

FAIRCHILD

A Schlumberger Company

2N5223/FTSO5223NPN Small Signal General Purpose
Amplifier & Oscillator*T-29-23*

- P_D ... 625 mW @ $T_A = 25^\circ\text{C}$
- V_{CE0} ... 20 V (Min)
- h_{FE} ... 50-800 @ 2.0 mA
- f_T ... 150 MHz (Min) @ 10 mA
- C_{cb} ... 4.0 pF (Max)
- Complement ... 2N/FTSO5227

PACKAGE

2N5223

TO-92

FTSO5223

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	2N	FTSO
25° C Ambient Temperature	0.625 W	0.350 W*
25° C Case Temperature	1.0 W	

Voltages & Currents

V_{CE0} Collector to Emitter Voltage	20 V
(Note 4)	
V_{CBO} Collector to Base Voltage	25 V
V_{EBO} Emitter to Base Voltage	3.0 V
I_C Collector Current	100 mA

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

SYMBOL	CHARACTERISTIC	MIN	MAX	UNITS	TEST CONDITIONS
BV_{CE0}	Collector to Emitter Breakdown Voltage	20		V	$I_C = 1.0\text{ mA}$, $I_B = 0$
BV_{CBO}	Collector to Base Breakdown Voltage	25		V	$I_C = 100\ \mu\text{A}$, $I_E = 0$
BV_{EBO}	Emitter to Base Breakdown Voltage	3.0		V	$I_E = 100\ \mu\text{A}$, $I_C = 0$
I_{EBO}	Emitter Cutoff Current		500	nA	$V_{EB} = 2.0\text{ V}$, $I_C = 0$
I_{CBO}	Collector Cutoff Current		100	nA	$V_{CB} = 10\text{ V}$, $I_E = 0$
h_{FE}	DC Current Gain	50	800		$I_C = 2.0\text{ mA}$, $V_{CE} = 10\text{ V}$

NOTES:

1. These ratings are limiting values above which the serviceability of any individual semiconductor device may be impaired.
 2. These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.
 3. 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).
 4. Rating refers to a high current point where collector to emitter voltage is lowest.
 5. Pulse conditions: length = 300 μs ; duty cycle < 2%.
 6. For product family characteristic curves, refer to Curve Set T144.
- * Package mounted on 99.5% alumina 8 mm x 8 mm x 0.6 mm.

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

SYMBOL	CHARACTERISTIC	MIN	MAX	UNITS	TEST CONDITIONS
$V_{CE(sat)}$	Collector to Emitter Saturation Voltage (Note 5)		0.7	V	$I_C = 10 \text{ mA}$, $I_B = 1.0 \text{ mA}$
$V_{BE(sat)}$	Base to Emitter Saturation Voltage (Note 5)		1.2	V	$I_C = 10 \text{ mA}$, $I_B = 1.0 \text{ mA}$
C_{cb}	Collector to Base Capacitance		4.0	pF	$V_{CB} = 10 \text{ V}$, $I_E = 0$, $f = 1.0 \text{ MHz}$
h_{fe}	Small Signal Current Gain	50	1600		$I_C = 2.0 \text{ mA}$, $V_{CE} = 10 \text{ V}$, $f = 1.0 \text{ kHz}$
f_T	Current Gain Bandwidth Product	150		MHz	$I_C = 10 \text{ mA}$, $V_{CE} = 10 \text{ V}$, $f = 100 \text{ MHz}$

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2N5224/FTSO5224

NPN Low Level Switch

T-29-23

- V_{CEO} ... 12 V (Min)
- t_{on} ... 45 ns (Max) @ 10 mA
- t_{off} ... 60 ns (Max) @ 10 mA
- f_T ... 250 MHz (Min) @ 10 mA
- C_{cb} ... 4.0 pF (Max)
- Complement ... MPSL08

PACKAGE

2N5224

TO-92

FTSO5224

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	2N	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	12 V
(Note 4)	
V_{CBO} Collector to Base Voltage	25 V
V_{EBO} Emitter to Base Voltage	5.0 V
I_C DC Collector Current	100 mA

