

3469674 FAIRCHILD SEMICONDUCTOR

84D 27430

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A Schlumberger Company

PN3644/FTSO3644

PN3645/FTSO3645

PNP Small Signal General Purpose
Amplifiers & Switches

- $V_{CE0} \dots -45 \text{ V (Min) (PN/FTSO3644), } 60 \text{ V (Min) (PN/FTSO3645)}$
- $h_{FE} \dots 80\text{-}240 @ 50 \text{ mA}$
- $t_{on} \dots 40 \text{ ns (Max) @ } 300 \text{ mA}$
- $t_{off} \dots 100 \text{ ns (Max) @ } 300 \text{ mA}$
- Complements ... PN3569

PACKAGE

PN3644	TO-92
PN3645	TO-92
FTSO3644	TO-236AA/AB
FTSO3645	TO-236AA/AB

ABSOLUTE MAXIMUM RATINGS (Note 1)

Temperatures

Storage Temperature -55°C to 150°C Operating Junction Temperature 150°C

Power Dissipation (Notes 2 & 3)

Total Dissipation at	PN	FTSO
25°C Ambient Temperature	0.625 W	0.350 W*
25°C Case Temperature	1.0 W	

Voltages & Currents

	3645	3644
V_{CE0} Collector to Emitter Voltage	-60 V	-45 V
(Note 4)		
V_{CB0} Collector to Base Voltage	-60 V	-45 V
V_{EB0} Emitter to Base Voltage	-5.0 V	-5.0 V
I_C Collector Current	500 mA	500 mA

ELECTRICAL CHARACTERISTICS (25°C Ambient Temperature unless otherwise noted) (Note 6)

SYMBOL	CHARACTERISTIC	3644		3645		UNITS	TEST CONDITIONS
		MIN	MAX	MIN	MAX		
BV_{CB0}	Collector to Base Breakdown Voltage	-45		-60		V	$I_C = 100 \mu\text{A}, I_E = 0$
BV_{EB0}	Emitter to Base Breakdown Voltage	-5.0		-5.0		V	$I_E = 10 \mu\text{A}, I_C = 0$
I_{CES}	Collector Reverse Current (Note 5)		35		35	nA	$V_{CE} = -30 \text{ V}, V_{BE} = 0$
			2.0		2.0	μA	$V_{CE} = -50 \text{ V}, V_{BE} = 0$
						μA	$V_{CE} = -30 \text{ V}, V_{BE} = 0, T_A = 65^{\circ}\text{C}$
						μA	$V_{CE} = -50 \text{ V}, V_{BE} = 0, T_A = 65^{\circ}\text{C}$
h_{FE}	DC Current Gain	40		40			$I_C = 100 \mu\text{A}, V_{CE} = -10 \text{ V}$
		80		80			$I_C = 1.0 \text{ mA}, V_{CE} = -10 \text{ V}$

NOTES:

- These ratings are limiting values above which the serviceability of any individual semiconductor device may be impaired.
- These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.
- These ratings give a maximum junction temperature of 150°C and (TO-92) junction-to-case thermal resistance of 125°C/W (derating factor of $8.0 \text{ mW}^{\circ}\text{C}$); junction-to-ambient thermal resistance of 200°C/W (derating factor of $5.0 \text{ mW}^{\circ}\text{C}$); (TO-236) junction-to-ambient thermal resistance of 357°C/W (derating factor of $2.8 \text{ mW}^{\circ}\text{C}$).
- Rating refers to a high current point where collector to emitter voltage is lowest.
- Pulse conditions: length = $300 \mu\text{s}$; duty cycle = 1%.
- For product family characteristic curves, refer to Curve Set T212.

* Package mounted on 99.5% alumina $8 \text{ mm} \times 8 \text{ mm} \times 0.6 \text{ mm}$.

