 2N2954  | S        | N        |                  |                | RFA  | 200M            | A         | 200            | 30              | 20                | 0                          | 25              | 300              | 2.0M                                  |                 |           | 25             | E         | 200M | T |
| 2N2955  | G        | P        |                  | 8-173          | HSS  | 0.15W           | A         | 100            | 40              | 40                |                            | 20              | 60               | 50M                                   | 0.2             | 10M       |                |           | 200M | T |

## GENERAL PURPOSE SWITCHING AND AMPLIFIER TRANSISTORS (SILICON)

### Current versus Voltage

| BV <sub>CEO</sub><br>Min<br>Volts | OPTIMUM COLLECTOR CURRENT                                              |                                        |                                                                        |                                                |                                                                              |                                                                              |                  |                  |                  |     |
|-----------------------------------|------------------------------------------------------------------------|----------------------------------------|------------------------------------------------------------------------|------------------------------------------------|------------------------------------------------------------------------------|------------------------------------------------------------------------------|------------------|------------------|------------------|-----|
|                                   | 0 to 10 mA                                                             |                                        | 10 mA to 100 mA                                                        |                                                | 100 mA to 500 mA                                                             |                                                                              | 500 mA to 1.0 A  |                  | 1.0 A to 3.0 A   |     |
|                                   | NPN                                                                    | PNP                                    | NPN                                                                    | PNP                                            | NPN                                                                          | PNP                                                                          | NPN              | PNP              | NPN              | PNP |
| 15<br>↓<br>29                     | 2N916<br>2N2330<br>2N2331                                              |                                        | 2N916<br>2N1983<br>2N1984                                              |                                                | 2N696<br>2N697<br>2N718<br>2N1420<br>2N2195                                  | 2N1991                                                                       |                  |                  |                  |     |
| 30<br>↓<br>39                     |                                                                        |                                        | 2N2218<br>2N2219<br>2N2221<br>2N2222                                   | 2N3133<br>2N3134<br>2N3135<br>2N3136           | 2N2218<br>2N2219<br>2N2221<br>2N2222<br>2N3299<br>2N3300<br>2N3301<br>2N3302 | 2N2800<br>2N2801<br>2N2837<br>2N2838<br>2N3133<br>2N3134<br>2N3135<br>2N3136 |                  |                  |                  |     |
| 49<br>↓<br>59                     | 2N758<br>2N795<br>2N760<br>2N915<br>2N929<br>2N930<br>2N3946<br>2N3947 | 2N3250<br>2N3251<br>MM4048             | 2N2218A<br>2N2219A<br>2N2221A<br>2N2222A<br>2N2224<br>2N3946<br>2N3947 | 2N3250<br>2N3251                               | 2N2194<br>2N2218A<br>2N2219A<br>2N2221A<br>2N2222A                           | 2N2904<br>2N2905<br>2N2906<br>2N2907<br>2N3485<br>2N3486<br>2N4890           | 2N2192<br>2N2193 | 2N3244<br>2N3245 | 2N3506<br>2N3507 |     |
| 60<br>↓<br>79                     | 2N758A<br>2N759A<br>2N760A<br>2N929A<br>2N930A<br>MM2483<br>MM2484     | 2N3798<br>2N3799<br>2N3250A<br>2N3251A | 2N910<br>2N911<br>2N1990                                               | 2N3250A<br>2N3251A                             | 2N656<br>2N699                                                               | 2N2904A<br>2N2905A<br>2N2906A<br>2N2907A<br>2N3485A<br>2N3486A               |                  |                  |                  |     |
| 80<br>↓<br>99                     | 2N739<br>2N740                                                         | 2N3494<br>2N3496                       | 2N720A<br>2N1893<br>2N2405                                             | 2N3494<br>2N3496                               | 2N720A<br>2N3019<br>2N3020                                                   |                                                                              | 2N3019<br>2N3020 |                  |                  |     |
| 100<br>↓<br>149                   | 2N4924                                                                 | 2N3495<br>2N3497<br>2N4928             | 2N3498<br>2N3499<br>2N4924                                             | 2N3495<br>2N3497<br>2N3634<br>2N3635<br>2N4928 | 2N3498<br>2N3499<br>2N4924                                                   | 2N3634<br>2N3635                                                             |                  |                  |                  |     |
| 150<br>↓<br>249                   | 2N3114<br>2N4925<br>2N4926                                             | 2N4929<br>2N4930                       | 2N3500<br>2N3501<br>2N4925<br>2N4926                                   | 2N3635<br>2N3637<br>2N4929<br>2N4930           | 2N3500<br>2N3501<br>2N4925                                                   | 2N3636<br>2N3637                                                             |                  |                  |                  |     |
| 250<br>UP                         | 2N3742<br>2N4927                                                       | 2N3743<br>2N4931                       | 2N3742<br>2N4927                                                       | 2N3743<br>2N4931                               |                                                                              |                                                                              |                  |                  |                  |     |

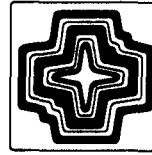
**2N2218** (SILICON)

**2N2219**

**2N2221**

**2N2222**

**2N2904 thru 2N2907**

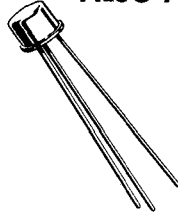


$V_{CEO} = 30-40\text{ V}$   
 $f_T = 400\text{ MHz Typ}$

**ALSO AVAILABLE AS JAN AND HI-REL UNITS**



**CASE 22**  
(TO-18)



**CASE 31**  
(TO-5)

**2N2221**

**2N2222**

**2N2906**

**2N2907**

**2N2218, 2N2219,**

**2N2904, 2N2905**

Silicon annular star transistors for high-speed switching and DC to UHF amplifier applications. NPN types 2N2218 thru 2N2222 are complementary to PNP types 2N2904 thru 2N2907.

