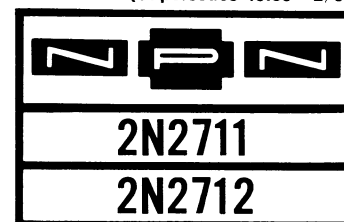


# Silicon General Purpose Transistors

## PLANAR PASSIVATED



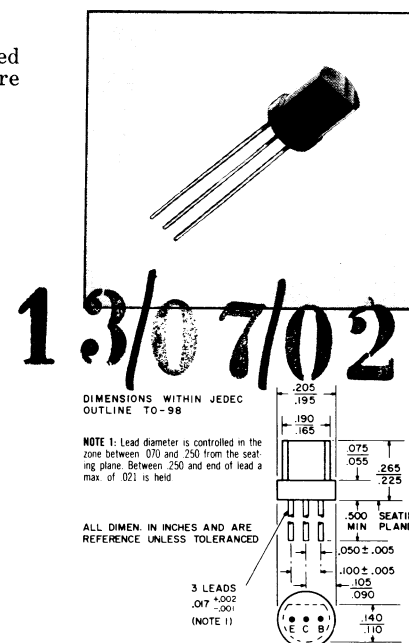
The 2N2711 and 2N2712 are planar passivated NPN Silicon transistors specifically manufactured for radio and general purpose commercial applications. They are housed in an epoxy case and are intended to perform all small signal functions in a conventional AM radio.

absolute maximum ratings: (25°C) (unless otherwise specified)

| 2N2711<br>2N2712                |           |             |       |
|---------------------------------|-----------|-------------|-------|
| <b>Voltages</b>                 |           |             |       |
| Collector to Emitter            | $V_{CEO}$ | 18          | volts |
| Emitter to Base                 | $V_{EBO}$ | 5           | volts |
| Collector to Base               | $V_{CBO}$ | 18          | volts |
| <b>Current</b>                  |           |             |       |
| Collector* (Steady State)       | $I_C$     | 100         | mA    |
| <b>Dissipation</b>              |           |             |       |
| Total Power (Free air @ 25°C)** | $P_T$     | 200         | mW    |
| Total Power (Free air @ 55°C)** | $P_T$     | 120         | mW    |
| <b>Temperature</b>              |           |             |       |
| Storage                         | $T_{STG}$ | -55 to +125 | °C    |
| Operating                       | $T_J$     | +100        | °C    |

\*Determined from power limitations due to saturation voltage at this current.

\*\*Derate 2.67 mW/°C increase in ambient temperature above 25°C.



electrical characteristics: (25°C) (unless otherwise specified)

### D-C CHARACTERISTICS

Collector Cutoff Current ( $V_{CB} = 18V$ )

( $V_{CB} = 18V$ ,  $T_A = 100^\circ C$ )

Emitter Cutoff Current ( $V_{EB} = 5V$ )

Forward Current Transfer Ratio ( $V_{CE} = 4.5V$ ,  $I_C = 2 mA$ )

### SMALL SIGNAL CHARACTERISTICS

Common Emitter ( $V_{CE} = 5V$ ,  $I = 2 mA$ ,  $f = 455 kHz$ )

Forward Current Transfer Ratio: Output a.c. Short Circuited

Input Impedance: Output a.c. Short Circuited

Reverse Voltage Transfer Ratio: Input a.c. Open Circuited

Output Admittance: Input a.c. Open Circuited

Forward Transfer Admittance: Output a.c. Short Circuited

Input Admittance: Output a.c. Short Circuited

Reverse Transfer Admittance: Input a.c. Short Circuited

Output Admittance: Input a.c. Short Circuited

### HIGH FREQUENCY CHARACTERISTICS

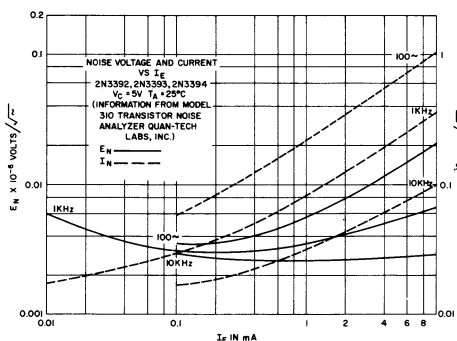
Collector Capacitance ( $V_{CB} = 10V$ ,  $I_E = 0$ ,  $f = 1 MHz$ )

### NOISE

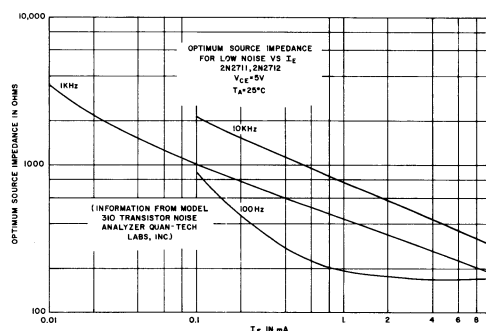
Noise Figure ( $I_C = 100 \mu A$ ,  $V_{CE} = 5V$ ,  $f = 10 kHz$ ,  $BW = 1 Hz$ ,  $R_g = 2000 \Omega$ )

Signal to Noise Ratio in Typical RF Circuit (1600 kHz, 12  $\mu V$  signal)

