·M·C·C·

Micro Commercial Components
20736 Marilla Street Chatsworth
CA 91311
Phone: (818) 701-4933
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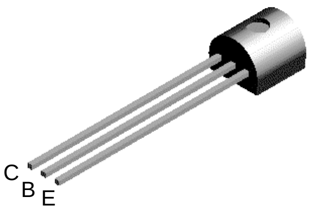
S9012

PNP Silicon Transistors

Features

- TO-92 Plastic-Encapsulate Transistors
- Capable of 0.625Watts(Tamb=25^{O}C) of Power Dissipation.
- Collector-current 0.5A
- Collector-base Voltage 40V
- Operating and storage junction temperature range: -55^{O}C to +150^{O}C
- Marking Code: S9012

Pin Configuration



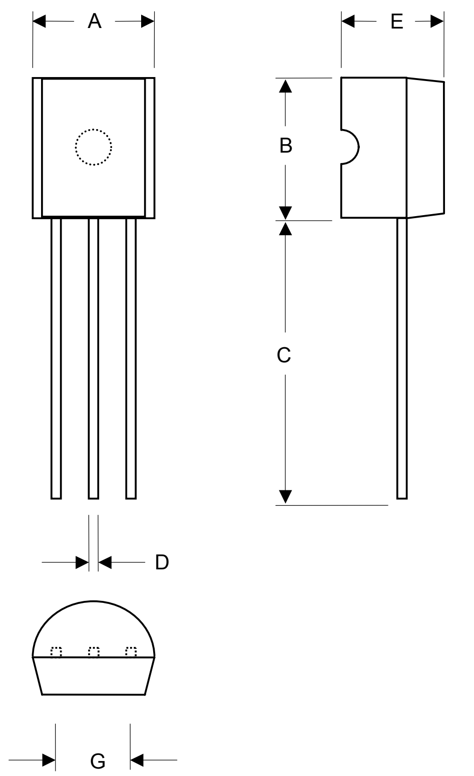
Electrical Characteristics @ 25^{O}C Unless Otherwise Specified

Symbol	Parameter	Min	Max	Units
OFF CHARACTERISTICS				
$V_{(BR)CBO}$	Collector-Base Breakdown Voltage (I_C=100uAdc, I_E=0)	40	---	Vdc
$V_{(BR)CEO}$	Collector-Emitter Breakdown Voltage (I_C=0.1mAdc, I_B=0)	25	---	Vdc
$V_{(BR)EBO}$	Emitter-Base Breakdown Voltage (I_E=100uAdc, I_C=0)	5.0	---	Vdc
I_{CBO}	Collector Cutoff Current (V_{CB}=40Vdc, I_E=0)	---	0.1	uAdc
I_{CEO}	Collector Cutoff Current (V_{CE}=20Vdc, I_B=0)	---	0.2	uAdc
I_{EBO}	Emitter Cutoff Current (V_{EB}=5.0Vdc, I_C=0)	---	0.1	uAdc
ON CHARACTERISTICS				
$h_{FE(1)}$	DC Current Gain (I_C=50mAdc, V_{CE}=1.0Vdc)	64	300	---
$h_{FE(2)}$	DC Current Gain (I_C=500mAdc, V_{CE}=1.0Vdc)	40	---	---
$V_{CE(sat)}$	Collector-Emitter Saturation Voltage (I_C=500mAdc, I_B=50mAdc)	---	0.6	Vdc
$V_{BE(sat)}$	Base-Emitter Saturation Voltage (I_C=500mAdc, I_B=50mAdc)	---	1.2	Vdc
V_{EB}	Base- Emitter Voltage (I_E=100mAdc)	---	1.4	Vdc
SMALL-SIGNAL CHARACTERISTICS				
f_T	Transistor Frequency (I_C=20mAdc, V_{CE}=6.0Vdc, f=30MHz)	150	---	MHz

CLASSIFICATION OF $H_{FE(1)}$

Rank	E	F	G	H	I
Range	78-112	96-135	112-166	144-220	190-300

TO-92

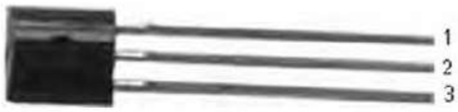


DIMENSIONS					
	INCHES		MM		
DIM	MIN	MAX	MIN	MAX	NOTE
A	.175	.185	4.45	4.70	
B	.175	.185	4.46	4.70	
C	.500	---	12.7	---	
D	.016	.020	0.41	0.63	
E	.135	.145	3.43	3.68	
G	.095	.105	2.42	2.67	

Open Impulse

http://www.openimpulse.com

S9013 NPN Transistor (TO-92) Datasheet

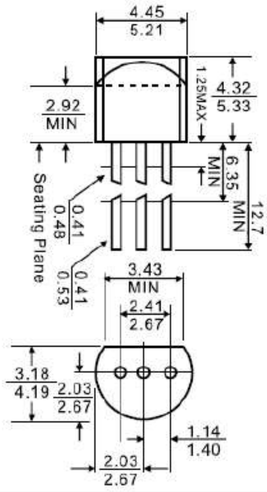


1. EMITTER
2. BASE
3. COLLECTOR

S9013

Transistor(NPN)

TO-92



Dimensions in inches and (millimeters)

Features

- Complementary to S9012
- Excellent h_{FE} linearity

MAXIMUM RATINGS T_A=25℃ unless otherwise noted

Symbol	Parameter	Value	Units
V_{CBO}	Collector-Base Voltage	40	V
V_{CEO}	Collector-Emitter Voltage	25	V
V_{EBO}	Emitter-Base Voltage	5	V
I_C	Collector Current -Continuous	500	mA
P_C	Collector Dissipation	625	mW
T_J	Junction Temperature	150	℃
T_{stg}	Storage Temperature	-55-150	℃

ELECTRICAL CHARACTERISTICS (Tamb=25℃ unless otherwise specified)

Parameter	Symbol	Test conditions	MIN	TYP	MAX	UNIT
Collector-base breakdown voltage	$V_{(BR)CBO}$	I_C= 100μA , I_E=0	40			V
Collector-emitter breakdown voltage	$V_{(BR)CEO}$	I_C= 1mA , I_B=0	25			V
Emitter-base breakdown voltage	$V_{(BR)EBO}$	I_E= 100μA , I_C=0	5			V
Collector cut-off current	I_{CBO}	V_{CB}= 40V , I_E=0			0.1	μA
Collector cut-off current	I_{CEO}	V_{CE}=20V , I_E=0			0.1	μA
Emitter cut-off current	I_{EBO}	V_{EB}= 5V, I_C=0			0.1	μA
DC current gain	$h_{FE(1)}$	V_{CE}=1V, I_C=50mA	64		400	
	$h_{FE(2)}$	V_{CE}=1V, I_C= 500mA	40			
Collector-emitter saturation voltage	$V_{CE(sat)}$	I_C= 500mA, I_B= 50mA			0.6	V
Base-emitter voltage	$V_{BE(sat)}$	I_C= 500mA, I_B= 50mA			1.2	V
Transition frequency	f_T	V_{CE}=6V,I_C=20mA,f=30MHz	150			MHz

CLASSIFICATION OF $h_{FE(1)}$

Rank	D	E	F	G	H	I	J
Range	64-91	78-112	96-135	112-166	144-202	190-300	300-400

http://www.openimpulse.com

Typical Characteristics

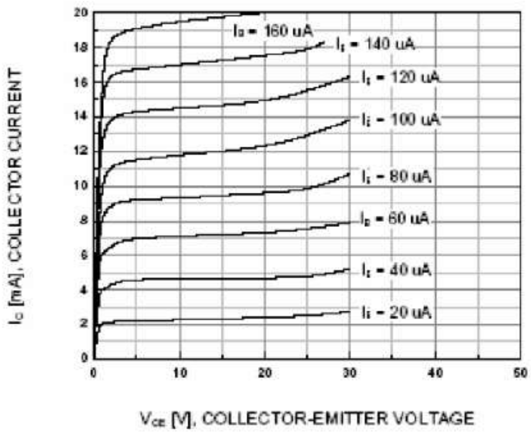


Figure 1. Static Characteristic

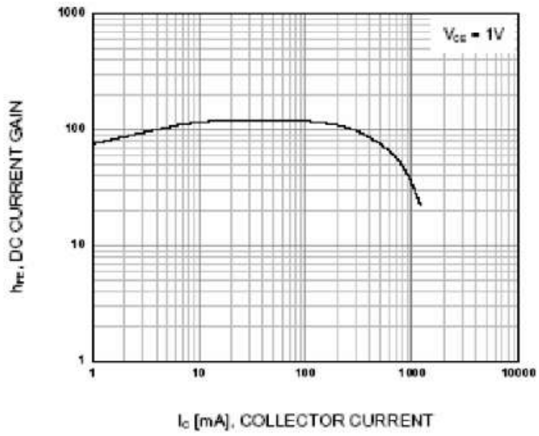


Figure 2. DC current Gain

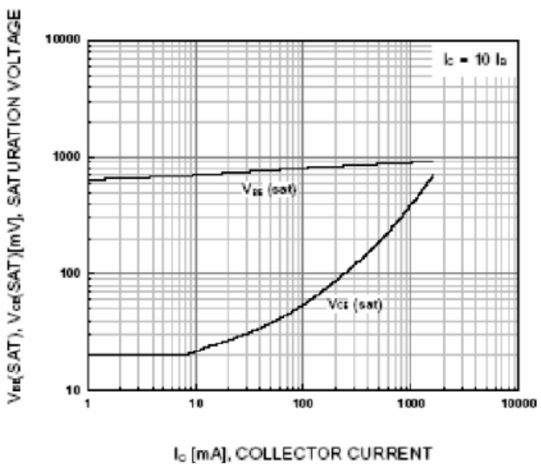


Figure 3. Base-Emitter Saturation Voltage Collector-Emitter Saturation Voltage

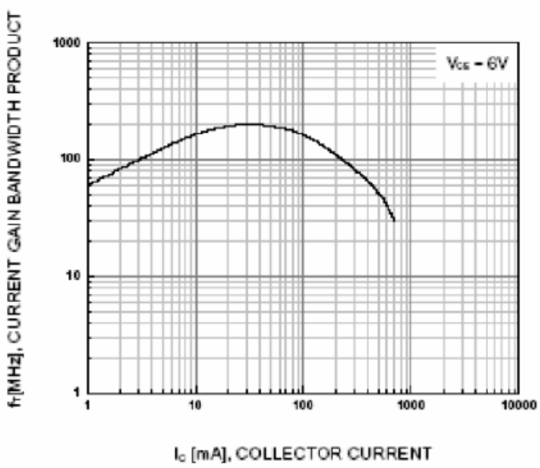


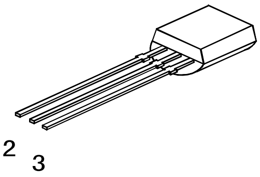
Figure 4. Current Gain Bandwidth Product

MICRO ELECTRONICS

S9014

DESCRIPTION

The S9014 is an NPN epitaxial silicon planar transistor designed for use in the audio output stage and converter/inverter circuits.



S9014: 1. Emitter 2. Base 3. Collect

ABSOLUTE MAXIMUM RATINGS

Maximum Temperatures

Storage Temperature	-55~135℃
Operating Temperature	135℃
Lead Temperature (Soldering, <10s)	230℃

Maximum Power Dissipation

Total Disspation at 25℃ Ambient Temperature	0.4W

Maximum Voltage

V_{CBO} Collector to Base Voltage	50V
V_{CEO} Collector to Emitter Voltage	45V
V_{EBO} Emitter to Base Voltage	5V
I_C Collector Current (continuous)	0.5A

ELECTRICAL CHARACTERISTICS (Ta=25℃ Unless otherwise noted)

SYMBOL	CHARACTERISTICS	MIN.	TYP.	MAX.	UNITS	TEST CONDITIOMNS
H_{FE1}	DC current gain	60		1000		Ic=1mA Vce=5V
$V_{CE(SAT)}$	Collector Saturation Voltage			0.3	V	Ic=100mA Ib=10mA
V_{BE}	Base-Emitter Voltage			0.85	V	Ic=1mA V_{CE}=5V
BV_{CEO}	Collector to Emitter Breakdown Voltage	45			V	Ic=1mA Ib=0
BV_{CBO}	Collector to Base Breakdown Voltage	50			V	Ic=100μA Ie=0
BV_{EBO}	Emitter to Base Breakdown Voltage	5			V	Ie=100μA Ic=0
I_{CBO}	Collector Cutoff Current			0.1	μA	Vcb=50V Ie=0
f_T	Transition frequency	150				Ic=10mA Vce=5V f=30MHz
C_{CB}	Collector to Base Capacitance			6	pF	Vcb=10V Ic=0 f=1MHz

Note:

H_{FE1} classification: A: 60~150 B: 100~300 C: 200~600 D: 400~1000

MICRO ELECTRONICS LTD.
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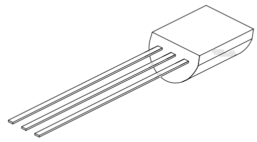
Wang Chiu Road P.O. Box 69477 Hong Kong. Fax No. 2341 0321 Telex:43510 Micro Hx. Tel: 2343 0181-5

REV:0
25-May-05

S8050

NPN SILICON TRANSISTOR

LOW VOLTAGE HIGH CURRENT SMALL SIGNAL NPN TRANSISTOR



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TO-92

■ DESCRIPTION

The UTC **S8050** is a low voltage high current small signal NPN transistor, designed for Class B push-pull audio amplifier and general purpose applications.

■ FEATURES

* Collector current up to 700mA
* Collector-Emitter voltage up to 20 V
* Complementary to S8550

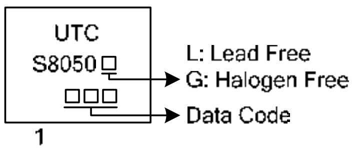
■ ORDERING INFORMATION

Order Number		Package	Pin Assignment			Packing
Lead Free Plating	Halogen Free		1	2	3	
S8050L-x-T92-B	S8050G-x-T92-B	TO-92	E	B	C	Tape Box
S8050L-x-T92-K	S8050G-x-T92-K	TO-92	E	B	C	Bulk

Note: Pin Assignment: E: Emitter B: Base C: Collector

S8050L-x-T92-B	
(1)Packing Type	(1) B: Tape Box, K: Bulk
(2)Package Type	(2) T92: TO-92
(3)Rank	(3) x: refer to Classification of h_{FE_2}
(4)Lead Plating	(4) L: Lead Free, G: Halogen Free

■ MARKING INFORMATION

PACKAGE	MARKING
TO-92	

QW-R201-013.D

■ ABSOLUTE MAXIMUM RATING (T_A=25°C, unless otherwise specified)

PARAMETER	SYMBOL	RATINGS	UNIT
Collector-Base Voltage	V_{CBO}	30	V
Collector-Emitter Voltage	V_{CEO}	20	V
Emitter-Base Voltage	V_{EBO}	5	V
Collector Current	I_C	700	mA
Collector Dissipation(T_A=25°C)	P_C	1	W
Junction Temperature	T_J	150	°C
Storage Temperature	T_{STG}	-65 ~ +150	°C

Note: Absolute maximum ratings are those values beyond which the device could be permanently damaged. Absolute maximum ratings are stress ratings only and functional device operation is not implied.

■ ELECTRICAL CHARACTERISTICS (T_A=25°C, unless otherwise specified)

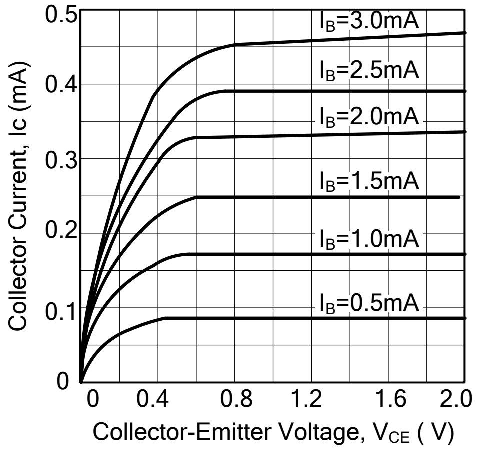
PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNIT
Collector-Base Breakdown Voltage	BV_{CBO}	I_C=100μA, I_E=0	30			V
Collector-Emitter Breakdown Voltage	BV_{CEO}	I_C=1mA, I_B=0	20			V
Emitter-Base Breakdown Voltage	BV_{EBO}	I_E=100μA, Ic=0	5			V
Collector Cut-Off Current	I_{CBO}	V_{CB}=30V, I_E=0			1	μA
Emitter Cut-Off Current	I_{EBO}	V_{EB}=5V, I_C=0			100	nA
DC Current Gain	h_{FE1}	V_{CE}=1V, I_C=1mA	100			
	h_{FE2}	V_{CE}=1V, I_C=150 mA	120		400	
	h_{FE3}	V_{CE}=1V, I_C=500mA	40			
Collector-Emitter Saturation Voltage	$V_{CE(SAT)}$	I_C=500mA, I_B=50mA			0.5	V
Base-Emitter Saturation Voltage	$V_{BE(SAT)}$	I_C=500mA, I_B=50mA			1.2	V
Base-Emitter Saturation Voltage	V_{BE}	V_{CE}=1V, I_C=10mA			1.0	V
Current Gain Bandwidth Product	f_T	V_{CE}=10V, I_C=50mA	100			MHz
Output Capacitance	C_{ob}	V_{CB}=10V, I_E=0, f=1MHz		9.0		pF

■ CLASSIFICATION OF h_{FE2}

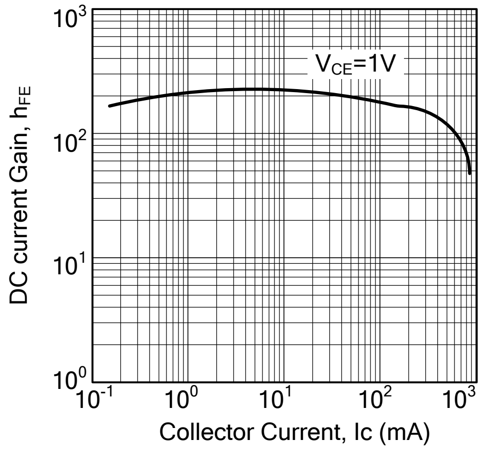
RANK	C	D	E
RANGE	120-200	160-300	280-400

■ TYPICAL CHARACTERISTICS

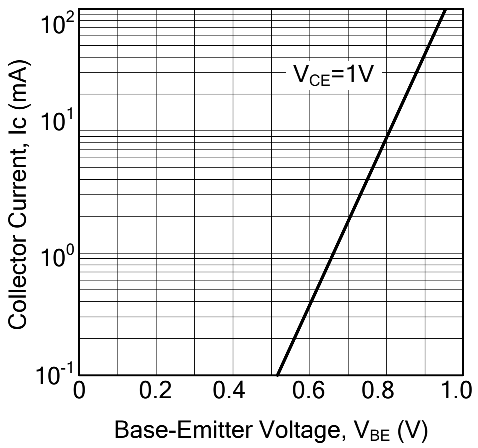
Static Characteristics



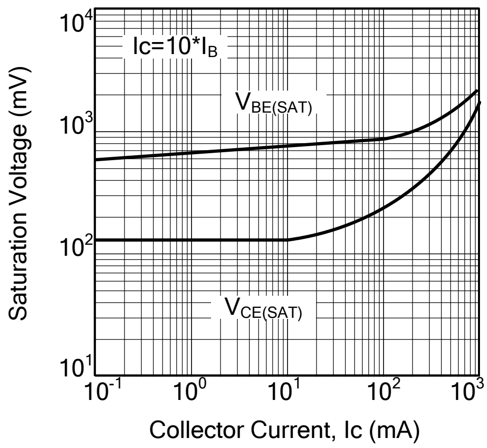
DC Current Gain



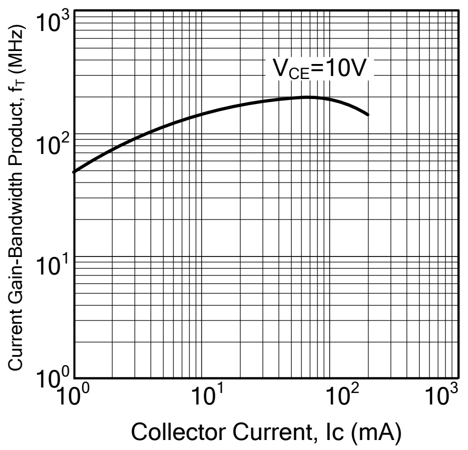
Base-Emitter on Voltage



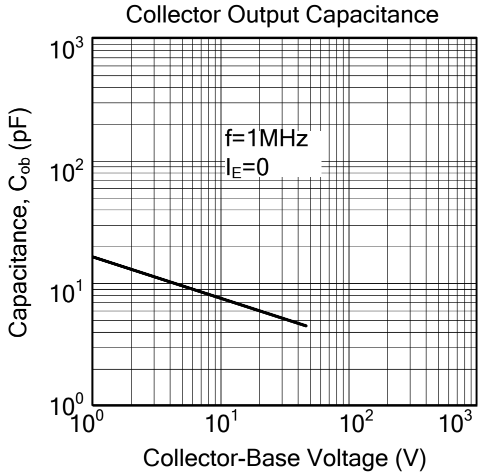
Saturation Voltage



Current Gain-Bandwidth Product



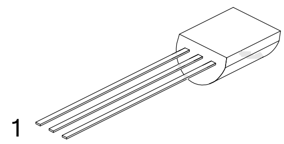
Collector Output Capacitance



S8550

PNP SILICON TRANSISTOR

LOW VOLTAGE HIGH CURRENT SMALL SIGNAL PNP TRANSISTOR



TO-92

■ DESCRIPTION

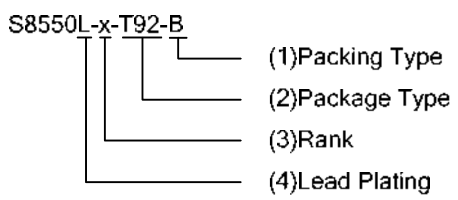
The UTC **S8550** is a low voltage high current small signal PNP transistor, designed for Class B push-pull audio amplifier and general purpose applications.

■ FEATURES

* Collector current up to 700mA
* Collector-Emitter voltage up to 20 V
* Complementary to UTC S8050

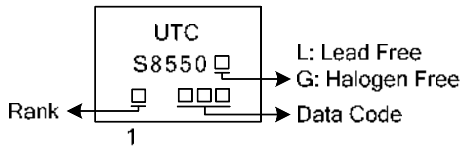
■ ORDERING INFORMATION

Order Number		Package	Pin Assignment			Packing
Lead Free Plating	Halogen Free		1	2	3	
S8550L-x-T92-B	S8550G-x-T92-B	TO-92	E	B	C	Tape Box
S8550L-x-T92-K	S8550G-x-T92-K	TO-92	E	B	C	Bulk



(1) B: Tape Box, K: Bulk
(2) T92: TO-92
(3) x: refer to Classification of h_{FE_2}
(4) L: Lead Free, G: Halogen Free

■ MARKING



■ ABSOLUTE MAXIMUM RATING (T_A=25°C, unless otherwise specified.)

PARAMETER	SYMBOL	RATINGS	UNIT
Collector-Base Voltage	V_{CBO}	-30	V
Collector-Emitter Voltage	V_{CEO}	-20	V
Emitter-Base Voltage	V_{EBO}	-5	V
Collector Current	I_C	-700	mA
Collector Dissipation (T_A=25°C)	P_C	1	W
Junction Temperature	T_J	150	°C
Storage Temperature	T_{STG}	-65 ~ +150	°C

Note: Absolute maximum ratings are those values beyond which the device could be permanently damaged. Absolute maximum ratings are stress ratings only and functional device operation is not implied.

■ ELECTRICAL CHARACTERISTICS (T_A=25°C, unless otherwise specified.)

