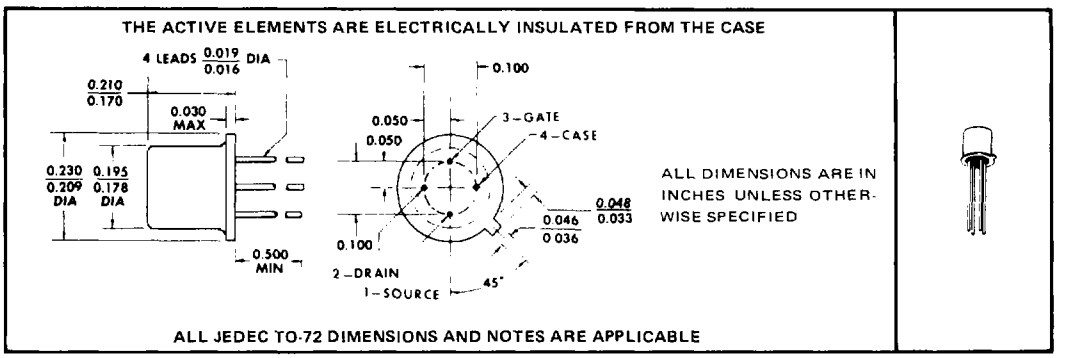
# TYPES 2N4416, 2N4416A
# N-CHANNEL SILICON JUNCTION FIELD-EFFECT TRANSISTORS

BULLETIN NO. DL-S 6810649, JANUARY 1968

## FOR VHF AMPLIFIER AND MIXER APPLICATIONS

- **High Power Gain . . . 10 dB Min at 400 MHz**
- **Low Noise Figure . . . 4 dB Max at 400 MHz**
- **High Transconductance . . . 4000 $\mu$mho Min at 400 MHz**
- **Low $C_{rss}$ . . . 0.8 pF Max**
- **High $|y_{fs}|/C_{iss}$ Ratio (High-Frequency Figure-of-Merit)**
- **Cross-Modulation Minimized by Square-Law Transfer Characteristic**
- **Recommended for Use in VHF-UHF Bandpass Amplifiers**
- **Excellent for General Purpose Amplifier and Chopper Applications**

***mechanical data**

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***absolute maximum ratings at 25°C free-air temperature (unless otherwise noted)***

| | 2N4416 | 2N4416A |
|---|---|---|
| *Drain-Gate Voltage | 30 V | 35 V |
| *Drain-Source Voltage | 30 V | 35 V |
| *Reverse Gate-Source Voltage | –30 V | –35 V |
| *Continuous Forward Gate Current | ← 10 mA → | |
| *Continuous Device Dissipation at (or below) 25°C Free-Air Temperature (See Note 1) | ←300 mW→ | |
| Continuous Device Dissipation at (or below) 125°C Case Temperature (See Note 2) | ←450 mW→ | |
| *Storage Temperature Range | –65°C to 200°C | |
| *Lead Temperature 1/16 Inch from Case for 60 Seconds | ← 300°C → | |

NOTES: 1. Derate linearly to 200°C free-air temperature at the rate of 1.7 mW/°C.
2. Derate linearly to 200°C case temperature at the rate of 6 mW/°C.

*Indicates JEDEC registered data

USES CHIP JN53



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## electrical characteristics at 25°C free-air temperature (unless otherwise noted)

