

## JFET Voltage-Controlled Resistors

PRODUCT SUMMARY			
Part Number	$V_{GS(off)}$ Max (V)	$V_{(BR)GS}$ Min (V)	$r_{DS(on)}$ Max ( $\Omega$ )
VCR2N	-7	-25	60
VCR4N	-7	-25	600
VCR7N	-5	-25	8000

### FEATURES

- Continuous Voltage-Controlled Resistance
- High Off-Isolation
- High Input Impedance

### BENEFITS

- Gain Ranging Capability/Wide Range Signal Attenuation
- No Circuit Interaction
- Simplified Drive

### APPLICATIONS

- Variable Gain Amplifiers
- Voltage Controlled Oscillator
- AGC

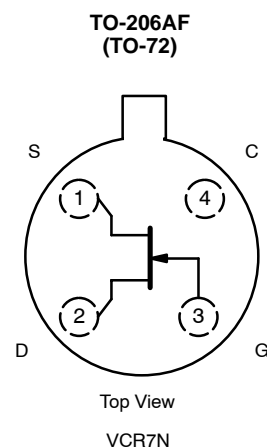
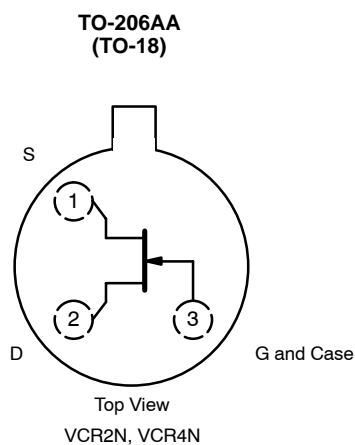
### DESCRIPTION

The VCR2N/4N/7N JFET voltage controlled resistors have an ac drain-source resistance that is controlled by a dc bias voltage ( $V_{GS}$ ) applied to their high impedance gate terminal. Minimum  $r_{DS}$  occurs when  $V_{GS} = 0$  V. As  $V_{GS}$  approaches the pinch-off voltage,  $r_{DS}$  rapidly increases. This series of junction FETs is intended for applications where the drain-source voltage is a low-level ac signal with no dc component.

Key to device performance is the predictable  $r_{DS}$  change versus  $V_{GS}$  bias where:

$$r_{DS}^{bias} \approx \frac{r_{DS}(@V_{GS} = 0)}{1 - \left| \frac{V_{GS}}{V_{GS(off)}} \right|}$$

These n-channel devices feature  $r_{DS(on)}$  ranging from 20 to 8000  $\Omega$ . All packages are hermetically sealed and may be processed per MIL-S-19500 (see Military Information).



For applications information see AN105.



### ABSOLUTE MAXIMUM RATINGS<sup>a</sup>

Gate-Source, Gate-Drain Voltage .....	-25 V
Gate Current .....	10 mA
Power Dissipation <sup>b</sup> .....	300 mW
Operating Junction Temperature Range .....	-55 to 175°C
Storage Temperature .....	-65 to 200°C

Lead Temperature (1/16" from case for 10 sec.) ..... 300°C

Notes:

- a.  $T_A = 25^\circ\text{C}$  unless otherwise noted.
- b. Derate 2 mW/°C above 25°C.