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

SYMBOL	CHARACTERISTIC	MIN	MAX	UNITS	TEST CONDITIONS
BV_{CEO}	Collector to Emitter Breakdown Voltage (Note 5)	12		V	$I_C = 10$ mA, $I_B = 0$
BV_{CBO}	Collector to Base Breakdown Voltage	25		V	$I_C = 100$ μ A, $I_E = 0$
BV_{EBO}	Emitter to Base Breakdown Voltage	5.0		V	$I_E = 100$ μ A, $I_C = 0$
I_{EBO}	Emitter Cutoff Current		100	μ A	$V_{EB} = 4.0$ V, $I_C = 0$
I_{CBO}	Collector Cutoff Current		500	nA	$V_{CB} = 15$ V, $I_E = 0$
h_{FE}	DC Current Gain (Note 5)	40 15	400		$I_C = 10$ mA, $V_{CE} = 1.0$ V $I_C = 100$ mA, $V_{CE} = 1.0$ V
$V_{CE(sat)}$	Collector to Emitter Saturation Voltage (Note 5)		0.35	V	$I_C = 10$ mA, $I_B = 3.0$ mA
$V_{BE(sat)}$	Base to Emitter Saturation Voltage (Note 5)		0.9	V	$I_C = 10$ mA, $I_B = 3.0$ mA

NOTES:

1. These ratings are limiting values above which the serviceability of any individual semiconductor device may be impaired.
 2. These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.
 3. 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).
 4. Rating refers to a high current point where collector to emitter voltage is lowest.
 5. Pulse conditions: length = 300 μ s; duty cycle < 2%.
 6. For product family characteristic curves, refer to Curve Set T162.
- * Package mounted on 99.5% alumina 8 mm x 8 mm x 0.6 mm.

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

SYMBOL	CHARACTERISTIC	MIN	MAX	UNITS	TEST CONDITIONS
C_{cb}	Collector to Base Capacitance		4.0	pF	$V_{CB} = 5.0 \text{ V}$, $I_E = 0$, $f = 1.0 \text{ MHz}$
f_T	Current Gain Bandwidth Product	250		MHz	$I_C = 10 \text{ mA}$, $V_{CE} = 10 \text{ V}$, $f = 100 \text{ MHz}$
t_d	Delay Time (test circuit no. 531)		25	ns	$I_C = 10 \text{ mA}$, $V_{CC} = 3.0 \text{ V}$, $I_{B1} = 3.0 \text{ mA}$
t_r	Rise Time (test circuit no. 531)		20	ns	$I_C = 10 \text{ mA}$, $V_{CC} = 3.0 \text{ V}$, $I_{B1} = 3.0 \text{ mA}$
t_s	Storage Time (test circuit no. 531)		35	ns	$I_C = 10 \text{ mA}$, $V_{CC} = 3.0 \text{ V}$, $I_{B1} = I_{B2} = 3.0 \text{ mA}$
t_f	Fall Time (test circuit no. 531)		25	ns	$I_C = 10 \text{ mA}$, $V_{CC} = 3.0 \text{ V}$, $I_{B1} = I_{B2} = 3.0 \text{ mA}$

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A Schlumberger Company

2N5225/FTSO5225
2N5226/FTOS5226

NPN-PNP Small Signal General Purpose Complementary Amplifiers

T-29.23

- $V_{CE0} \dots 25 \text{ V (Min)}$
- $h_{FE} \dots 30-600 @ 50 \text{ mA}$
- $V_{CE(sat)} \dots 0.8 \text{ V (Max) @ } 100 \text{ mA}$
- Complement ... 2N5225 (NPN), 2N5226 (PNP)

PACKAGE

2N5225	TO-92
2N5226	TO-92
FTSO5225	TO-236AA/AB
FTSO5226	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)

	2N	FTSO
Total Dissipation at 25° C Ambient Temperature	0.625 W	0.350 W*
25° C Case Temperature	1.0 W	

Voltages & Currents

	5225	5226
V_{CE0} Collector to Emitter Voltage (Note 4)	25 V	-25 V
V_{CBO} Collector to Base Voltage	25 V	-25 V
V_{EBO} Emitter to Base Voltage	4.0 V	-4.0 V
I_c Collector Current	500 mA	500 mA

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

SYMBOL	CHARACTERISTIC	2N5225		2N5226		UNITS	TEST CONDITIONS
		MIN	MAX	MIN	MAX		
BV_{CE0}	Collector to Emitter Breakdown Voltage	25		-25		V	$I_c = 10 \text{ mA}, I_B = 0$
BV_{CBO}	Collector to Base Breakdown Voltage	25		-25		V	$I_c = 100 \mu\text{A}, I_E = 0$
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		500		500	nA	$V_{EB} = 4.0 \text{ V}, I_C = 0$
I_{CBO}	Collector Cutoff Current		300		300	nA	$V_{CB} = 15 \text{ V}, I_E = 0$
h_{FE}	DC Current Gain (Note 5)	25 30	600	25 30	600		$I_C = 10 \mu\text{A}, V_{CE} = 10 \text{ V}$ $I_C = 50 \text{ mA}, V_{CE} = 10 \text{ V}$

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 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 = 2%.
 - For product family characteristic curves, refer to Curve Set T145 for 2N5225 and T212 for 2N5226.
- * Package mounted on 99.5% alumina 8 mm x 8 mm x 0.6 mm.