Collector connected to case

**MAXIMUM RATINGS**

| Rating                                                                                                                                                                                                                                          | Symbol    | NPN         | PNP         | Unit  |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|-------------|-------------|-------|
| Collector - Base Voltage                                                                                                                                                                                                                        | $V_{CB}$  | 60          | 60          | Vdc   |
| Collector - Emitter Voltage                                                                                                                                                                                                                     | $V_{CEO}$ | 30          | 40          | Vdc   |
| Emitter - Base Voltage                                                                                                                                                                                                                          | $V_{EB}$  | 5           | 5           | Vdc   |
| Collector Current                                                                                                                                                                                                                               | $I_C$     | 800         | 600         | mA dc |
| Total Device Dissipation<br>@ 25°C Case Temperature<br>To - 5: 2N2218, 2N2219<br>Derate Above 25°C<br><br>2N2904, 2N2905<br>Derate Above 25°C<br><br>To - 18: 2N2221, 2N2222<br>Derate Above 25°C<br><br>2N2906, 2N2907<br>Derate Above 25°C    | $P_D$     | 3           |             | W     |
|                                                                                                                                                                                                                                                 |           | 20          |             | mW/°C |
|                                                                                                                                                                                                                                                 |           |             | 3           | W     |
|                                                                                                                                                                                                                                                 |           |             | 17.2        | mW/°C |
| Total Device Dissipation<br>@ 25°C Ambient Temperature<br>To - 5: 2N2218, 2N2219<br>Derate Above 25°C<br><br>2N2904, 2N2905<br>Derate Above 25°C<br><br>To - 18: 2N2221, 2N2222<br>Derate Above 25°C<br><br>2N2906, 2N2907<br>Derate Above 25°C | $P_D$     | 1.8         |             | W     |
|                                                                                                                                                                                                                                                 |           | 12          |             | mW/°C |
|                                                                                                                                                                                                                                                 |           |             | 1.8         | W     |
|                                                                                                                                                                                                                                                 |           |             | 10.3        | mW/°C |
| Total Device Dissipation<br>@ 25°C Ambient Temperature<br>To - 5: 2N2218, 2N2219<br>Derate Above 25°C<br><br>2N2904, 2N2905<br>Derate Above 25°C<br><br>To - 18: 2N2221, 2N2222<br>Derate Above 25°C<br><br>2N2906, 2N2907<br>Derate Above 25°C | $P_D$     | 0.8         |             | W     |
|                                                                                                                                                                                                                                                 |           | 5.33        |             | mW/°C |
|                                                                                                                                                                                                                                                 |           |             | 0.6         | W     |
|                                                                                                                                                                                                                                                 |           |             | 3.43        | mW/°C |
| Total Device Dissipation<br>@ 25°C Ambient Temperature<br>To - 5: 2N2218, 2N2219<br>Derate Above 25°C<br><br>2N2904, 2N2905<br>Derate Above 25°C<br><br>To - 18: 2N2221, 2N2222<br>Derate Above 25°C<br><br>2N2906, 2N2907<br>Derate Above 25°C | $P_D$     | 0.5         |             | W     |
|                                                                                                                                                                                                                                                 |           | 3.33        |             | mW/°C |
|                                                                                                                                                                                                                                                 |           |             | 0.4         | W     |
|                                                                                                                                                                                                                                                 |           |             | 2.28        | mW/°C |
| Operating Junction Temperature                                                                                                                                                                                                                  | $T_J$     | -65 to +175 | -65 to +200 | °C    |
| Storage Temperature                                                                                                                                                                                                                             | $T_{stg}$ | -65 to +200 | -65 to +200 | °C    |

## 2N2218 SERIES, 2N2904 SERIES (continued)

### ELECTRICAL CHARACTERISTICS ( $T_A = 25^\circ\text{C}$ unless otherwise noted)

| Static Characteristic                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Fig. No. | Symbol          | Min                                                       | Max                    | Unit          |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|-----------------|-----------------------------------------------------------|------------------------|---------------|
| Collector-Base Breakdown Voltage<br>( $I_C = 10\text{ }\mu\text{A}$ , $I_E = 0$ ) All Types                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | ---      | $BV_{CBO}$      | 60                                                        | ---                    | Vdc           |
| Collector-Emitter Breakdown Voltage*<br>( $I_C = 10\text{ mA}$ , $I_B = 0$ ) 2N2218-19, 2N2221-22<br>2N2904 thru 2N2907                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | 9        | $BV_{CEO}^*$    | 30<br>40                                                  | ---                    | Vdc           |
| Emitter-Base Breakdown Voltage<br>( $I_E = 10\text{ }\mu\text{A}$ , $I_C = 0$ ) All Types                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | ---      | $BV_{EBO}$      | 5                                                         | ---                    | Vdc           |
| Collector Cutoff Current<br>( $V_{CB} = 50\text{ Vdc}$ , $I_E = 0$ ) 2N2218-19, 2N2221-22<br>2N2904 thru 2N2907<br>( $V_{CB} = 50\text{ Vdc}$ , $I_E = 0$ , $T_A = 150^\circ\text{C}$ ) 2N2218-19, 2N2221-22<br>2N2904 thru 2N2907                                                                                                                                                                                                                                                                                                                                                                                                                              | ---      | $I_{CBO}$       | ---                                                       | .01<br>.02<br>10<br>20 | $\mu\text{A}$ |
| Collector Cutoff Current<br>( $V_{CE} = 30\text{ Vdc}$ , $V_{BE} = 0.5\text{ Vdc}$ ) 2N2904 thru 2N2907                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | ---      | $I_{CEX}$       | ---                                                       | 50                     | nA            |
| Base Cutoff Current<br>( $V_{CE} = 30\text{ Vdc}$ , $V_{BE} = 0.5\text{ Vdc}$ ) 2N2904 thru 2N2907                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | ---      | $I_{BL}$        | ---                                                       | 50                     | nA            |
| Collector-Emitter Saturation Voltage*<br>( $I_C = 150\text{ mA}$ , $I_B = 15\text{ mA}$ ) All Types<br>( $I_C = 500\text{ mA}$ , $I_B = 50\text{ mA}$ ) All Types                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | 12, 15   | $V_{CE(sat)}^*$ | ---                                                       | 0.4<br>1.6             | Vdc           |
| Base-Emitter Saturation Voltage*<br>( $I_C = 150\text{ mA}$ , $I_B = 15\text{ mA}$ ) All Types<br>( $I_C = 500\text{ mA}$ , $I_B = 50\text{ mA}$ ) All Types                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | 13, 16   | $V_{BE(sat)}^*$ | ---                                                       | 1.3<br>2.6             | Vdc           |
| DC Forward Current Transfer Ratio<br>( $I_C = 0.1\text{ mA}$ , $V_{CE} = 10\text{ Vdc}$ ) 2N2218, 2N2221, 2N2904, 2N2906<br>2N2219, 2N2222, 2N2905, 2N2907<br>( $I_C = 1.0\text{ mA}$ , $V_{CE} = 10\text{ Vdc}$ ) 2N2218, 2N2221, 2N2904, 2N2906<br>2N2219, 2N2222, 2N2905, 2N2907<br>( $I_C = 10\text{ mA}$ , $V_{CE} = 10\text{ Vdc}$ ) 2N2218, 2N2221, 2N2904, 2N2906<br>2N2219, 2N2222, 2N2905, 2N2907<br>( $I_C = 150\text{ mA}$ , $V_{CE} = 10\text{ Vdc}$ )* 2N2218, 2N2221, 2N2904, 2N2906<br>2N2219, 2N2222, 2N2905, 2N2907<br>( $I_C = 500\text{ mA}$ , $V_{CE} = 10\text{ Vdc}$ )* 2N2218, 2N2221, 2N2904, 2N2906<br>2N2219, 2N2222, 2N2905, 2N2907 | 10<br>11 | $h_{FE}$        | 20<br>35<br>25<br>50<br>35<br>75<br>40<br>100<br>20<br>30 | ---                    | ---           |