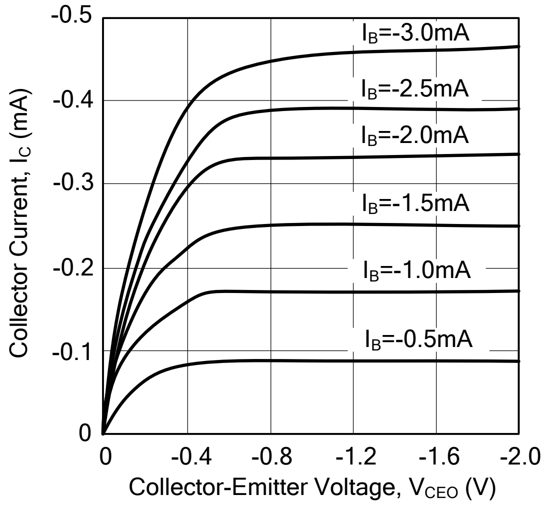
PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNIT
Collector-Base Breakdown Voltage	BV_{CBO}	I_C =-100µA, I_E =0	-30			V
Collector-Emitter Breakdown Voltage	BV_{CEO}	I_C =-1mA, I_B =0	-20			V
Emitter-Base Breakdown Voltage	BV_{EBO}	I_E =-100µA, I_C =0	-5			V
Collector Cut-Off Current	I_{CBO}	V_{CB} =-30V, I_E =0			-1	µA
Emitter Cut-Off Current	I_{EBO}	V_{EB} =-5V, I_C =0			-100	nA
DC Current Gain	h_{FE1}	V_{CE} =-1V, I_C =-1mA	100			
	h_{FE2}	V_{CE} =-1V, I_C =-150mA	120		400	
	h_{FE3}	V_{CE} =-1V, I_C =-500mA	40			
Collector-Emitter Saturation Voltage	$V_{CE(SAT)}$	I_C =-500mA, I_B =-50mA			-0.5	V
Base-Emitter Saturation Voltage	$V_{BE(SAT)}$	I_C =500mA, I_B =-50mA			-1.2	V
Base-Emitter Saturation Voltage	V_{BE}	V_{CE} =-1V, I_C =-10mA			-1.0	V
Current Gain Bandwidth Product	f_T	V_{CE} =-10V, I_C =-50mA	100			MHz
Output Capacitance	Cob	V_{CB} =10V, I_E =0, f =1MHz		9.0		pF

■ CLASSIFICATION OF hFE2

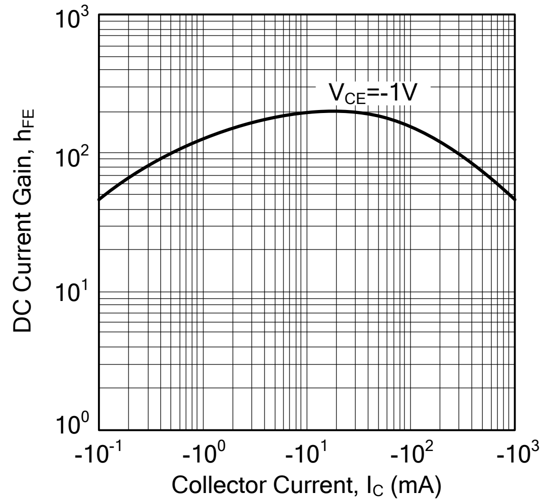
RANK	C	D	E
RANGE	120-200	160-300	280-400

■ TYPICAL CHARACTERISTICS

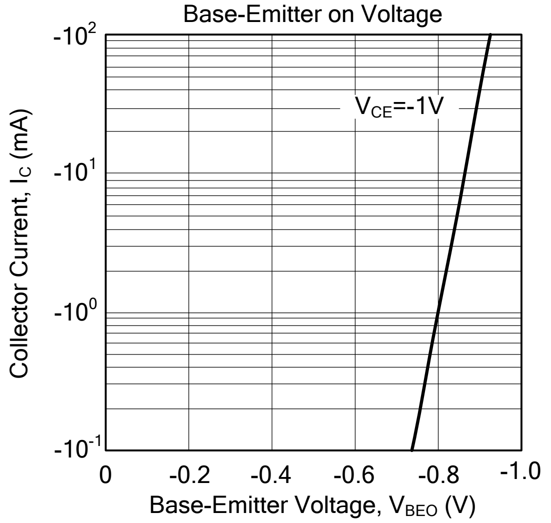
Static Characteristics



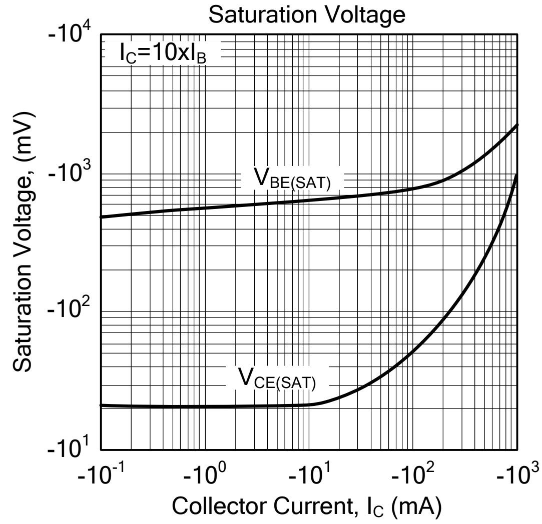
DC Current Gain



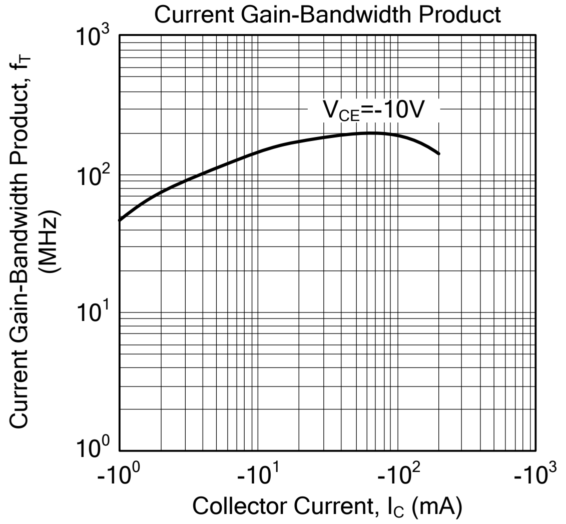
Base-Emitter on Voltage



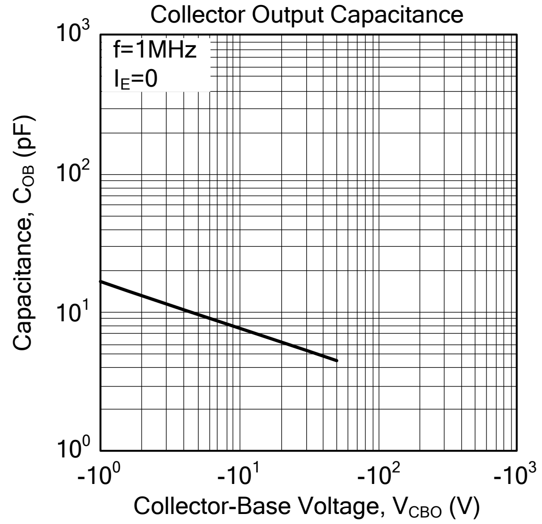
Saturation Voltage



Current Gain-Bandwidth Product



Collector Output Capacitance



FAIRCHILD
SEMICONDUCTOR®

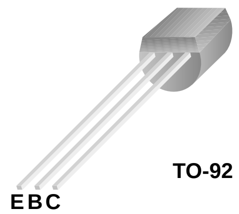
October 2011

2N3904 / MMBT3904 / PZT3904
NPN General Purpose Amplifier

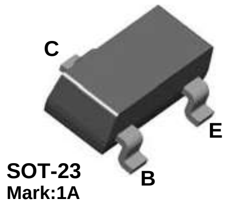
Features

- This device is designed as a general purpose amplifier and switch.
- The useful dynamic range extends to 100 mA as a switch and to 100 MHz as an amplifier.

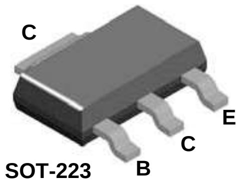
2N3904



MMBT3904



PZT3904



Absolute Maximum Ratings* T_a = 25°C unless otherwise noted

Symbol	Parameter	Value	Units
V_{CEO}	Collector-Emitter Voltage	40	V
V_{CBO}	Collector-Base Voltage	60	V
V_{EBO}	Emitter-Base Voltage	6.0	V
I_C	Collector Current - Continuous	200	mA
T_J, T_{stg}	Operating and Storage Junction Temperature Range	-55 to +150	°C

* These ratings are limiting values above which the serviceability of any semiconductor device may be impaired.

NOTES:

1) These ratings are based on a maximum junction temperature of 150 degrees C.

2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

Thermal Characteristics T_a = 25°C unless otherwise noted

Symbol	Parameter	Max.			Units
		2N3904	*MMBT3904	**PZT3904	
P_D	Total Device Dissipation Derate above 25°C	625 5.0	350 2.8	1,000 8.0	mW mW/°C
$R_{\theta JC}$	Thermal Resistance, Junction to Case	83.3			°C/W
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	200	357	125	°C/W

* Device mounted on FR-4 PCB 1.6" X 1.6" X 0.06".

** Device mounted on FR-4 PCB 36 mm X 18 mm X 1.5 mm; mounting pad for the collector lead min. 6 cm^2.

Electrical Characteristics T_a = 25°C unless otherwise noted

Symbol	Parameter	Test Condition	Min.	Max.	Units
OFF CHARACTERISTICS					
$V_{(BR)CEO}$	Collector-Emitter Breakdown Voltage	I_C = 1.0mA, I_B = 0	40		V
$V_{(BR)CBO}$	Collector-Base Breakdown Voltage	I_C = 10μA, I_E = 0	60		V
$V_{(BR)EBO}$	Emitter-Base Breakdown Voltage	I_E = 10μA, I_C = 0	6.0		V
I_{BL}	Base Cutoff Current	V_{CE} = 30V, V_{EB} = 3V		50	nA
I_{CEX}	Collector Cutoff Current	V_{CE} = 30V, V_{EB} = 3V		50	nA
ON CHARACTERISTICS*					
h_{FE}	DC Current Gain	I_C = 0.1mA, V_{CE} = 1.0V I_C = 1.0mA, V_{CE} = 1.0V I_C = 10mA, V_{CE} = 1.0V I_C = 50mA, V_{CE} = 1.0V I_C = 100mA, V_{CE} = 1.0V	40 70 100 60 30	 300	
$V_{CE(sat)}$	Collector-Emitter Saturation Voltage	I_C = 10mA, I_B = 1.0mA I_C = 50mA, I_B = 5.0mA		0.2 0.3	V V
$V_{BE(sat)}$	Base-Emitter Saturation Voltage	I_C = 10mA, I_B = 1.0mA I_C = 50mA, I_B = 5.0mA	0.65	0.85 0.95	V V
SMALL SIGNAL CHARACTERISTICS					
f_T	Current Gain - Bandwidth Product	I_C = 10mA, V_{CE} = 20V, f = 100MHz	300		MHz
C_{obo}	Output Capacitance	V_{CB} = 5.0V, I_E = 0, f = 1.0MHz		4.0	pF
C_{ibo}	Input Capacitance	V_{EB} = 0.5V, I_C = 0, f = 1.0MHz		8.0	pF
NF	Noise Figure	I_C = 100μA, V_{CE} = 5.0V, R_S = 1.0kΩ, f = 10Hz to 15.7kHz		5.0	dB
SWITCHING CHARACTERISTICS					
t_d	Delay Time	V_{CC} = 3.0V, V_{BE} = 0.5V I_C = 10mA, I_{B1} = 1.0mA		35	ns
t_r	Rise Time			35	ns
t_s	Storage Time	V_{CC} = 3.0V, I_C = 10mA, I_{B1} = I_{B2} = 1.0mA		200	ns
t_f	Fall Time			50	ns

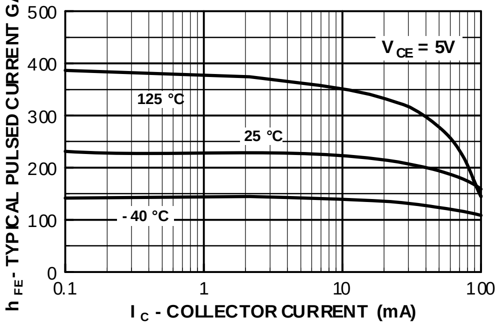
* Pulse Test: Pulse Width ≤ 300μs, Duty Cycle ≤ 2.0%

Ordering Information

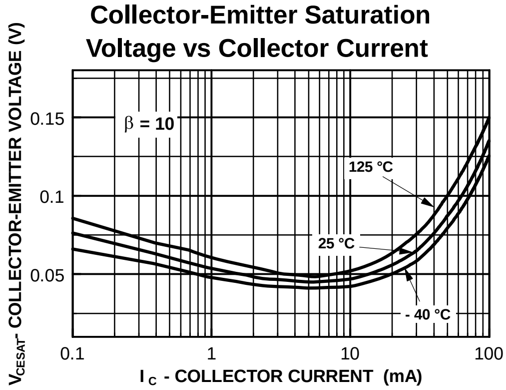
Part Number	Marking	Package	Packing Method	Pack Qty
2N3904BU	2N3904	TO-92	BULK	10000
2N3904TA	2N3904	TO-92	AMMO	2000
2N3904TAR	2N3904	TO-92	AMMO	2000
2N3904TF	2N3904	TO-92	TAPE REEL	2000
2N3904TFR	2N3904	TO-92	TAPE REEL	2000
MMBT3904	1A	SOT-23	TAPE REEL	3000
MMBT3904_D87Z	1A	SOT-23	TAPE REEL	10000
PZT3904	3904	SOT-223	TAPE REEL	2500

Typical Performance Characteristics

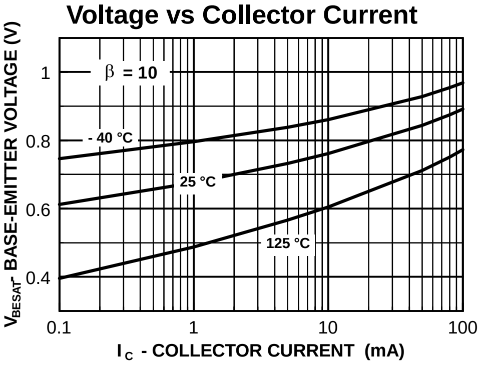
Typical Pulsed Current Gain vs Collector Current



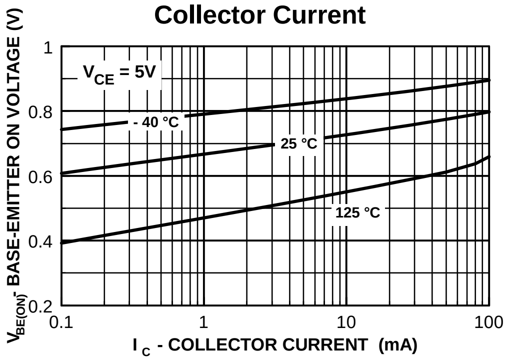
Collector-Emitter Saturation Voltage vs Collector Current



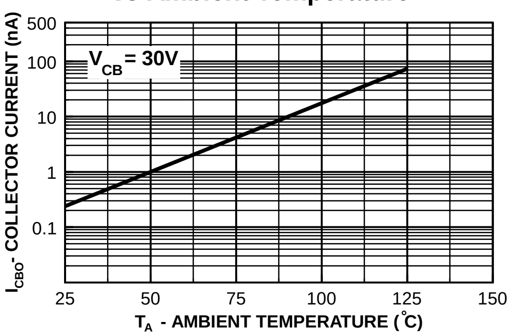
Base-Emitter Saturation Voltage vs Collector Current



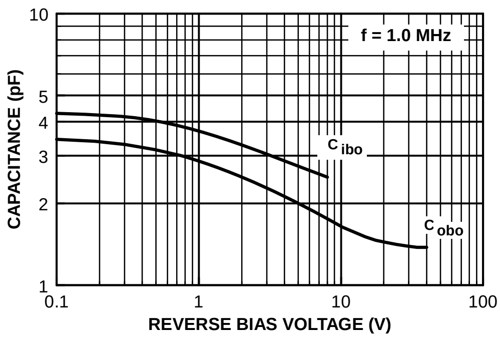
Base-Emitter ON Voltage vs Collector Current



Collector-Cutoff Current vs Ambient Temperature

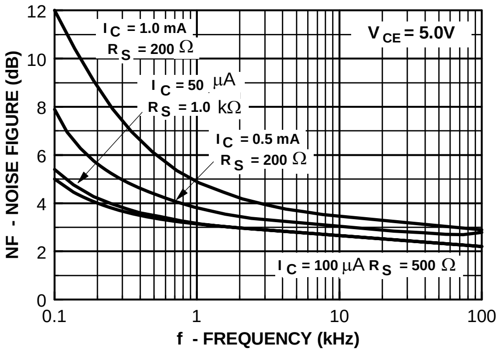


Capacitance vs Reverse Bias Voltage

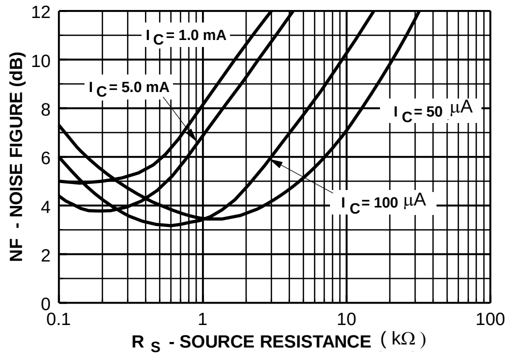


Typical Performance Characteristics (continued)

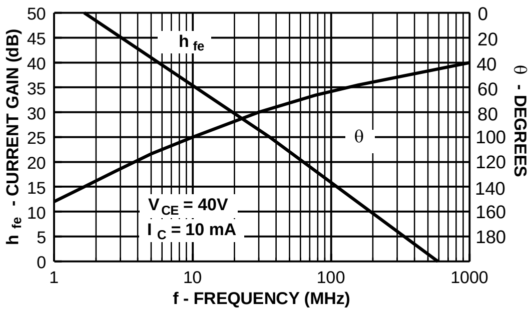
Noise Figure vs Frequency



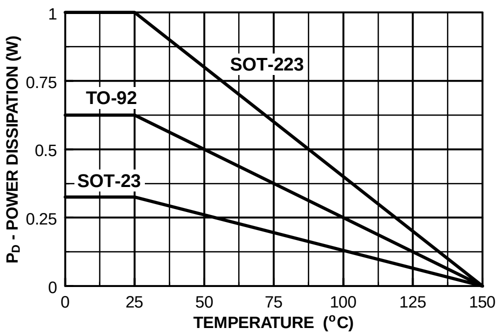
Noise Figure vs Source Resistance



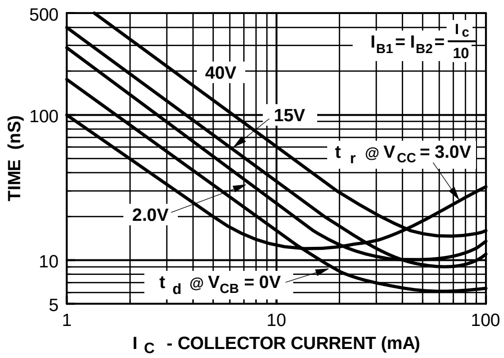
Current Gain and Phase Angle vs Frequency



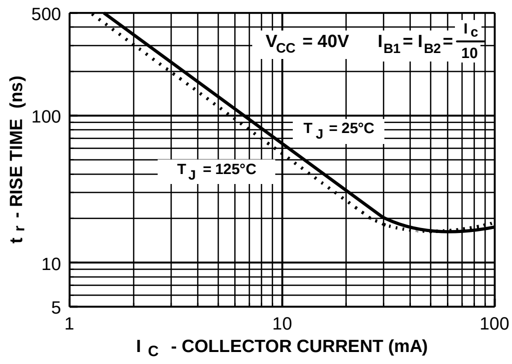
Power Dissipation vs Ambient Temperature



Turn-On Time vs Collector Current

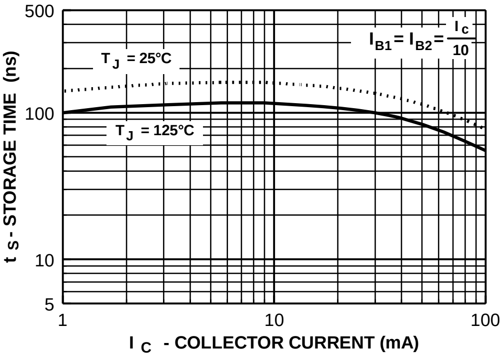


Rise Time vs Collector Current

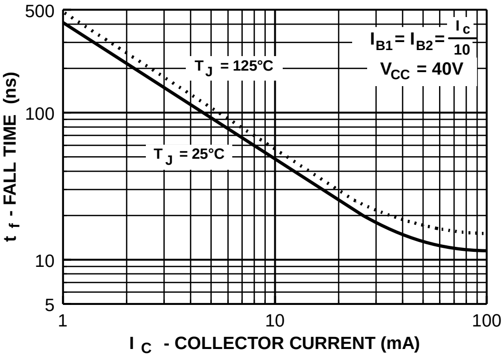


Typical Performance Characteristics (continued)

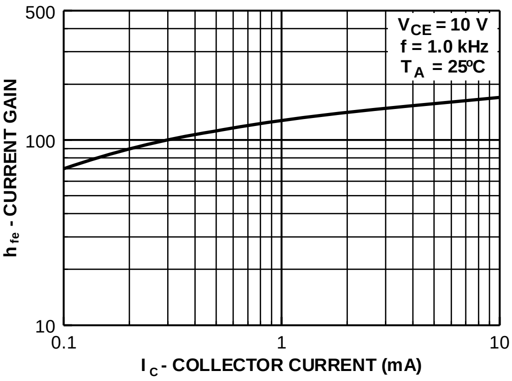
Storage Time vs Collector Current



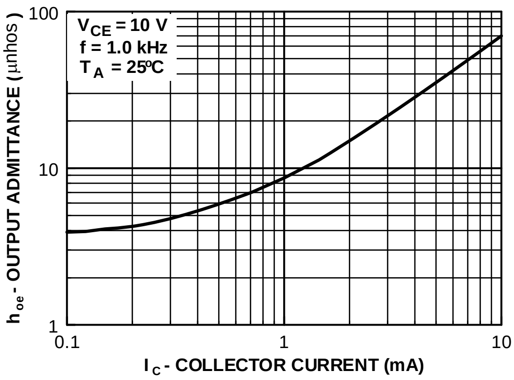
Fall Time vs Collector Current



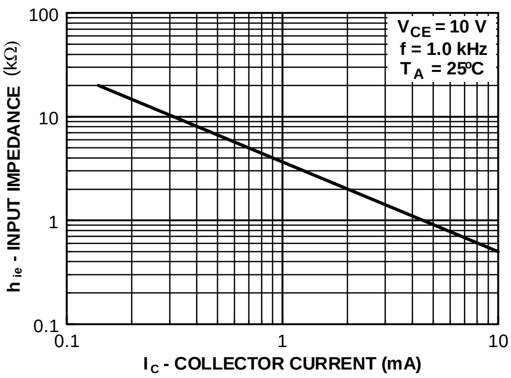
Current Gain



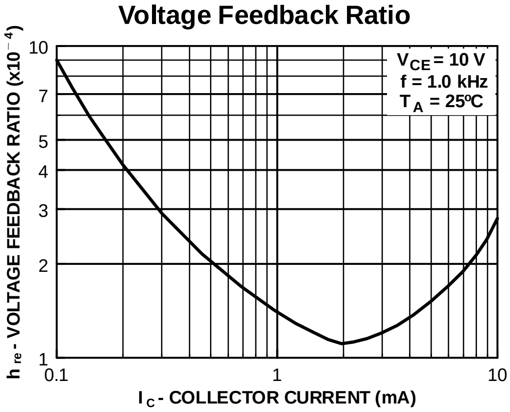
Output Admittance



Input Impedance



Voltage Feedback Ratio



Test Circuits

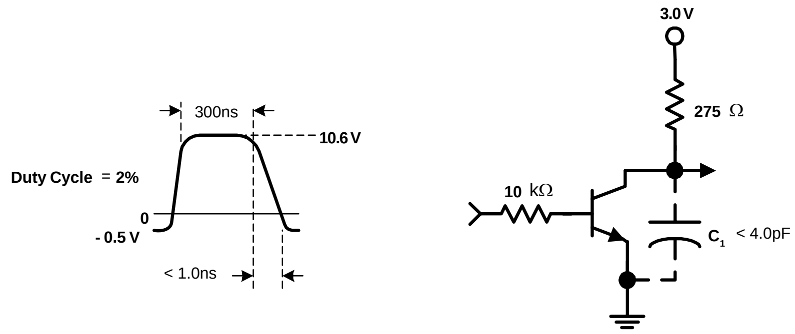


FIGURE 1: Delay and Rise Time Equivalent Test Circuit

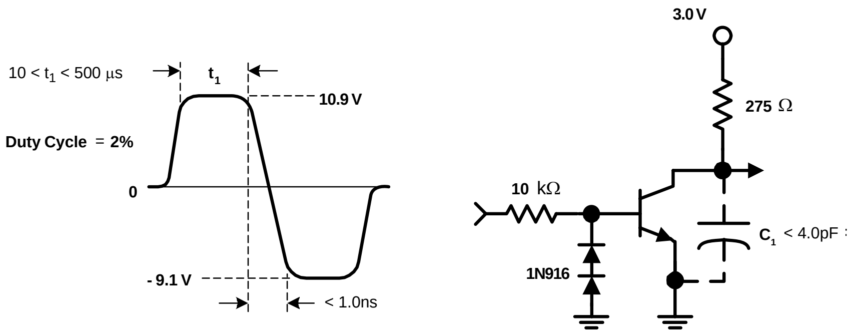


FIGURE 2: Storage and Fall Time Equivalent Test Circuit

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Datasheet Identification	Product Status	Definition
Advance Information	Formative / In Design	Datasheet contains the design specifications for product development. Specifications may change in any manner without notice.
Preliminary	First Production	Datasheet contains preliminary data; supplementary data will be published at a later date. Fairchild Semiconductor reserves the right to make changes at any time without notice to improve design.
No Identification Needed	Full Production	Datasheet contains final specifications. Fairchild Semiconductor reserves the right to make changes at any time without notice to improve the design.
Obsolete	Not In Production	Datasheet contains specifications on a product that is discontinued by Fairchild Semiconductor. The datasheet is for reference information only.