| PARAMETER | | TEST CONDITIONS‡ | 2N4416 MIN | 2N4416 MAX | 2N4416A MIN | 2N4416A MAX | UNIT |
|---|---|---|---|---|---|---|---|
| $V_{(BR)GSS}$ | Gate-Source Breakdown Voltage | $I_G = -1\ \mu A$, $V_{DS} = 0$ | −30* | | −35* | | V |
| $V_{GSF}$ | Gate-Source Forward Voltage | $I_G = 1$ mA, $V_{DS} = 0$ | | 1* | | 1* | V |
| $I_{GSS}$ | Gate Reverse Current | $V_{GS} = -20$ V, $V_{DS} = 0$ | | −0.1* | | −0.1* | nA |
| | | $V_{GS} = -20$ V, $V_{DS} = 0$, $T_A = 150°C$ | | −0.2*<br>−0.1† | | −0.2*<br>−0.1† | μA |
| $V_{GS(off)}$ | Gate-Source Cutoff Voltage | $V_{DS} = 15$ V, $I_D = 1$ nA | | −6* | −2.5* | −6* | V |
| $V_{GS}$ | Gate-Source Voltage | $V_{DS} = 15$ V, $I_D = 0.5$ mA | −1* | −5.5* | −1* | −5.5* | V |
| $I_{DSS}$ | Zero-Gate-Voltage Drain Current | $V_{DS} = 15$ V, $V_{GS} = 0$, See Note 3 | 5* | 15* | 5* | 15* | mA |
| $\lvert y_{fs} \rvert$ | Small-Signal Common-Source Forward Transfer Admittance | $V_{DS} = 15$ V, $V_{GS} = 0$, $f = 1$ kHz | 4.5* | 7.5* | 4.5* | 7.5* | mmho |
| $\lvert y_{os} \rvert$ | Small-Signal Common-Source Output Admittance | | | 0.05* | | 0.05* | |
| $C_{iss}$ | Common-Source Short-Circuit Input Capacitance | $V_{DS} = 15$ V, $V_{GS} = 0$, $f = 1$ MHz | | 4* | | 4* | pF |
| $C_{rss}$ | Common-Source Short-Circuit Reverse Transfer Capacitance | | | 0.8* | | 0.8* | |
| $C_{oss}$ | Common-Source Short-Circuit Output Capacitance | | | 2* | | 2* | |
| $Re(y_{is})$ | Small-Signal Common-Source Input Conductance | $V_{DS} = 15$ V, $V_{GS} = 0$, $f = 100$ MHz | | 0.1* | | 0.1* | mmho |
| $Im(y_{is})$ | Small-Signal Common-Source Input Susceptance | | | 2.5* | | 2.5* | |
| $Re(y_{os})$ | Small-Signal Common-Source Output Conductance | | | 0.075* | | 0.075* | |
| $Im(y_{os})$ | Small-Signal Common-Source Output Susceptance | | | 1* | | 1* | |
| $Re(y_{rs})$ | Small-Signal Common-Source Input Conductance | $V_{DS} = 15$ V, $V_{GS} = 0$, $f = 400$ MHz | | 1* | | 1* | mmho |
| $Im(y_{is})$ | Small-Signal Common-Source Input Susceptance | | | 10* | | 10* | |
| $Re(y_{fs})$ | Small-Signal Common-Source Forward Transfer Conductance | | 4* | | 4* | | |
| $Re(y_{os})$ | Small-Signal Common-Source Output Conductance | | | 0.1* | | 0.1* | |
| $Im(y_{os})$ | Small-Signal Common-Source Output Susceptance | | | 4* | | 4* | |

NOTE 3: This parameter must be measured using pulse techniques. $t_p = 300\ \mu s$, duty cycle $\leq 1\%$.

†Texas Instruments guarantees this value in addition to the JEDEC registered value, which is also shown.

## *operating characteristics at 25°C free-air temperature

| PARAMETER | | TEST CONDITIONS‡ | MIN | MAX | UNIT |
|---|---|---|---|---|---|
| $G_{ps}$ | Small-Signal Common-Source Neutralized Insertion Power Gain | $V_{DS} = 15$ V, $I_D = 5$ mA, $R_G' = 1$ kΩ, f = 100 MHz, See Figure 1 | 18 | | dB |
| | | $V_{DS} = 15$ V, $I_D = 5$ mA, $R_G' = 1$ kΩ, f = 400 MHz, See Figure 1 | 10 | | |
| NF | Spot Noise Figure | $V_{DS} = 15$ V, $I_D = 5$ mA, $R_G' = 1$ kΩ, f = 100 MHz, See Figure 1 | | 2 | dB |
| | | $V_{DS} = 15$ V, $I_D = 5$ mA, $R_G' = 1$ kΩ, f = 400 MHz, See Figure 1 | | 4 | |

‡The fourth lead (case) is connected to the source for all measurements.