PN3644/FTSO3644

PN3645/FTSO3645

ELECTRICAL CHARACTERISTICS (25° C Ambient Temperature unless otherwise noted) (Note 6)

SYMBOL	CHARACTERISTIC	3644		3645		UNITS	TEST CONDITIONS
		MIN	MAX	MIN	MAX		
h_{FE}	DC Pulse Current Gain (Note 5)	100 80 100 20	240 300	100 80 100 20	240 300		$I_C = 10 \text{ mA}$, $V_{CE} = -10 \text{ V}$ $I_C = 50 \text{ mA}$, $V_{CE} = 1.0 \text{ V}$ $I_C = 150 \text{ mA}$, $V_{CE} = -10 \text{ V}$ $I_C = 300 \text{ mA}$, $V_{CE} = -2.0 \text{ V}$
$V_{CE(sat)}$	Collector to Emitter Sustaining Voltage (Pulsed) (Notes 4 & 5)	-45		-60		V	$I_C = 10 \text{ mA}$, $I_E = 0$
$V_{CE(sat)}$	Collector to Emitter Saturation Voltage (Pulsed) (Note 5)		-0.25		-0.25	V	$I_C = 50 \text{ mA}$, $I_B = 2.5 \text{ mA}$
			-0.4		-0.4	V	$I_C = 150 \text{ mA}$, $I_B = 15 \text{ mA}$
			-1.0		-1.0	V	$I_C = 300 \text{ mA}$, $I_B = 30 \text{ mA}$
$V_{BE(sat)}$	Base to Emitter Saturation Voltage (Pulsed) (Note 5)		-1.0		-1.0	V	$I_C = 50 \text{ mA}$, $I_B = 2.5 \text{ mA}$
			-1.3		-1.3	V	$I_C = 150 \text{ mA}$, $I_B = 15 \text{ mA}$
		-0.8	-2.0	-0.8	-2.0	V	$I_C = 300 \text{ mA}$, $I_B = 30 \text{ mA}$
C_{ob}	Output Capacitance		8.0		8.0	pF	$V_{CE} = -10 \text{ V}$, $I_E = 0$, $f = 140 \text{ kHz}$
C_{ib}	Input Capacitance		35		35	pF	$V_{EB} = -0.5 \text{ V}$, $I_C = 0$, $f = 140 \text{ kHz}$
h_{fe}	High Frequency Current Gain	2.0		2.0			$I_C = 20 \text{ mA}$, $V_{CE} = -20 \text{ V}$, $f = 100 \text{ MHz}$
t_{on}	Turn On Time (test circuit no. 246)		40		40	ns	$I_C \approx 300 \text{ mA}$, $I_{B1} \approx 30 \text{ mA}$, $V_{CC} = -30 \text{ V}$
t_{off}	Turn Off Time (test circuit no. 246)		100		100	ns	$I_C \approx 300 \text{ mA}$, $I_{B1} \approx I_{B2} \approx 30 \text{ mA}$, $V_{CC} = -30 \text{ V}$

FAIRCHILD

A Schlumberger Company

**PN/MPS/FTSO3646
2N/FTSO5772****NPN High Speed Saturated Logic
Switches**

- $V_{CE0} \dots 15 \text{ V (Min)}$
- $\tau_R \dots 18 \text{ ns (Max) @ } 10 \text{ mA}$
- $t_{on} \dots 18 \text{ ns (Max) @ } 300 \text{ mA}$
- $t_{off} \dots 28 \text{ ns (Max) @ } 300 \text{ mA}$

ABSOLUTE MAXIMUM RATINGS (Note 1)**Temperatures**Storage Temperature -55°C to 150°C Operating Junction Temperature 150°C **Power Dissipation (Notes 2 & 3)**

Total Dissipation at

 25°C Ambient Temperature**MPS**

0.625 W

FTSO

0.350 W*

 25°C Case Temperature

1.0 W

Voltages & Currents V_{CE0} Collector to Emitter Voltage
(Note 4) 15 V V_{CES} Collector to Emitter Voltage 40 V V_{CBO} Collector to Base Voltage 40 V V_{EBO} Emitter to Base Voltage 5.0 V I_C Collector Current 200 mA
Pulse = 10 μs 500 mA**PACKAGE**

PN3646

TO-92

MPS3646

TO-92

2N5772

TO-92

FTSO3646

TO-236AA/AB

FTSO5772

TO-236AA/AB

ELECTRICAL CHARACTERISTICS (25°C Ambient Temperature unless otherwise noted) (Note 6)