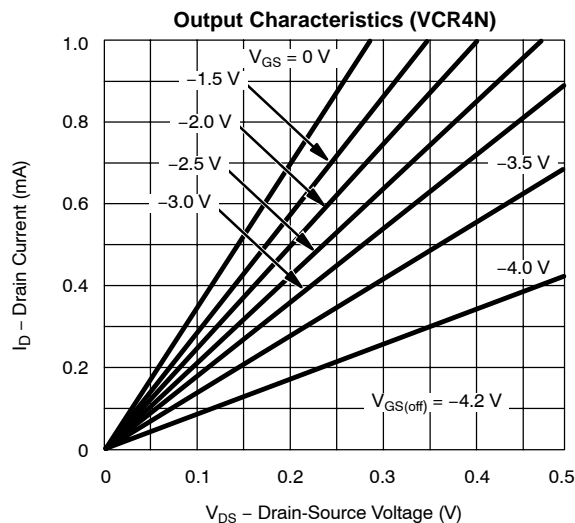
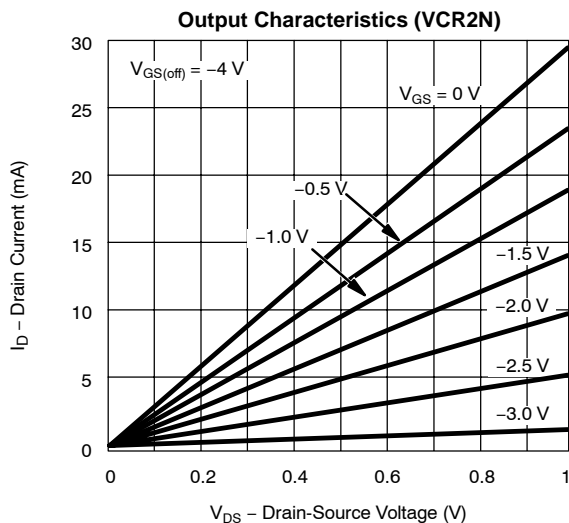
SPECIFICATIONS ( $T_A = 25^\circ\text{C}$ UNLESS OTHERWISE NOTED)										
Parameter	Symbol	Test Conditions	Typ <sup>a</sup>	Limits						Unit
				VCR2N		VCR4N		VCR7N		
				Min	Max	Min	Max	Min	Max	
<b>Static</b>										
Gate-Source Breakdown Voltage	$V_{(BR)GSS}$	$I_G = -1 \mu\text{A}, V_{DS} = 0 \text{ V}$	-55	-25		-25		-25		V
Gate-Source Cutoff Voltage	$V_{GS(off)}$	$V_{DS} = 10 \text{ V}, I_D = 1 \mu\text{A}$		-3.5	-7	-3.5	-7	-2.5	-5	
Gate Reverse Current	$I_{GSS}$	$V_{GS} = -15 \text{ V}, V_{DS} = 0 \text{ V}$			-5		-0.2		-0.1	nA
Drain-Source On-Resistance	$r_{DS(on)}$	$V_{GS} = 0 \text{ V}, I_D = 10 \text{ mA}$		20	60					Ω
		$V_{GS} = 0 \text{ V}, I_D = 1 \text{ mA}$				200	600			
		$V_{GS} = 0 \text{ V}, I_D = 0.1 \text{ mA}$						4000	8000	
Gate-Source Forward Voltage	$V_{GS(F)}$	$V_{DS} = 0 \text{ V}, I_G = 1 \text{ mA}$	0.7							V
<b>Dynamic</b>										
Drain-Source On-Resistance	$r_{ds(on)}$	$V_{GS} = 0 \text{ V}, I_D = 0 \text{ mA}$ $f = 1 \text{ kHz}$		20	60	200	600	4000	8000	Ω
Drain-Gate Capacitance	$C_{dg}$	$V_{GD} = -10 \text{ V}, I_S = 0 \text{ mA}$ $f = 1 \text{ MHz}$			7.5		3		1.5	pF
Source-Gate Capacitance	$C_{sg}$	$V_{GS} = -10 \text{ V}, I_D = 0 \text{ mA}$ $f = 1 \text{ kHz}$			7.5		3		1.5	

Notes:

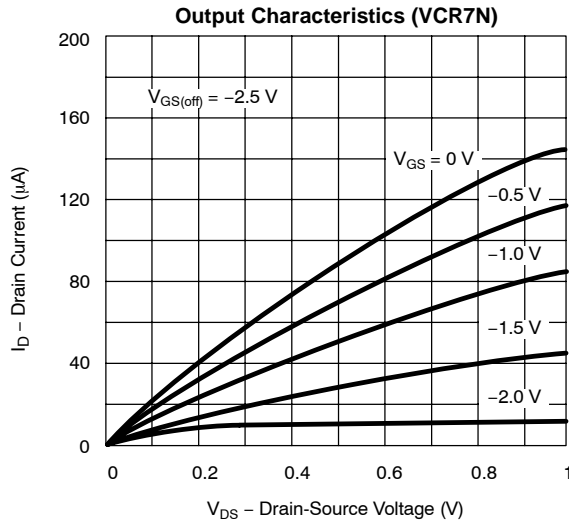
- a. Typical values are for DESIGN AID ONLY, not guaranteed nor subject to production testing.

NCB/NPA/NT

### TYPICAL CHARACTERISTICS ( $T_A = 25^\circ\text{C}$ UNLESS OTHERWISE NOTED)



**TYPICAL CHARACTERISTICS (T<sub>A</sub> = 25 °C UNLESS OTHERWISE NOTED)**



**APPLICATIONS**

A simple application of a FET VCR is shown in Figure 1, the circuit for a voltage divider attenuator.

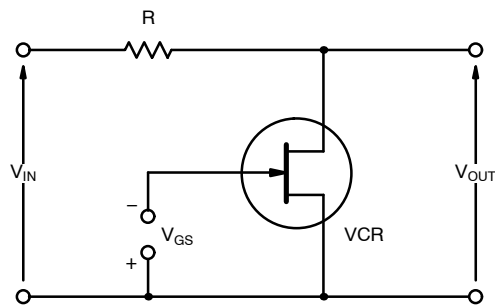


FIGURE 1. Simple Attenuator Circuit

The output voltage is:

$$V_{OUT} = \frac{V_{IN} r_{DS}}{R + r_{DS}}$$

It is assumed that the output voltage is not so large as to push the VCR out of the linear resistance region, and that the  $r_{DS}$  is not shunted by the load.

The lowest value which  $V_{OUT}$  can assume is:

$$V_{OUT(min)} = \frac{V_{IN} r_{DS(on)}}{R + r_{DS(on)}}$$

Since  $r_{DS}$  can be extremely large, the highest value is:

$$V_{OUT(max)} = V_{IN}$$