

**FAIRCHILD**

A Schlumberger Company

**2N5223/FTSO5223**NPN 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	<b>2N</b>	<b>FTSO</b>
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  $\mu\text{s}$ ; 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	$I_C = 10 \text{ mA}$ , $V_{CE} = 10 \text{ V}$ , $f = 100 \text{ MHz}$

3469674 FAIRCHILD SEMICONDUCTOR

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**FAIRCHILD**

A Schlumberger Company

**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	<b>2N</b>	<b>FTSO</b>
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	$I_C = 100$ $\mu$ A, $I_E = 0$
$BV_{EBO}$	Emitter to Base Breakdown Voltage	5.0		V	$I_E = 100$ $\mu$ A, $I_C = 0$
$I_{EBO}$	Emitter Cutoff Current		100	$\mu$ 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  $\mu$ 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.

2N5224/FTSO5224

T-29.23

**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	$I_C = 10 \text{ mA}$ , $V_{CC} = 3.0 \text{ V}$ , $I_{B1} = I_{B2} = 3.0 \text{ mA}$

**FAIRCHILD**

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  $\mu\text{s}$ ; 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

T-29.23

**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/FTSO5227**PNP 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	<b>2N</b>	<b>FTSO</b>
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	$I_C = 100$ $\mu$ A, $I_E = 0$
$BV_{EBO}$	Emitter to Base Breakdown Voltage	-3.0		V	$I_E = 100$ $\mu$ 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		$I_C = 100$ $\mu$ 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  $\mu$ 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.

**FAIRCHILD**

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**2N5228/FTSO5228**

PNP Low Level Switch

T-29-23

- $V_{CE0} \dots -5.0 \text{ V (Min)}$
- $t_{on} \dots 75 \text{ ns (Max) @ } 10 \text{ mA}$
- $t_{off} \dots 140 \text{ ns (Max) @ } 10 \text{ mA}$
- $f_T \dots 300 \text{ MHz (Min) @ } 10 \text{ mA}$
- $C_{cb} \dots 5.0 \text{ pF (Max)}$
- 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  $150^\circ\text{C}$

**Power Dissipation (Notes 2 & 3)**

Total Dissipation at	<b>2N</b>	<b>FTSO</b>
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	$\mu\text{A}$	$V_{EB} = -2.5 \text{ V}, I_C = 0$
$h_{FE}$	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  $150^\circ\text{C}$  and (TO-92) junction-to-case thermal resistance of  $125^\circ\text{C/W}$  (derating factor of  $8.0 \text{ mW}^\circ\text{C}$ ); junction-to-ambient thermal resistance of  $200^\circ\text{C/W}$  (derating factor of  $5.0 \text{ mW}^\circ\text{C}$ ); (TO-236) junction-to-ambient thermal resistance of  $357^\circ\text{C/W}$  (derating factor of  $2.8 \text{ mW}^\circ\text{C}$ ).
  4. Pulse conditions: length =  $300 \mu\text{s}$ ; 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

T-29-23

**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	$I_C \approx 10 \text{ mA}$ , $V_{CC} = -3.0 \text{ V}$ , $I_{B1} \approx -I_{B2} \approx 3.0 \text{ mA}$