SYMBOL	CHARACTERISTIC	MIN	MAX	UNITS	TEST CONDITIONS
BV_{CES}	Collector to Emitter Breakdown Voltage	40		V	$I_C = 10 \mu\text{A}$, $V_{BE} = 0$
BV_{EBO}	Emitter to Base Breakdown Voltage	5.0		V	$I_C = 0$, $I_E = 100 \mu\text{A}$
BV_{CBO}	Collector to Base Breakdown Voltage	40		V	$I_C = 100 \mu\text{A}$, $I_E = 0$
I_{CES}	Collector Reverse Current		0.5	μA	$V_{CE} = 20 \text{ V}$, $V_{BE} = 0$
h_{FE}	DC Current Gain (Note 5)	30 25 15	120		$I_C = 30 \text{ mA}$, $V_{CE} = 0.4 \text{ V}$ $I_C = 100 \text{ mA}$, $V_{CE} = 0.5 \text{ V}$ $I_C = 300 \text{ mA}$, $V_{CE} = 1.0 \text{ V}$

NOTES:

- These ratings are limiting values above which the serviceability of any individual semiconductor device may be impaired.
- These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.
- These ratings give a maximum junction temperature of 150°C and (TO92) junction-to-case thermal resistance of 125°C/W (derating factor of $8.0 \text{ mW}/^\circ \text{C}$); junction-to-ambient thermal resistance of 200°C/W (derating factor of $5.0 \text{ mW}/^\circ \text{C}$); (TO236) junction-to-ambient thermal resistance of 357°C/W (derating factor of $2.8 \text{ mW}/^\circ \text{C}$).
- Rating refers to a high current point where collector to emitter voltage is lowest.
- Pulse conditions: length = 300 μs ; duty cycle = 1%.
- For product family characteristic curves, refer to Curve Set T162.
- Package mounted on 99.5% alumina $8 \text{ mm} \times 8 \text{ mm} \times 0.6 \text{ mm}$.

PN/MPS/FTSO3646
2N/FTSO5772
ELECTRICAL CHARACTERISTICS (25° C Ambient Temperature unless otherwise noted) (Note 6)

SYMBOL	CHARACTERISTIC	MIN	MAX	UNITS	TEST CONDITIONS
$V_{CE(sus)}$	Collector to Emitter Sustaining Voltage (Notes 4 & 5)	15		V	$I_C = 10 \text{ mA}$, $I_B = 0$
$V_{CE(sat)}$	Collector to Emitter Saturation Voltage (Note 5)		0.20	V	$I_C = 30 \text{ mA}$, $I_B = 3.0 \text{ mA}$
			0.28	V	$I_C = 100 \text{ mA}$, $I_B = 10 \text{ mA}$
			0.5	V	$I_C = 300 \text{ mA}$, $I_B = 30 \text{ mA}$
			0.3	V	$I_C = 30 \text{ mA}$, $I_B = 3.0 \text{ mA}$, $T_A = 65^\circ \text{C}$
$V_{BE(sat)}$	Base to Emitter Saturation Voltage (Note 5)	0.75	0.95	V	$I_C = 30 \text{ mA}$, $I_B = 3.0 \text{ mA}$
			1.2	V	$I_C = 100 \text{ mA}$, $I_B = 10 \text{ mA}$
			1.7	V	$I_C = 300 \text{ mA}$, $I_B = 30 \text{ mA}$
C_{ob}	Output Capacitance		5.0	pF	$V_{CB} = 5.0 \text{ V}$, $I_E = 0$, $f = 140 \text{ kHz}$
C_{TE}	Emitter Transition Capacitance		8.0	pF	$V_{BE} = 0.5 \text{ V}$, $I_C = 0$, $f = 140 \text{ kHz}$
h_{fe}	High Frequency Current Gain	3.5			$I_C = 30 \text{ mA}$, $V_{CE} = 10 \text{ V}$, $f = 100 \text{ MHz}$
τ_s	Charge Storage Time Constant (test circuit no. 3111)		18	ns	$I_C \approx I_{B1} \approx -I_{B2} \approx 10 \text{ mA}$, $V_{CC} = 10 \text{ V}$
t_{on}	Turn On Time (test circuit no. 233)		18	ns	$I_C \approx 300 \text{ mA}$, $I_{B1} \approx 30 \text{ mA}$, $V_{CC} = 10 \text{ V}$
t_{off}	Turn Off Time (test circuit no. 233)		28	ns	$I_C \approx 300 \text{ mA}$, $I_{B1} \approx -I_{B2} = 30 \text{ mA}$, $V_{CC} = 10 \text{ V}$