NOISE VOLTAGE AND CURRENT vs.  $I_E$

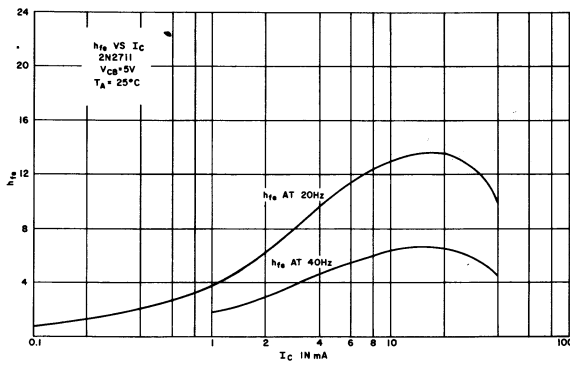


OPTIMUM SOURCE IMPEDANCE FOR LOW NOISE vs.  $I_E$

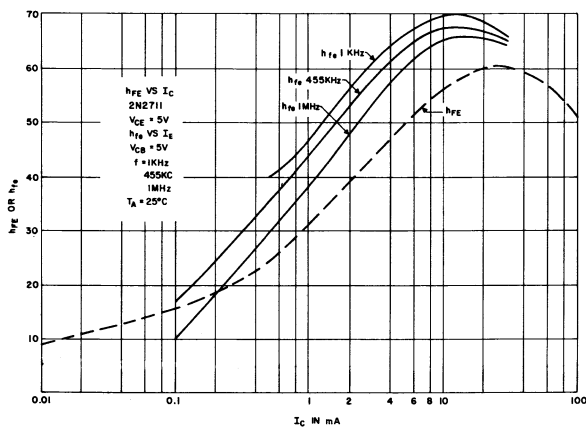


## TYPE 2N2711,

### $h_{fe}$ vs. $I_C$

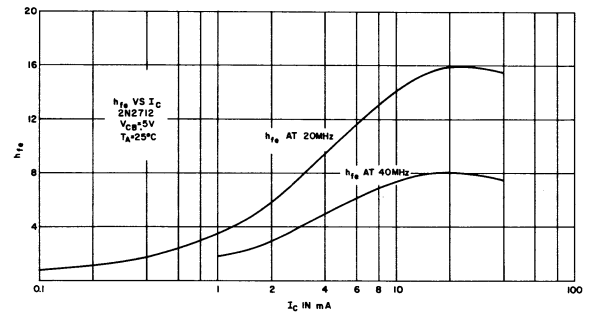


### $h_{fe}$ or $h_{FE}$ vs. $I_C$

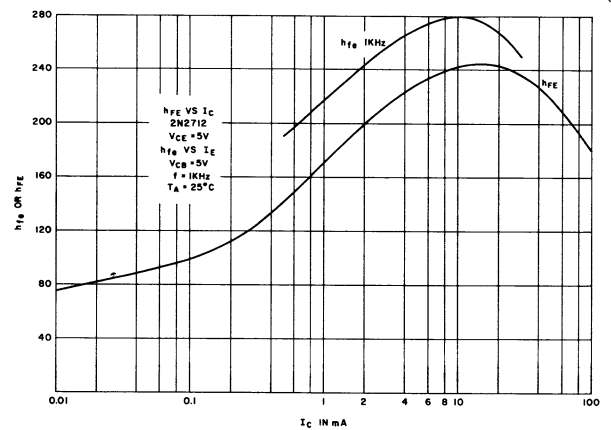


## TYPE 2N2712

### $h_{fe}$ vs. $I_C$

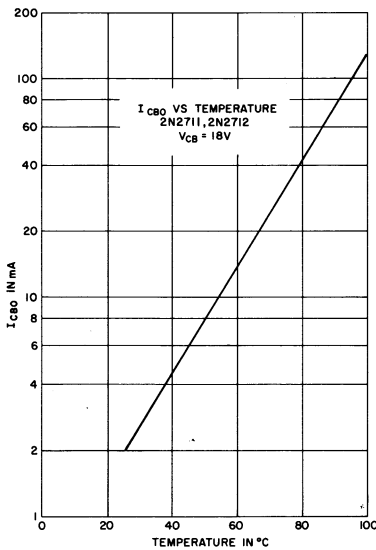


### $h_{fe}$ or $h_{FE}$ vs. $I_C$

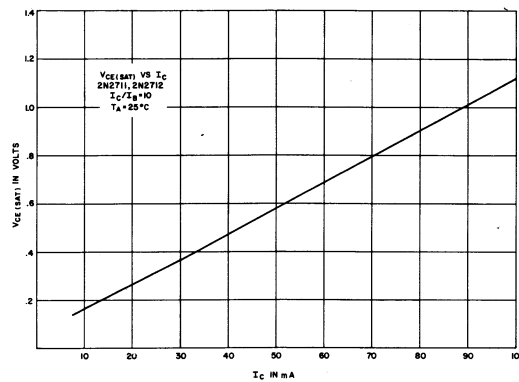


## TYPE 2N2711, 2N2712

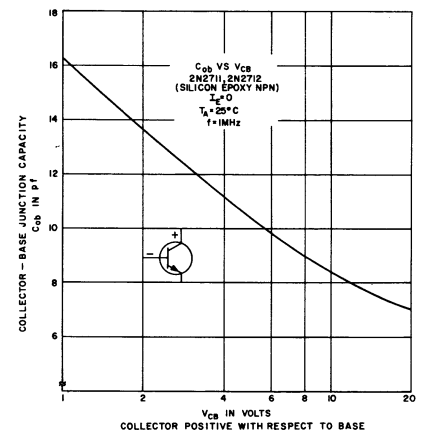
### $I_{CBO}$ vs. TEMPERATURE

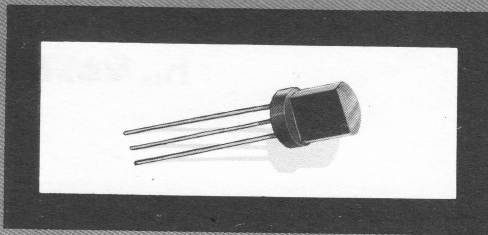


### $V_{CE(SAT)}$ vs. $I_C$



### $C_{ob}$ vs. $V_{CB}$





# General Purpose TRANSISTORS

PLANAR EPITAXIAL PASSIVATED

NPN

SILICON TYPES

2N2713

2N2714

The General Electric 2N2713 and 2N2714 are epoxy encapsulated planar epitaxial passivated NPN silicon transistors specifically manufactured for general purpose commercial applications. They are particularly useful in output stages where low saturation voltage is desirable. They may also be used to advantage in switching applications due to their low storage time, good beta holdup to beyond 150 ma and low  $V_{CE(SAT)}$ .

absolute maximum ratings: (25°C) (unless otherwise specified)

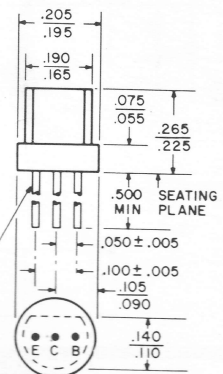
|                                 |           |               |    |       |
|---------------------------------|-----------|---------------|----|-------|
| <b>Voltages</b>                 |           |               |    |       |
| Collector to Emitter            | $V_{CEO}$ | 18            | v  | volts |
| Emitter to Base                 | $V_{EBO}$ | 5             | v  | volts |
| Collector to Base               | $V_{CBO}$ | 18            | v  | volts |
| <b>Current</b>                  |           |               |    |       |
| Collector* (Steady State)       | $I_C$     | 200           | mA |       |
| <b>Dissipation</b>              |           |               |    |       |
| Total Power (Free air @ 25°C)** | $P_T$     | 200           | mW |       |
| Total Power (Free air @ 55°C)** | $P_T$     | 120           | mW |       |
| <b>Temperature</b>              |           |               |    |       |
| Storage                         | $T_{STG}$ | -55°C to +125 | °C |       |
| Operating                       | $T_J$     | +100          | °C |       |

\*Determined from power limitations due to saturation voltage at this current.  
 \*\*Derate 2.67 mW/°C increase in ambient temperature above 25°C.