| Dynamic Characteristic                                                                                                                                                                                                               | Fig. No. | Symbol      | Min        | Typ      | Max      | Unit |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|-------------|------------|----------|----------|------|
| Output Capacitance<br>( $V_{CB} = 10\text{ Vdc}$ , $I_E = 0$ , $f = 100\text{ kHz}$ ) All Types                                                                                                                                      | 4        | $C_{ob}$    | ---        | ---      | 8        | pF   |
| Input Capacitance<br>( $V_{BE} = 0.5\text{ Vdc}$ , $I_C = 0$ , $f = 100\text{ kHz}$ ) 2N2218-19, 2N2221-22<br>( $V_{BE} = 2\text{ Vdc}$ , $I_C = 0$ , $f = 100\text{ kHz}$ ) 2N2904 thru 2N2907                                      | 4        | $C_{ib}$    | ---        | ---      | 30<br>30 | pF   |
| Current Gain - Bandwidth Product<br>( $I_C = 20\text{ mA}$ , $V_{CE} = 20\text{ Vdc}$ , $f = 100\text{ MHz}$ ) 2N2218-19, 2N2221-22<br>( $I_C = 50\text{ mA}$ , $V_{CE} = 20\text{ Vdc}$ , $f = 100\text{ MHz}$ ) 2N2904 thru 2N2907 | 8        | $f_T$       | 250<br>200 | ---      | ---      | MHz  |
| Delay Time 2N2904 thru 2N2907                                                                                                                                                                                                        | 1        | $t_d$       | ---        | 6        | 10       | ns   |
| Rise Time 2N2904 thru 2N2907                                                                                                                                                                                                         | 1        | $t_r$       | ---        | 20       | 40       | ns   |
| Turn-On Time 2N2218-19, 2N2221-22<br>2N2904 thru 2N2907                                                                                                                                                                              | 1        | $t_{on}$    | ---        | 26<br>26 | ---      | ns   |
| Storage Time 2N2904 thru 2N2907                                                                                                                                                                                                      | 2        | $t_s$       | ---        | 50       | 80       | ns   |
| Fall Time 2N2904 thru 2N2907                                                                                                                                                                                                         | 2        | $t_f$       | ---        | 20       | 30       | ns   |
| Turn-Off Time 2N2218-19, 2N2221-22<br>2N2904 thru 2N2907                                                                                                                                                                             | 2        | $t_{off}$   | ---        | 70<br>70 | ---      | ns   |
| Total Switching Time All Types                                                                                                                                                                                                       | 3        | $t_{total}$ | ---        | 12       | ---      | ns   |

\*Pulse Test, Pulse Width  $\leq 300\text{ }\mu\text{s}$  Duty Cycle  $\leq 2\%$

### PNP SWITCHING-TIME CIRCUITS

For NPN Switching Tests, reverse diodes, polarities, and input pulses.

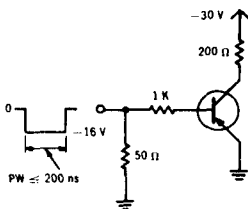


FIGURE 1 — SATURATED TURN-ON SWITCHING-TIME TEST CIRCUIT

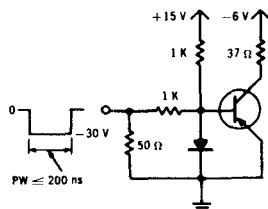


FIGURE 2 — SATURATED TURN-OFF SWITCHING-TIME TEST CIRCUIT

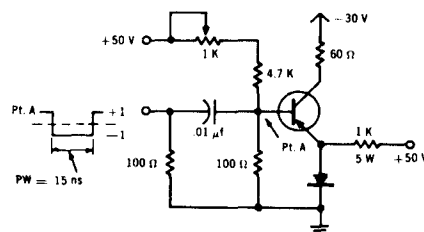
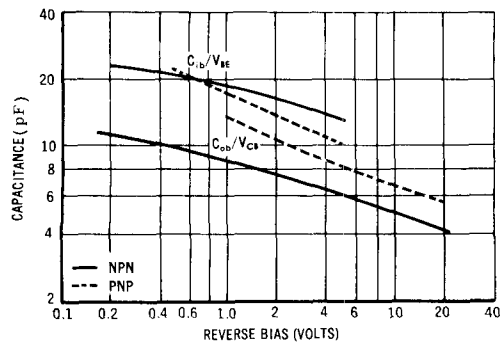


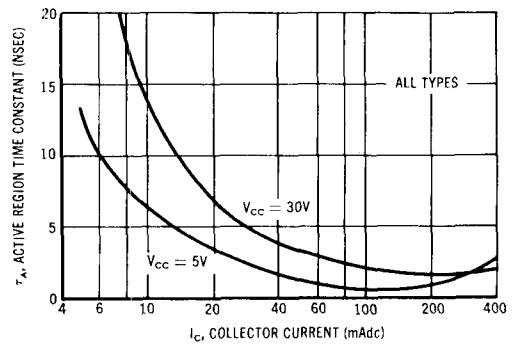
FIGURE 3 — NON-SATURATED SWITCHING-TIME TEST CIRCUIT

## 2N2218 SERIES, 2N2904 SERIES (continued)

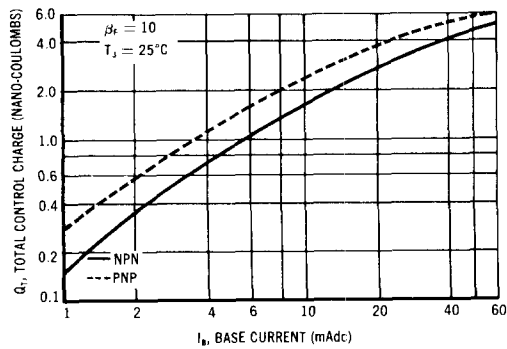
**FIGURE 4 — CAPACITANCE VARIATIONS  
versus VOLTAGE**



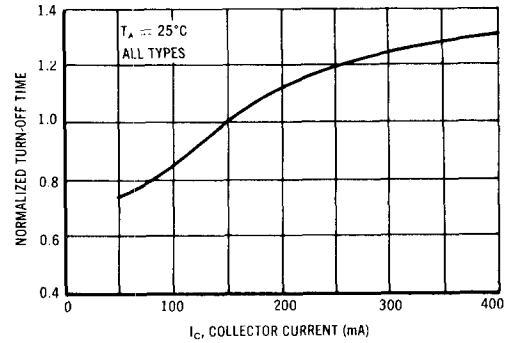
**FIGURE 5 — ACTIVE REGION TIME CONSTANT  
versus COLLECTOR CURRENT**



