TYPES 2N4856 THRU 2N4861, 2N4856A THRU 2N4861A
N-CHANNEL SILICON JUNCTION FIELD-EFFECT TRANSISTORS

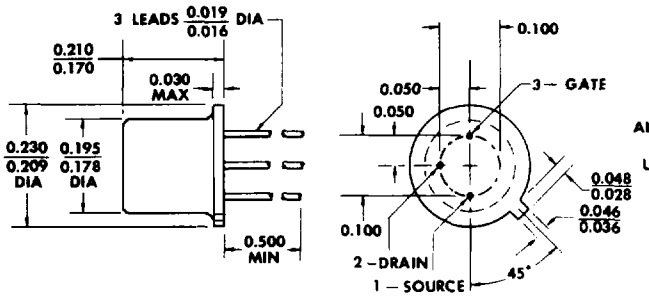
BULLETIN NO. DL-S 7311911, JUNE 1973

SYMMETRICAL N-CHANNEL FIELD-EFFECT TRANSISTORS FOR HIGH-SPEED COMMUTATOR AND CHOPPER APPLICATIONS

- Low $r_{ds(on)}$ . . . 25 Ω Max (2N4856, 2N4856A, 2N4859, 2N4859A)
- Low $I_{D(off)}$ . . . 0.25 nA Max
- Low $r_{ds(on)}$ C_{iss} Product

***mechanical data**

THE GATE IS IN ELECTRICAL CONTACT WITH THE CASE



ALL JEDEC TO-18 DIMENSIONS AND NOTES ARE APPLICABLE

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

	2N4856 2N4857 2N4858 2N4856A 2N4857A 2N4858A	2N4859 2N4860 2N4861 2N4859A 2N4860A 2N4861A
Drain-Gate Voltage	40 V	30 V
Drain-Source Voltage	40 V	30 V
Reverse Gate-Source Voltage	−40 V	−30 V
Continuous Forward Gate Current	50 mA	
Continuous Device Dissipation at (or below) 25°C Free-Air Temperature (See Note 1)	360 mW	
Continuous Device Dissipation at (or below) 25°C Case Temperature (See Note 2)	1.8 W	
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 2.06 mW/°C.
2. Derate linearly to 200°C case temperature at the rate of 10.3 mW/°C.

USES CHIP JN52

*JEDEC registered data. This data sheet contains all applicable registered data in effect at the time of publication.

2N4856 THRU 2N4861

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

PARAMETER		TEST CONDITIONS	2N4856		2N4857		2N4858		2N4859		2N4860		2N4861		UNIT
			MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	
$V_{(BR)GSS}$	Gate-Source Breakdown Voltage	$I_G = -1\ \mu A$, $V_{DS} = 0$	−40		−40		−40		−30		−30		−30		V
I_{GSS}	Gate Reverse Current	$V_{GS} = -20$ V, $V_{DS} = 0$		−0.25		−0.25		−0.25							nA
		$V_{GS} = -20$ V, $V_{DS} = 0$, $T_A = 150°C$		−0.5		−0.5		−0.5							μA
		$V_{GS} = -15$ V, $V_{DS} = 0$								−0.25		−0.25		−0.25	nA
		$V_{GS} = -15$ V, $V_{DS} = 0$, $T_A = 150°C$								−0.5		−0.5		−0.5	μA
$I_{D(off)}$	Drain Cutoff Current	$V_{DS} = 15$ V, $V_{GS} = -10$ V		0.25		0.25		0.25		0.25		0.25		0.25	nA
		$V_{DS} = 15$ V, $V_{GS} = -10$ V, $T_A = 150°C$		0.5		0.5		0.5		0.5		0.5		0.5	μA
$V_{GS(off)}$	Gate-Source Cutoff Voltage	$V_{DS} = 15$ V, $I_D = 0.5$ nA	−4	−10	−2	−6	−0.8	−4	−4	−10	−2	−6	−0.8	−4	V
I_{DSS}	Zero-Gate-Voltage Drain Current	$V_{DS} = 15$ V, $V_{GS} = 0$, See Note 3	50		20	100	8	80	50		20	100	8	80	mA
$V_{DS(on)}$	Drain-Source On-State Voltage	$I_D = 20$ mA, $V_{GS} = 0$		0.75						0.75					V
		$I_D = 10$ mA, $V_{GS} = 0$				0.5						0.5			
		$I_D = 5$ mA, $V_{GS} = 0$						0.5						0.5	
$r_{ds(on)}$	Small-Signal Drain-Source On-State Resistance	$V_{GS} = 0$, $I_D = 0$, $f = 1$ kHz		25		40		60		25		40		60	Ω
C_{iss}	Common-Source Short-Circuit Input Capacitance	$V_{DS} = 0$, $V_{GS} = -10$ V, $f = 1$ MHz		18		18		18		18		18		18	pF
C_{rss}	Common-Source Short-Circuit Reverse Transfer Capacitance	$V_{DS} = 0$, $V_{GS} = -10$ V, $f = 1$ MHz		8		8		8		8		8		8	pF