NOTE 1: Lead diameter is controlled in the zone between .070 and .250 from the seating plane. Between .250 and end of lead a max. of .021 is held.

ALL DIMEN. IN INCHES AND ARE REFERENCE UNLESS TOLERANCED

3 LEADS  
 .017  $\pm$  .002  
 .001  
 (NOTE 1)



electrical characteristics: (25°C)

## DC CHARACTERISTICS

Collector Cutoff Current ( $V_{CB} = 18V$ )  
 ( $V_{CB} = 18V, T_A = 100^\circ C$ )  
 Emitter Cutoff Current ( $V_{EB} = 5V$ )  
 Forward Current Transfer Ratio ( $V_{CE} = 4.5V, I_C = 2 mA$ )  
 2N2713  
 2N2714  
 Collector Saturation Voltage ( $I_B = 3 mA, I_C = 50 mA$ )  
 Base Saturation Voltage ( $I_B = 3 mA, I_C = 50 mA$ )

|               | Min. | Typ. | Max. |         |
|---------------|------|------|------|---------|
| $I_{CBO}$     |      |      | 0.5  | $\mu A$ |
| $I_{CBO}$     |      |      | 15   | $\mu A$ |
| $I_{EBO}$     |      |      | 0.5  | $\mu A$ |
| $h_{FE}$      | 30   |      | 90   |         |
| $h_{FE}$      | 75   |      | 225  |         |
| $V_{CE(SAT)}$ |      |      | 0.30 | volts   |
| $V_{BE(SAT)}$ |      |      | 1.3  | volts   |

## LARGE SIGNAL CHARACTERISTICS

Input Impedance ( $\frac{V_{BE2} - V_{BE1}}{I_{B2} - I_{B1}}$ ; where condition "1" is  
 $I_B = .05 mA$  and condition "2" is  $I_B = .5 mA, V_{CE} = 1V$ )

|          |     |      |
|----------|-----|------|
| $h_{IE}$ | 200 | ohms |
|----------|-----|------|

## SWITCHING SPEEDS (See Figure 1)

|              |       |    |    |
|--------------|-------|----|----|
| Delay Time   | $t_d$ | 60 | ns |
| Rise Time    | $t_r$ | 85 | ns |
| Storage Time | $t_s$ | 85 | ns |
| Fall Time    | $t_f$ | 40 | ns |

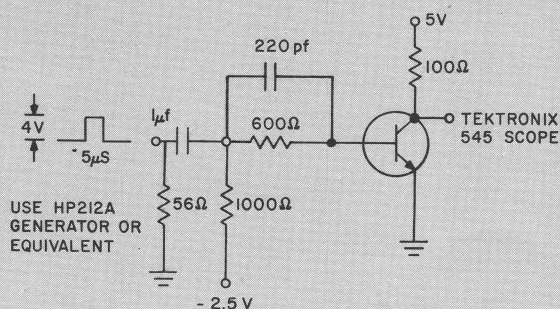


FIGURE 1 SWITCHING CIRCUIT

absolute maximum ratings: (25°C) (unless otherwise specified)

#### Voltages

|                      |           |    |      |
|----------------------|-----------|----|------|
| Collector to Emitter | $V_{CE0}$ | 18 | vols |
| Emitter to Base      | $V_{EB0}$ | 5  | vols |
| Collector to Base    | $V_{CB0}$ | 18 | vols |

#### Current

|                           |       |     |    |
|---------------------------|-------|-----|----|
| Collector* (Steady State) | $I_C$ | 200 | mA |
|---------------------------|-------|-----|----|

#### Dissipation

|                                 |       |     |    |
|---------------------------------|-------|-----|----|
| Total Power (Free air @ 25°C)** | $P_T$ | 200 | mW |
| Total Power (Free air @ 55°C)** | $P_T$ | 120 | mW |

#### Temperature

|           |           |               |    |
|-----------|-----------|---------------|----|
| Storage   | $T_{STG}$ | -55°C to +125 | °C |
| Operating | $T_J$     | +100          | °C |

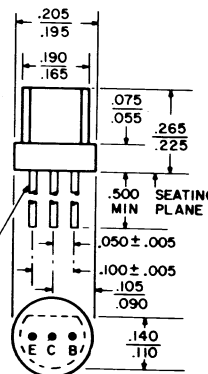
\*Determined from power limitations due to saturation voltage at this current.

\*\*Derate 2.67 mW/°C increase in ambient temperature above 25°C.

NOTE 1: Lead diameter is controlled in the zone between .070 and .250 from the seating plane. Between .250 and end of lead a max. of .021 is held.

ALL DIMEN. IN INCHES AND ARE REFERENCE UNLESS TOLERANCED

3 LEADS  
.017  $\pm$ .002  
-.001  
(NOTE 1)



## electrical characteristics: (25°C)

### DC CHARACTERISTICS

Collector Cutoff Current ( $V_{CB} = 18V$ )

( $V_{CB} = 18V$ ,  $T_A = 100^\circ C$ )

Emitter Cutoff Current ( $V_{EB} = 5V$ )

Forward Current Transfer Ratio ( $V_{CE} = 4.5V$ ,  $I_C = 2 mA$ )

2N2713

2N2714

Collector Saturation Voltage ( $I_B = 3 mA$ ,  $I_C = 50 mA$ )

Base Saturation Voltage ( $I_B = 3 mA$ ,  $I_C = 50 mA$ )

### LARGE SIGNAL CHARACTERISTICS

Input Impedance ( $\frac{V_{BE2} - V_{BE1}}{I_{B2} - I_{B1}}$ ; where condition "1" is