3469674 FAIRCHILD SEMICONDUCTOR

84D 27434 D



PN3693/FTSO3693

PN3694/FTSO3694

NPN Small Signal General Purpose Amplifiers

- $V_{CEO} \dots 45 \text{ V (Min)}$
- $h_{FE} \dots 100\text{-}400 \text{ (PN/FTSO3694)}$
- $A_{PG} \dots 55 \text{ dB (Typ) @ } 455 \text{ kHz}$
- $G_C \dots 20 \text{ dB (Typ) from } 108 \text{ MHz to } 10.7 \text{ MHz}$
- $NF \dots 4.0 \text{ dB (Typ) @ } 1.0 \text{ MHz}$
- Complements $\dots \text{PN4121, PN4122}$

PACKAGE

PN3693	TO-92
PN3694	TO-92
FTSO3693	TO-236AA/AB
FTSO3694	TO-236AA/AB

ABSOLUTE MAXIMUM RATINGS (Note 1)

Temperatures

Storage Temperature	-55°C to 150°C
Operating Junction Temperature	150°C

Power Dissipation (Notes 2 & 3)

Total Dissipation at	PN	FTSO
25°C Ambient Temperature	0.625 W	0.350 W^*
25°C Case Temperature	1.0 W	

Voltages & Currents

V_{CEO} Collector to Emitter Voltage	45 V
(Note 4)	
V_{CBO} Collector to Base Voltage	45 V
V_{EBO} Emitter to Base Voltage	4.0 V
I_C Collector Current	30 mA

ELECTRICAL CHARACTERISTICS (25°C Ambient Temperature unless otherwise noted) (Note 6)

SYMBOL	CHARACTERISTIC	3693		3694		UNITS	TEST CONDITIONS
		MIN	MAX	MIN	MAX		
BV_{CBO}	Collector to Base Breakdown Voltage	45		45		V	$I_C = 0.1 \text{ mA}, I_E = 0$
BV_{EBO}	Emitter to Base Breakdown Voltage	4.0		4.0		V	$I_E = 100 \mu\text{A}, I_C = 0$
I_{EBO}	Emitter Cutoff Current		100		100	μA	$V_{EB} = 4.0 \text{ V}, I_C = 0$
I_{CBO}	Collector Cutoff Current		50		50	nA	$V_{CB} = 30 \text{ V}, I_E = 0$
			5.0		5.0	μA	$V_{CB} = 30 \text{ V}, I_E = 0, T_A = 65^{\circ}\text{C}$
h_{FE}	DC Pulse Current Gain (Note 5)	40	160	100	400		$I_C = 10 \text{ mA}, V_{CE} = 10 \text{ V}$
$V_{CE(sat)}$	Collector to Emitter Sustaining Voltage (Note 5)	45		45		V	$I_C = 10 \text{ mA (pulsed)}, I_E = 0$

NOTES:

- These ratings are limiting values above which the serviceability of any individual semiconductor device may be impaired.
- These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.
- These ratings give a maximum junction temperature of 150°C and (TO-92) junction-to-case thermal resistance of 125°C/W (derating factor of $8.0 \text{ mW}^{\circ}\text{C}$); junction-to-ambient thermal resistance of 200°C/W (derating factor of $5.0 \text{ mW}^{\circ}\text{C}$); (TO-236) junction-to-ambient thermal resistance of 357°C/W (derating factor of $2.8 \text{ mW}^{\circ}\text{C}$).
- Rating refers to a high current point where collector to emitter voltage is lowest.
- Pulse conditions: length = $300 \mu\text{s}$; duty cycle = 1%.
- For product family characteristic curves, refer to Curve Set T144.
- * Package mounted on 99.5% alumina $8 \text{ mm} \times 8 \text{ mm} \times 0.6 \text{ mm}$.