Rev. I57

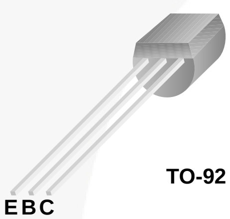
April 2014

2N3906 / MMBT3906 / PZT3906
PNP General-Purpose Amplifier

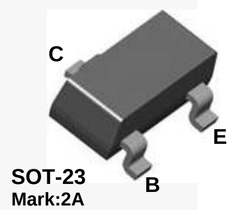
Description

This device is designed for general-purpose amplifier and switching applications at collector currents of 10 mA to 100 mA.

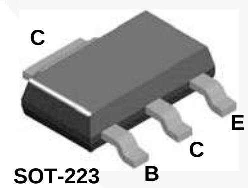
2N3906



MMBT3906



PZT3906



Ordering Information

Part Number	Marking	Package	Packing Method	Pack Quantity
2N3906BU	2N3906	TO-92 3L	Bulk	10000
2N3906TA	2N3906	TO-92 3L	Ammo	2000
2N3906TAR	2N3906	TO-92 3L	Ammo	2000
2N3906TF	2N3906	TO-92 3L	Tape and Reel	2000
2N3906TFR	2N3906	TO-92 3L	Tape and Reel	2000
MMBT3906	2A	SOT-23 3L	Tape and Reel	3000
PZT3906	3906	SOT-223 4L	Tape and Reel	2500

Absolute Maximum Ratings[1]

Stresses exceeding the absolute maximum ratings may damage the device. The device may not function or be operable above the recommended operating conditions and stressing the parts to these levels is not recommended. In addition, extended exposure to stresses above the recommended operating conditions may affect device reliability. The absolute maximum ratings are stress ratings only. Values are at T_A = 25°C unless otherwise noted.

Symbol	Parameter	Value	Unit
V_{CEO}	Collector-Emitter Voltage	-40	V
V_{CBO}	Collector-Base Voltage	-40	V
V_{EBO}	Emitter-Base Voltage	-5.0	V
I_C	Collector Current - Continuous	-200	mA
$T_{J,}$ T_{STG}	Operating and Storage Junction Temperature Range	-55 to +150	°C

Note:

1. These ratings are based on a maximum junction temperature of 150°C.
   These are steady-state limits. Fairchild Semiconductor should be consulted on applications involving pulsed or low-duty cycle operations.

Thermal Characteristics

Values are at T_A = 25°C unless otherwise noted.

Symbol	Parameter	Maximum			Unit
		2N3906[3]	MMBT3906[2]	PZT3906[3]	
P_D	Total Device Dissipation	625	350	1,000	mW
	Derate Above 25°C	5.0	2.8	8.0	mW/°C
$R_{\theta JC}$	Thermal Resistance, Junction to Case	83.3			°C/W
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	200	357	125	°C/W

Notes:

2. Device is mounted on FR-4 PCB 1.6 inch X 1.6 inch X 0.06 inch.
3. PCB size: FR-4, 76 mm x 114 mm x 1.57 mm (3.0 inch x 4.5 inch x 0.062 inch) with minimum land pattern size.

Electrical Characteristics

Values are at T_A = 25°C unless otherwise noted.

Symbol	Parameter	Conditions	Min.	Max.	Unit
OFF CHARACTERISTICS					
$V_{(BR)CEO}$	Collector-Emitter Breakdown Voltage(4)	I_C = -1.0 mA, I_B = 0	-40		V
$V_{(BR)CBO}$	Collector-Base Breakdown Voltage	I_C = -10 µA, I_E = 0	-40		V
$V_{(BR)EBO}$	Emitter-Base Breakdown Voltage	I_E = -10 µA, I_C = 0	-5.0		V
I_{BL}	Base Cut-Off Current	V_{CE} = -30 V, V_{BE} = 3.0 V		-50	nA
I_{CEX}	Collector Cut-Off Current	V_{CE} = -30 V, V_{BE} = 3.0 V		-50	nA
ON CHARACTERISTICS					
h_{FE}	DC Current Gain(4)	I_C = -0.1 mA, V_{CE} = -1.0 V	60		
		I_C = -1.0 mA, V_{CE} = -1.0 V	80		
		I_C = -10 mA, V_{CE} = -1.0 V	100	300	
		I_C = -50 mA, V_{CE} = -1.0 V	60		
		I_C = -100 mA, V_{CE} = -1.0V	30		
V_{CE}(sat)	Collector-Emitter Saturation Voltage	I_C = -10 mA, I_B = -1.0 mA		-0.25	V
		I_C = -50 mA, I_B = -5.0 mA		-0.40	
V_{BE}(sat)	Base-Emitter Saturation Voltage	I_C = -10 mA, I_B = -1.0 mA	-0.65	-0.85	V
		I_C = -50 mA, I_B = -5.0 mA		-0.95	
SMALL SIGNAL CHARACTERISTICS					
f_T	Current Gain - Bandwidth Product	I_C = -10 mA, V_{CE} = -20 V, f = 100 MHz	250		MHz
C_{obo}	Output Capacitance	V_{CB} = -5.0 V, I_E = 0, f = 100 kHz		4.5	pF
C_{ibo}	Input Capacitance	V_{EB} = -0.5 V, I_C = 0, f = 100 kHz		10.0	pF
NF	Noise Figure	I_C = -100 µA, V_{CE} = -5.0 V, R_S = 1.0 kΩ, f = 10 Hz to 15.7 kHz		4.0	dB
SWITCHING CHARACTERISTICS					
t_d	Delay Time	V_{CC} = -3.0 V, V_{BE} = -0.5 V I_C = -10 mA, I_{B1} = -1.0 mA		35	ns
t_r	Rise Time			35	ns
t_s	Storage Time	V_{CC} = -3.0 V, I_C = -10 mA, I_{B1} = I_{B2} = -1.0 mA		225	ns
t_f	Fall Time			75	ns

Note:

4. Pulse test: pulse width ≤ 300 µs, duty cycle ≤ 2.0%.

Typical Performance Characteristics

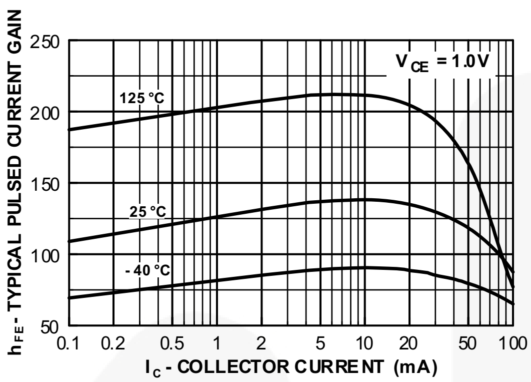


Figure 1. Typical Pulsed Current Gain vs. Collector Current

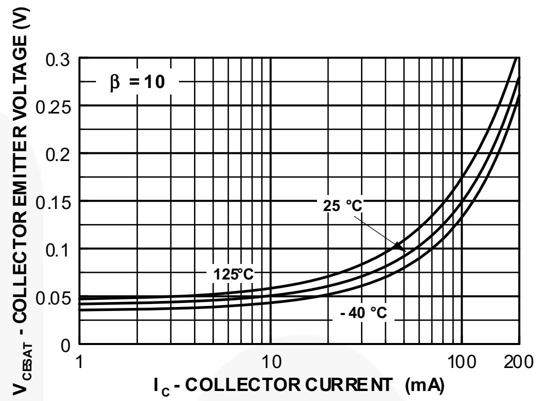


Figure 2. Collector-Emitter Saturation Voltage vs. Collector Current

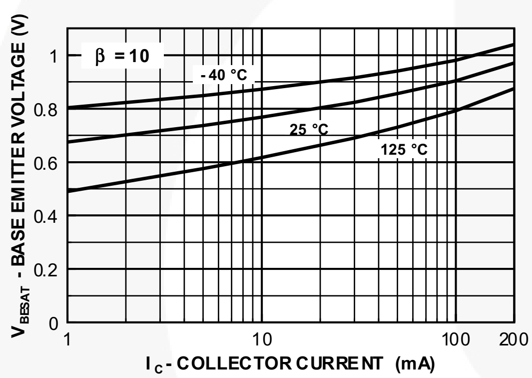


Figure 3. Base-Emitter Saturation Voltage vs. Collector Current

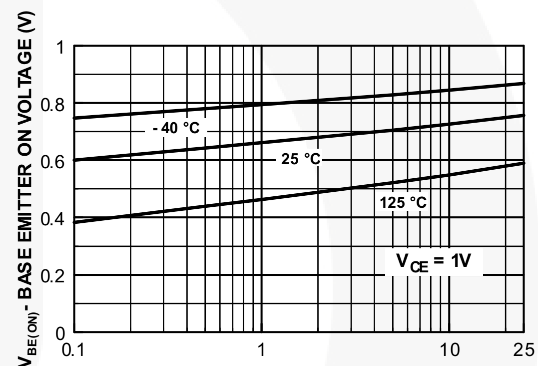


Figure 4. Base-Emitter On Voltage vs. Collector Current

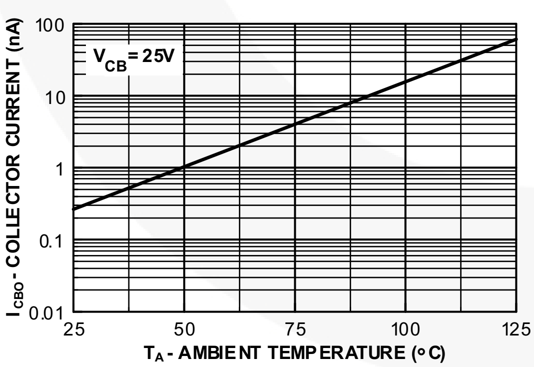


Figure 5. Collector Cut-Off Current vs. Ambient Temperature

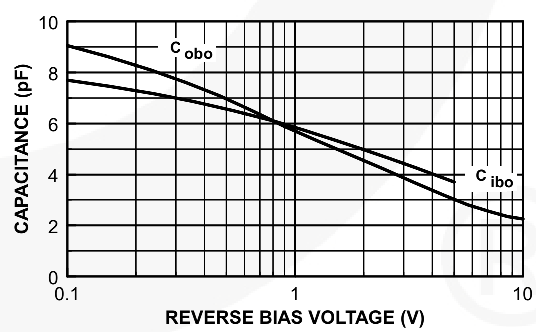


Figure 6. Common-Base Open Circuit Input and Output Capacitance vs. Reverse Bias Voltage

Typical Performance Characteristics (Continued)

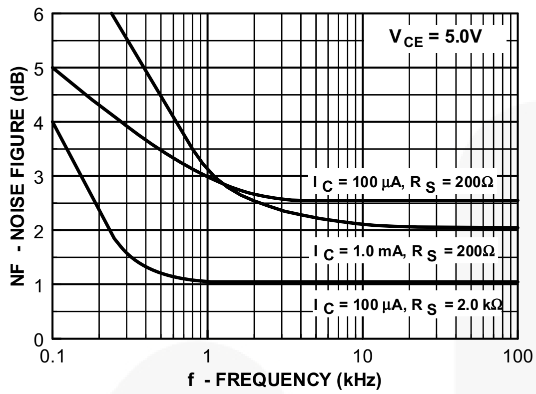


Figure 7. Noise Figure vs. Frequency

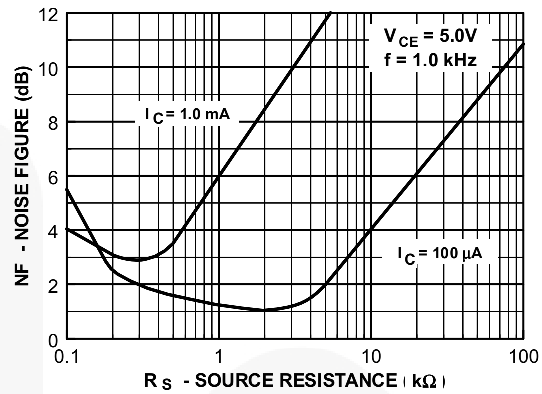


Figure 8. Noise Figure vs. Source Resistance

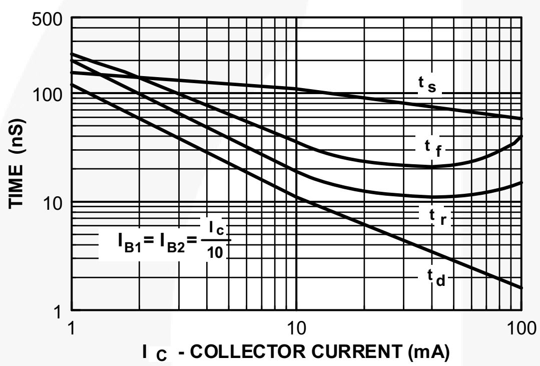


Figure 9. Switching Times vs. Collector Current

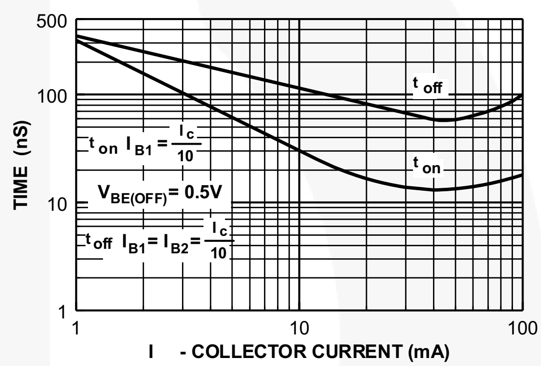


Figure 10. Turn-On and Turn-Off Times vs. Collector Current

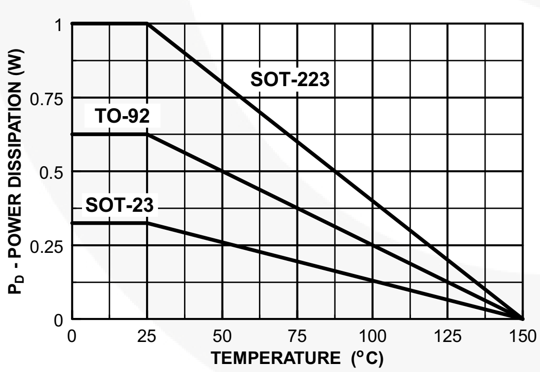


Figure 11. Power Dissipation vs. Ambient Temperature

Typical Performance Characteristics (Continued)

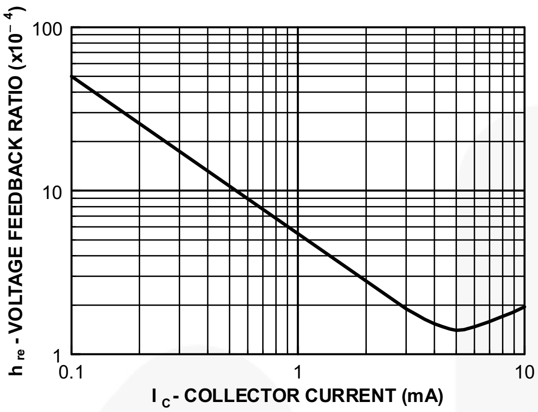


Figure 12. Voltage Feedback Ratio

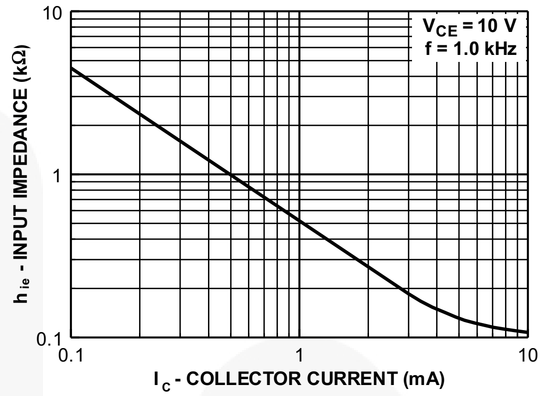


Figure 13. Input Impedance

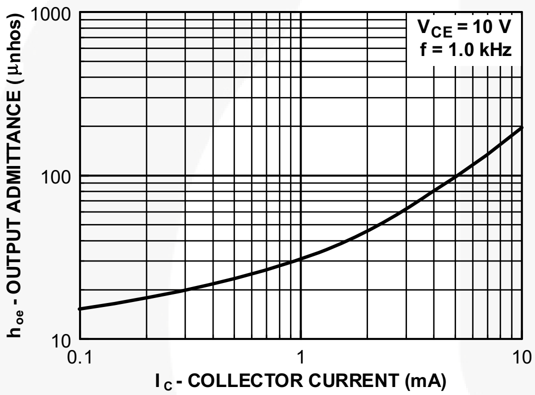


Figure 14. Output Admittance

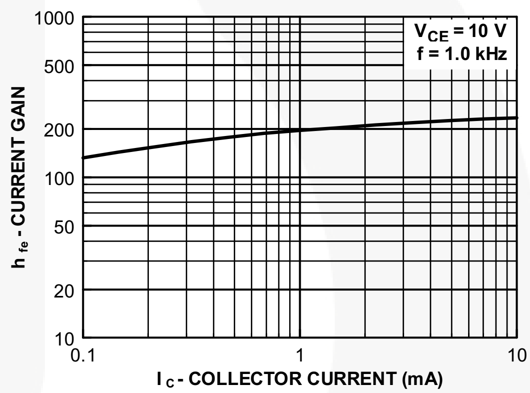
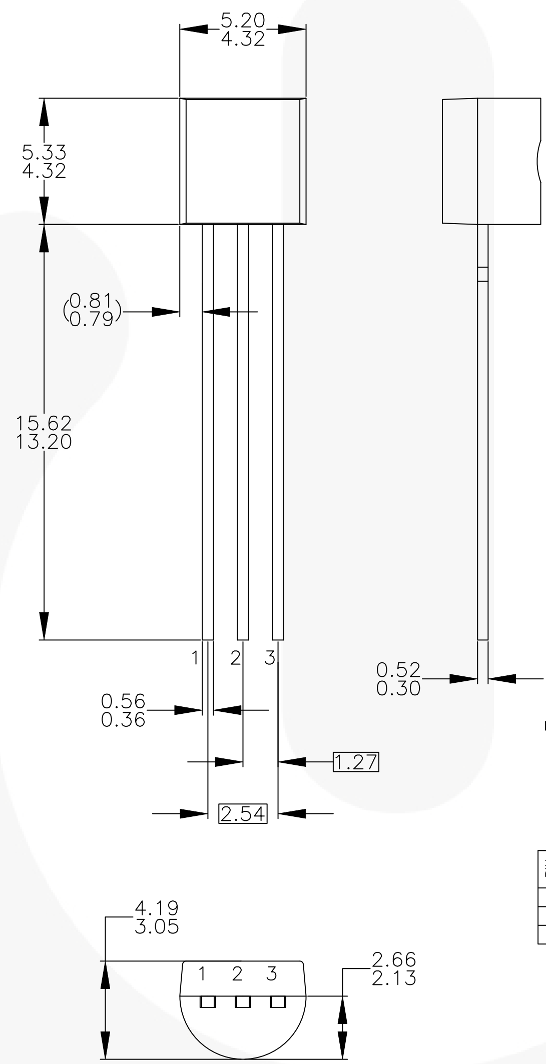


Figure 15. Current Gain

Physical Dimensions

TO-92 (Bulk)



NOTES: UNLESS OTHERWISE SPECIFIED

A) DRAWING WITH REFERENCE TO JEDEC TO–92 RECOMMENDATIONS.
B) ALL DIMENSIONS ARE IN MILLIMETERS.
C) DRAWING CONFORMS TO ASME Y14.5M–1994.
D) TO–92 (92,94,96,97,98) PIN CONFIGURATION:

PIN	92			94			96			97			98		
	P	F	M	P	F	M	B	F	M	P	F	M	P	F	M
1	E	S	S	E	S	S	B	D	G	C	G	D	C	G	D
2	B	D	G	C	G	D	E	S	S	B	D	G	E	S	S
3	C	G	D	B	D	G	C	G	D	E	S	S	B	D	G

LEGEND:
P – BIPOLAR E – EMITTER D – DRAIN
F – JFET B – BASE S – SOURCE
M – DMOS C – COLLECTOR G – GATE

E) FOR PACKAGE 92, 94, 96, 97 AND 98: PIN CONFIGURATION DRAIN "D" AND SOURCE "S" ARE INTERCHANGEAGLE AT JFET "F" OPTION.
F) DRAWING FILENAME: MKT–ZA03DREV3.

Figure 16. 3-LEAD, TO92, JEDEC TO-92 COMPLIANT STRAIGHT LEAD CONFIGURATION (OLD TO92AM3)

Package drawings are provided as a service to customers considering Fairchild components. Drawings may change in any manner without notice. Please note the revision and/or date on the drawing and contact a Fairchild Semiconductor representative to verify or obtain the most recent revision. Package specifications do not expand the terms of Fairchild's worldwide terms and conditions, specifically the warranty therein, which covers Fairchild products.

Always visit Fairchild Semiconductor's online packaging area for the most recent package drawings:
http://www.fairchildsemi.com/dwg/ZA/ZA03D.pdf.

For current tape and reel specifications, visit Fairchild Semiconductor's online packaging area:
http://www.fairchildsemi.com/packing_dwg/PKG-ZA03D_BK.pdf.