**FIGURE 6 — TOTAL CONTROL CHARGE  
versus BASE CURRENT**



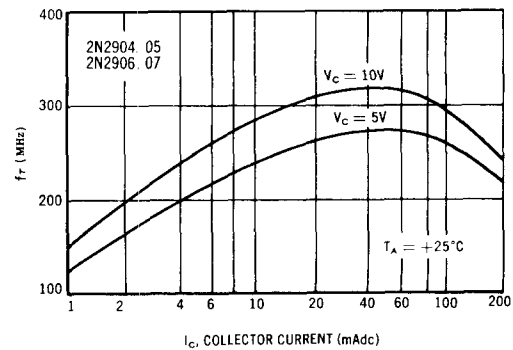
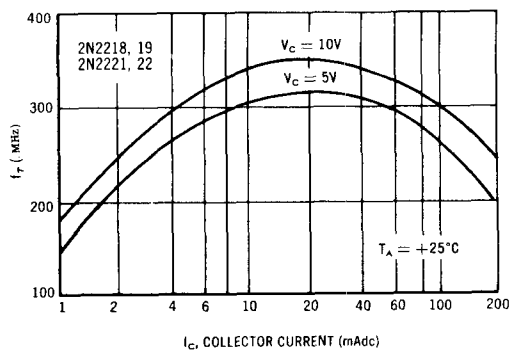
**FIGURE 7 — NORMALIZED TURN-OFF TIME  
versus COLLECTOR CURRENT**



**NPN**

**PNP**

**FIGURE 8 — CURRENT-GAIN — BANDWIDTH PRODUCT versus COLLECTOR CURRENT**

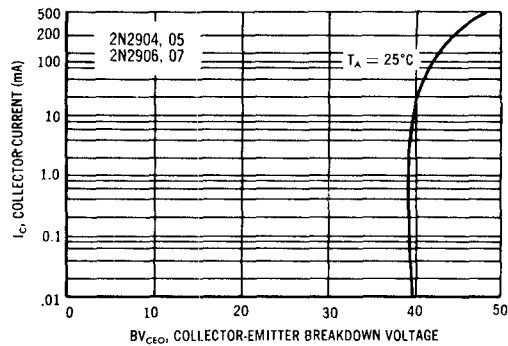
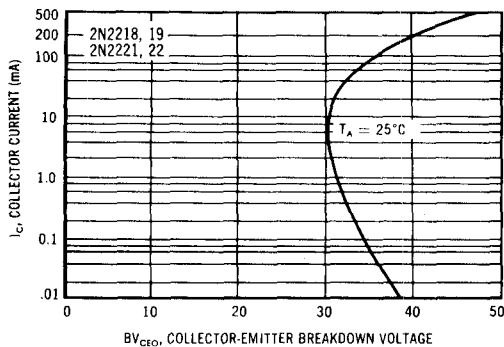


## 2N2218 SERIES, 2N2904 SERIES (continued)

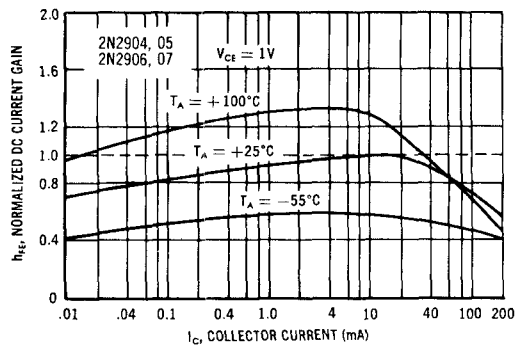
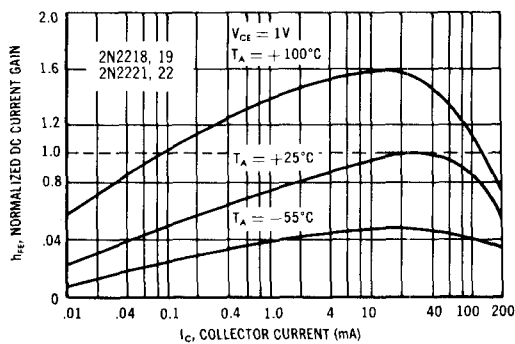
NPN

PNP

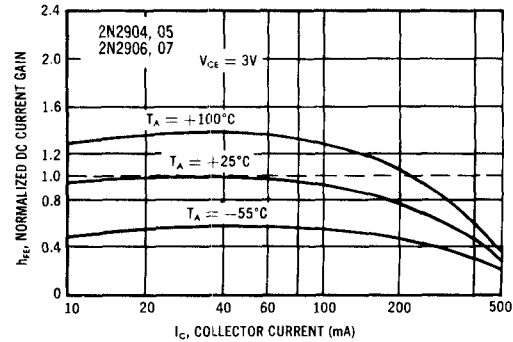
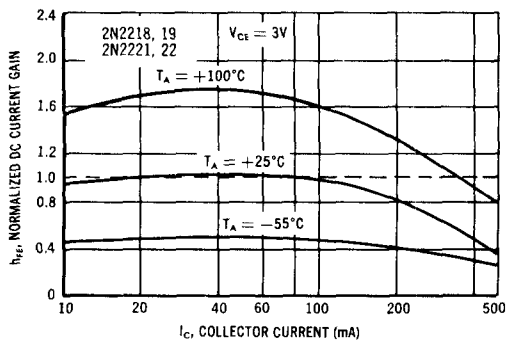
**FIGURE 9 — COLLECTOR CURRENT versus MINIMUM COLLECTOR-EMITTER BREAKDOWN VOLTAGE**