2N5225/FTSO5225
2N5226/FTOS5226

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

SYMBOL	CHARACTERISTIC	2N5225		2N5226		UNITS	TEST CONDITIONS
		MIN	MAX	MIN	MAX		
$V_{CE(sat)}$	Collector to Emitter Saturation Voltage (Note 5)		0.8		-0.8	V	$I_C = 100 \text{ mA}$, $I_B = 10 \text{ mA}$
$V_{BE(sat)}$	Base to Emitter Saturation Voltage (Note 5)		1.0		-1.0	V	$I_C = 100 \text{ mA}$, $I_B = 10 \text{ mA}$
C_{cb}	Collector to Base Capacitance		20		20	pF	$V_{CB} = 5.0 \text{ V}$, $I_E = 0$, $f = 1.0 \text{ MHz}$
h_{fe}	Small Signal Current Gain	30	1800	30	1800		$I_C = 50 \text{ mA}$, $V_{CE} = 10 \text{ V}$, $f = 1.0 \text{ kHz}$
f_T	Current Gain Bandwidth Product		50		50	MHz	$I_C = 20 \text{ mA}$, $V_{CE} = 10 \text{ V}$, $f = 20 \text{ MHz}$

FAIRCHILD

A Schlumberger Company

2N5227/FTSO5227PNP Small Signal General Purpose
Amplifier & Oscillator

T-29.23

- V_{CE0} ... 30 V (Min)
- h_{FE} ... 50-700 @ 2.0 mA
- f_T ... 100 MHz (Min) @ 10 mA
- C_{cb} ... 5.0 pF (Max)
- Complements ... 2N5223

PACKAGES

2N5227 TO-92
FTSO5227 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	2N	FTSO
25° C Ambient Temperature	0.625 W	0.350 W*
25° C Case Temperature	1.0 W	

Voltages & Currents

V_{CE0} Collector to Emitter Voltage	-30 V
(Note 4)	
V_{CBO} Collector to Base Voltage	-30 V
V_{EBO} Emitter to Base Voltage	-3.0 V
I_C Collector Current	50 mA

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

SYMBOL	CHARACTERISTIC	MIN	MAX	UNITS	TEST CONDITIONS
BV_{CE0}	Collector to Emitter Breakdown Voltage	-30		V	$I_C = 1.0$ mA, $I_E = 0$
BV_{CBO}	Collector to Base Breakdown Voltage	-30		V	$I_C = 100$ μ A, $I_E = 0$
BV_{EBO}	Emitter to Base Breakdown Voltage	-3.0		V	$I_E = 100$ μ A, $I_C = 0$
I_{EBO}	Emitter Cutoff Current		500	nA	$V_{EB} = -2.0$ V, $I_C = 0$
I_{CBO}	Collector Cutoff Current		100	nA	$V_{CB} = -10$ V, $I_E = 0$
h_{FE}	DC Current Gain (Note 5)	30 50	700		$I_C = 100$ μ A, $V_{CE} = -10$ V $I_C = 2.0$ mA, $V_{CE} = -10$ V
$V_{CE(sat)}$	Collector to Emitter Saturation Voltage		-0.4	V	$I_C = 10$ mA, $I_B = 1.0$ mA
$V_{BE(sat)}$	Base to Emitter Saturation Voltage		-1.0	V	$I_C = 10$ mA, $I_B = 1.0$ mA
C_{cb}	Collector to Base Capacitance		5.0	pF	$V_{CB} = 10$ V, $I_E = 0$, $f = 1.0$ MHz
h_{fe}	Small Signal Current Gain	50	1500		$I_C = 2.0$ mA, $V_{CE} = -10$ V, $f = 1.0$ kHz
f_T	Current Gain Bandwidth Product	100		MHz	$I_C = 10$ mA, $V_{CE} = -10$ V, $f = 100$ MHz

NOTES:

1. These ratings are limiting values above which the serviceability of any individual semiconductor device may be impaired.
 2. These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.
 3. 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).
 4. Rating refers to a high current point where collector to emitter voltage is lowest.
 5. Pulse conditions: length = 300 μ s; duty cycle = 1%.
 6. 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.

