HEWLETT PACKARD

AT-21400
20 GHz NPN Silicon Bipolar Oscillator Transistor

Features

- **Fundamental Oscillation to > 20 GHz**
- **Low Phase Noise Compared to GaAs FETs**
- **High S21 Gain: 9.5 dB Typical at 4 GHz**
- **High MAG: 16.5 dB Typical at 4 GHz**

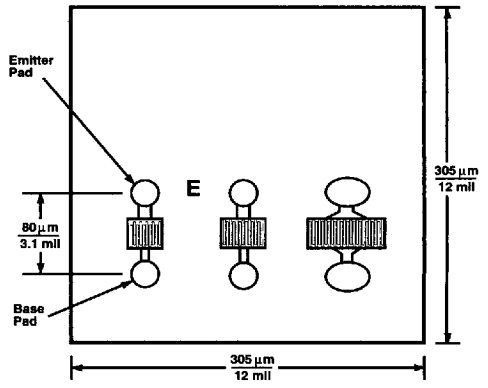
Description

The AT-21400 is a very high performance NPN silicon bipolar transistor chip designed for use in low-phase noise narrow and wideband oscillator applications at fundamental frequencies to greater than 20 GHz.

The AT-21400 oscillator transistor is fabricated using HP's 10 GHz, f_T, 40 GHz f_{MAX} TurboSAT silicon bipolar process which uses nitride self-alignment, thick planar-field oxide, subhalf-micrometer lithography, ion implantation, gold metallization and nitride scratch protection to achieve excellent performance, uniformity and reliability.

The recommended mounting procedure is gold-silicon eutectic die attach at 400°C. Assembly can be performed with either wedge or ball bonding using 0.5 or 0.7 mil gold wire. See also "Chip Use" in the APPLICATIONS section.

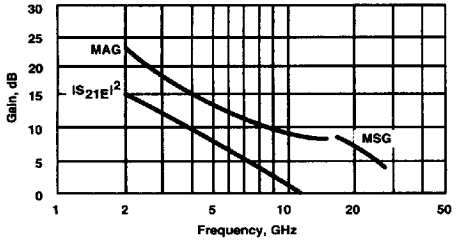
Chip Outline[1]



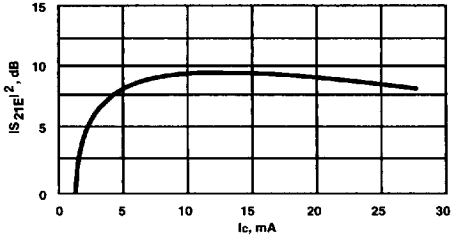
Typical Dimensions are in µm / mil

Bond Pad Diameters are 20 µm / 0.8 mil

MAXIMUM STABLE GAIN, MAXIMUM AVAILABLE GAIN and INSERTION POWER GAIN vs. FREQUENCY
V_{CE} = 8 V, I_C = 14 mA



INSERTION POWER GAIN vs. COLLECTOR CURRENT
f = 4 GHz, V_{CE} = 8 V



Electrical Specifications, T_A = 25°C

Symbol	Parameters and Test Conditions [1,2,3]		Units	Min.	Typ.	Max.
MAG	Maximum Available Gain: V_{CE} = 8 V, I_C = 14 mA	f = 4 GHz	dB		16.5	
$\|S_{21E}\|^2$	Insertion Power Gain: V_{CE} = 8 V, I_C = 14 mA	f = 4 GHz	dB		9.5	
f_T	Gain Bandwidth Product: V_{CE} = 8 V, I_C = 14 mA	f = 2 GHz	GHz		10	
h_{FE}	Forward Current Transfer Ratio: V_{CE} = 8 V, I_C = 14 mA			30	100	300
I_{CBO}	Collector Cutoff Current: V_{CB} = 8 V		µA			0.2
I_{EBO}	Emitter Cutoff Current: V_{EB} = 1 V		µA			5.0
C_{CB}	Collector Base Capacitance: V_{CB} = 8 V	f = 1 MHz	pF		.08	

Notes:
1. This chip contains 3 active transistors. The performance specified applies only to the device whose base and emitter pads are indicated on the chip outline. Performance and functionality of the other 2 transistors is not guaranteed.
2. RF performance of the chip is determined by testing 10 devices per wafer assembled in a common-emitter configuration on a standard chip carrier.
3. The normal operating collector current range for this transistor is 10 to 15 mA.