**FIGURE 10 — LOW CURRENT GAIN**



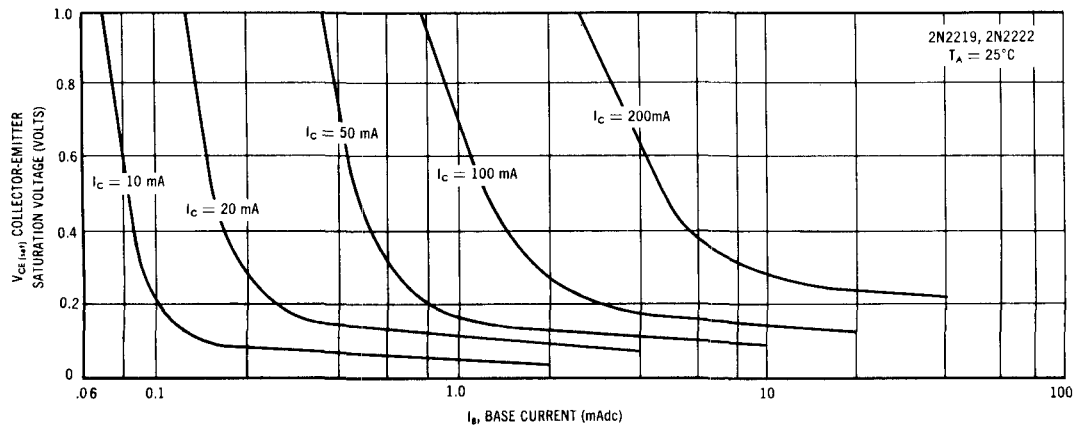
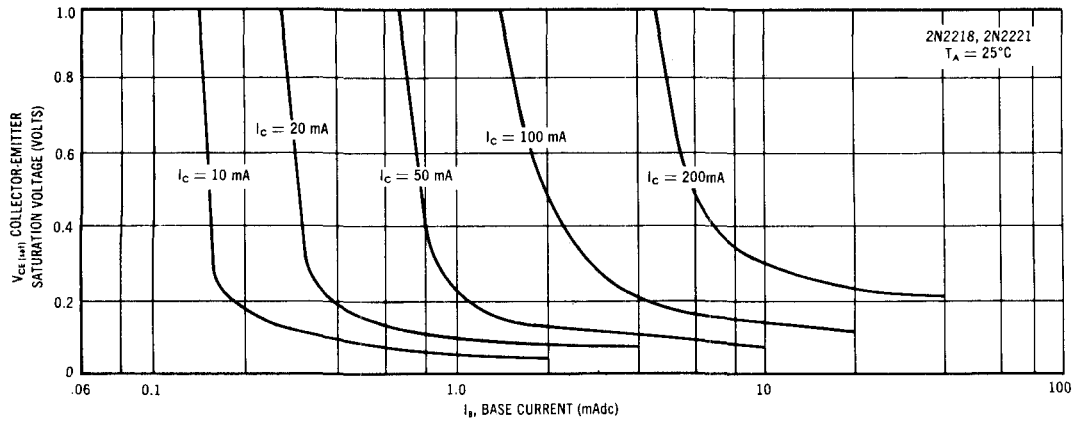
**FIGURE 11 — HIGH CURRENT GAIN**



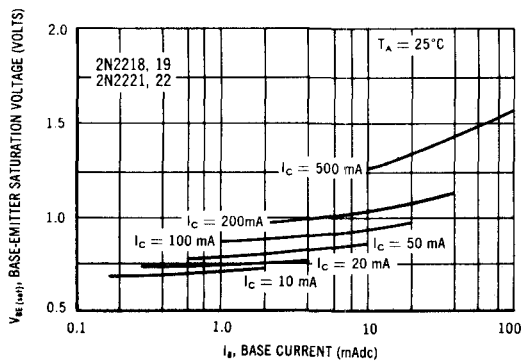
**2N2218 SERIES, 2N2904 SERIES** (continued)

**NPN**

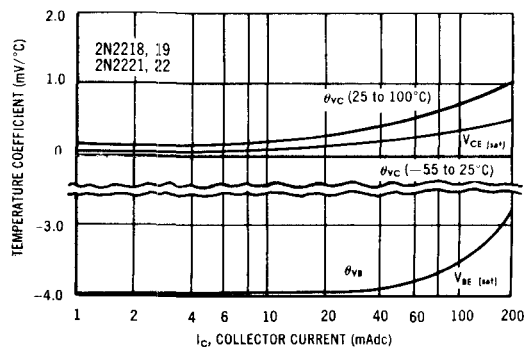
**FIGURE 12 — COLLECTOR SATURATION VOLTAGE versus BASE CURRENT**



**FIGURE 13 — BASE SATURATION VOLTAGE versus BASE CURRENT**



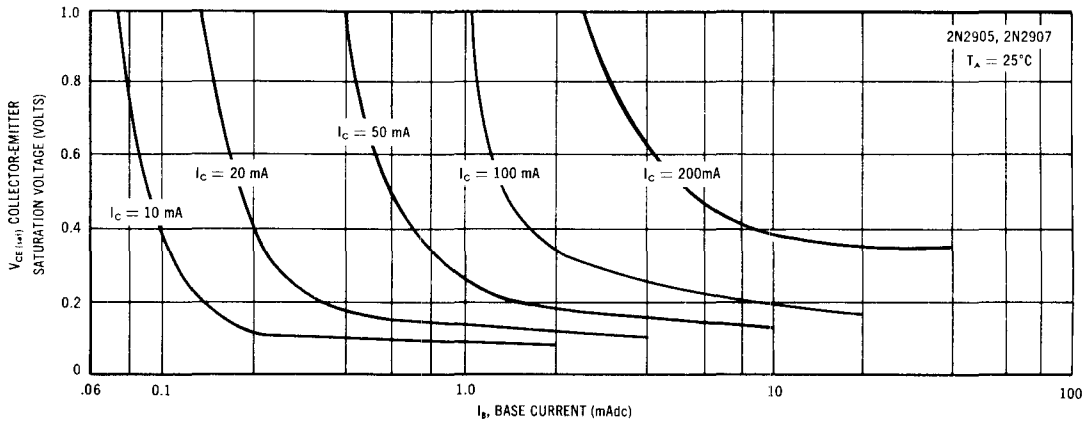
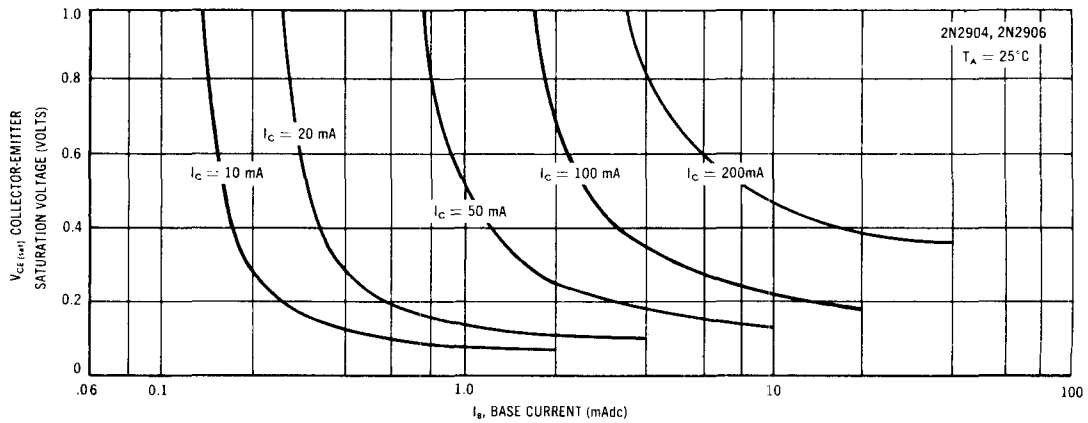
**FIGURE 14 — TEMPERATURE COEFFICIENTS**