Physical Dimensions (Continued)

TO-92 (Ammo, Tape and Reel)

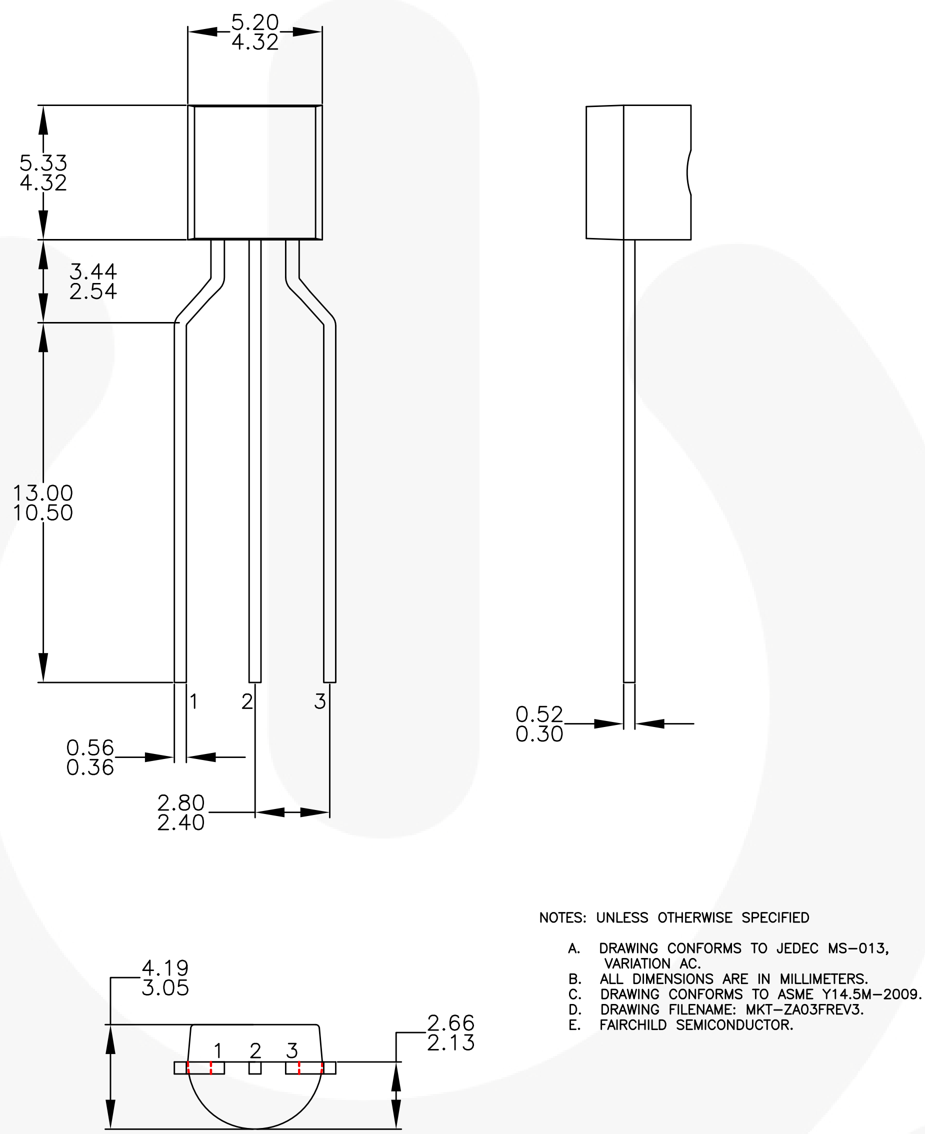


Figure 17. 3-LEAD, TO92, MOLDED 0.200 IN LINE SPACING LEAD FORM (J61Z OPTION)

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For current tape and reel specifications, visit Fairchild Semiconductor's online packaging area:
http://www.fairchildsemi.com/packing_dwg/PKG-ZA03F_BK.pdf.

Physical Dimensions (Continued)

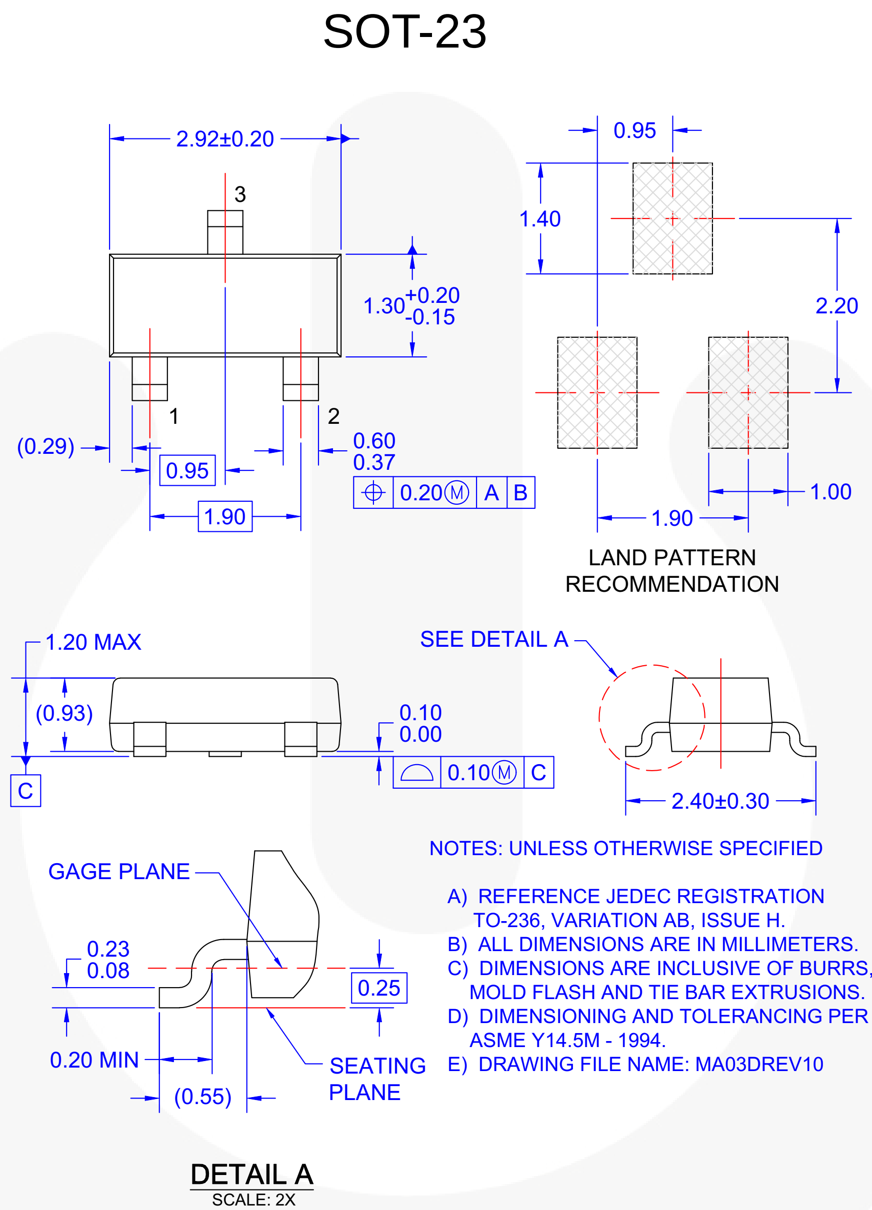

Figure 18. 3-LEAD, SOT23, JEDEC TO-236, LOW PROFILE

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For current tape and reel specifications, visit Fairchild Semiconductor's online packaging area:
http://www.fairchildsemi.com/packing_dwg/PKG-MA03D.pdf.

Physical Dimensions (Continued)

SOT-223 4L

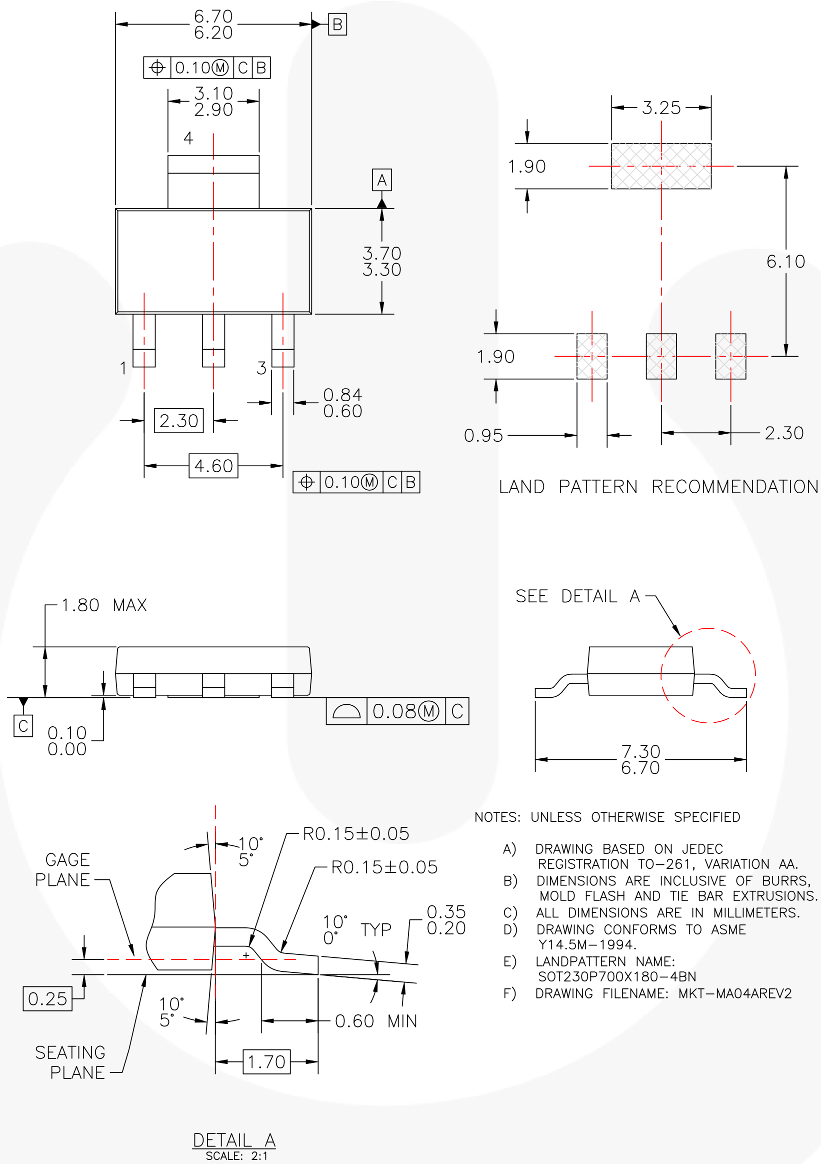

Figure 19. MOLDED PACKAGE, SOT-223, 4-LEAD

Package drawings are provided as a service to customers considering Fairchild components. Drawings may change in any manner without notice. Please note the revision and/or date on the drawing and contact a Fairchild Semiconductor representative to verify or obtain the most recent revision. Package specifications do not expand the terms of Fairchild's worldwide terms and conditions, specifically the warranty therein, which covers Fairchild products.

Always visit Fairchild Semiconductor's online packaging area for the most recent package drawings:
http://www.fairchildsemi.com/dwg/MA/MA04A.pdf.

For current tape and reel specifications, visit Fairchild Semiconductor's online packaging area:
http://www.fairchildsemi.com/packing_dwg/PKG-MA04A_BK.pdf.

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FETBench™
FPS™
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Gmax™
GTO™
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MegaBuck™
MICROCOUPLER™
MicroFET™
MicroPak™
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MotionMax™
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SuperSOT™-6
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TinyBuck®
TinyCalc™
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TINYOPTO™
TinyPower™
TinyPWM™
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2. A critical component in any component of a life support, device, or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.

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PRODUCT STATUS DEFINITIONS

Definition of Terms

Datasheet Identification	Product Status	Definition
Advance Information	Formative / In Design	Datasheet contains the design specifications for product development. Specifications may change in any manner without notice.
Preliminary	First Production	Datasheet contains preliminary data; supplementary data will be published at a later date. Fairchild Semiconductor reserves the right to make changes at any time without notice to improve design.
No Identification Needed	Full Production	Datasheet contains final specifications. Fairchild Semiconductor reserves the right to make changes at any time without notice to improve the design.
Obsolete	Not In Production	Datasheet contains specifications on a product that is discontinued by Fairchild Semiconductor. The datasheet is for reference information only.

Rev. I68

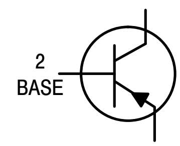
BC327, BC327-16, BC327-25, BC327-40

Amplifier Transistors

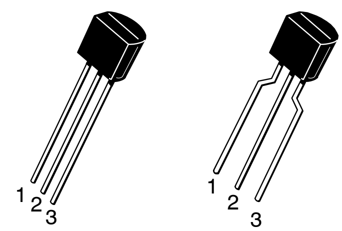
PNP Silicon

ON Semiconductor®

http://onsemi.com



TO−92
CASE 29
STYLE 17



STRAIGHT LEAD
BULK PACK

BENT LEAD
TAPE & REEL
AMMO PACK

Features

- These are Pb−Free Devices*

MAXIMUM RATINGS

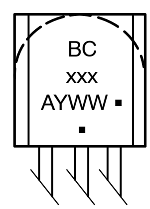
Rating	Symbol	Value	Unit
Collector − Emitter Voltage	V_{CEO}	−45	Vdc
Collector − Emitter Voltage	V_{CES}	−50	Vdc
Emitter− Base Voltage	V_{EBO}	−5.0	Vdc
Collector Current − Continuous	I_C	−800	mAdc
Total Power Dissipation @ T_A = 25°C Derate above T_A = 25°C	P_D	625 5.0	mW mW/°C
Total Power Dissipation @ T_A = 25°C Derate above T_A = 25°C	P_D	1.5 12	W mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction−to−Ambient	$R_{\theta JA}$	200	°C/W
Thermal Resistance, Junction−to−Case	$R_{\theta JC}$	83.3	°C/W

Stresses exceeding Maximum Ratings may damage the device. Maximum Ratings are stress ratings only. Functional operation above the Recommended Operating Conditions is not implied. Extended exposure to stresses above the Recommended Operating Conditions may affect device reliability.

MARKING DIAGRAM



BCxxx = Device Code
A = Assembly Location
Y = Year
WW = Work Week
▪ = Pb−Free Package
(Note: Microdot may be in either location)

ORDERING INFORMATION

See detailed ordering, marking, and shipping information in the package dimensions section on page 4 of this data sheet.

*For additional information on our Pb−Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector−Emitter Breakdown Voltage (I_C = −10 mA, I_B = 0)	$V_{(BR)CEO}$	−45	−	−	Vdc
Collector−Emitter Breakdown Voltage (I_C = −100 μA, I_E = 0)	$V_{(BR)CES}$	−50	−	−	Vdc
Emitter−Base Breakdown Voltage (I_E = −10 μA, I_C = 0)	$V_{(BR)EBO}$	−5.0	−	−	Vdc
Collector Cutoff Current (V_{CB} = −30 V, I_E = 0)	I_{CBO}	−	−	−100	nAdc
Collector Cutoff Current (V_{CE} = −45 V, V_{BE} = 0)	I_{CES}	−	−	−100	nAdc
Emitter Cutoff Current (V_{EB} = −4.0 V, I_C = 0)	I_{EBO}	−	−	−100	nAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = −100 mA, V_{CE} = −1.0 V) BC327 BC327−16 BC327−25 BC327−40 (I_C = −300 mA, V_{CE} = −1.0 V)	h_{FE}	 100 100 160 250 40	 − − − − −	 630 250 400 630 −	−
Base−Emitter On Voltage (I_C = −300 mA, V_{CE} = −1.0 V)	$V_{BE(on)}$	−	−	−1.2	Vdc
Collector−Emitter Saturation Voltage (I_C = −500 mA, I_B = −50 mA)	$V_{CE(sat)}$	−	−	−0.7	Vdc
SMALL−SIGNAL CHARACTERISTICS					
Output Capacitance (V_{CB} = −10 V, I_E = 0, f = 1.0 MHz)	C_{ob}	−	11	−	pF
Current−Gain − Bandwidth Product (I_C = −10 mA, V_{CE} = −5.0 V, f = 100 MHz)	f_T	−	260	−	MHz

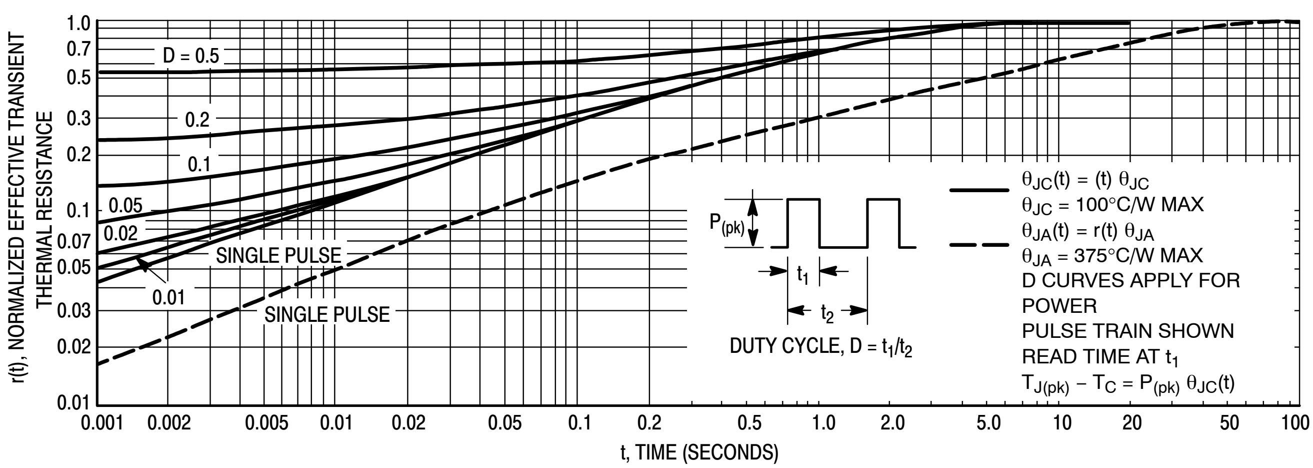


Figure 1. Thermal Response

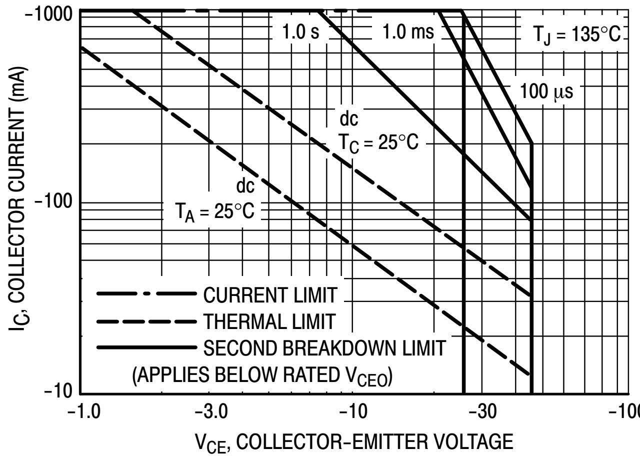


Figure 2. Active Region − Safe Operating Area

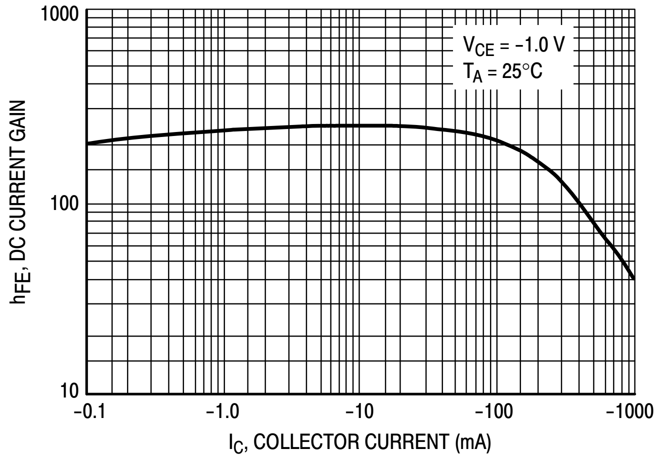


Figure 3. DC Current Gain

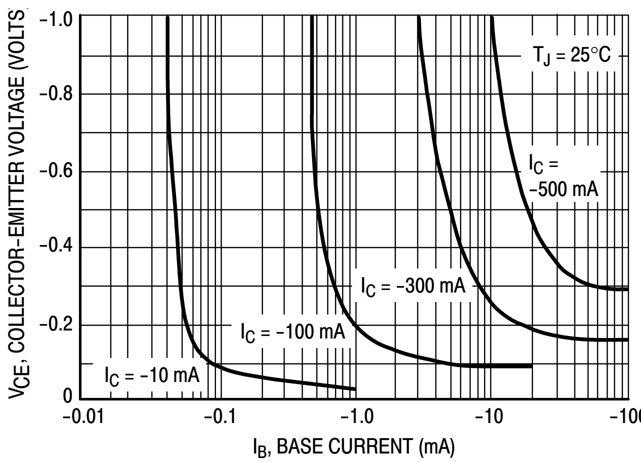


Figure 4. Saturation Region

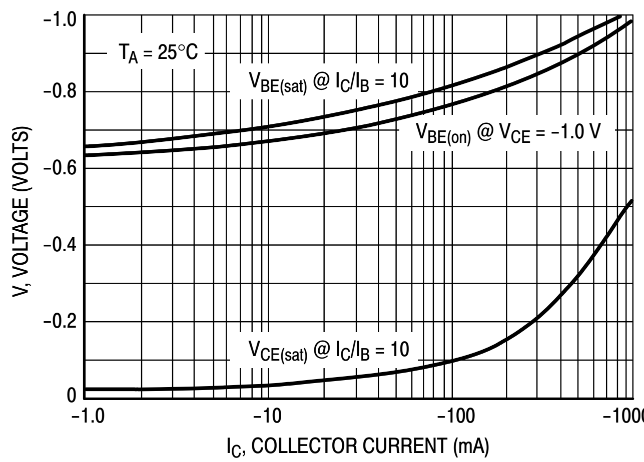


Figure 5. “On” Voltages

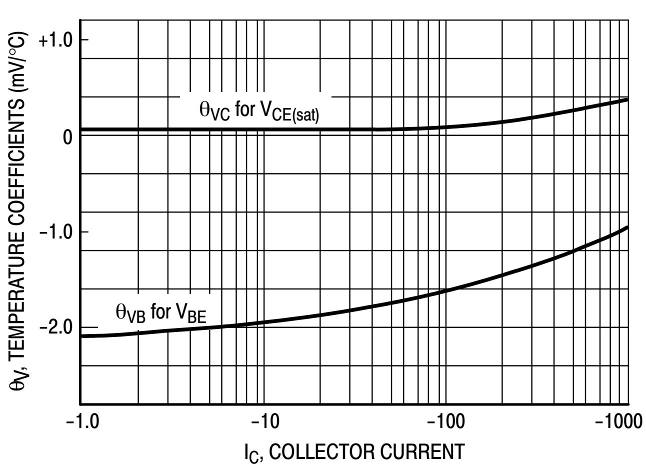


Figure 6. Temperature Coefficients

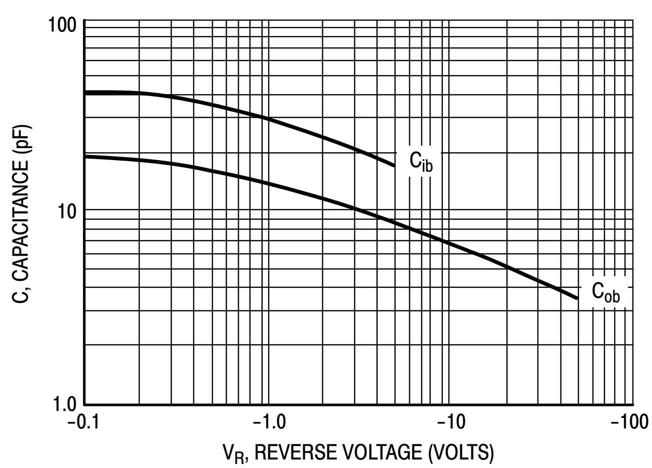


Figure 7. Capacitances

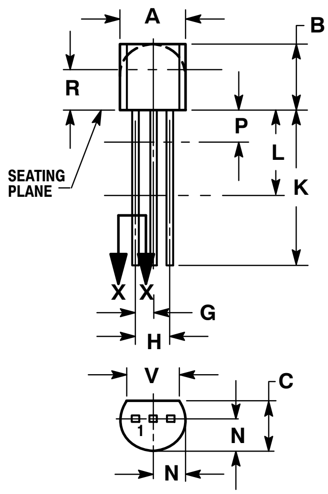
ORDERING INFORMATION

Device Order Number	Specific Device Marking	Package Type	Shipping†
BC327G	7	TO−92 Straight Lead (Pb−Free)	5000 Units / Bulk
BC327RL1G	327	TO−92 Bent Lead (Pb−Free)	2000 / Tape & Reel
BC327−025G	327	TO−92 Straight Lead (Pb−Free)	5000 Units / Bulk
BC327−25RL1G	7−25	TO−92 Bent Lead (Pb−Free)	2000 / Tape & Reel
BC327−25ZL1G	32725	TO−92 Bent Lead (Pb−Free)	2000 / Tape & Ammo Box
BC327−40ZL1G	7−40	TO−92 Bent Lead (Pb−Free)	2000 / Tape & Ammo Box

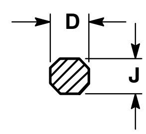
†For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.