$I_B = .05 mA$  and condition "2" is  $I_B = .5 mA$ ,  $V_{CE} = 1V$ )

### SWITCHING SPEEDS

(See Figure 1)

Delay Time

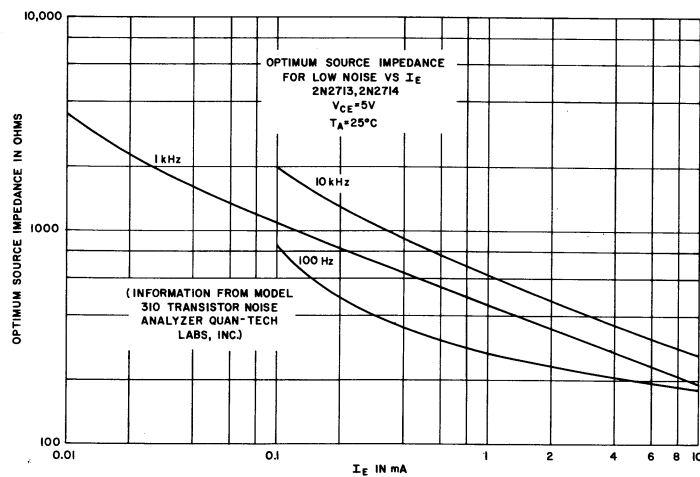
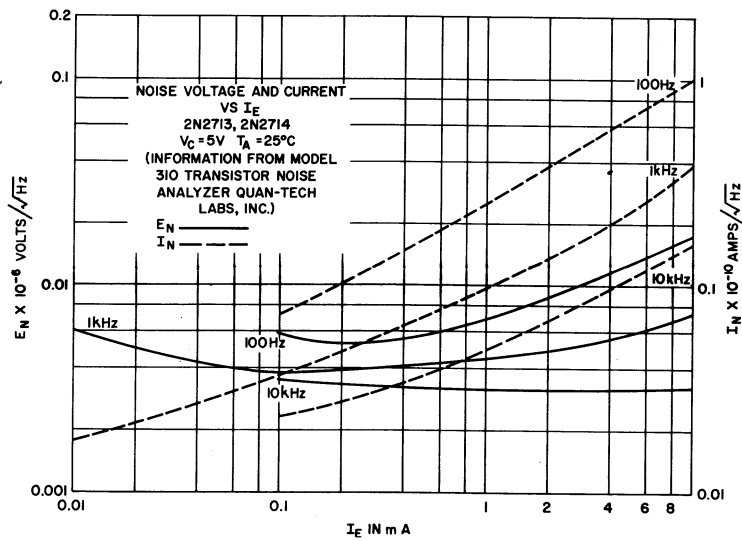
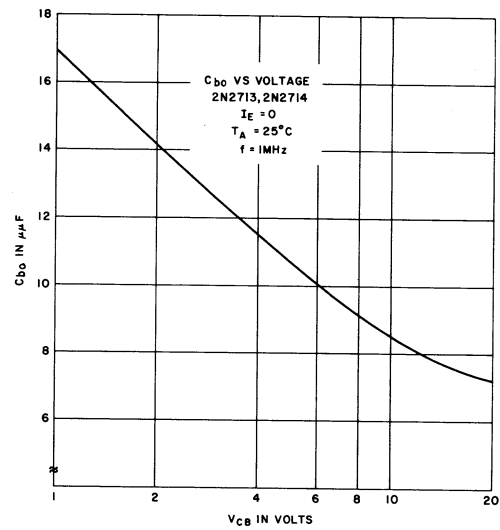
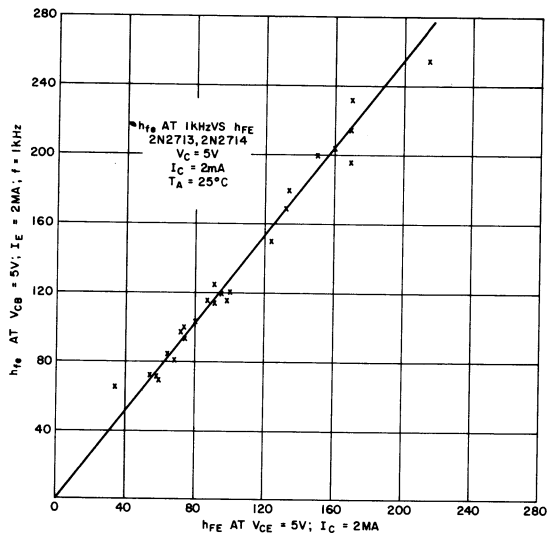
Rise Time

Storage Time

Fall Time

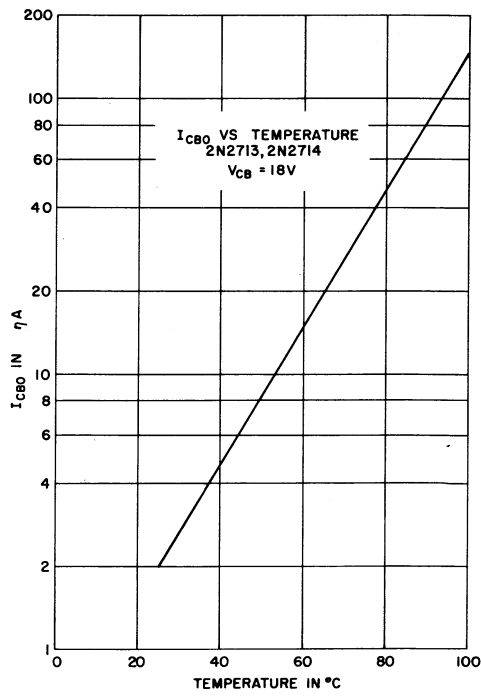
|               | Min. | Typ. | Max. |         |
|---------------|------|------|------|---------|
| $I_{CBO}$     |      |      | 0.5  | $\mu A$ |
| $I_{CBO}$     |      |      | 15   | $\mu A$ |
| $I_{EBO}$     |      |      | 0.5  | $\mu A$ |
| $h_{FE}$      | 30   |      | 90   |         |
| $h_{FE}$      | 75   |      | 225  |         |
| $V_{CE(SAT)}$ |      |      | 0.30 | vols    |
| $V_{BE(SAT)}$ |      |      | 1.3  | vols    |
| $h_{iE}$      |      | 200  |      | ohms    |
| $t_d$         |      | 60   |      | ns      |
| $t_r$         |      | 85   |      | ns      |
| $t_s$         |      | 85   |      | ns      |
| $t_f$         |      | 40   |      | ns      |