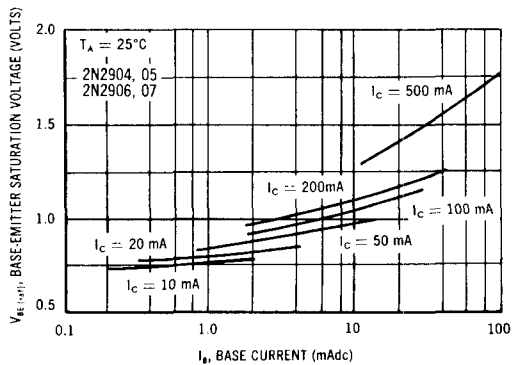
## 2N2218 SERIES, 2N2904 SERIES (continued)

### PNP

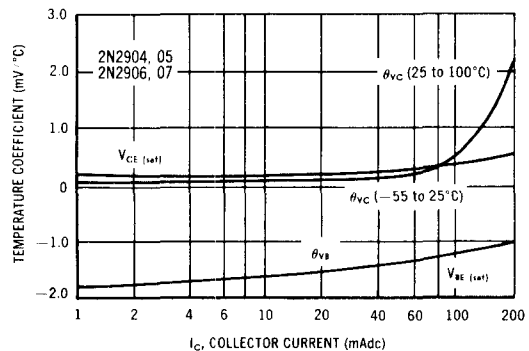
**FIGURE 15 — COLLECTOR SATURATION VOLTAGE versus BASE CURRENT**



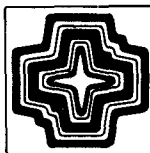
**FIGURE 16 — BASE SATURATION versus BASE CURRENT**



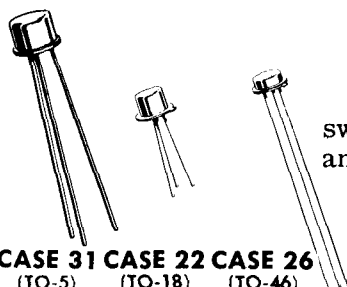
**FIGURE 17 — TEMPERATURE COEFFICIENTS**



**2N2904, A thru 2N2907, A (SILICON)**  
**2N2904 thru 2N2907 USA/JAN and**  
**HI-REL**  
**2N3485, A, 2N3486, A**



$V_{CEO} = 40-60 \text{ V}$   
 $I_C = 600 \text{ mA}$   
 $f_T = 200 \text{ MHz}$



PNP silicon annular Star transistors for high-speed switching, complementary circuitry and DC to VHF amplifier applications.

Collector connected to case

**CASE 31 CASE 22 CASE 26**  
**(TO-5) (TO-18) (TO-46)**  
 2N2904, A 2N2906, A 2N3485, A  
 2N2905, A 2N2907, A 2N3486, A

#### MAXIMUM RATINGS

| Rating                                                                                                                                                                                                                                       | Symbol    | Value                                  | Unit                                                                                |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|----------------------------------------|-------------------------------------------------------------------------------------|
| Collector-Base Voltage                                                                                                                                                                                                                       | $V_{CBO}$ | 60                                     | Vdc                                                                                 |
| Collector-Emitter Voltage<br>2N2904-2N2907, 2N3485, 2N3486<br>2N2904A-2N2907A, 2N3485A, 2N3486A                                                                                                                                              | $V_{CEO}$ | 40<br>60                               | Vdc                                                                                 |
| Emitter-Base Voltage                                                                                                                                                                                                                         | $V_{EBO}$ | 5                                      | Vdc                                                                                 |
| Collector Current                                                                                                                                                                                                                            | $I_C$     | 600                                    | mAdc                                                                                |
| Total Device Dissipation @ $T_C = 25^\circ\text{C}$<br>TO-5: 2N2904, 2N2904A, 2N2905, 2N2905A<br>DERATING FACTOR<br>TO-18: 2N2906, 2N2906A, 2N2907, 2N2907A<br>DERATING FACTOR<br>TO-46: 2N3485, 2N3485A, 2N3486, 2N3486A<br>DERATING FACTOR | $P_D$     | 3<br>17.2<br>1.8<br>10.3<br>2<br>11.43 | W<br>mW/ $^\circ\text{C}$<br>W<br>mW/ $^\circ\text{C}$<br>W<br>mW/ $^\circ\text{C}$ |
| Total Device Dissipation @ $T_A = 25^\circ\text{C}$<br>TO-5: 2N2904, 2N2904A, 2N2905, 2N2905A<br>DERATING FACTOR<br>TO-18: 2N2906, 2N2906A, 2N2907, 2N2907A<br>TO-46: 2N3485, 2N3485A, 2N3486, 2N3486A<br>DERATING FACTOR                    | $P_D$     | 600<br>3.43<br>400<br>2.28             | mW<br>mW/ $^\circ\text{C}$<br>mW<br>mW/ $^\circ\text{C}$                            |
| Operating Junction Temperature Range                                                                                                                                                                                                         | $T_J$     | -65 to +200                            | $^\circ\text{C}$                                                                    |
| Storage Temperature Range                                                                                                                                                                                                                    | $T_{stg}$ | -65 to +200                            | $^\circ\text{C}$                                                                    |