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2N5228/FTSO5228

PNP Low Level Switch

T-29-23

- $V_{CEO} \dots -5.0 \text{ V (Min)}$
- $t_{on} \dots 75 \text{ ns (Max) @ } 10 \text{ mA}$
- $t_{off} \dots 140 \text{ ns (Max) @ } 10 \text{ mA}$
- $f_T \dots 300 \text{ MHz (Min) @ } 10 \text{ mA}$
- $C_{cb} \dots 5.0 \text{ pF (Max)}$
- Complement ... 2N5224

PACKAGE
 2N5228 TO-92
 FTSO5228 TO-236AA/AB

ABSOLUTE MAXIMUM RATINGS (Note 1)

Temperatures
 Storage Temperature $-55^\circ\text{C to } 150^\circ\text{C}$
 Operating Junction Temperature 150°C

Power Dissipation (Notes 2 & 3)

Total Dissipation at	2N	FTSO
25°C Ambient Temperature	0.625 W	0.350 W*
25°C Case Temperature	1.0 W	

Voltages & Currents

V_{CES} Collector to Emitter Voltage	-6.0 V
V_{CEO} Collector to Emitter Voltage	-5.0 V
V_{CBO} Collector to Base Voltage	-5.0 V
V_{EBO} Emitter to Base Voltage	-3.0 V
I_C DC Collector Current	50 mA

ELECTRICAL CHARACTERISTICS (25°C Ambient Temperature unless otherwise noted) (Note 5)

SYMBOL	CHARACTERISTIC	MIN	MAX	UNITS	TEST CONDITIONS
BV_{CEO}	Collector to Emitter Breakdown Voltage (Note 4)	-5.0		V	$I_C = 10 \text{ mA}, I_B = 0$
BV_{CES}	Collector to Emitter Breakdown Voltage	-6.0		V	$I_C = 100 \mu\text{A}, V_{BE} = 0$
BV_{CBO}	Collector to Base Breakdown Voltage	-5.0		V	$I_C = 100 \mu\text{A}, I_E = 0$
BV_{EBO}	Emitter to Base Breakdown Voltage	-3.0		V	$I_E = 100 \mu\text{A}, I_C = 0$
I_{CES}	Collector Cutoff Current		100	nA	$V_{CE} = -4.0 \text{ V}, V_{BE} = 0$
I_{EBO}	Emitter Cutoff Current		100	μA	$V_{EB} = -2.5 \text{ V}, I_C = 0$
h_{FE}	DC Current Gain (Note 4)	30	15		$I_C = 10 \text{ mA}, V_{CE} = -0.3 \text{ V}$ $I_C = 50 \text{ mA}, V_{CE} = -1.0 \text{ V}$

NOTES:

1. These ratings are limiting values above which the serviceability of any individual semiconductor device may be impaired.
 2. These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.
 3. 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).
 4. Pulse conditions: length = 300 μs ; duty cycle * 2%.
 5. For product family characteristic curves, refer to Curve Set T292.
- * Package mounted on 99.5% alumina 8 mm x 8 mm x 0.6 mm.

2N5228/FTSO5228

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ELECTRICAL CHARACTERISTICS (25° C Ambient Temperature unless otherwise noted) (Note 5)

SYMBOL	CHARACTERISTIC	MIN	MAX	UNITS	TEST CONDITIONS
$V_{CE(sat)}$	Collector to Emitter Saturation Voltage (Note 4)		-0.4	V	$I_C = 10 \text{ mA}$, $I_B = 3.0 \text{ mA}$
$V_{BE(sat)}$	Base to Emitter Saturation Voltage (Note 4)	-0.65	-1.25	V	$I_C = 10 \text{ mA}$, $I_B = 3.0 \text{ mA}$
C_{cb}	Collector to Base Capacitance		5.0	pF	$V_{CB} = -5.0 \text{ V}$, $I_E = 0$, $f = 1.0 \text{ MHz}$
f_T	Current Gain Bandwidth Product	300		MHz	$I_C = 10 \text{ mA}$, $V_{CE} = -5.0 \text{ V}$, $f = 100 \text{ MHz}$
t_d	Delay Time (test circuit no. 532)		25	ns	$I_C \approx 10 \text{ mA}$, $V_{CC} = -3.0 \text{ V}$, $I_{B1} \approx 3.0 \text{ mA}$
t_r	Rise Time (test circuit no. 532)		50	ns	$I_C \approx 10 \text{ mA}$, $V_{CC} = -3.0 \text{ V}$, $I_{B1} \approx 3.0 \text{ mA}$
t_s	Storage Time (test circuit no. 532)		90	ns	$I_C \approx 10 \text{ mA}$, $V_{CC} = -3.0 \text{ V}$, $I_{B1} \approx -I_{B2} = 3.0 \text{ mA}$
t_f	Fall Time (test circuit no. 532)		50	ns	$I_C \approx 10 \text{ mA}$, $V_{CC} = -3.0 \text{ V}$, $I_{B1} \approx -I_{B2} \approx 3.0 \text{ mA}$