*switching characteristics at 25°C free-air temperature

PARAMETER		TEST CONDITIONS	2N4856 2N4859	2N4857 2N4860	2N4858 2N4861	UNIT
			MAX	MAX	MAX	
$t_{d(on)}$	Turn-On Delay Time	$V_{DD} = 10$ V, $I_{D(on)}$† = 20 mA (2N4856, 2N4859) / 10 mA (2N4857, 2N4860) / 5 mA (2N4858, 2N4861)	6	6	10	ns
t_r	Rise Time	$V_{GS(on)} = 0$,	3	4	10	ns
t_{off}	Turn-Off Time	See Figure 1 $V_{GS(off)}$ = −10 V (2N4856, 2N4859) / −6 V (2N4857, 2N4860) / −4 V (2N4858, 2N4861)	25	50	100	ns

NOTE 3: This parameter must be measured using pulse techniques. $t_w \approx 100$ ms, duty cycle $\leq 10\%$.

†These are nominal values; exact values vary slightly with transistor parameters.

*JEDEC registered data

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2N4856A THRU 2N4861A

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

PARAMETER		TEST CONDITIONS	2N4856A		2N4857A		2N4858A		2N4859A		2N4860A		2N4861A		UNIT
			MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	
$V_{(BR)GSS}$	Gate-Source Breakdown Voltage	I_G = −1 μA, V_{DS} = 0	−40		−40		−40		−30		−30		−30		V
I_{GSS}	Gate Reverse Current	V_{GS} = −20 V, V_{DS} = 0		−0.25		−0.25		−0.25							nA
		V_{GS} = −20 V, V_{DS} = 0, T_A = 150°C		−0.5		−0.5		−0.5							μA
		V_{GS} = −15 V, V_{DS} = 0								−0.25		−0.25		−0.25	nA
		V_{GS} = −15 V, V_{DS} = 0, T_A = 150°C								−0.5		−0.5		−0.5	μA
$I_{D(off)}$	Drain Cutoff Current	V_{DS} = 15 V, V_{GS} = −10 V		0.25		0.25		0.25		0.25		0.25		0.25	nA
		V_{DS} = 15 V, V_{GS} = −10 V, T_A = 150°C		0.5		0.5		0.5		0.5		0.5		0.5	μA
$V_{GS(off)}$	Gate-Source Cutoff Voltage	V_{DS} = 15 V, I_D = 0.5 nA	−4	−10	−2	−6	−0.8	−4	−4	−10	−2	−6	−0.8	−4	V
I_{DSS}	Zero-Gate-Voltage Drain Current	V_{DS} = 15 V, V_{GS} = 0, See Note 3	50		20	100	8	80	50		20	100	8	80	mA
$V_{DS(on)}$	Drain-Source On-State Voltage	I_D = 20 mA, V_{GS} = 0		0.75						0.75					V
		I_D = 10 mA, V_{GS} = 0				0.5						0.5			
		I_D = 5 mA, V_{GS} = 0						0.5						0.5	
$r_{ds(on)}$	Small-Signal Drain-Source On-State Resistance	V_{GS} = 0, I_D = 0, f = 1 kHz		25		40		60		25		40		60	Ω
C_{iss}	Common-Source Short-Circuit Input Capacitance	V_{DS} = 0, V_{GS} = −10 V, f = 1 MHz		10		10		10		10		10		10	pF
C_{rss}	Common-Source Short-Circuit Reverse Transfer Capacitance	V_{DS} = 0, V_{GS} = −10 V, f = 1 MHz		4		3.5		3.5		4		3.5		3.5	pF

