JFET Voltage-Controlled Resistors

PRODUCT SUMMARY			
Part Number	$V_{GS(off)}$ Max (V)	$V_{(BR)GSS}$ Min (V)	$r_{DS(on)}$ Max (Ω)
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

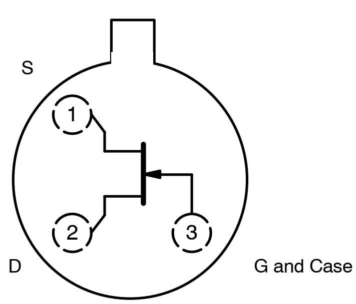
The VCR2N/4N/7N JFET voltage controlled resistors have an ac drain-source resistance that is controlled by a dc bias voltage (V_{GS}) applied to their high impedance gate terminal. Minimum r_{DS} occurs when V_{GS} = 0 V. As V_{GS} approaches the pinch-off voltage, r_{DS} rapidly increases. This series 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:

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

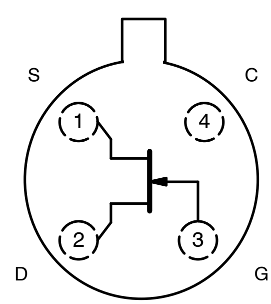
These n-channel devices feature $r_{DS(on)}$ ranging from 20 to 8000 Ω. All packages are hermetically sealed and may be processed per MIL-S-19500 (see Military Information).

**TO-206AA
(TO-18)**



Top View
VCR2N, VCR4N

**TO-206AF
(TO-72)**



Top View
VCR7N

For applications information see AN105.

ABSOLUTE MAXIMUM RATINGS[a]

Gate-Source, Gate-Drain Voltage . . . . –25 V
Gate Current . . . . 10 mA
Power Dissipation[b] . . . . 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°C unless otherwise noted.
b. Derate 2 mW/°C above 25°C.

SPECIFICATIONS (T_A = 25°C UNLESS OTHERWISE NOTED)

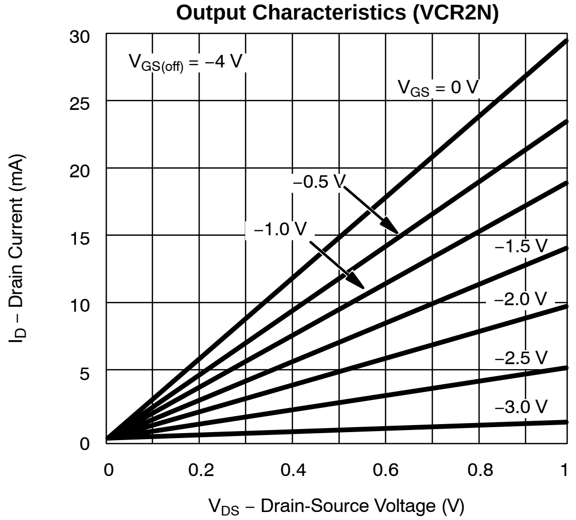
Parameter	Symbol	Test Conditions	Typ[a]	Limits						Unit
				VCR2N		VCR4N		VCR7N		
				Min	Max	Min	Max	Min	Max	
Static										
Gate-Source Breakdown Voltage	$V_{(BR)GSS}$	I_G = –1 μA, V_{DS} = 0 V	–55	–25		–25		–25		V
Gate-Source Cutoff Voltage	$V_{GS(off)}$	V_{DS} = 10 V, I_D = 1 μA		–3.5	–7	–3.5	–7	–2.5	–5	V
Gate Reverse Current	I_{GSS}	V_{GS} = –15 V, V_{DS} = 0 V			–5		–0.2		–0.1	nA
Drain-Source On-Resistance	$r_{DS(on)}$	V_{GS} = 0 V, I_D = 10 mA		20	60					Ω
		V_{GS} = 0 V, I_D = 1 mA				200	600			Ω
		V_{GS} = 0 V, I_D = 0.1 mA						4000	8000	Ω
Gate-Source Forward Voltage	$V_{GS(F)}$	V_{DS} = 0 V, I_G = 1 mA	0.7							V
Dynamic										
Drain-Source On-Resistance	$r_{ds(on)}$	V_{GS} = 0 V, I_D = 0 mA f = 1 kHz		20	60	200	600	4000	8000	Ω
Drain-Gate Capacitance	C_{dg}	V_{GD} = –10 V, I_S = 0 mA f = 1 MHz			7.5		3		1.5	pF
Source-Gate Capacitance	C_{sg}	V_{GS} = –10 V, I_D = 0 mA f = 1 kHz			7.5		3		1.5	pF

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

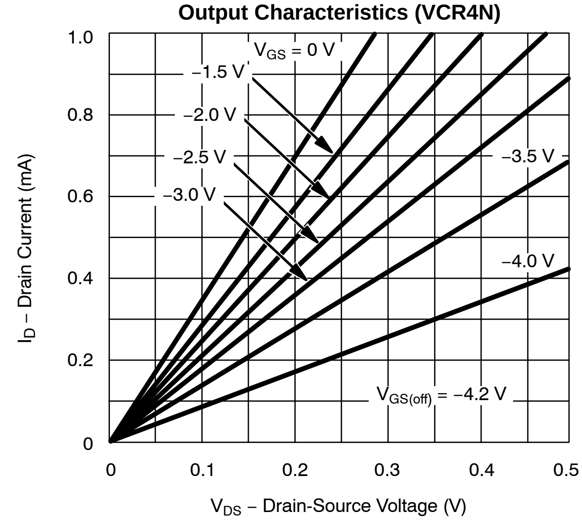
NCB/NPA/NT

TYPICAL CHARACTERISTICS (T_A = 25°C UNLESS OTHERWISE NOTED)

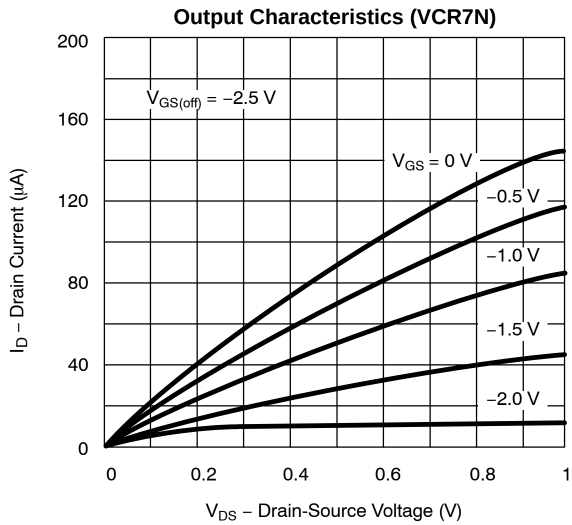
Output Characteristics (VCR2N)



Output Characteristics (VCR4N)



TYPICAL CHARACTERISTICS (T_A = 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.

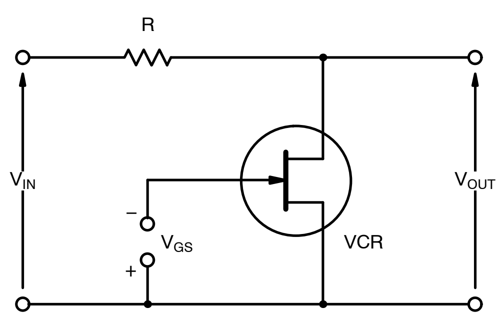


FIGURE 1. Simple Attenuator Circuit

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:

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

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