PACKAGE DIMENSIONS

TO−92 (TO−226)
CASE 29−11
ISSUE AM



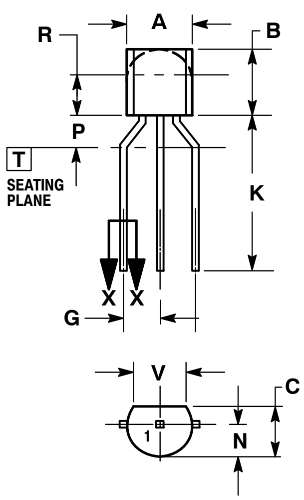
STRAIGHT LEAD
BULK PACK



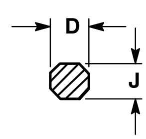
SECTION X−X

NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. CONTOUR OF PACKAGE BEYOND DIMENSION R IS UNCONTROLLED.
4. LEAD DIMENSION IS UNCONTROLLED IN P AND BEYOND DIMENSION K MINIMUM.

	INCHES		MILLIMETERS	
DIM	MIN	MAX	MIN	MAX
A	0.175	0.205	4.45	5.20
B	0.170	0.210	4.32	5.33
C	0.125	0.165	3.18	4.19
D	0.016	0.021	0.407	0.533
G	0.045	0.055	1.15	1.39
H	0.095	0.105	2.42	2.66
J	0.015	0.020	0.39	0.50
K	0.500	---	12.70	---
L	0.250	---	6.35	---
N	0.080	0.105	2.04	2.66
P	---	0.100	---	2.54
R	0.115	---	2.93	---
V	0.135	---	3.43	---



BENT LEAD
TAPE & REEL
AMMO PACK



SECTION X−X

NOTES:
1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: MILLIMETERS.
3. CONTOUR OF PACKAGE BEYOND DIMENSION R IS UNCONTROLLED.
4. LEAD DIMENSION IS UNCONTROLLED IN P AND BEYOND DIMENSION K MINIMUM.

	MILLIMETERS	
DIM	MIN	MAX
A	4.45	5.20
B	4.32	5.33
C	3.18	4.19
D	0.40	0.54
G	2.40	2.80
J	0.39	0.50
K	12.70	---
N	2.04	2.66
P	1.50	4.00
R	2.93	---
V	3.43	---

STYLE 17:
PIN 1. COLLECTOR
2. BASE
3. EMITTER

PUBLICATION ORDERING INFORMATION

LITERATURE FULFILLMENT:
Literature Distribution Center for ON Semiconductor
P.O. Box 5163, Denver, Colorado 80217 USA
Phone: 303−675−2175 or 800−344−3860 Toll Free USA/Canada
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ON Semiconductor Website: **www.onsemi.com**

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For additional information, please contact your local Sales Representative

BC337, BC337-25, BC337-40

Amplifier Transistors

NPN Silicon

Features

- These are Pb−Free Devices

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector − Emitter Voltage	V_{CEO}	45	Vdc
Collector − Base Voltage	V_{CBO}	50	Vdc
Emitter − Base Voltage	V_{EBO}	5.0	Vdc
Collector Current − Continuous	I_C	800	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	625 5.0	mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	1.5 12	W mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction−to−Ambient	$R_{\theta JA}$	200	°C/W
Thermal Resistance, Junction−to−Case	$R_{\theta JC}$	83.3	°C/W

Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

*For additional information on our Pb−Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

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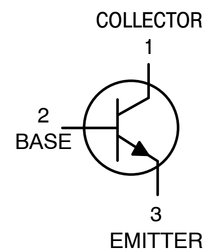
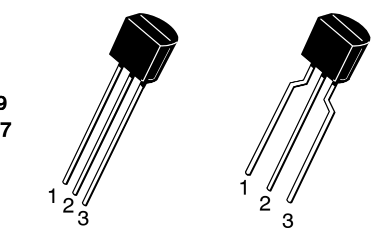
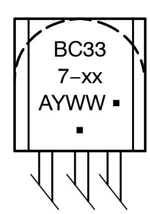


TO−92
CASE 29
STYLE 17



MARKING DIAGRAM



BC337−xx = Device Code
(Refer to page 4)
A = Assembly Location
Y = Year
WW = Work Week
▪ = Pb−Free Package
(Note: Microdot may be in either location)

ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 4 of this data sheet.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector−Emitter Breakdown Voltage (I_C = 10 mA, I_B = 0)	$V_{(BR)CEO}$	45	–	–	Vdc
Collector−Emitter Breakdown Voltage (I_C = 100 μA, I_E = 0)	$V_{(BR)CES}$	50	–	–	Vdc
Emitter−Base Breakdown Voltage (I_E = 10 μA, I_C = 0)	$V_{(BR)EBO}$	5.0	–	–	Vdc
Collector Cutoff Current (V_{CB} = 30 V, I_E = 0)	I_{CBO}	–	–	100	nAdc
Collector Cutoff Current (V_{CE} = 45 V, V_{BE} = 0)	I_{CES}	–	–	100	nAdc
Emitter Cutoff Current (V_{EB} = 4.0 V, I_C = 0)	I_{EBO}	–	–	100	nAdc
ON CHARACTERISTICS					
DC Current Gain	h_{FE}				–
(I_C = 100 mA, V_{CE} = 1.0 V) BC337		100	–	630	
BC337−25		160	–	400	
BC337−40		250	–	630	
(I_C = 300 mA, V_{CE} = 1.0 V)		60	–	–	
Base−Emitter On Voltage (I_C = 300 mA, V_{CE} = 1.0 V)	$V_{BE(on)}$	–	–	1.2	Vdc
Collector−Emitter Saturation Voltage (I_C = 500 mA, I_B = 50 mA)	$V_{CE(sat)}$	–	–	0.7	Vdc
SMALL−SIGNAL CHARACTERISTICS					
Output Capacitance (V_{CB} = 10 V, I_E = 0, f = 1.0 MHz)	C_{ob}	–	15	–	pF
Current−Gain − Bandwidth Product (I_C = 10 mA, V_{CE} = 5.0 V, f = 100 MHz)	f_T	–	210	–	MHz

Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

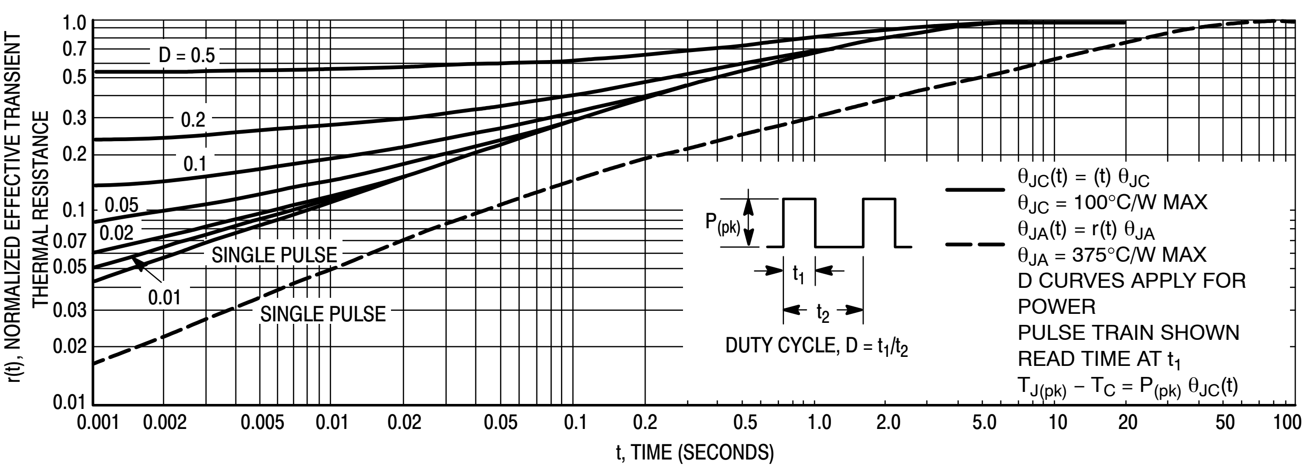


Figure 1. Thermal Response

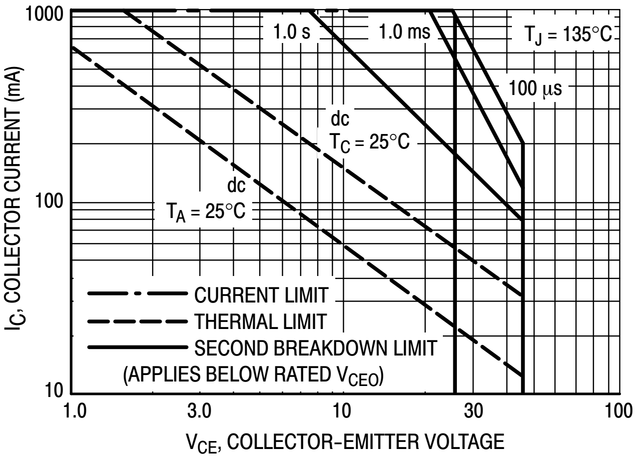


Figure 2. Active Region − Safe Operating Area

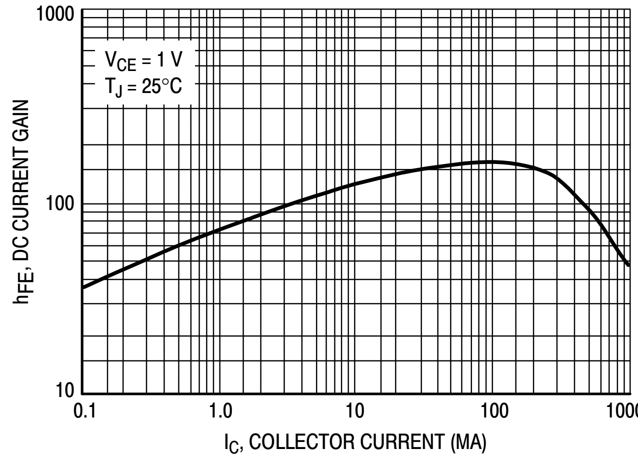


Figure 3. DC Current Gain

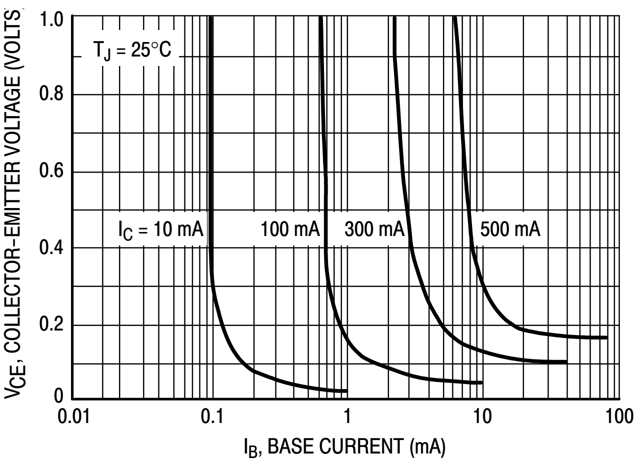


Figure 4. Saturation Region

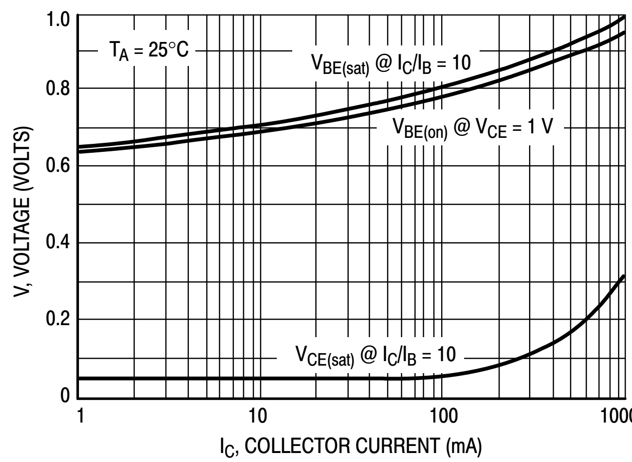


Figure 5. “On” Voltages

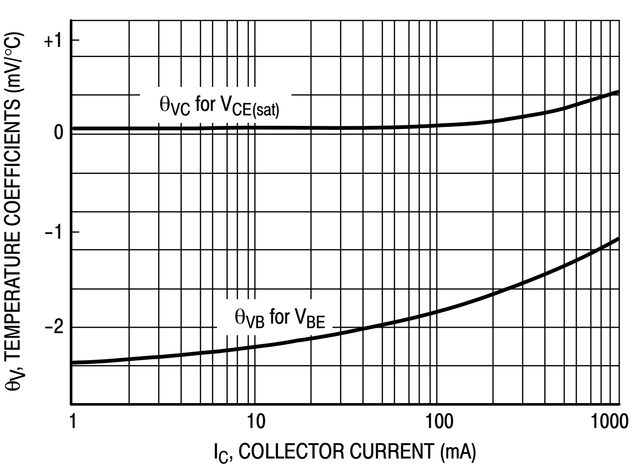


Figure 6. Temperature Coefficients

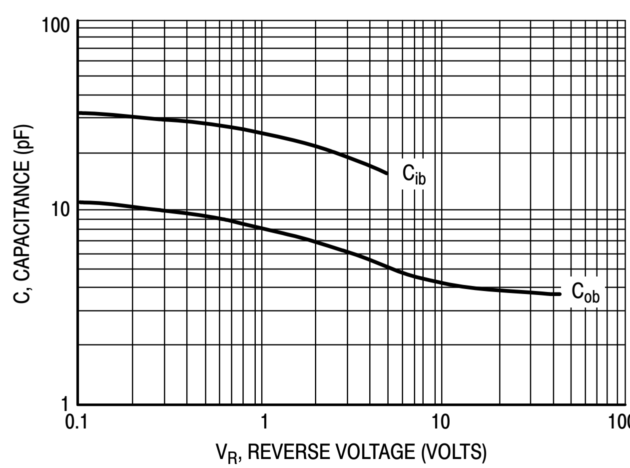


Figure 7. Capacitances

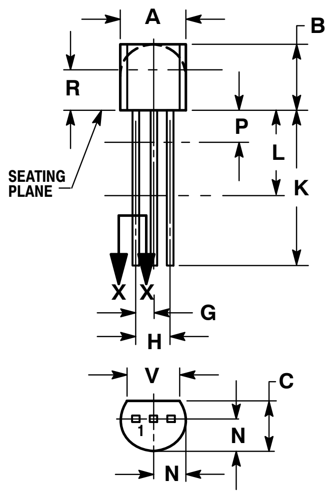
ORDERING INFORMATION

Device	Marking	Package	Shipping†
BC337G	7	TO−92 (Pb−Free)	5000 Units / Bulk
BC337RL1G	7		2000 / Tape & Reel
BC337−025G	7−25		5000 Units / Bulk
BC337−25RL1G	7−25		2000 / Tape & Reel
BC337−25RLRAG	7−25		2000 / Tape & Reel
BC337−25ZL1G	7−25		2000 / Ammo Box
BC337−040G	7−40		5000 Units / Bulk
BC337−40RL1G	7−40		2000 / Tape & Reel
BC337−40ZL1G	7−40		2000 / Ammo Box

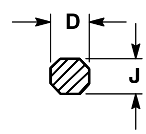
†For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.

PACKAGE DIMENSIONS

TO−92 (TO−226)
CASE 29−11
ISSUE AM



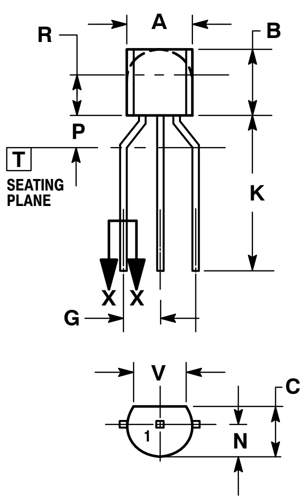
STRAIGHT LEAD
BULK PACK



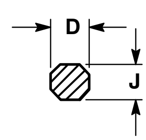
SECTION X−X

NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. CONTOUR OF PACKAGE BEYOND DIMENSION R IS UNCONTROLLED.
4. LEAD DIMENSION IS UNCONTROLLED IN P AND BEYOND DIMENSION K MINIMUM.

	INCHES		MILLIMETERS	
DIM	MIN	MAX	MIN	MAX
A	0.175	0.205	4.45	5.20
B	0.170	0.210	4.32	5.33
C	0.125	0.165	3.18	4.19
D	0.016	0.021	0.407	0.533
G	0.045	0.055	1.15	1.39
H	0.095	0.105	2.42	2.66
J	0.015	0.020	0.39	0.50
K	0.500	---	12.70	---
L	0.250	---	6.35	---
N	0.080	0.105	2.04	2.66
P	---	0.100	---	2.54
R	0.115	---	2.93	---
V	0.135	---	3.43	---



BENT LEAD
TAPE & REEL
AMMO PACK



SECTION X−X

NOTES:
1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: MILLIMETERS.
3. CONTOUR OF PACKAGE BEYOND DIMENSION R IS UNCONTROLLED.
4. LEAD DIMENSION IS UNCONTROLLED IN P AND BEYOND DIMENSION K MINIMUM.

	MILLIMETERS	
DIM	MIN	MAX
A	4.45	5.20
B	4.32	5.33
C	3.18	4.19
D	0.40	0.54
G	2.40	2.80
J	0.39	0.50
K	12.70	---
N	2.04	2.66
P	1.50	4.00
R	2.93	---
V	3.43	---

STYLE 17:
PIN 1. COLLECTOR
2. BASE
3. EMITTER

PUBLICATION ORDERING INFORMATION

LITERATURE FULFILLMENT:
Literature Distribution Center for ON Semiconductor
P.O. Box 5163, Denver, Colorado 80217 USA
Phone: 303−675−2175 or 800−344−3860 Toll Free USA/Canada
Fax: 303−675−2176 or 800−344−3867 Toll Free USA/Canada
Email: orderlit@onsemi.com

N. American Technical Support: 800−282−9855 Toll Free USA/Canada
Europe, Middle East and Africa Technical Support:
Phone: 421 33 790 2910
Japan Customer Focus Center
Phone: 81−3−5817−1050

ON Semiconductor Website: **www.onsemi.com**

Order Literature: http://www.onsemi.com/orderlit

For additional information, please contact your local Sales Representative

TL431A, B Series, NCV431A, B Series, SCV431A

Programmable Precision References

The TL431A, B integrated circuits are three−terminal programmable shunt regulator diodes. These monolithic IC voltage references operate as a low temperature coefficient zener which is programmable from V_{ref} to 36 V with two external resistors. These devices exhibit a wide operating current range of 1.0 mA to 100 mA with a typical dynamic impedance of 0.22 Ω. The characteristics of these references make them excellent replacements for zener diodes in many applications such as digital voltmeters, power supplies, and op amp circuitry. The 2.5 V reference makes it convenient to obtain a stable reference from 5.0 V logic supplies, and since the TL431A, B operates as a shunt regulator, it can be used as either a positive or negative voltage reference.

Features

- Programmable Output Voltage to 36 V
- Voltage Reference Tolerance: ±0.4%, Typ @ 25°C (TL431B)
- Low Dynamic Output Impedance, 0.22 Ω Typical
- Sink Current Capability of 1.0 mA to 100 mA
- Equivalent Full−Range Temperature Coefficient of 50 ppm/°C Typical
- Temperature Compensated for Operation over Full Rated Operating Temperature Range
- Low Output Noise Voltage
- NCV/SCV Prefixes for Automotive and Other Applications Requiring Unique Site and Control Change Requirements; AEC−Q100 Qualified and PPAP Capable
- These Devices are Pb−Free, Halogen Free/BFR Free and are RoHS Compliant

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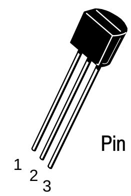
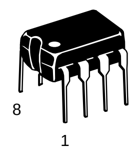
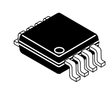


TO−92 (TO−226)
LP SUFFIX
CASE 29

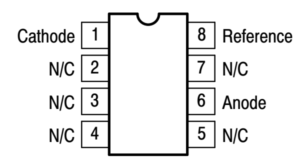
Pin 1. Reference
2. Anode
3. Cathode



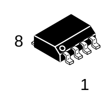
PDIP−8
P SUFFIX
CASE 626



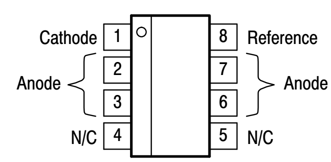
Micro8™
DM SUFFIX
CASE 846A



(Top View)



SOIC−8
D SUFFIX
CASE 751



(Top View)

This is an internally modified SOIC−8 package. Pins 2, 3, 6 and 7 are electrically common to the die attach flag. This internal lead frame modification increases power dissipation capability when appropriately mounted on a printed circuit board. This modified package conforms to all external dimensions of the standard SOIC−8 package.

ORDERING INFORMATION

See detailed ordering and shipping information on page 13 of this data sheet.

DEVICE MARKING INFORMATION

See general marking information in the device marking section on page 14 of this data sheet.

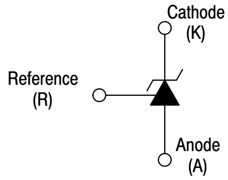


Figure 1. Symbol

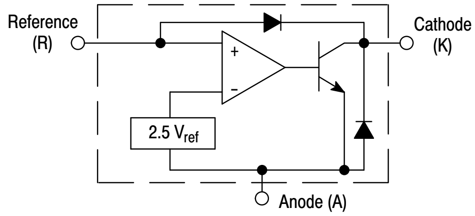
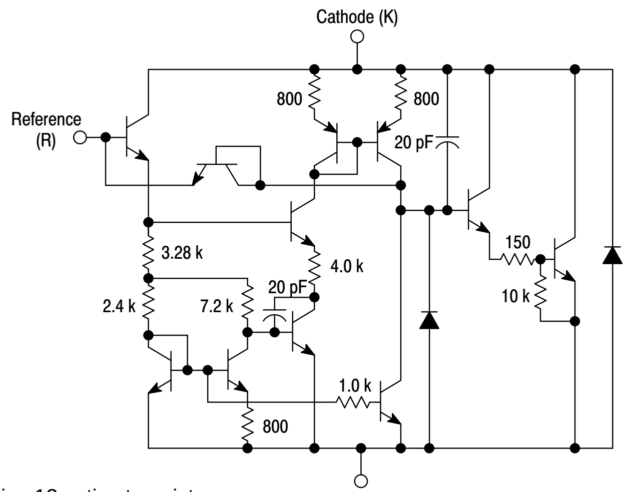


Figure 2. Representative Block Diagram



This device contains 12 active transistors.