**2N2904, A-2N2907, A and 2N3485, A, 2N3486, A (Continued)**

**ELECTRICAL CHARACTERISTICS (At 25°C unless otherwise noted)**

| Characteristic                                                                                                                                                                                                                                                                                                                                                 | Symbol          | Min                                                                                                                         | Max                      | Unit            |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|-----------------------------------------------------------------------------------------------------------------------------|--------------------------|-----------------|
| Collector Cutoff Current<br>( $V_{CB} = 50 \text{ Vdc}$ , $I_E = 0$ )<br><br>( $V_{CB} = 50 \text{ Vdc}$ , $I_E = 0$ , $T_A = 150^\circ\text{C}$ )                                                                                                                                                                                                             | $I_{CBO}$       | ---                                                                                                                         | .020<br>.010<br>20<br>10 | $\mu\text{Adc}$ |
| Collector Cutoff Current<br>( $V_{CE} = 30 \text{ V}$ , $V_{BE} = 0.5 \text{ V}$ )                                                                                                                                                                                                                                                                             | $I_{CEX}$       | ---                                                                                                                         | 50                       | nAdc            |
| Base Cutoff Current<br>( $V_{CE} = 30 \text{ V}$ , $V_{BE} = 0.5 \text{ V}$ )                                                                                                                                                                                                                                                                                  | $I_{BL}$        | ---                                                                                                                         | 50                       | nAdc            |
| Collector-Base Breakdown Voltage<br>( $I_C = 10 \mu\text{Adc}$ , $I_E = 0$ )                                                                                                                                                                                                                                                                                   | $BV_{CBO}$      | 60                                                                                                                          | ---                      | Vdc             |
| Collector-Emitter Breakdown Voltage*<br>( $I_C = 10 \text{ mAdc}$ , $I_B = 0$ )                                                                                                                                                                                                                                                                                | $BV_{CEO}^*$    | 40<br>60                                                                                                                    | ---                      | Vdc             |
| Emitter-Base Breakdown Voltage<br>( $I_B = 10 \mu\text{Adc}$ , $I_C = 0$ )                                                                                                                                                                                                                                                                                     | $BV_{EBO}$      | 5                                                                                                                           | ---                      | Vdc             |
| Collector Saturation Voltage*<br>( $I_C = 150 \text{ mAdc}$ , $I_B = 15 \text{ mAdc}$ )<br>( $I_C = 500 \text{ mAdc}$ , $I_B = 50 \text{ mAdc}$ )                                                                                                                                                                                                              | $V_{CE(sat)}^*$ | ---                                                                                                                         | 0.4<br>1.6               | Vdc             |
| Base-Emitter Saturation Voltage<br>( $I_C = 150 \text{ mAdc}$ , $I_B = 15 \text{ mAdc}$ )*<br>( $I_C = 500 \text{ mAdc}$ , $I_B = 50 \text{ mAdc}$ )                                                                                                                                                                                                           | $V_{BE(sat)}^*$ | ---                                                                                                                         | 1.3<br>2.6               | Vdc             |
| DC Forward Current Transfer Ratio<br>( $I_C = 0.1 \text{ mAdc}$ , $V_{CE} = 10 \text{ Vdc}$ )<br><br>( $I_C = 1.0 \text{ mAdc}$ , $V_{CE} = 10 \text{ Vdc}$ )<br><br>( $I_C = 10 \text{ mAdc}$ , $V_{CE} = 10 \text{ Vdc}$ )<br><br>( $I_C = 150 \text{ mAdc}$ , $V_{CE} = 10 \text{ Vdc}$ )*<br><br>( $I_C = 500 \text{ mAdc}$ , $V_{CE} = 10 \text{ Vdc}$ )* | $h_{FE}$        | 20<br>35<br>40<br>75<br><br>25<br>50<br>40<br>100<br><br>35<br>75<br>40<br>100<br><br>40<br>100<br><br>20<br>30<br>40<br>50 | ---                      | ---             |
| Output Capacitance<br>( $V_{CE} = 10 \text{ Vdc}$ , $I_E = 0$ , $f = 100 \text{ kHz}$ )                                                                                                                                                                                                                                                                        | $C_{ob}$        | ---                                                                                                                         | 8                        | pF              |
| Input Capacitance<br>( $V_{BE} = 2 \text{ Vdc}$ , $I_C = 0$ , $f = 100 \text{ kHz}$ )                                                                                                                                                                                                                                                                          | $C_{ib}$        | ---                                                                                                                         | 30                       | pF              |
| Current-Gain — Bandwidth Product<br>( $I_C = 50 \text{ mAdc}$ , $V_{CE} = 20 \text{ Vdc}$ , $f = 100 \text{ MHz}$ )                                                                                                                                                                                                                                            | $f_T$           | 200                                                                                                                         | ---                      | MHz             |

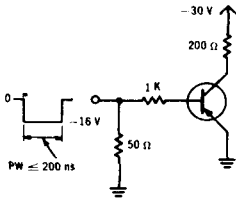
**SWITCHING CHARACTERISTICS (At 25°C unless otherwise noted)**

| Characteristic       | Symbol      | Typ | Max | Unit |
|----------------------|-------------|-----|-----|------|
| Delay Time           | $t_d$       | 6   | 10  | ns   |
| Rise Time            | $t_r$       | 20  | 40  | ns   |
| Turn-On Time         | $t_{on}$    | 26  | 45  | ns   |
| Storage Time         | $t_s$       | 50  | 80  | ns   |
| Fall Time            | $t_f$       | 20  | 30  | ns   |
| Turn-Off Time        | $t_{off}$   | 70  | 100 | ns   |
| Total Switching Time | $t_{total}$ | 12  | --- | ns   |

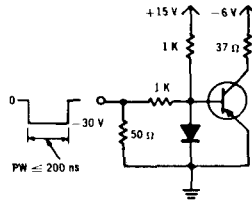
\*Pulse Test: Pulse Width = 300  $\mu\text{s}$ ; Duty Cycle  $\leq 2\%$

## 2N2904, A-2N2907, A and 2N3485, A, 2N3486, A (Continued)

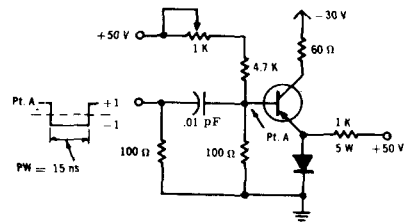
**SATURATED TURN-ON  
SWITCHING-TIME TEST CIRCUIT**



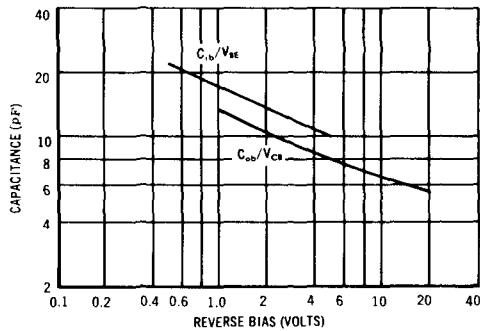
**SATURATED TURN-OFF  
SWITCHING-TIME TEST CIRCUIT**



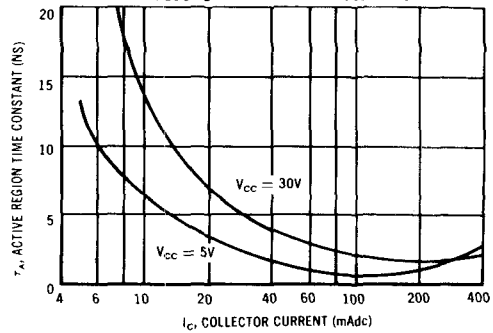
**NON-SATURATED SWITCHING-TIME  
TEST CIRCUIT**