# TYPES 2N2713, 2N2714

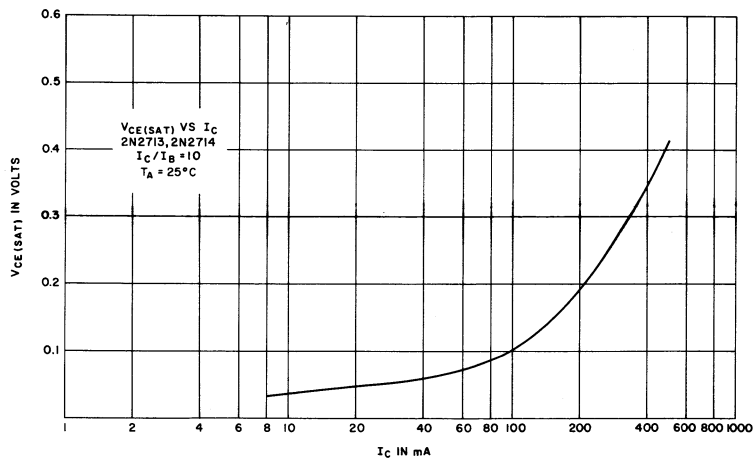
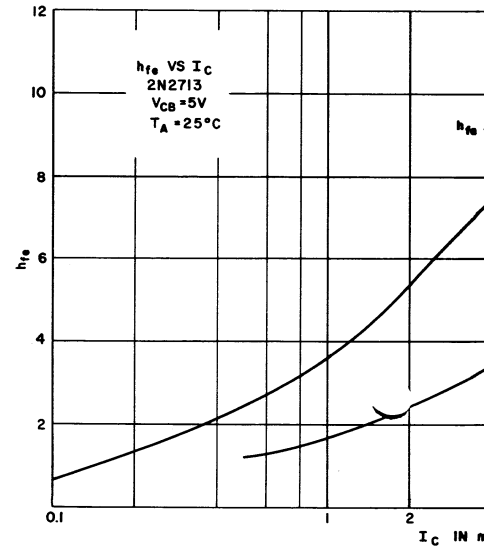


PRINTED IN U.S.A.

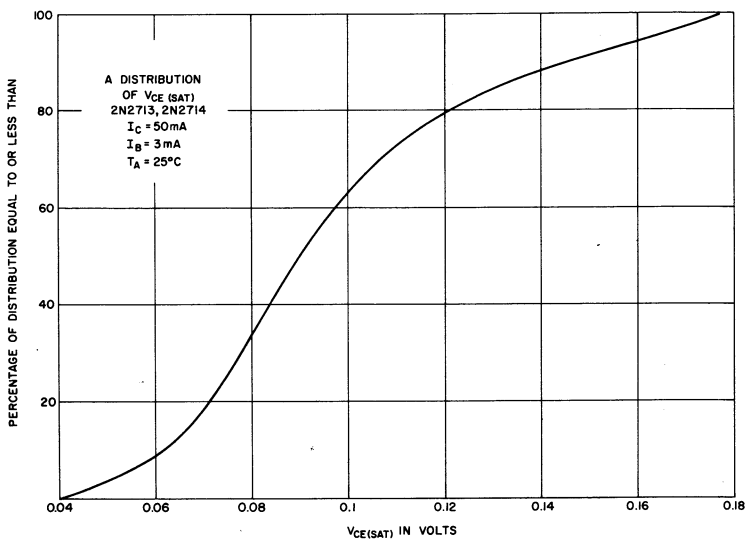
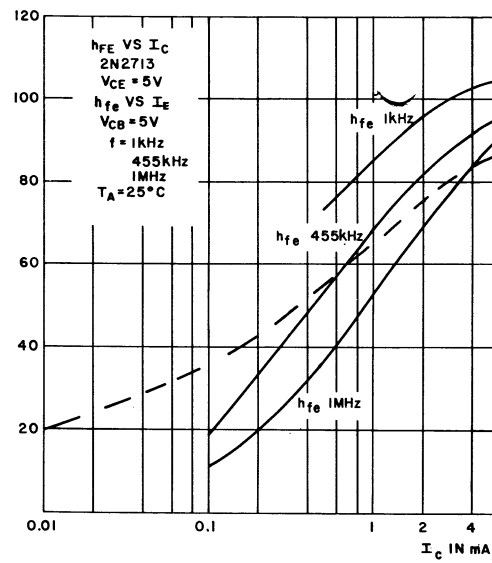
# **TYPES** **2N2713,** **2N2714**



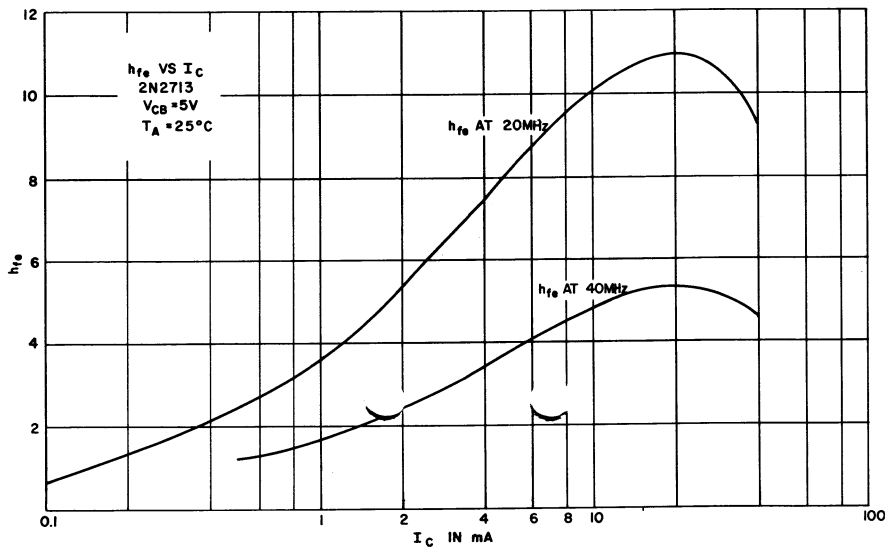
## **$h_{fe}$ VS. $I_C$ - TYP**



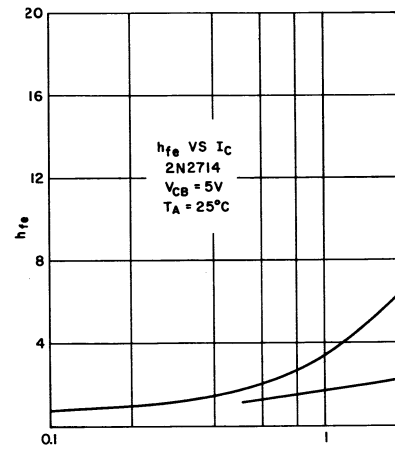
## **$h_{fe}$ or $h_{FE}$ VS. $I_C$ - TY**