Figure 3. Representative Schematic Diagram

Component values are nominal

MAXIMUM RATINGS (Full operating ambient temperature range applies, unless otherwise noted.)

Rating	Symbol	Value	Unit
Cathode to Anode Voltage	V_{KA}	37	V
Cathode Current Range, Continuous	I_K	−100 to +150	mA
Reference Input Current Range, Continuous	I_{ref}	−0.05 to +10	mA
Operating Junction Temperature	T_J	150	°C
Operating Ambient Temperature Range	T_A		°C
TL431I, TL431AI, TL431BI		−40 to +85	
TL431C, TL431AC, TL431BC		0 to +70	
NCV431AI, NCV431B, TL431BV, SCV431AI		−40 to +125	
Storage Temperature Range	T_{stg}	−65 to +150	°C
Total Power Dissipation @ T_A = 25°C	P_D		W
Derate above 25°C Ambient Temperature			
D, LP Suffix Plastic Package		0.70	
P Suffix Plastic Package		1.10	
DM Suffix Plastic Package		0.52	
Total Power Dissipation @ T_C = 25°C	P_D		W
Derate above 25°C Case Temperature			
D, LP Suffix Plastic Package		1.5	
P Suffix Plastic Package		3.0	
ESD Rating (Note 1)			V
Human Body Model per JEDEC JESD22−A114F	HBM	>2000	
Machine Model per JEDEC JESD22−A115C	MM	>200	
Charged Device Model per JEDEC JESD22−C101E	CDM	>500	

Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

1. This device contains latch−up protection and exceeds ±100 mA per JEDEC standard JESD78.

RECOMMENDED OPERATING CONDITIONS

Condition	Symbol	Min	Max	Unit
Cathode to Anode Voltage	V_{KA}	V_{ref}	36	V
Cathode Current	I_K	1.0	100	mA

Functional operation above the stresses listed in the Recommended Operating Ranges is not implied. Extended exposure to stresses beyond the Recommended Operating Ranges limits may affect device reliability.

THERMAL CHARACTERISTICS

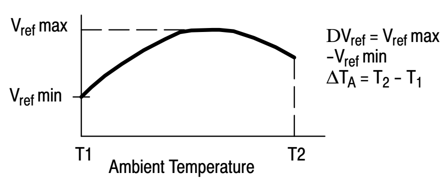
Characteristic	Symbol	D, LP Suffix Package	P Suffix Package	DM Suffix Package	Unit
Thermal Resistance, Junction−to−Ambient	$R_{\theta JA}$	178	114	240	°C/W
Thermal Resistance, Junction−to−Case	$R_{\theta JC}$	83	41	−	°C/W

ELECTRICAL CHARACTERISTICS (T_A = 25°C, unless otherwise noted.)

Characteristic	Symbol	TL431I			TL431C			Unit
		Min	Typ	Max	Min	Typ	Max	
Reference Input Voltage (Figure 1) $V_{KA} = V_{ref}$, I_K = 10 mA T_A = 25°C $T_A = T_{low}$ to T_{high} (Note 2)	V_{ref}	 2.44 2.41	 2.495 −	 2.55 2.58	 2.44 2.423	 2.495 −	 2.55 2.567	V
Reference Input Voltage Deviation Over Temperature Range (Figure 1, Notes 3, 4) $V_{KA} = V_{ref}$, I_K = 10 mA	ΔV_{ref}	−	7.0	30	−	3.0	17	mV
Ratio of Change in Reference Input Voltage to Change in Cathode to Anode Voltage I_K = 10 mA (Figure 2), ΔV_{KA} = 10 V to V_{ref} ΔV_{KA} = 36 V to 10 V	$\frac{\Delta V_{ref}}{\Delta V_{KA}}$	 − −	 −1.4 −1.0	 −2.7 −2.0	 − −	 −1.4 −1.0	 −2.7 −2.0	mV/V
Reference Input Current (Figure 2) I_K = 10 mA, R1 = 10 k, R2 = ∞ T_A = 25°C $T_A = T_{low}$ to T_{high} (Note 2)	I_{ref}	 − −	 1.8 −	 4.0 6.5	 − −	 1.8 −	 4.0 5.2	μA
Reference Input Current Deviation Over Temperature Range (Figure 2, Note 3) I_K = 10 mA, R1 = 10 k, R2 = ∞	ΔI_{ref}	−	0.8	2.5	−	0.4	1.2	μA
Minimum Cathode Current For Regulation $V_{KA} = V_{ref}$ (Figure 1)	I_{min}	−	0.5	1.0	−	0.5	1.0	mA
Off−State Cathode Current (Figure 3) V_{KA} = 36 V, V_{ref} = 0 V	I_{off}	−	20	1000	−	20	1000	nA
Dynamic Impedance (Figure 1, Note 5) $V_{KA} = V_{ref}$, ΔI_K = 1.0 mA to 100 mA, f ≤ 1.0 kHz	$\lvert Z_{KA} \rvert$	−	0.22	0.5	−	0.22	0.5	Ω

Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

2. T_{low} = −40°C for TL431AIP TL431AILP, TL431IP, TL431ILP, TL431BID, TL431BIP, TL431BILP, TL431AIDM, TL431IDM, TL431BIDM;
   = 0°C for TL431ACP, TL431ACLP, TL431CP, TL431CLP, TL431CD, TL431ACD, TL431BCD, TL431BCP, TL431BCLP, TL431CDM, TL431ACDM, TL431BCDM
   T_{high} = +85°C for TL431AIP, TL431AILP, TL431IP, TL431ILP, TL431BID, TL431BIP, TL431BILP, TL431IDM, TL431AIDM, TL431BIDM
   = +70°C for TL431ACP, TL431ACLP, TL431CP, TL431ACD, TL431BCD, TL431BCP, TL431BCLP, TL431CDM, TL431ACDM, TL431BCDM
3. Guaranteed by design.
4. The deviation parameter ΔV_{ref} is defined as the difference between the maximum and minimum values obtained over the full operating ambient temperature range that applies.



The average temperature coefficient of the reference input voltage, αV_{ref} is defined as:

$$V_{ref}\ \frac{ppm}{°C} = \frac{\left(\frac{\Delta V_{ref}}{V_{ref}\ @\ 25°C}\right) \times 10^6}{\Delta T_A} = \frac{\Delta V_{ref} \times 10^6}{\Delta T_A (V_{ref}\ @\ 25°C)}$$

αV_{ref} can be positive or negative depending on whether V_{ref} Min or V_{ref} Max occurs at the lower ambient temperature. (Refer to Figure 6.)

Example : ΔV_{ref} = 8.0 mV and slope is positive,
V_{ref} @ 25°C = 2.495 V, ΔT_A = 70°C

$$\alpha V_{ref} = \frac{0.008 \times 10^6}{70\ (2.495)} = 45.8\ ppm/°C$$

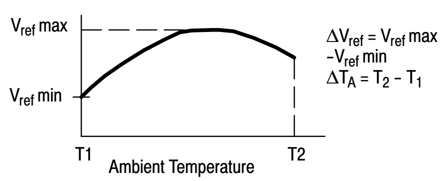
5. The dynamic impedance Z_{KA} is defined as: $|Z_{KA}| = \frac{\Delta V_{KA}}{\Delta I_K}$. When the device is programmed with two external resistors, R1 and R2, (refer to Figure 2) the total dynamic impedance of the circuit is defined as: $|Z_{KA}'| \approx |Z_{KA}| \left(1 + \frac{R1}{R2}\right)$

ELECTRICAL CHARACTERISTICS (T_A = 25°C, unless otherwise noted.)

Characteristic	Symbol	TL431AI / NCV431AI/ SCV431AI			TL431AC			TL431BC / TL431BI / TL431BV / NCV431BV			Unit
		Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
Reference Input Voltage (Figure 1) $V_{KA} = V_{ref}$, I_K = 10 mA T_A = 25°C $T_A = T_{low}$ to T_{high} (Note 6)	V_{ref}	2.47 2.44	2.495 −	2.52 2.55	2.47 2.453	2.495 −	2.52 2.537	2.485 2.475	2.495 2.495	2.505 2.515	V
Reference Input Voltage Deviation Over Temperature Range (Figure 1, Notes 7, 8) $V_{KA} = V_{ref}$, I_K = 10 mA	ΔV_{ref}	−	7.0	30	−	3.0	17	−	3.0	17	mV
Ratio of Change in Reference Input Voltage to Change in Cathode to Anode Voltage I_K = 10 mA (Figure 2), ΔV_{KA} = 10 V to V_{ref} ΔV_{KA} = 36 V to 10 V	$\frac{\Delta V_{ref}}{\Delta V_{KA}}$	− −	−1.4 −1.0	−2.7 −2.0	− −	−1.4 −1.0	−2.7 −2.0	− −	−1.4 −1.0	−2.7 −2.0	mV/V
Reference Input Current (Figure 2) I_K = 10 mA, R1 = 10 k, R2 = ∞ T_A = 25°C $T_A = T_{low}$ to T_{high} (Note 6)	I_{ref}	− −	1.8 −	4.0 6.5	− −	1.8 −	4.0 5.2	− −	1.1 −	2.0 4.0	μA
Reference Input Current Deviation Over Temperature Range (Figure 2, Note 7) I_K = 10 mA, R1 = 10 k, R2 = ∞	ΔI_{ref}	−	0.8	2.5	−	0.4	1.2	−	0.8	2.5	μA
Minimum Cathode Current For Regulation $V_{KA} = V_{ref}$ (Figure 1)	I_{min}	−	0.5	1.0	−	0.5	1.0	−	0.5	1.0	mA
Off−State Cathode Current (Figure 3) V_{KA} = 36 V, V_{ref} = 0 V	I_{off}	−	20	1000	−	20	1000	−	0.23	500	nA
Dynamic Impedance (Figure 1, Note 9) $V_{KA} = V_{ref}$, ΔI_K = 1.0 mA to 100 mA f ≤ 1.0 kHz	$\lvert Z_{KA}\rvert$	−	0.22	0.5	−	0.22	0.5	−	0.14	0.3	Ω

Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

6. T_{low} = −40°C for TL431AIP TL431AILP, TL431IP, TL431ILP, TL431BID, TL431BIP, TL431BILP, TL431BV, TL431AIDM, TL431IDM, TL431BIDM, NCV431AIDMR2G, NCV431AIDR2G, NCV431BVDR2G, SCV431AIDMR2G
   = 0°C for TL431ACP, TL431ACLP, TL431CP, TL431CLP, TL431CD, TL431ACD, TL431BCD, TL431BCP, TL431BCLP, TL431CDM, TL431ACDM, TL431BCDM, SCV431AIDMR2G
   T_{high} = +85°C for TL431AIP, TL431AILP, TL431IP, TL431ILP, TL431BID, TL431BIP, TL431BILP, TL431IDM, TL431AIDM, TL431BIDM
   = +70°C for TL431ACP, TL431ACLP, TL431CP, TL431ACD, TL431BCD, TL431BCP, TL431BCLP, TL431CDM, TL431ACDM, TL431BCDM
   = +125°C TL431BV, NCV431AIDMR2G, NCV431AIDR2G, NCV431BVDMR2G, NCV431BVDR2G, SCV431AIDMR2G
7. Guaranteed by design.
8. The deviation parameter ΔV_{ref} is defined as the difference between the maximum and minimum values obtained over the full operating ambient temperature range that applies.



The average temperature coefficient of the reference input voltage, αV_{ref} is defined as:

$$V_{ref}\ \frac{ppm}{°C} = \frac{\left(\frac{\Delta V_{ref}}{V_{ref}\ @\ 25°C}\right) \times 10^6}{\Delta T_A} = \frac{\Delta V_{ref} \times 10^6}{\Delta T_A (V_{ref}\ @\ 25°C)}$$

αV_{ref} can be positive or negative depending on whether V_{ref} Min or V_{ref} Max occurs at the lower ambient temperature. (Refer to Figure 6.)

Example : ΔV_{ref} = 8.0 mV and slope is positive,
V_{ref} @ 25°C = 2.495 V, ΔT_A = 70°C

$$\alpha V_{ref} = \frac{0.008 \times 10^6}{70\ (2.495)} = 45.8\ ppm/°C$$

9. The dynamic impedance Z_{KA} is defined as $|Z_{KA}| = \frac{\Delta V_{KA}}{\Delta I_K}$ When the device is programmed with two external resistors, R1 and R2, (refer to Figure 2) the total dynamic impedance of the circuit is defined as: $|Z_{KA}'| \approx |Z_{KA}| \left(1 + \frac{R1}{R2}\right)$
10. NCV431AIDMR2G, NCV431AIDR2G, NCV431BVDMR2G, NCV431BVDR2G, SCV431AIDMR2G T_{low} = −40°C, T_{high} = +125°C. NCV prefix is for automotive and other applications requiring unique site and control change requirements.

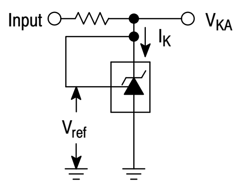


Figure 1. Test Circuit for $V_{KA} = V_{ref}$

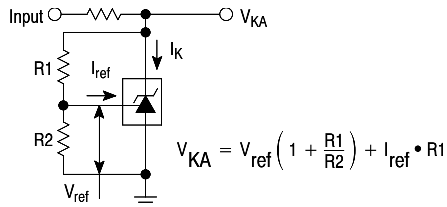


Figure 2. Test Circuit for $V_{KA} > V_{ref}$

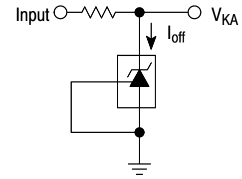


Figure 3. Test Circuit for I_{off}

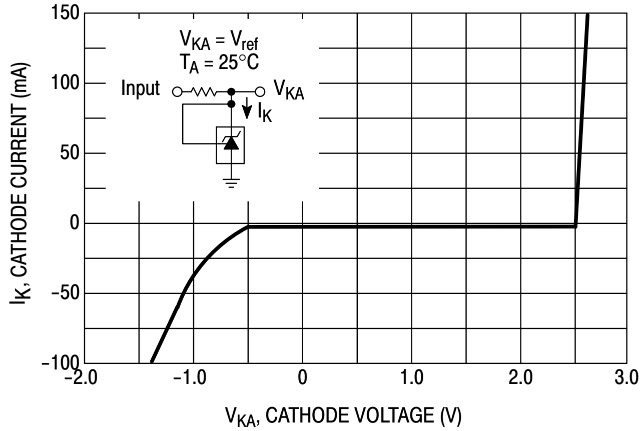


Figure 4. Cathode Current versus Cathode Voltage

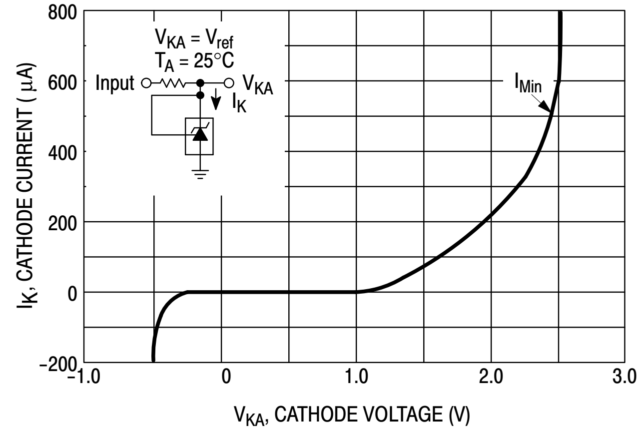


Figure 5. Cathode Current versus Cathode Voltage

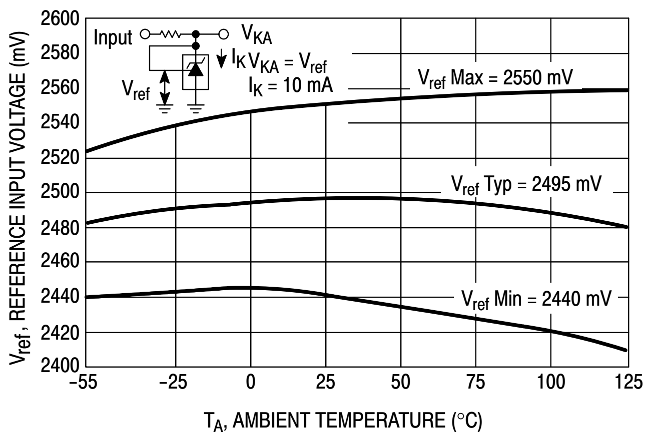


Figure 6. Reference Input Voltage versus Ambient Temperature

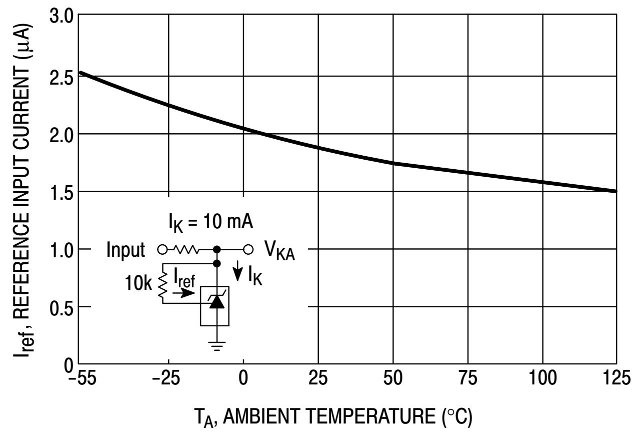


Figure 7. Reference Input Current versus Ambient Temperature

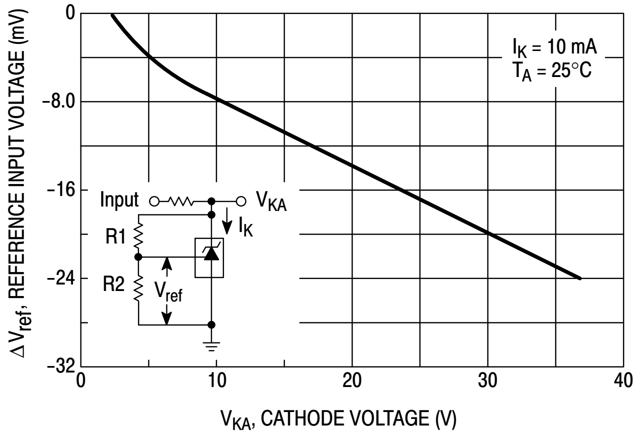


Figure 8. Change in Reference Input Voltage versus Cathode Voltage

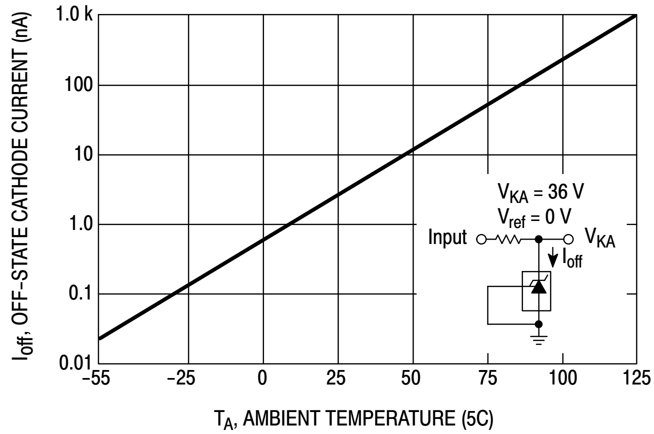


Figure 9. Off−State Cathode Current versus Ambient Temperature

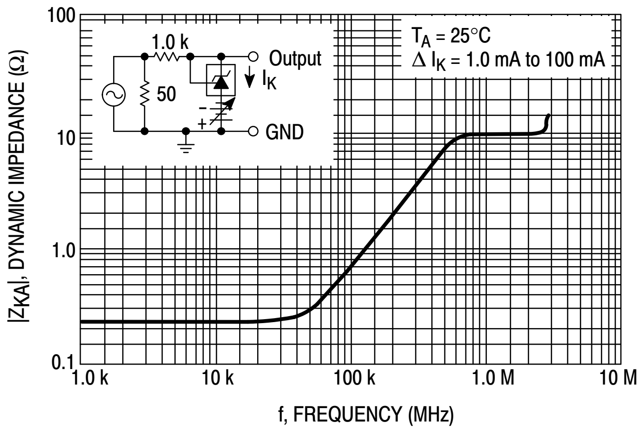


Figure 10. Dynamic Impedance versus Frequency

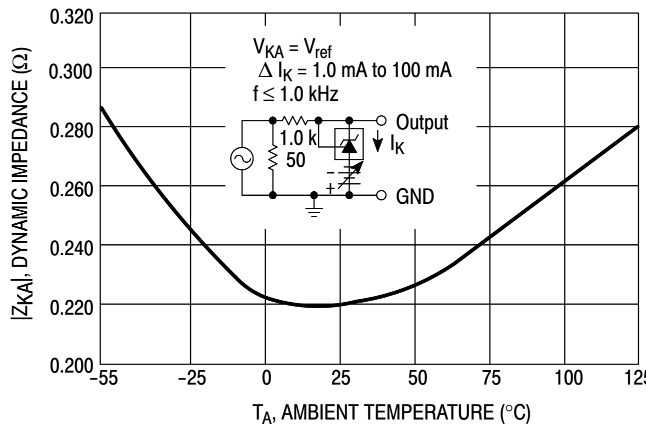


Figure 11. Dynamic Impedance versus Ambient Temperature

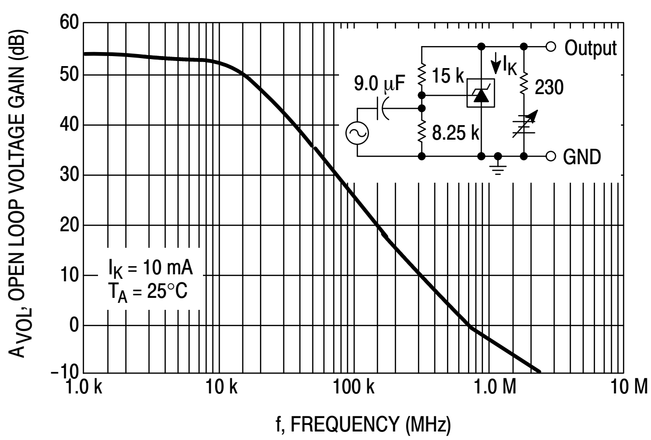


Figure 12. Open−Loop Voltage Gain versus Frequency

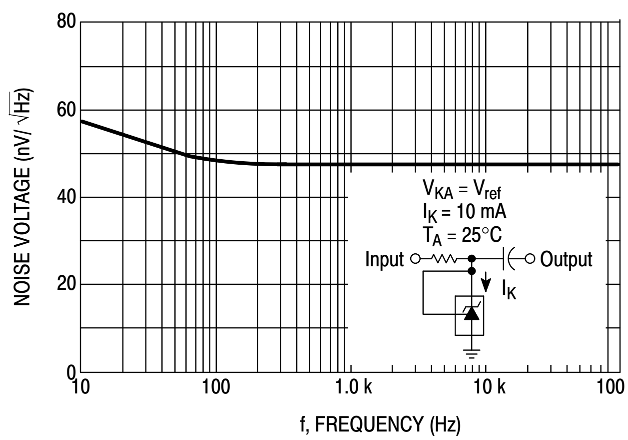


Figure 13. Spectral Noise Density

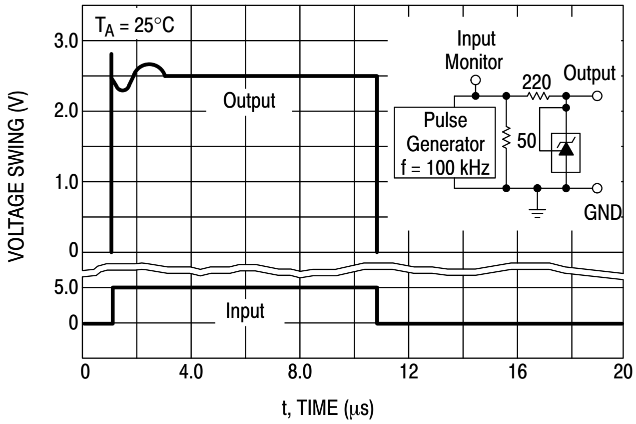


Figure 14. Pulse Response

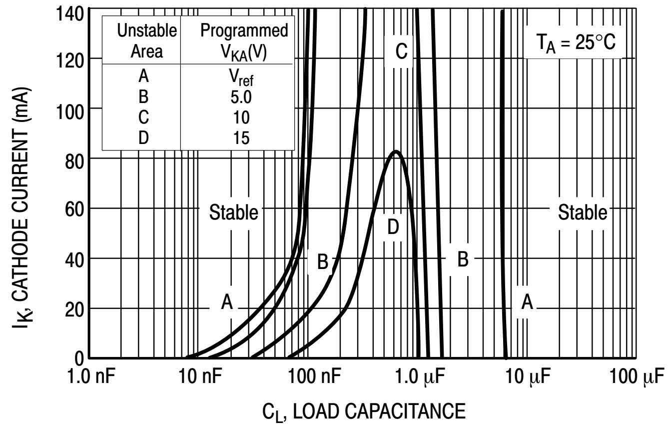


Figure 15. Stability Boundary Conditions

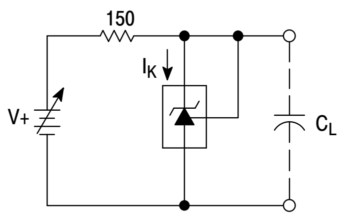


Figure 16. Test Circuit For Curve A of Stability Boundary Conditions

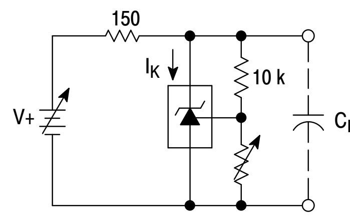
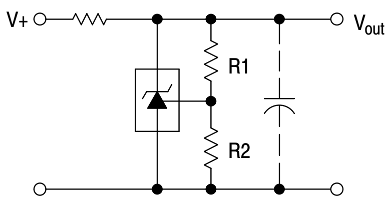