3469674 FAIRCHILD SEMICONDUCTOR

84D 27435 D

PN3693/FTSO3693

PN3694/FTSO3694

ELECTRICAL CHARACTERISTICS (25° C Ambient Temperature unless otherwise noted) (Note 6)

SYMBOL	CHARACTERISTIC	3693		3694		UNITS	TEST CONDITIONS
		MIN	MAX	MIN	MAX		
C_{ob}	Output Capacitance	0.5	6.0	0.5	6.0	pF	$V_{CB} = 10 \text{ V}$, $I_E = 0$, $f = 1.0 \text{ MHz}$
h_{fe}	High Frequency Current Gain	2.0	5.0	2.0	5.0		$I_C = 10 \text{ mA}$, $V_{CE} = 15 \text{ V}$, $f = 100 \text{ MHz}$
$r_b'C_o$	Collector Base Time Constant		55		55	ps	$I_C = 10 \text{ mA}$, $V_{CE} = 15 \text{ V}$, $f = 80 \text{ MHz}$


PN4121/FTSO4121
PN4122/FTSO4122
PNP Small Signal General Purpose
Amplifiers & Switches

- $V_{CE0} \dots 40 \text{ V (Min)}$
- $h_{FE} \dots 150-300 @ 10 \text{ mA (PN/FTSO4122)}$
- $f_T \dots 450 \text{ MHz (Min) @ } 10 \text{ mA (PN/FTSO4122)}$
- $r_b/C_o \dots 50 \text{ ps (Max)}$
- $C_{cb} \dots 4.5 \text{ pF (Max)}$
- $NF \dots 6.0 \text{ dB (Max) @ } 100 \text{ MHz}$

PACKAGE

PN4121	TO-92
PN4122	TO-92
FTSO4121	TO-236AA/AB
FTSO4122	TO-236AA/AB

ABSOLUTE MAXIMUM RATINGS (Note 1)**Temperatures**

Storage Temperature	-55° C to 150° C
Operating Junction Temperature	150° C

Power Dissipation (Notes 2 & 3)

Total Dissipation at	PN	FTSO
25° C Ambient Temperature	0.625 W	0.350 W*
70° C Ambient Temperature	0.400 W	
25° C Case Temperature	1.0 W	

Voltages & Currents

V_{CE0} Collector to Emitter Voltage	-40 V
(Note 4)	
V_{CBO} Collector to Base Voltage	-40 V
V_{EBO} Emitter to Base Voltage	-5.0 V
I_C Collector Current	100 mA

ELECTRICAL CHARACTERISTICS (25° C Ambient Temperature unless otherwise noted) (Note 6)

SYMBOL	CHARACTERISTIC	4121		4122		UNITS	TEST CONDITIONS
		MIN	MAX	MIN	MAX		
BV_{CES}	Collector to Emitter Breakdown Voltage	-40		-40		V	$I_C = 10 \mu\text{A}, V_{BE} = 0$
BV_{CBO}	Collector to Base Breakdown Voltage	-40		-40		V	$I_C = 10 \mu\text{A}, I_E = 0$
BV_{EBO}	Emitter to Base Breakdown Voltage	-5.0		-50.0		V	$I_E = 10 \mu\text{A}, I_C = 0$
I_{CES}	Collector Reverse Current		25 25		25 25	nA μA	$V_{CE} = -30 \text{ V}, V_{BE} = 0$ $V_{CE} = -30 \text{ V}, V_{BE} = 0, T_A = 65^\circ \text{C}$
h_{FE}	DC Current Gain	40 60		100 150			$I_C = 100 \mu\text{A}, V_{CE} = -1.0 \text{ V}$ $I_C = 1.0 \text{ mA}, V_{CE} = -1.0 \text{ V}$

NOTES:

- These ratings are limiting values above which the serviceability of any individual semiconductor device may be impaired.
- These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.
- These ratings give a maximum junction temperature of 150° C and (TO-92) junction-to-case thermal resistance of 125° C/W (derating factor of 8.0 mW/° C); junction-to-ambient thermal resistance of 200° C/W (derating factor of 5.0 mW/° C); (TO-236) junction-to-ambient thermal resistance of 357° C/W (derating factor of 2.8 mW/° C).
- Rating refers to a high current point where collector to emitter voltage is lowest.
- Pulse conditions: length = 300 μs ; duty cycle = 1%.
- For product family characteristic curves, refer to Curve Set T215.
- * Package mounted on 99.5% alumina 8 mm x 8 mm x 0.6 mm.