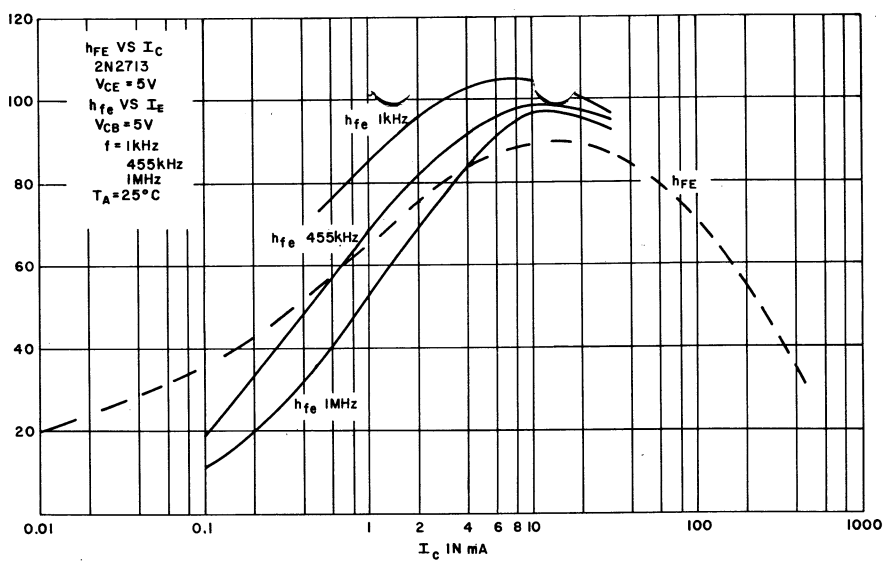
## $h_{fe}$ vs. $I_C$ - TYPE 2N2713



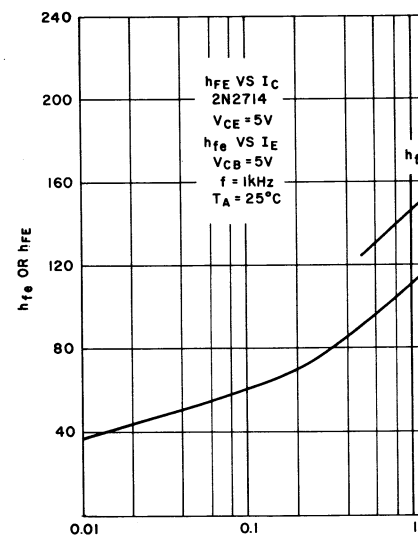
## $h_{fe}$ vs. $I_C$ -



## $h_{fe}$ or $h_{FE}$ vs. $I_C$ - TYPE 2N2713

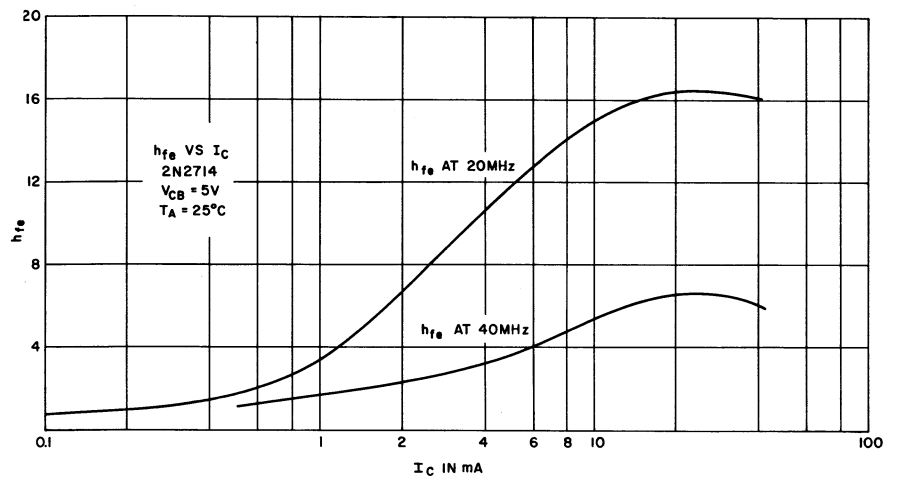
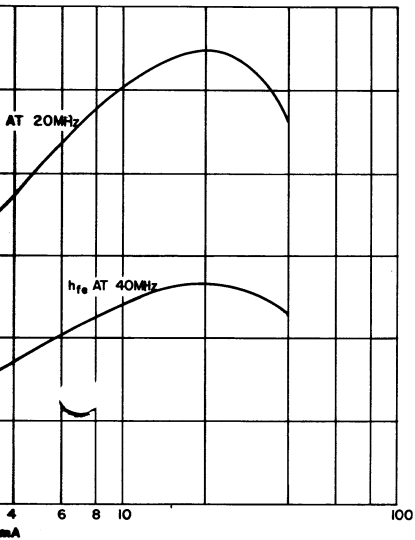