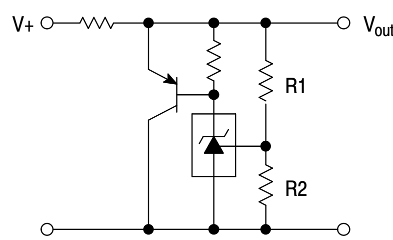
Figure 17. Test Circuit For Curves B, C, And D of Stability Boundary Conditions

TYPICAL APPLICATIONS



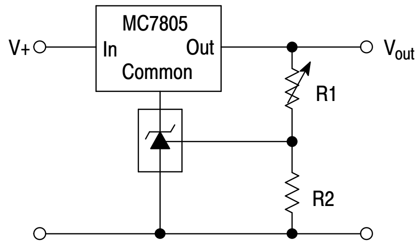
$$V_{out} = \left(1 + \frac{R1}{R2}\right) V_{ref}$$

Figure 18. Shunt Regulator



$$V_{out} = \left(1 + \frac{R1}{R2}\right) V_{ref}$$

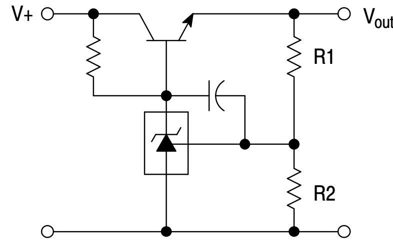
Figure 19. High Current Shunt Regulator



$$V_{out} = \left(1 + \frac{R1}{R2}\right) V_{ref}$$

$$V_{out(min)} = V_{ref} + 5.0\ V$$

Figure 20. Output Control for a Three−Terminal Fixed Regulator

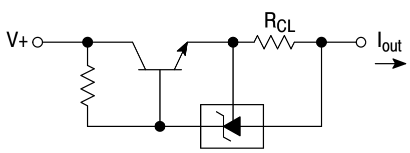


$$V_{out} = \left(1 + \frac{R1}{R2}\right) V_{ref}$$

$$V_{in(min)} = V_{out} + V_{be}$$

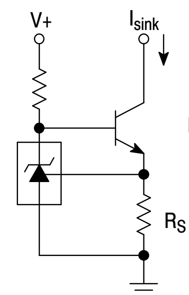
$$V_{out(min)} = V_{ref}$$

Figure 21. Series Pass Regulator



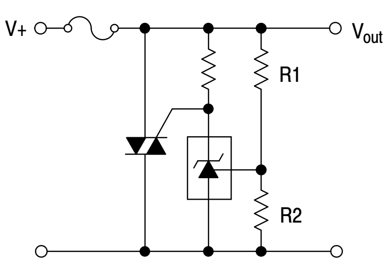
$$I_{out} = \frac{V_{ref}}{R_{CL}}$$

Figure 22. Constant Current Source



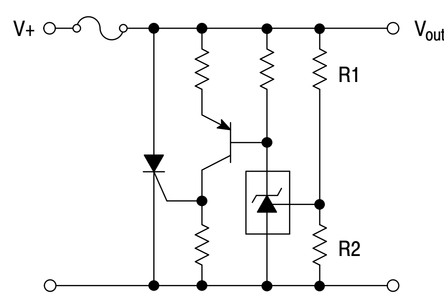
$$I_{Sink} = \frac{V_{ref}}{R_S}$$

Figure 23. Constant Current Sink



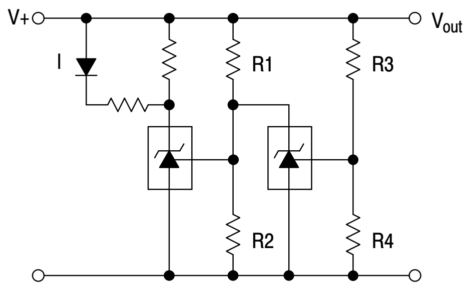
$$V_{out(trip)} = \left(1 + \frac{R1}{R2}\right) V_{ref}$$

Figure 24. TRIAC Crowbar



$$V_{out(trip)} = \left(1 + \frac{R1}{R2}\right) V_{ref}$$

Figure 25. SRC Crowbar

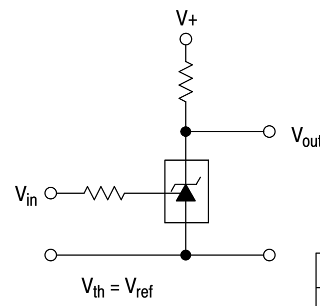


L.E.D. indicator is 'on' when V+ is between the upper and lower limits.

$$\text{Lower Limit} = \left(1 + \frac{R1}{R2}\right) V_{ref}$$

$$\text{Upper Limit} = \left(1 + \frac{R3}{R4}\right) V_{ref}$$

Figure 26. Voltage Monitor



V_{in}	V_{out}
< V_{ref}	V+
> V_{ref}	≈ 2.0 V

Figure 27. Single−Supply Comparator with Temperature−Compensated Threshold

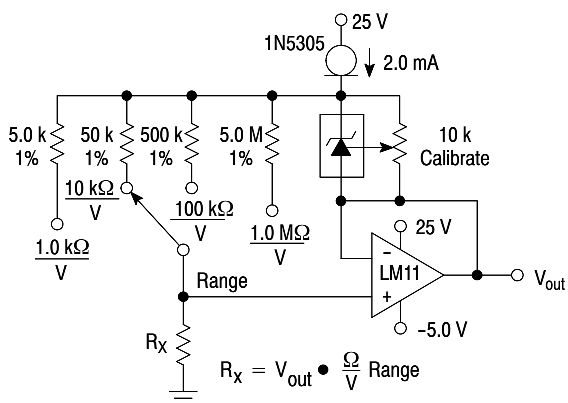


Figure 28. Linear Ohmmeter

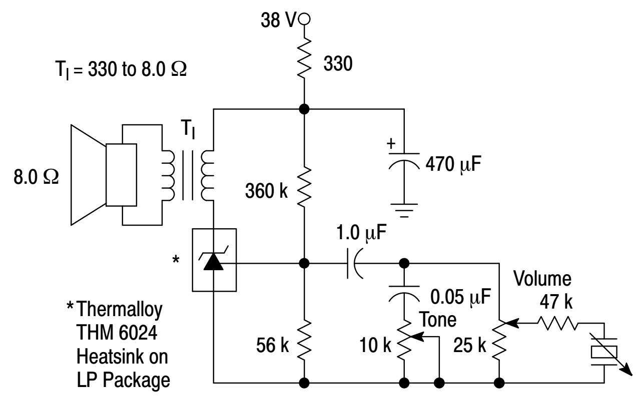


Figure 29. Simple 400 mW Phono Amplifier

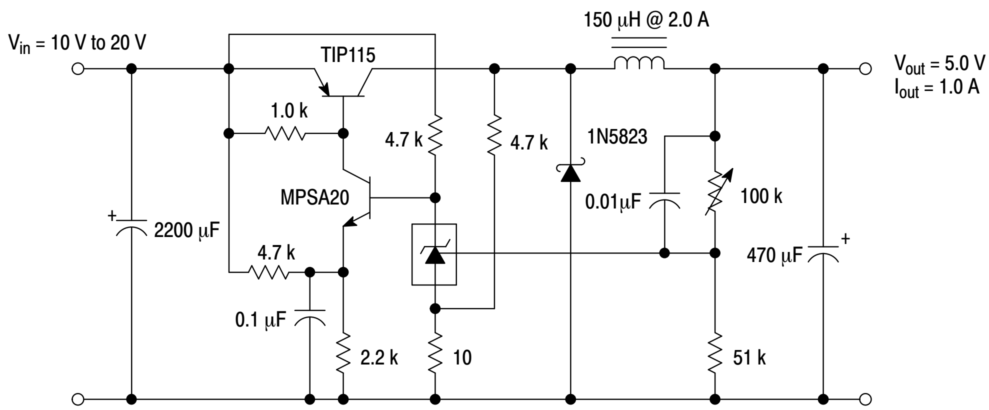


Figure 30. High Efficiency Step−Down Switching Converter

Test	Conditions	Results
Line Regulation	V_{in} = 10 V to 20 V, I_o = 1.0 A	53 mV (1.1%)
Load Regulation	V_{in} = 15 V, I_o = 0 A to 1.0 A	25 mV (0.5%)
Output Ripple	V_{in} = 10 V, I_o = 1.0 A	50 mVpp P.A.R.D.
Output Ripple	V_{in} = 20 V, I_o = 1.0 A	100 mVpp P.A.R.D.
Efficiency	V_{in} = 15 V, I_o = 1.0 A	82%

APPLICATIONS INFORMATION

The TL431 is a programmable precision reference which is used in a variety of ways. It serves as a reference voltage in circuits where a non−standard reference voltage is needed. Other uses include feedback control for driving an optocoupler in power supplies, voltage monitor, constant current source, constant current sink and series pass regulator. In each of these applications, it is critical to maintain stability of the device at various operating currents and load capacitances. In some cases the circuit designer can estimate the stabilization capacitance from the stability boundary conditions curve provided in Figure 15. However, these typical curves only provide stability information at specific cathode voltages and at a specific load condition. Additional information is needed to determine the capacitance needed to optimize phase margin or allow for process variation.

A simplified model of the TL431 is shown in Figure 31. When tested for stability boundaries, the load resistance is 150 Ω. The model reference input consists of an input transistor and a dc emitter resistance connected to the device anode. A dependent current source, Gm, develops a current whose amplitude is determined by the difference between the 1.78 V internal reference voltage source and the input transistor emitter voltage. A portion of Gm flows through compensation capacitance, C_{P2}. The voltage across C_{P2} drives the output dependent current source, Go, which is connected across the device cathode and anode.

Model component values are:
V_{ref} = 1.78 V
Gm = 0.3 + 2.7 exp ($-I_C$/26 mA)
where I_C is the device cathode current and Gm is in mhos

Go = 1.25 (V_{cp}2) μmhos.

Resistor and capacitor typical values are shown on the model. Process tolerances are ±20% for resistors, ±10% for capacitors, and ±40% for transconductances.

An examination of the device model reveals the location of circuit poles and zeroes:

$$P1 = \frac{1}{2\pi R_{GM} C_{P1}} = \frac{1}{2\pi * 1.0\ M * 20\ pF} = 7.96\ kHz$$

$$P2 = \frac{1}{2\pi R_{P2} C_{P2}} = \frac{1}{2\pi * 10\ M * 0.265\ pF} = 60\ kHz$$

$$Z1 = \frac{1}{2\pi R_{Z1} C_{P1}} = \frac{1}{2\pi * 15.9\ k * 20\ pF} = 500\ kHz$$

In addition, there is an external circuit pole defined by the load:

$$P_L = \frac{1}{2\pi R_L C_L}$$

Also, the transfer dc voltage gain of the TL431 is:

$$G = G_M R_{GM} G_o R_L$$

Example 1:

$I_C = 10\ mA, R_L = 230\ \Omega, C_L = 0.$ Define the transfer gain.

The DC gain is:

$$G = G_M R_{GM} G_o R_L = (2.138)(1.0\ M)(1.25\ \mu)(230) = 615 = 56\ dB$$

$$\text{Loop gain} = G \frac{8.25\ k}{8.25\ k + 15\ k} = 218 = 47\ dB$$

The resulting transfer function Bode plot is shown in Figure 32. The asymptotic plot may be expressed as the following equation:

$$Av = 615 \frac{\left(1 + \frac{jf}{500\ kHz}\right)}{\left(1 + \frac{jf}{8.0\ kHz}\right)\left(1 + \frac{jf}{60\ kHz}\right)}$$

The Bode plot shows a unity gain crossover frequency of approximately 600 kHz. The phase margin, calculated from the equation, would be 55.9 degrees. This model matches the Open−Loop Bode Plot of Figure 12. The total loop would have a unity gain frequency of about 300 kHz with a phase margin of about 44 degrees.

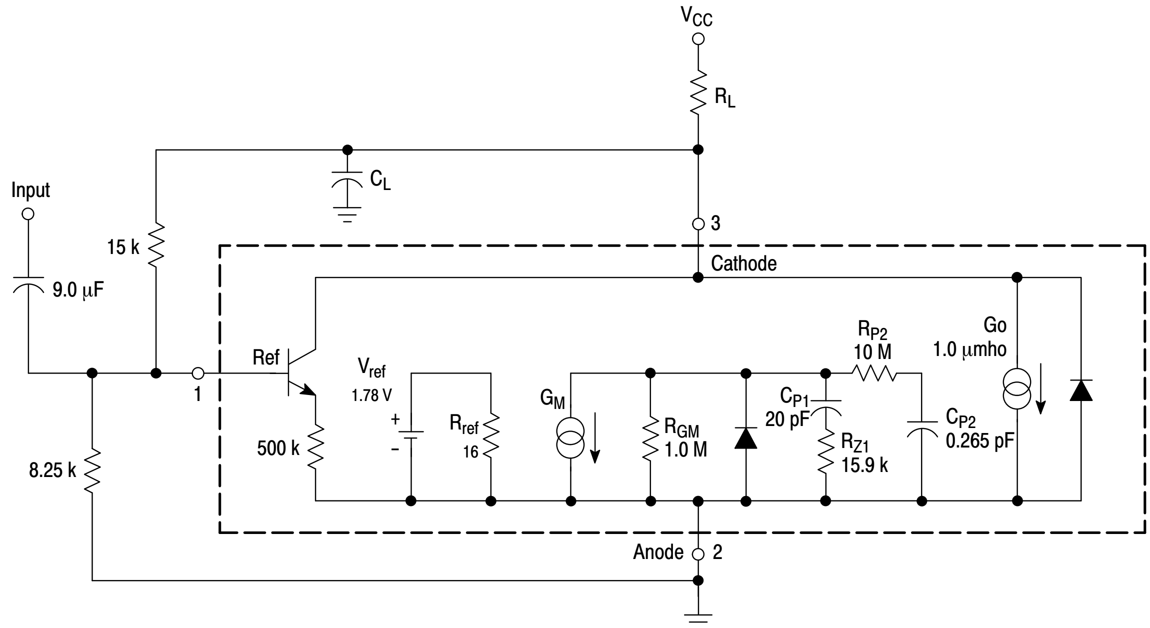


Figure 31. Simplified TL431 Device Model

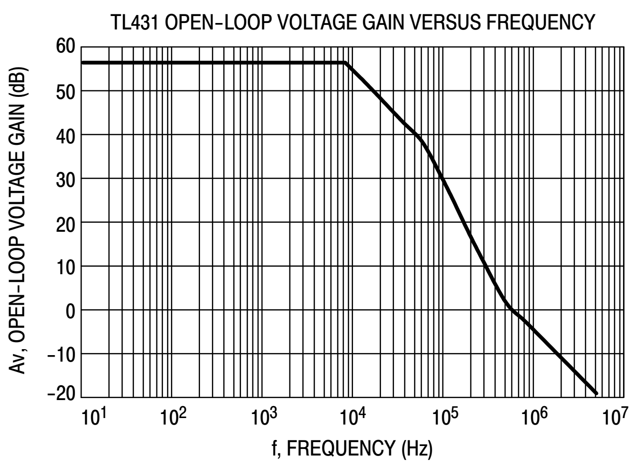


Figure 32. Example 1 Circuit Open Loop Gain Plot

Example 2.

I_C = 7.5 mA, R_L = 2.2 kΩ, C_L = 0.01 µF. Cathode tied to reference input pin. An examination of the data sheet stability boundary curve (Figure 15) shows that this value of load capacitance and cathode current is on the boundary. Define the transfer gain.

The DC gain is:

$$G = G_M R_{GM} G_o R_L =$$

$$(2.323)(1.0\ M)(1.25\ \mu)(2200) = 6389 = 76\ dB$$

The resulting open loop Bode plot is shown in Figure 33. The asymptotic plot may be expressed as the following equation:

$$Av = 615 \frac{\left(1 + \frac{jf}{500\ kHz}\right)}{\left(1 + \frac{jf}{8.0\ kHz}\right)\left(1 + \frac{jf}{60\ kHz}\right)\left(1 + \frac{jf}{7.2\ kHz}\right)}$$

Note that the transfer function now has an extra pole formed by the load capacitance and load resistance.

Note that the crossover frequency in this case is about 250 kHz, having a phase margin of about −46 degrees. Therefore, instability of this circuit is likely.

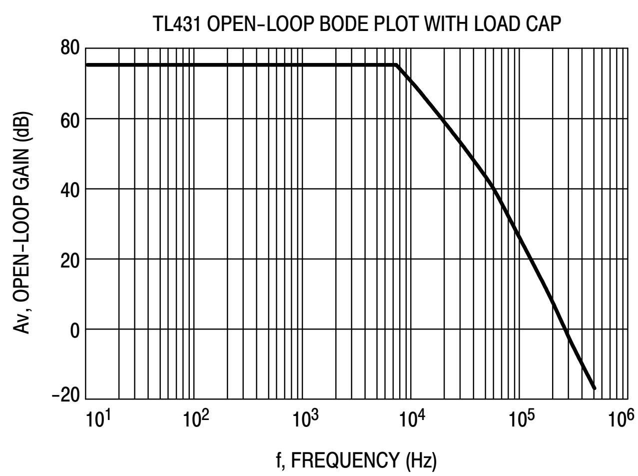


Figure 33. Example 2 Circuit Open Loop Gain Plot

With three poles, this system is unstable. The only hope for stabilizing this circuit is to add a zero. However, that can only be done by adding a series resistance to the output capacitance, which will reduce its effectiveness as a noise filter. Therefore, practically, in reference voltage applications, the best solution appears to be to use a smaller value of capacitance in low noise applications or a very large value to provide noise filtering and a dominant pole rolloff of the system.

ORDERING INFORMATION

Device	Marking Code	Operating Temperature Range	Package Code	Shipping Information†	Tolerance
TL431ACDG	AC	0°C to 70°C	SOIC−8 (Pb−Free)	98 Units / Rail	1.0%
TL431BCDG	BC				0.4%
TL431CDG	C				2.2%
TL431ACDR2G	AC			2500 / Tape & Reel	1.0%
TL431BCDR2G	BC				0.4%
TL431CDR2G	C				2.2%
TL431ACDMR2G	TAC		Micro8 (Pb−Free)	4000 / Tape & Reel	1.0%
TL431BCDMR2G	TBC				0.4%
TL431CDMR2G	T−C				2.2%
TL431ACPG	ACP		PDIP−8 (Pb−Free)	50 Units / Rail	1.0%
TL431BCPG	BCP				0.4%
TL431CPG	CP				2.2%
TL431ACLPG	ACLP		TO−92 (Pb−Free)	2000 Units / Bag	1.0%
TL431BCLPG	BCLP				0.4%
TL431CLPG	CLP				2.2%
TL431ACLPRAG	ACLP			2000 / Tape & Reel	1.0%
TL431BCLPRAG	BCLP				0.4%
TL431CLPRAG	CLP				2.2%
TL431ACLPREG	ACLP				1.0%
TL431BCLPREG	BCLP				0.4%
TL431CLPREG	CLP				2.2%
TL431ACLPRPG	ACLP			2000 / Tape & Ammo Box	1.0%
TL431BCLPRMG	BCLP			2000 / Fan−Fold	0.4%
TL431CLPRMG	CLP				2.2%
TL431CLPRPG	CLP				
TL431AIDG	AI	−40°C to 85°C	SOIC−8 (Pb−Free)	98 Units / Rail	1.0%
TL431BIDG	BI				0.4%
TL431IDG	I				2.2%
TL431AIDR2G	AI			2500s / Tape & Reel	1.0%
TL431BIDR2G	BI				0.4%
TL431IDR2G	I				2.2%
TL431AIDMR2G	TAI		Micro8 (Pb−Free)	4000 / Tape & Reel	1.0%
TL431BIDMR2G	TBI				0.4%
TL431IDMR2G	T−I				2.2%
TL431AIPG	AIP		PDIP−8 (Pb−Free)	50 Units / Rail	1.0%
TL431BIPG	BIP				0.4%
TL431IPG	IP				2.2%
TL431AILPG	AILP		TO−92 (Pb−Free)	2000 Units / Bag	1.0%
TL431BILPG	BILP				0.4%
TL431ILPG	ILP				2.2%
TL431AILPRAG	AILP			2000 / Tape & Reel	1.0%
TL431BILPRAG	BILP				0.4%
SC431ILPRAG	ILP				2.2%
TL431ILPRAG	ILP				
TL431AILPRMG	AILP			2000 / Tape & Ammo Box	1.0%
TL431AILPRPG					
TL431ILPRPG	ILP				2.2%

†For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.
*NCV/SCV Prefixes for Automotive and Other Applications Requiring Unique Site and Control Change Requirements; AEC−Q100 Qualified and PPAP Capable.

ORDERING INFORMATION

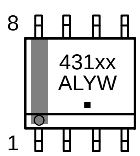
Device	Marking Code	Operating Temperature Range	Package Code	Shipping Information†	Tolerance
TL431BVDG	BV	−40°C to 125°C	SOIC−8 (Pb−Free)	98 Units / Rail	0.4%
TL431BVDR2G				2500 / Tape & Reel	
TL431BVDMR2G	TBV		Micro8 (Pb−Free)	4000 / Tape & Reel	
TL431BVLPG	BVLP		TO−92 (Pb−Free)	2000 Units / Bag	
TL431BVLPRAG				2000 / Tape & Reel	
TL431BVPG	BVP		PDIP−8 (Pb−Free)	50 Units / Rail	0.4%
NCV431AIDMR2G*	RAN		Micro8 (Pb−Free)	4000 / Tape & Reel	1%
SCV431AIDMR2G*	RAP				
NCV431AIDR2G*	AV		SOIC−8 (Pb−Free)	2500 / Tape & Reel	
NCV431BVDMR2G*	NVB		Micro8 (Pb−Free)	4000 / Tape & Reel	0.4%
NCV431BVDR2G*	BV		SOIC−8 (Pb−Free)	2500 / Tape & Reel	

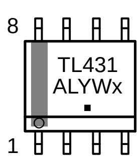
†For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.