*switching characteristics at 25°C free-air temperature

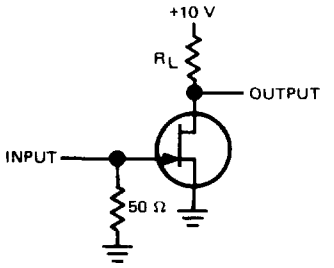
PARAMETER		TEST CONDITIONS		2N4856A 2N4859A	2N4857A 2N4860A	2N4858A 2N4861A	UNIT
				TYP MAX	TYP MAX	TYP MAX	
$t_{d(on)}$	Turn-On Delay Time	V_{DD} = 10 V, $V_{GS(on)}$ = 0, See Figure 1,	$I_{D(on)}$† = 20 mA (2N4856A, 2N4859A); 10 mA (2N4857A, 2N4860A); 5 mA (2N4858A, 2N4861A)	5	6	8	ns
t_r	Rise Time			3	4	8	ns
t_{off}	Turn-Off Time		$V_{GS(off)}$ = −10 V (2N4856A, 2N4859A); −6 V (2N4857A, 2N4860A); −4 V (2N4858A, 2N4861A)	20	40	80	ns
t_r	Rise Time	V_{DD} = 10 V, $V_{GS(on)}$ = 0, See Figure 2,	$I_{D(on)}$† = 12 mA (2N4856A, 2N4859A); 6 mA (2N4857A, 2N4860A); 3 mA (2N4858A, 2N4861A)	2	3	4	ns
t_{on}	Turn-On Time			5.5	6.5	8	ns
t_f	Fall Time		$V_{GS(off)}$ = −12 V (2N4856A, 2N4859A); −7 (2N4857A, 2N4860A); −5 V (2N4858A, 2N4861A)	7	13	27	ns
t_{off}	Turn-Off Time			10	18	31	ns

NOTE 3 This parameter must be measured using pulse techniques. t_w = 100 ms, duty cycle ≤ 10%.

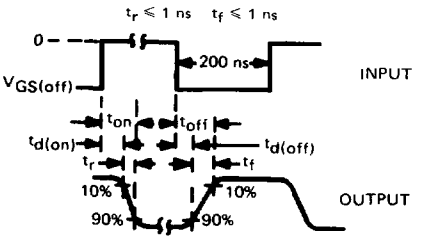
* JEDEC registered data (typical data excluded).

†These are nominal values; exact values vary slightly with transistor parameters.

PARAMETER MEASUREMENT INFORMATION



TEST CIRCUIT



(See Notes a and b)
VOLTAGE WAVEFORMS

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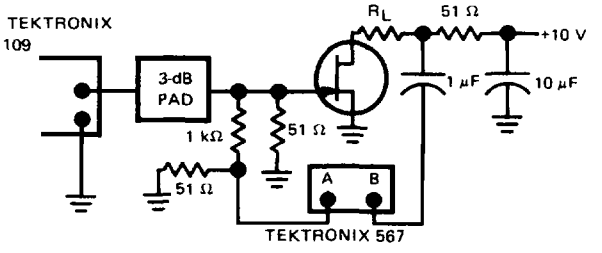
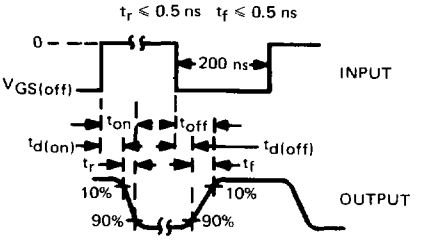
TYPES	R_L	$V_{GS(off)}$
2N4856A, 2N4859A	464 Ω	−10 V
2N4857A, 2N4860A	953 Ω	−6 V
2N4858A, 2N4861A	1910 Ω	−4 V

NOTES: a. The input waveforms are supplied by a generator with the following characteristics: $Z_{out} = 50\ \Omega$, duty cycle ≈ 2%.
b. Waveforms are monitored on an oscilloscope with the following characteristics: $t_r \leq 0.75$ ns, $R_{in} \geq 1\ M\Omega$, $C_{in} \leq 2.5$ pF.

FIGURE 1



TEST CIRCUIT



(See Note a)
VOLTAGE WAVEFORMS

TYPES	R_L	$V_{GS(off)}$
2N4856, 2N4856A, 2N4859, 2N4859A	750 Ω	−12 V
2N4857, 2N4857A, 2N4860, 2N4860A	1.54 kΩ	−7 V
2N4858, 2N4848A, 2N4861, 2N4861A	3.16 kΩ	−5 V

NOTE a: An equivalent generator and oscilloscope may be used. The oscilloscope must have a 50-Ω input impedance.

FIGURE 2

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