## $h_{fe}$ or $h_{FE}$ vs. $I_C$ -



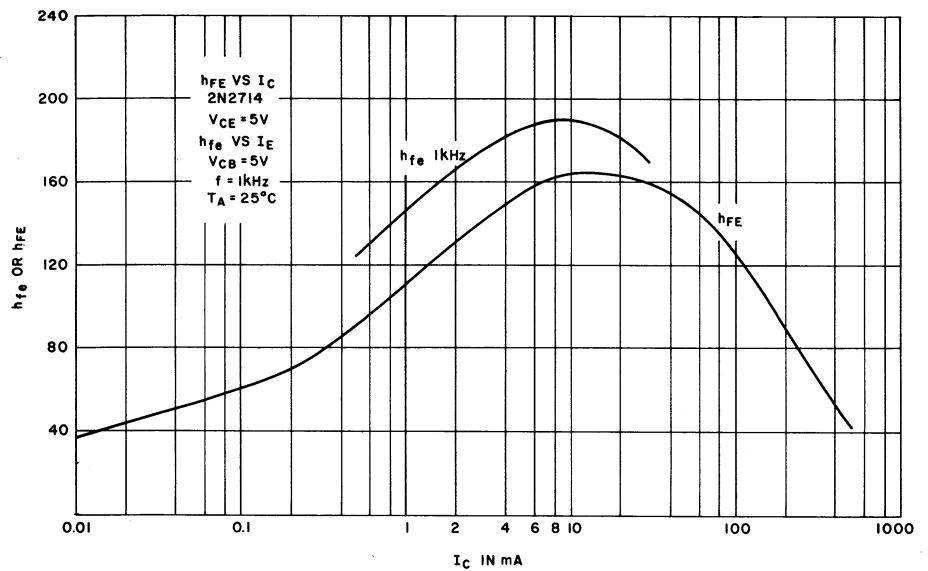
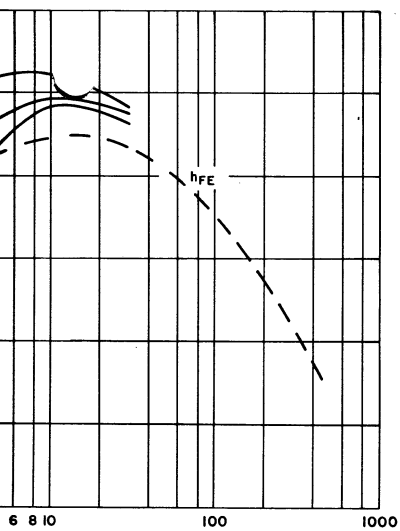
PE 2N2713

$h_{fe}$  vs.  $I_C$  - TYPE 2N2714



TYPE 2N2713

$h_{fe}$  or  $h_{FE}$  vs.  $I_C$  - TYPE 2N2714







**ELECTRONIC  
INNOVATIONS  
IN ACTION**

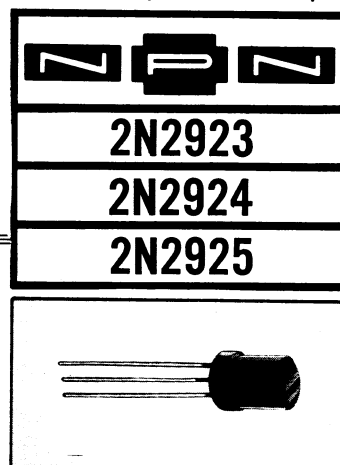
**SEMICONDUCTORS**

# Silicon TRANSISTORS

PLANAR PASSIVATED

13/07/02

40.61 7/66  
(Supersedes 40.61 8/63)



The General Electric 2N2923, 2N2924 and 2N2925 are a family of planar passivated NPN silicon transistors intended for general purpose applications. The planar passivated construction assures excellent device stability and life. These high performance, high value devices are made possible by utilizing advanced manufacturing techniques and epoxy encapsulation.

absolute maximum ratings: (25°C) (unless otherwise specified)

## Voltages

|                      |           |      |
|----------------------|-----------|------|
| Collector to Emitter | $V_{CEO}$ | 25 V |
| Emitter to Base      | $V_{EBO}$ | 5 V  |
| Collector to Base    | $V_{CBO}$ | 25 V |

## Current

|                           |       |        |
|---------------------------|-------|--------|
| Collector (Steady State)* | $I_C$ | 100 mA |
|---------------------------|-------|--------|

## Dissipation

|                                  |       |        |
|----------------------------------|-------|--------|
| Total Power (Free air at 25°C)** | $P_T$ | 200 mW |
| Total Power (Free air at 55°C)** | $P_T$ | 120 mW |

## Temperature

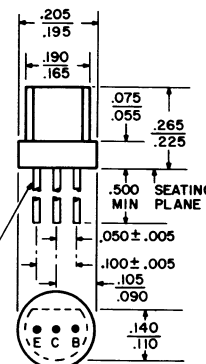
|           |           |               |
|-----------|-----------|---------------|
| Storage   | $T_{stg}$ | -55 to +125°C |
| Operating | $T_J$     | +100°C        |

DIMENSIONS WITHIN  
JEDEC OUTLINE TO-98

NOTE 1: Lead diameter is controlled in the zone between .070 and .250 from the seating plane. Between .250 and end of lead a max. of .021 is held.

ALL DIMEN. IN INCHES AND ARE  
REFERENCE UNLESS TOLERANCED

3 LEADS  
.017  $\pm$  .002  
-.001  
(NOTE 1)



\*Determined from power limitations due to saturation voltage at this current.  
\*\*Derate 2.67 mW/°C increase in ambient temperature above 25°C.

electrical characteristics: (25°C) (unless otherwise specified)

## D-C CHARACTERISTICS

|                                                                                      | Min.      | Typ. | Max.        |
|--------------------------------------------------------------------------------------|-----------|------|-------------|
| Collector Cutoff Current ( $V_{CB} = 25V$ )<br>( $V_{CB} = 25V, T_A = 100^\circ C$ ) | $I_{CBO}$ |      | 0.5 $\mu A$ |
|                                                                                      | $I_{CBO}$ |      | 15 $\mu A$  |
| Emitter Cutoff Current ( $V_{EB} = 5V$ )                                             | $I_{EBO}$ |      | 0.5 $\mu A$ |
| Forward Current Transfer Ratio<br>( $V_{CE} = 4.5V, I_C = 2 mA$ )                    | $h_{FE}$  |      |             |
| 2N2923                                                                               |           | 115  |             |
| 2N2924                                                                               |           | 155  |             |
| 2N2925                                                                               |           | 215  |             |

## SMALL SIGNAL CHARACTERISTICS

|                                                                            |          |     |      |
|----------------------------------------------------------------------------|----------|-----|------|
| Forward Current Transfer Ratio<br>( $V_{CE} = 10V, I_C = 2 mA, f = 1kHz$ ) | $h_{fe}$ |     |      |
| 2N2923                                                                     |          | 90  | 180  |
| 2N2924                                                                     |          | 150 | 300  |
| 2N2925                                                                     |          | 235 | 470  |
| Input Impedance ( $V_{CE} = 10V, I_C = 2 mA, f = 1kHz$ )                   | $h_{ib}$ | 15  | ohms |