*Indicates JEDEC registered data



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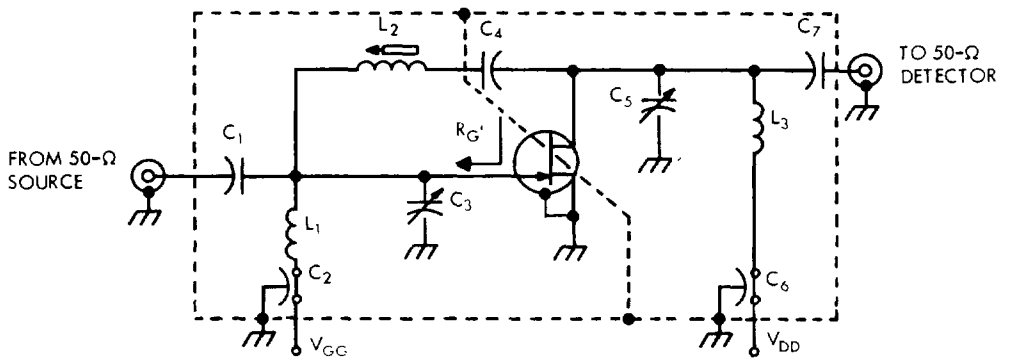
## PARAMETER MEASUREMENT INFORMATION




**CIRCUIT COMPONENT INFORMATION (See Note 4)**

| | CAPACITORS | | | COILS | |
|---|---|---|---|---|---|
| | 100 MHz | 400 MHz | | 100 MHz | 400 MHz |
| $C_1$ | 7 pF | 1.8 pF | $L_1$ | 0.14 μH, 3.5 T, #18 enameled copper wire, $\frac{3}{8}$" I.D., $\frac{1}{4}$" long | 0.022 μH, $\frac{5}{8}$" of #16 copper wire formed to 0.5 T, $\frac{1}{4}$" I.D. |
| $C_2$ | 0.0015 μF | 0.001 μF | | | |
| $C_3$ | 1–12 pF | 0.8–8 pF | $L_2$ | 3 μH, 17 T, #28 enameled copper wire, close wound, $\frac{9}{32}$" I.D., powdered iron slug | 0.2 μH, 6 T, #24 enameled copper wire, close wound, $\frac{7}{32}$" I.D., aluminum slug |
| $C_4$ | 1000 pF | 27 pF | | | |
| $C_5$ | 1–12 pF | 0.8–8 pF | | | |
| $C_6$ | 0.0015 μF | 0.001 μF | $L_3$ | 0.25 μH, 4.5 T, #18 enameled copper wire, $\frac{3}{8}$" I.D., $\frac{5}{16}$" long | 0.03 μH, $1\frac{1}{2}$" of #16 enameled copper wire formed to 1 T, $\frac{3}{8}$" I.D. |
| $C_7$ | 3 pF | 1 pF | | | |

**FIGURE 1–NEUTRALIZED POWER GAIN AND SPOT NOISE FIGURE TEST CIRCUIT**

NOTE 4: Transformed equivalent source resistance ($R_G'$) is 1000 Ω at 100 MHz for 100-MHz amplifier, and 1000 Ω at 400 MHz for 400-MHz amplifier

## THERMAL INFORMATION

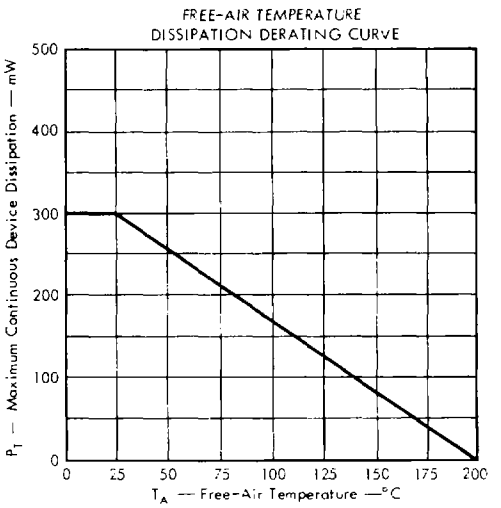



**FIGURE 2**

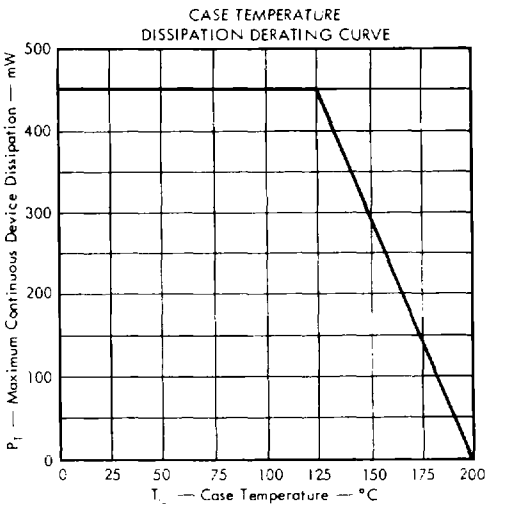



**FIGURE 3**





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