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Absolute Maximum Ratings

Parameter	Symbol	Absolute Maximum[1]
Emitter-Base Voltage	V_{EBO}	1.5 V
Collector-Base Voltage	V_{CBO}	20 V
Collector-Emitter Voltage	V_{CEO}	10 V
Collector Current	I_C	28 mA
Power Dissipation[2]	P_T	250 mW
Junction Temperature	T_J	200°C
Storage Temperature	T_{STG}	−65°C to 200°C

Thermal Resistance; junction to substrate[3]: θ_{JS} = 170°C/W

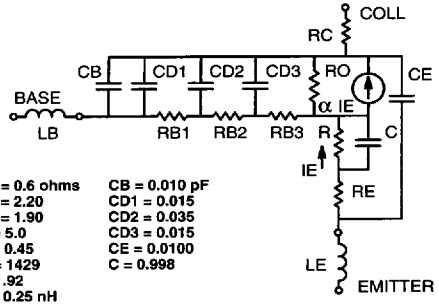
Notes:
1. Permanent damage may occur if any of these limits are exceeded.
2. Derate at 5.9 m W/°C for $T_{MOUNTING\ SURFACE}$ > 158°C.
3. $T_{MOUNTING\ SURFACE}$ = 25°C.

Part Number Ordering Information

Part Number	Devices Per Tray
AT–21400–GP1	5
AT–21400–GP4	100
AT–21400–GP6	up to 300

LINEAR EQUIVALENT CIRCUIT[4]

V_{CE} = 8 V, I_C = 14 mA

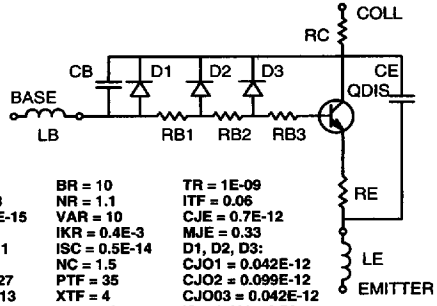


RB1 = 0.6 ohms
RB2 = 2.20
RB3 = 1.90
RC = 5.0
RE = 0.45
RO = 1429
R = 1.92
LB = 0.25 nH
LE = 0.10

CB = 0.010 pF
CD1 = 0.015
CD2 = 0.035
CD3 = 0.015
CE = 0.0100
C = 0.998

TOUCHSTONE™ CCCS: M=.99, A=0
R1=R, R2=1E6, F=22.7, T=7.4

SPICE EQUIVALENT CIRCUIT[4]



QDIS:
XTB = 1.8
IS = 0.65E-15
BF = 100
NF = 1.011
VAF = 20
IKF = 0.027
ISE = 3E-13
NE = 2.0

BR = 10
NR = 1.1
VAR = 10
IKR = 0.4E-3
ISC = 0.5E-14
NC = 1.5
PTF = 35
XTF = 4
TF = 12E-12

TR = 1E-09
ITF = 0.06
CJE = 0.7E-12
MJE = 0.33
D1, D2, D3:
CJO1 = 0.042E-12
CJO2 = 0.099E-12
CJO03 = 0.042E-12
IS = 0, VJ = 0.73

Modeled Scattering Parameters, Common Emitter [5]

T_A = 25°C, V_{CE} = 8 V, I_C = 14 mA

Freq.	S_{11}		S_{21}			S_{12}			S_{22}	
GHz	Mag	Ang	dB	Mag	Ang	dB	Mag	Ang	Mag	Ang
2	.67	−168	15.8	6.19	90	−34.0	.02	52	.65	−9
3	.67	−180	12.4	4.17	81	−32.0	.025	59	.65	−10
4	.67	172	10.0	3.15	74	−30.5	.03	64	.65	−11
5	.68	165	8.1	2.53	68	−28.0	.04	68	.65	−12
6	.68	160	6.5	2.12	62	−28.0	.04	70	.65	−14
7	.69	154	5.2	1.82	56	−26.0	.05	72	.65	−16
8	.70	149	4.1	1.60	51	−24.4	.06	73	.65	−18
9	.70	144	3.1	1.43	46	−24.4	.06	74	.65	−20
10	.71	140	2.2	1.29	41	−23.1	.07	74	.65	−22
11	.72	135	1.4	1.18	36	−21.9	.08	74	.65	−24
12	.73	131	0.7	1.08	31	−21.9	.08	75	.66	−26
13	.74	127	0	1.00	27	−20.9	.09	75	.66	−28
14	.75	123	−0.6	0.93	23	−20.0	.10	75	.66	−30
15	.76	120	−1.3	0.86	18	−19.2	.11	74	.67	−32
16	.77	116	−1.9	0.80	14	−19.2	.11	74	.67	−34
18	.79	109	−3.1	0.70	7	−17.7	.13	74	.68	−39
20	.80	103	−4.2	0.62	−1	−17.1	.14	73	.69	−44
22	.82	97	−5.4	0.54	−7	−15.9	.16	72	.70	−48
24	.84	92	−6.6	0.47	−14	−14.9	.18	71	.71	−53
26	.85	87	−8.0	0.40	−20	−14.0	.20	70	.72	−58

Notes: 4 These equivalent circuits are provided only as 1st-order design aids. Their accuracy for critical designs at very high frequencies has not been validated.
5 S-Parameters are from linear equivalent circuit Below 10 GHz, they have been fit to measurements of die on a standard carrier with 1 bond wire to the base and 4 bond wires to the emitter