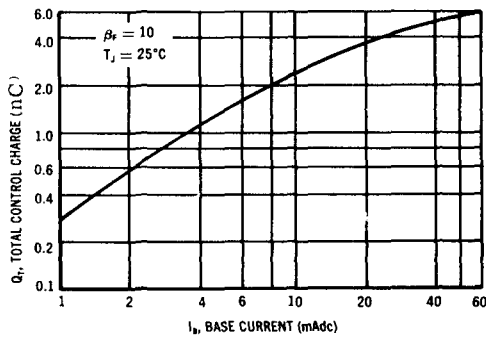
**CAPACITANCE VARIATIONS versus VOLTAGE**



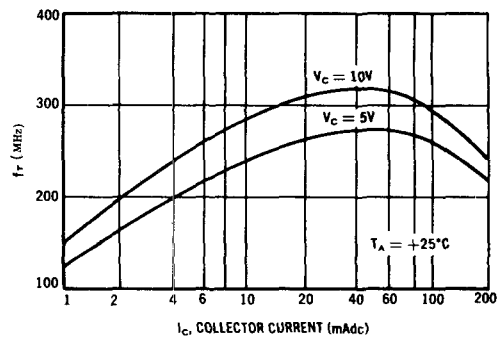
**ACTIVE REGION TIME CONSTANT  
versus COLLECTOR CURRENT**



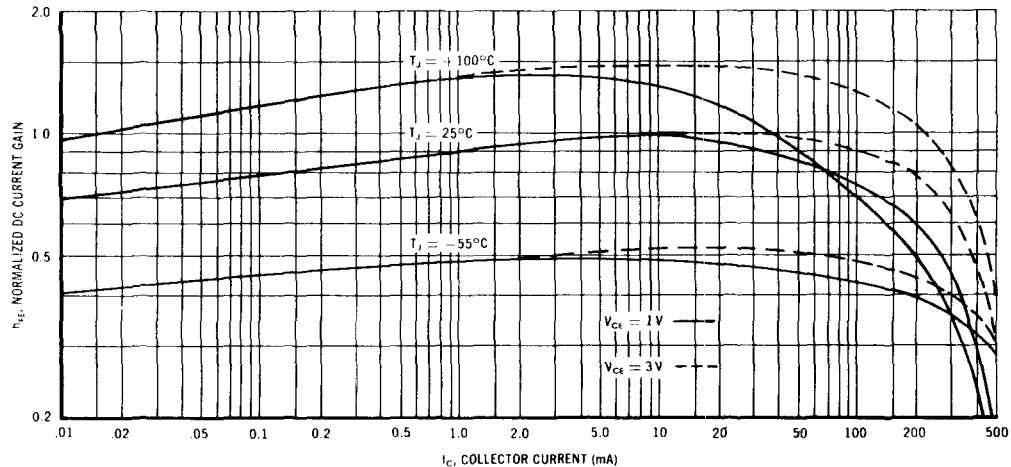
**TOTAL CONTROL CHARGE versus BASE CURRENT**



**CURRENT GAIN-BANDWIDTH PRODUCT versus  
COLLECTOR CURRENT**

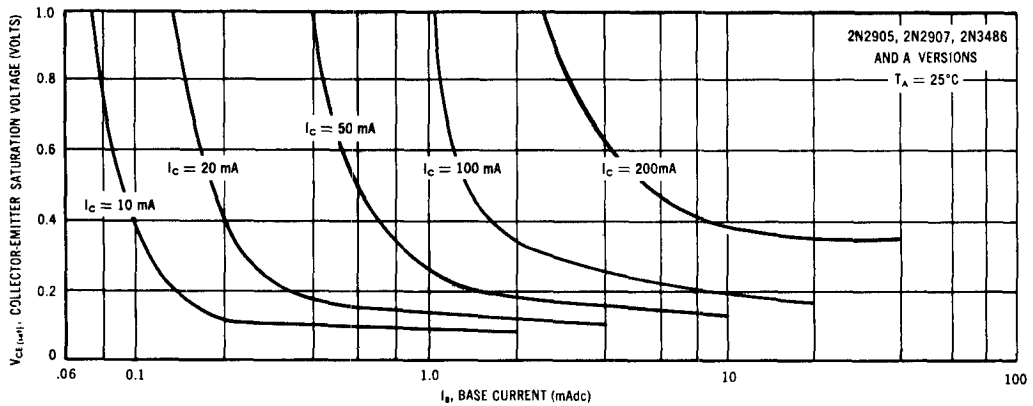
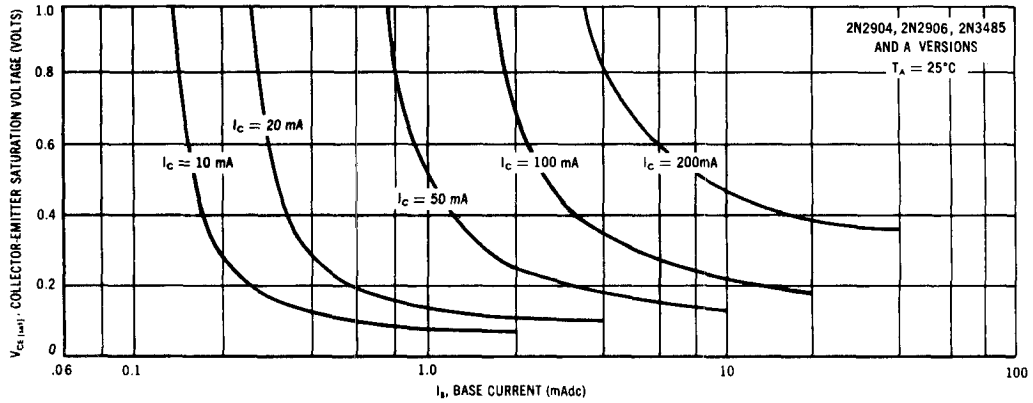


**CURRENT GAIN versus COLLECTOR CURRENT**

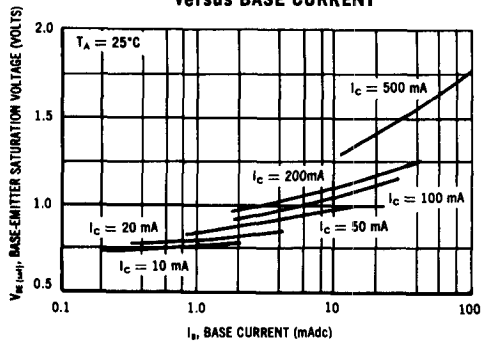


**2N2904, A-2N2907, A and 2N3485, A, 2N3486, A (Continued)**

**COLLECTOR SATURATION VOLTAGE versus BASE CURRENT**



**BASE SATURATION VOLTAGE  
versus BASE CURRENT**



**TEMPERATURE COEFFICIENTS**