## HIGH FREQUENCY CHARACTERISTICS

|                                                             |           |     |     |       |
|-------------------------------------------------------------|-----------|-----|-----|-------|
| Collector Capacitance ( $V_{CB} = 10V, I_E = 0, f = 1MHz$ ) | $C_{cbo}$ | 4.5 | 7   | 10 pF |
| Gain Bandwidth Product ( $I_C = 4 mA, V_{CB} = 5V$ )        | $f_T$     |     | 160 | MHz   |

## NOISE

|                                                                                               |       |                      |
|-----------------------------------------------------------------------------------------------|-------|----------------------|
| Noise Figure ( $I_C = 100 \mu A, V_{CE} = 5V, f = 10kHz$ ,<br>BW = 1 Hz, $R_g = 2000\Omega$ ) | N. F. | 2.8 (2N2925 only) dB |
|-----------------------------------------------------------------------------------------------|-------|----------------------|



# SEMICONDUCTOR SPECIFICATIONS

8/63 40.62  
Epoxy Encapsulated  
Silicon Transistor  
2N2926

13/07/02

The General Electric 2N2926 is a planar passivated silicon transistor intended for general purpose applications. The planar passivated construction assures excellent device stability and life. This high performance, high value device is made possible by advanced manufacturing techniques, epoxy encapsulation, and utilization of the full line distribution of  $h_{fe}$ . This full line distribution is supplied in five beta categories, each with a 2-1 beta spread. Each beta category is color coded and the per cent of the total order shipped in each category is shown below. Significant savings may be realized by designing equipment utilizing all beta categories in proportions compatible with this "full line distribution" type.

## ABSOLUTE MAXIMUM RATINGS (25°C) (unless otherwise specified)

### Voltages

|                      |           |    |   |
|----------------------|-----------|----|---|
| Collector to Emitter | $V_{CEO}$ | 18 | V |
| Emitter to Base      | $V_{EBO}$ | 5  | V |
| Collector to Base    | $V_{CBO}$ | 18 | V |

### Current

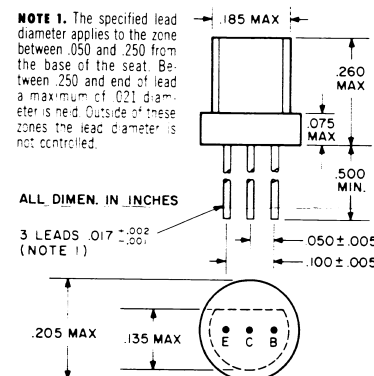
|                            |       |     |    |
|----------------------------|-------|-----|----|
| Collector (Steady State) * | $I_C$ | 100 | ma |
|----------------------------|-------|-----|----|

### Dissipation

|                                   |       |     |    |
|-----------------------------------|-------|-----|----|
| Total Power (Free air at 25°C) ** | $P_T$ | 200 | mw |
| Total Power (Free air at 55°C) ** | $P_T$ | 120 | mw |

### Temperature

|           |           |               |
|-----------|-----------|---------------|
| Storage   | $T_{STG}$ | -30 to +125°C |
| Operating | $T_J$     | +100°C        |



- \* Determined from power limitations due to saturation voltage at this current.  
\*\* Derate 2.67 mw/°C increase in ambient temperature above 25°C.

## ELECTRICAL CHARACTERISTICS (25°C) (unless otherwise specified)

### D-C Characteristics

|                                            |           | Min. | Typ. | Max.        |
|--------------------------------------------|-----------|------|------|-------------|
| Collector Cutoff Current: ( $V_{CB}=18V$ ) | $I_{CBO}$ |      |      | 0.5 $\mu a$ |
| ( $V_{CB}=18V$ , $T_A=100^\circ C$ )       | $I_{CBO}$ |      |      | 15 $\mu a$  |
| Emitter Cutoff Current ( $V_{EB}=5V$ )     | $I_{EBO}$ |      |      | 0.5 $\mu a$ |

### Small Signal Characteristics

#### Forward Current Transfer Ratio

|                                        |          |    |     |
|----------------------------------------|----------|----|-----|
| ( $V_{CE}=10V$ , $I_C=2ma$ , $f=1kc$ ) | $h_{fe}$ | 35 | 470 |
|----------------------------------------|----------|----|-----|

Each unit will be branded with the 2N2926 type number and will also be color coded to identify the A-C beta range into which it falls. Segregation of the beta distribution into the following five groups is provided, though it is not a requirement of the JEDEC registration. Typical D-C beta is also shown for guidance purposes.

| Color Code | $h_{fe}$<br>( $V_{CE}=10V$ , $I_C=2ma$ , $f=1kc$ ) |      | $h_{FE}$<br>( $V_{CE}=4.5V$ , $I_C=2ma$ )<br>Typ. | Content |
|------------|----------------------------------------------------|------|---------------------------------------------------|---------|
|            | Min.                                               | Max. |                                                   |         |
| Brown      | 35                                                 | 70   | 36                                                | 0-6%    |
| Red        | 55                                                 | 110  | 62                                                | 5-10%   |
| Orange     | 90                                                 | 180  | 115                                               | 20-26%  |
| Yellow     | 150                                                | 300  | 155                                               | 35-45%  |
| Green      | 235                                                | 470  | 215                                               | 20-30%  |

|                                                                                          | Min. | Typ. | Max. |     |
|------------------------------------------------------------------------------------------|------|------|------|-----|
| Input Impedance: ( $V_{CE}=10V$ , $I_C=2ma$ , $f=1kc$ )                                  |      | 15   |      | ohm |
| <u>High Frequency Characteristics</u>                                                    |      |      |      |     |
| Collector Capacitance: ( $V_{CB}=10V$ , $I_E=0$ , $f=1mc$ )                              | 4.5  | 9    | 12   | pf  |
| Gain Bandwidth Product: ( $I_C=4ma$ , $V_{CB}=5V$ )                                      |      | 200  |      | mc  |
| <u>Noise</u>                                                                             |      |      |      |     |
| Noise Figure: ( $I_C=100\mu a$ , $V_{CE}=5V$ , $f=10kc$ ,<br>BW=1cps, $R_g=2000\Omega$ ) |      | 2.8  |      | db  |