PN4121/FTSO4121
PN4122/FTSO4122

ELECTRICAL CHARACTERISTICS (25°C Ambient Temperature unless otherwise noted) (Note 6)

SYMBOL	CHARACTERISTIC	4121		4122		UNITS	TEST CONDITIONS
		MIN	MAX	MIN	MAX		
h_{FE}	DC Pulse Current Gain (Note 5)	70 15	200	150 30	300		$I_C = 10 \text{ mA}$, $V_{CE} = -1.0 \text{ V}$ $I_C = 50 \text{ mA}$, $V_{CE} = -1.0 \text{ V}$
$V_{CE(sat)}$	Collector to Emitter Sustaining Voltage (Note 5)	-40		-40		V	$I_C = 10 \text{ mA}$, $I_B = 0$
$V_{CE(sat)}$	Collector to Emitter Saturation Voltage (Note 5)		-0.13		-0.13	V	$I_C = 1.0 \text{ mA}$, $I_B = 0.1 \text{ mA}$
			-0.14		-0.14	V	$I_C = 10 \text{ mA}$, $I_B = 1.0 \text{ mA}$
			-0.3		-0.3	V	$I_C = 50 \text{ mA}$, $I_B = 5.0 \text{ mA}$
$V_{BE(sat)}$	Base to Emitter Saturation Voltage (Note 5)		-0.75		-0.75	V	$I_C = 1.0 \text{ mA}$, $I_B = 0.1 \text{ mA}$
		-0.7	-0.9	-0.7	-0.9	V	$I_C = 10 \text{ mA}$, $I_B = 1.0 \text{ mA}$
			-1.1		-1.1	V	$I_C = 50 \text{ mA}$, $I_B = 5.0 \text{ mA}$
C_{cb}	Collector to Base Capacitance		4.5		4.5	pF	$V_{CB} = -10 \text{ V}$, $I_E = 0$
C_{ib}	Open Circuit Input Capacitance		8.0		8.0	pF	$V_{EB} = -0.5 \text{ V}$, $I_C = 0$
$ h_{fe} $	Magnitude of Small Signal Current Gain	4.0		4.5			$I_C = 10 \text{ mA}$, $V_{CE} = -20 \text{ V}$, $f = 100 \text{ MHz}$
h_{fe}	Forward Current Transfer Ratio	50	300	150	450		$I_C = 1.0 \text{ mA}$, $V_{CE} = -10 \text{ V}$, $f = 1.0 \text{ kHz}$
h_{ie}	Input Resistance	1.0	8.0	4.0	12	k Ω	$I_C = 1.0 \text{ mA}$, $V_{CE} = -10 \text{ V}$, $f = 1.0 \text{ kHz}$
h_{oe}	Output Conductance	2.0	24	8.0	40	μmho	$I_C = 1.0 \text{ mA}$, $V_{CE} = -10 \text{ V}$, $f = 1.0 \text{ kHz}$
h_{re}	Voltage Feedback Ratio		3.0		4.0	$\times 10^{-4}$	$I_C = 1.0 \text{ mA}$, $V_{CE} = -10 \text{ V}$, $f = 1.0 \text{ kHz}$
$\tau_b \cdot C_c$	Collector to Base Time Constant		50		50	ps	$I_C = 10 \text{ mA}$, $V_{CE} = -20 \text{ V}$, $f = 80 \text{ MHz}$
t_{on}	Turn On Time (test circuit no. 342)		40		40	ns	$I_C = 50 \text{ mA}$, $I_{B1} = 5.0 \text{ mA}$
t_{off}	Turn Off Time (see test circuit no. 342)		150		150	ns	$I_C = 50 \text{ mA}$, $I_{B1} = 5.0 \text{ mA}$, $I_{B2} = 5.0 \text{ mA}$
NF	Noise Figure		6.0		6.0	dB	$I_C = 1.0 \text{ mA}$, $V_{CE} = -5.0 \text{ V}$, $f = 100 \text{ MHz}$, $BW = 15 \text{ MHz}$, $R_S = 100 \Omega$
			4.0		4.0	dB	$I_C = 100 \mu\text{A}$, $V_{CE} = -5.0 \text{ V}$, $BW = 15 \text{ MHz}$, $R_S = 1.0 \text{ k}\Omega$, $f = 10 \text{ Hz to } 10 \text{ kHz}$