*NCV/SCV Prefixes for Automotive and Other Applications Requiring Unique Site and Control Change Requirements; AEC−Q100 Qualified and PPAP Capable.

MARKING DIAGRAMS

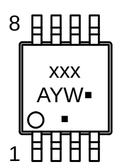
SOIC−8
D SUFFIX
CASE 751



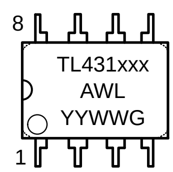


(Exception for the TL431CD and TL431ID only)

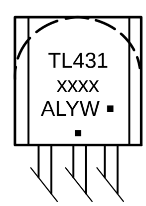
Micro8
CASE 846A



PDIP−8
CASE 626



TO−92 (TO−226)
CASE 29

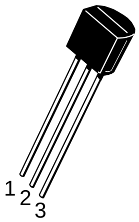


xxxx	= See Specific Marking Code
A	= Assembly Location
WL, L	= Wafer Lot
YY, Y	= Year
WW, W	= Work Week
▪ or G	= Pb−Free Package

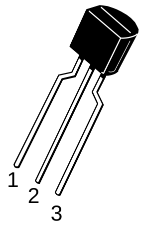
(Note: Microdot may be in either location)

PACKAGE DIMENSIONS

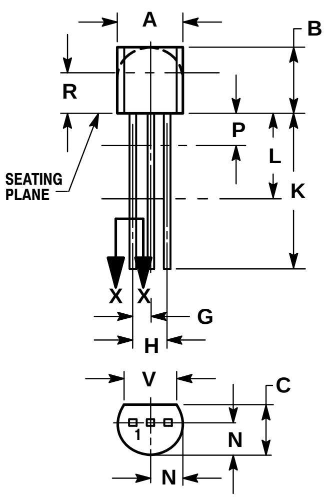
TO−92 (TO−226)
CASE 29−11
ISSUE AM



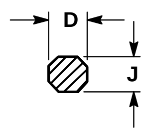
STRAIGHT LEAD
BULK PACK



BENT LEAD
TAPE & REEL
AMMO PACK



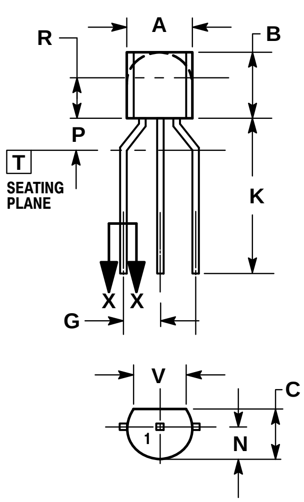
STRAIGHT LEAD
BULK PACK



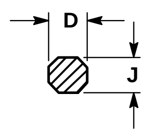
SECTION X−X

NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. CONTOUR OF PACKAGE BEYOND DIMENSION R IS UNCONTROLLED.
4. LEAD DIMENSION IS UNCONTROLLED IN P AND BEYOND DIMENSION K MINIMUM.

	INCHES		MILLIMETERS	
DIM	MIN	MAX	MIN	MAX
A	0.175	0.205	4.45	5.20
B	0.170	0.210	4.32	5.33
C	0.125	0.165	3.18	4.19
D	0.016	0.021	0.407	0.533
G	0.045	0.055	1.15	1.39
H	0.095	0.105	2.42	2.66
J	0.015	0.020	0.39	0.50
K	0.500	---	12.70	---
L	0.250	---	6.35	---
N	0.080	0.105	2.04	2.66
P	---	0.100	---	2.54
R	0.115	---	2.93	---
V	0.135	---	3.43	---



BENT LEAD
TAPE & REEL
AMMO PACK



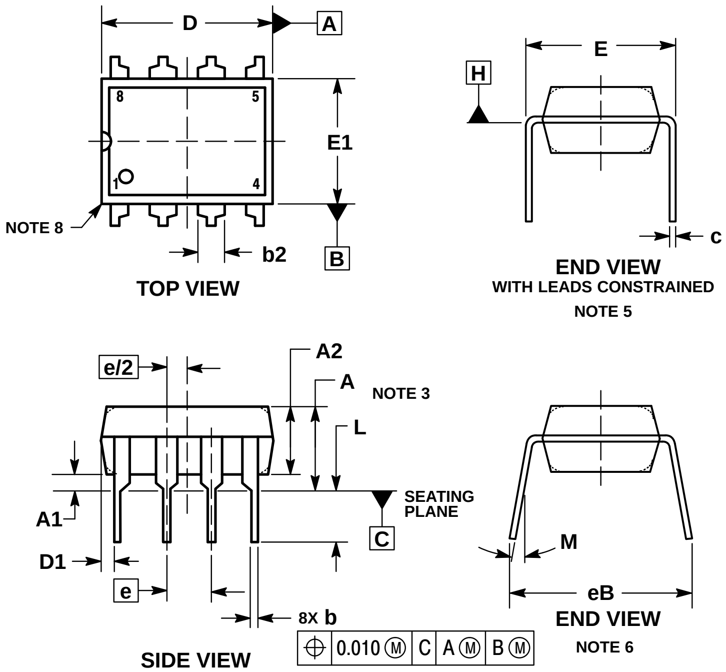
SECTION X−X

NOTES:
1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: MILLIMETERS.
3. CONTOUR OF PACKAGE BEYOND DIMENSION R IS UNCONTROLLED.
4. LEAD DIMENSION IS UNCONTROLLED IN P AND BEYOND DIMENSION K MINIMUM.

	MILLIMETERS	
DIM	MIN	MAX
A	4.45	5.20
B	4.32	5.33
C	3.18	4.19
D	0.40	0.54
G	2.40	2.80
J	0.39	0.50
K	12.70	---
N	2.04	2.66
P	1.50	4.00
R	2.93	---
V	3.43	---

PACKAGE DIMENSIONS

PDIP−8
CASE 626−05
ISSUE N

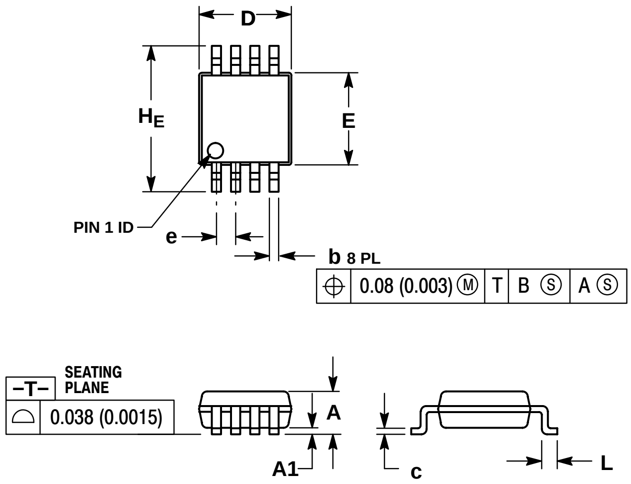


NOTES:
1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: INCHES.
3. DIMENSIONS A, A1 AND L ARE MEASURED WITH THE PACKAGE SEATED IN JEDEC SEATING PLANE GAUGE GS−3.
4. DIMENSIONS D, D1 AND E1 DO NOT INCLUDE MOLD FLASH OR PROTRUSIONS. MOLD FLASH OR PROTRUSIONS ARE NOT TO EXCEED 0.10 INCH.
5. DIMENSION E IS MEASURED AT A POINT 0.015 BELOW DATUM PLANE H WITH THE LEADS CONSTRAINED PERPENDICULAR TO DATUM C.
6. DIMENSION E3 IS MEASURED AT THE LEAD TIPS WITH THE LEADS UNCONSTRAINED.
7. DATUM PLANE H IS COINCIDENT WITH THE BOTTOM OF THE LEADS, WHERE THE LEADS EXIT THE BODY.
8. PACKAGE CONTOUR IS OPTIONAL (ROUNDED OR SQUARE CORNERS).

	INCHES		MILLIMETERS	
DIM	MIN	MAX	MIN	MAX
A	----	0.210	---	5.33
A1	0.015	----	0.38	---
A2	0.115	0.195	2.92	4.95
b	0.014	0.022	0.35	0.56
b2	0.060 TYP		1.52 TYP	
C	0.008	0.014	0.20	0.36
D	0.355	0.400	9.02	10.16
D1	0.005	----	0.13	---
E	0.300	0.325	7.62	8.26
E1	0.240	0.280	6.10	7.11
e	0.100 BSC		2.54 BSC	
eB	----	0.430	---	10.92
L	0.115	0.150	2.92	3.81
M	----	10°	---	10°

PACKAGE DIMENSIONS

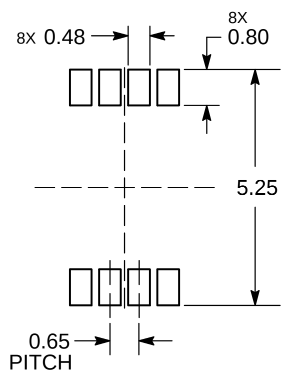
Micro8™
CASE 846A−02
ISSUE J



NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER.
3. DIMENSION A DOES NOT INCLUDE MOLD FLASH, PROTRUSIONS OR GATE BURRS. MOLD FLASH, PROTRUSIONS OR GATE BURRS SHALL NOT EXCEED 0.15 (0.006) PER SIDE.
4. DIMENSION B DOES NOT INCLUDE INTERLEAD FLASH OR PROTRUSION. INTERLEAD FLASH OR PROTRUSION SHALL NOT EXCEED 0.25 (0.010) PER SIDE.
5. 846A−01 OBSOLETE, NEW STANDARD 846A−02.

	MILLIMETERS			INCHES		
DIM	MIN	NOM	MAX	MIN	NOM	MAX
A	−−	−−	1.10	−−	−−	0.043
A1	0.05	0.08	0.15	0.002	0.003	0.006
b	0.25	0.33	0.40	0.010	0.013	0.016
c	0.13	0.18	0.23	0.005	0.007	0.009
D	2.90	3.00	3.10	0.114	0.118	0.122
E	2.90	3.00	3.10	0.114	0.118	0.122
e	0.65 BSC			0.026 BSC		
L	0.40	0.55	0.70	0.016	0.021	0.028
H_E	4.75	4.90	5.05	0.187	0.193	0.199

RECOMMENDED SOLDERING FOOTPRINT*

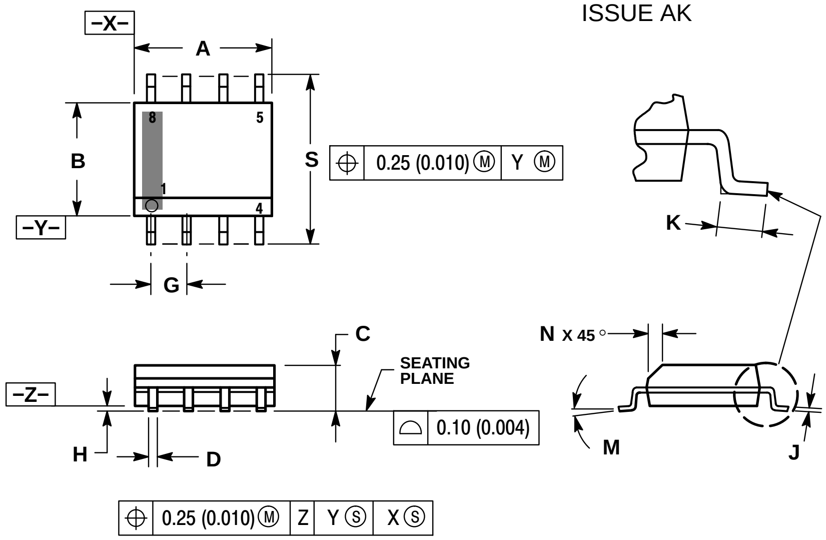


DIMENSION: MILLIMETERS

*For additional information on our Pb−Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

PACKAGE DIMENSIONS

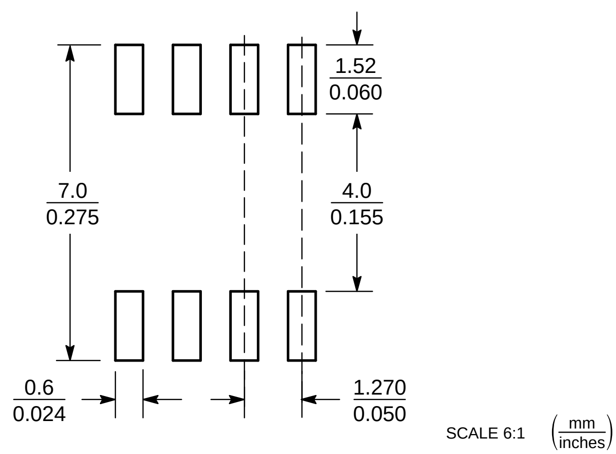
SOIC−8
D SUFFIX
CASE 751−07
ISSUE AK



NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER.
3. DIMENSION A AND B DO NOT INCLUDE MOLD PROTRUSION.
4. MAXIMUM MOLD PROTRUSION 0.15 (0.006) PER SIDE.
5. DIMENSION D DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.127 (0.005) TOTAL IN EXCESS OF THE D DIMENSION AT MAXIMUM MATERIAL CONDITION.
6. 751−01 THRU 751−06 ARE OBSOLETE. NEW STANDARD IS 751−07.

	MILLIMETERS		INCHES	
DIM	MIN	MAX	MIN	MAX
A	4.80	5.00	0.189	0.197
B	3.80	4.00	0.150	0.157
C	1.35	1.75	0.053	0.069
D	0.33	0.51	0.013	0.020
G	1.27 BSC		0.050 BSC	
H	0.10	0.25	0.004	0.010
J	0.19	0.25	0.007	0.010
K	0.40	1.27	0.016	0.050
M	0 °	8 °	0 °	8 °
N	0.25	0.50	0.010	0.020
S	5.80	6.20	0.228	0.244

SOLDERING FOOTPRINT*



*For additional information on our Pb−Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

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MPSA42, MPSA43

High Voltage Transistors

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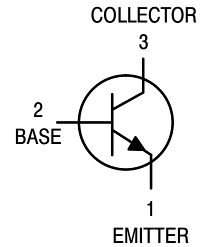
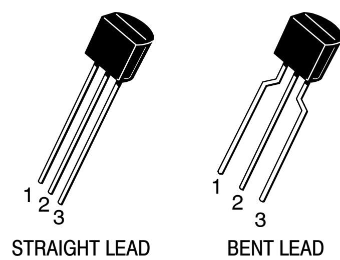


Features

- These are Pb−Free Devices*



TO−92
(TO−226AA)
CASE 29−11

MAXIMUM RATINGS

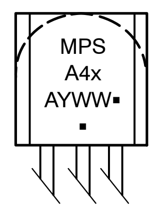
Rating	Symbol	Value	Unit
Collector−Emitter Voltage MPSA43 MPSA42	V_{CEO}	 200 300	Vdc
Collector−Base Voltage MPSA43 MPSA42	V_{CBO}	 200 300	Vdc
Emitter−Base Voltage	V_{EBO}	6.0	Vdc
Collector Current − Continuous	I_C	500	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	 625 5.0	 mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	 1.5 12	 W mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction−to−Ambient	$R_{\theta JA}$	200	°C/W
Thermal Resistance, Junction−to−Case	$R_{\theta JC}$	83.3	°C/W

Stresses exceeding Maximum Ratings may damage the device. Maximum Ratings are stress ratings only. Functional operation above the Recommended Operating Conditions is not implied. Extended exposure to stresses above the Recommended Operating Conditions may affect device reliability.

MARKING DIAGRAM



x = 2 or 3
A = Assembly Location
Y = Year
WW = Work Week
▪ = Pb−Free Package
(Note: Microdot may be in either location)

ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 3 of this data sheet.

*For additional information on our Pb−Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector–Emitter Breakdown Voltage (Note 1) (I_C = 1.0 mAdc, I_B = 0)	MPSA42 MPSA43	$V_{(BR)CEO}$	300 200	– –	Vdc
Collector–Base Breakdown Voltage (I_C = 100 μAdc, I_E = 0)	MPSA42 MPSA43	$V_{(BR)CBO}$	300 200	– –	Vdc
Emitter–Base Breakdown Voltage (I_E = 100 μAdc, I_C = 0)		$V_{(BR)EBO}$	6.0	–	Vdc
Collector Cutoff Current (V_{CB} = 200 Vdc, I_E = 0) (V_{CB} = 160 Vdc, I_E = 0)	MPSA42 MPSA43	I_{CBO}	– –	0.1 0.1	μAdc
Emitter Cutoff Current (V_{EB} = 6.0 Vdc, I_C = 0) (V_{EB} = 4.0 Vdc, I_C = 0)	MPSA42 MPSA43	I_{EBO}	– –	0.1 0.1	μAdc
ON CHARACTERISTICS (Note 1)					
DC Current Gain (I_C = 1.0 mAdc, V_{CE} = 10 Vdc) (I_C = 10 mAdc, V_{CE} = 10 Vdc) (I_C = 30 mAdc, V_{CE} = 10 Vdc)		h_{FE}	25 40 40	– – –	–
Collector–Emitter Saturation Voltage (I_C = 20 mAdc, I_B = 2.0 mAdc)	MPSA42 MPSA43	$V_{CE(sat)}$	– –	0.5 0.4	Vdc
Base–Emitter Saturation Voltage (I_C = 20 mAdc, I_B = 2.0 mAdc)		$V_{BE(sat)}$	–	0.9	Vdc
SMALL–SIGNAL CHARACTERISTICS					
Current–Gain – Bandwidth Product (I_C = 10 mAdc, V_{CE} = 20 Vdc, f = 100 MHz)		f_T	50	–	MHz
Collector–Base Capacitance (V_{CB} = 20 Vdc, I_E = 0, f = 1.0 MHz)	MPSA42 MPSA43	C_{cb}	– –	3.0 4.0	pF

1. Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2%.

ORDERING INFORMATION

Device	Package	Shipping†
MPSA42G	TO−92 (Pb−Free)	5000 Units / Box
MPSA42RL1G	TO−92 (Pb−Free)	2000 / Tape & Reel
MPSA42RLRAG	TO−92 (Pb−Free)	2000 / Tape & Reel
MPSA42RLRMG	TO−92 (Pb−Free)	2000 / Ammo Pack
MPSA42RLRPG	TO−92 (Pb−Free)	2000 / Ammo Pack
MPSA42ZL1G	TO−92 (Pb−Free)	2000 / Ammo Pack

†For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.

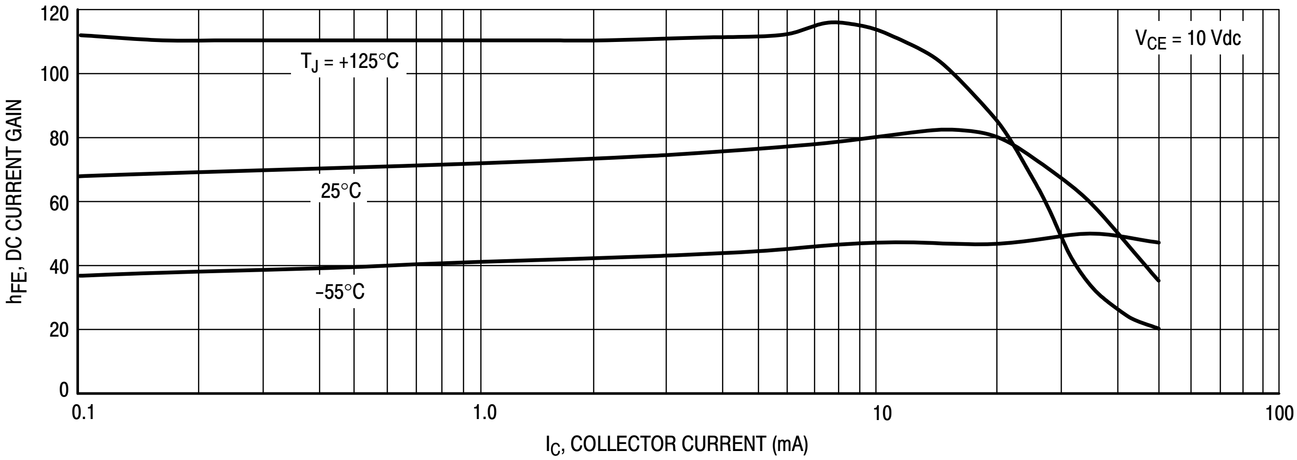


Figure 1. DC Current Gain

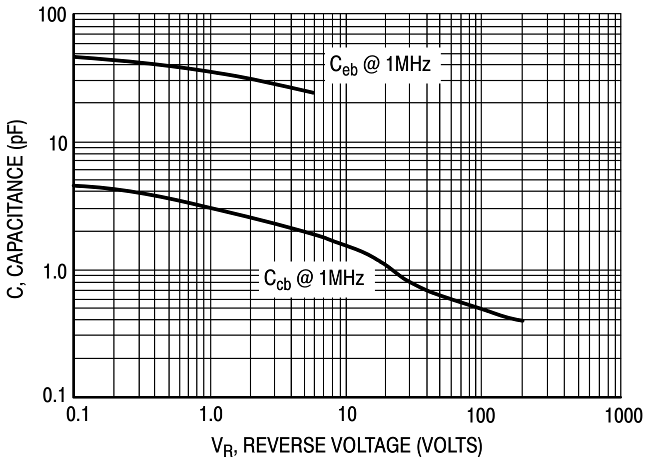


Figure 2. Capacitance

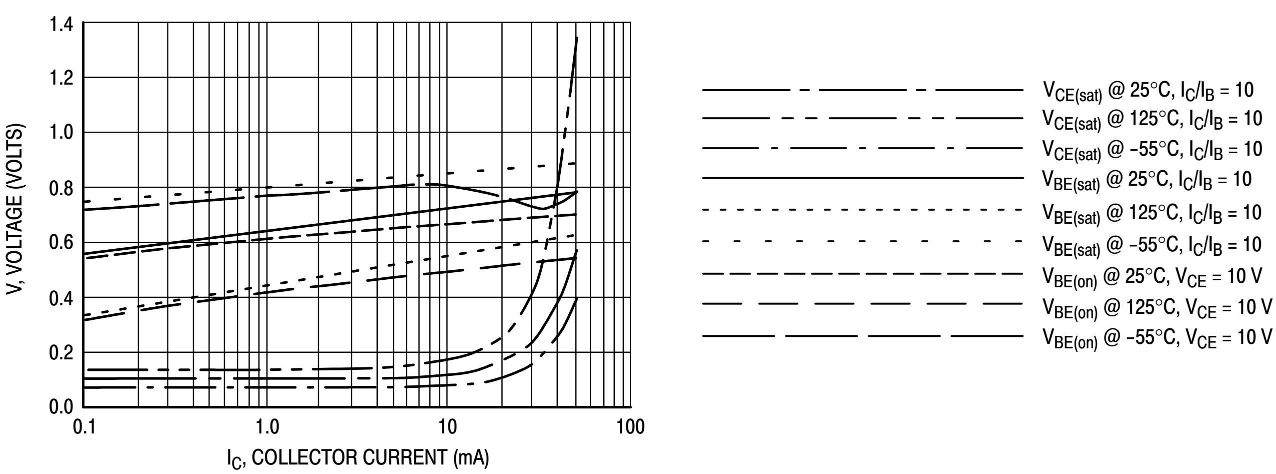


Figure 3. "ON" Voltages

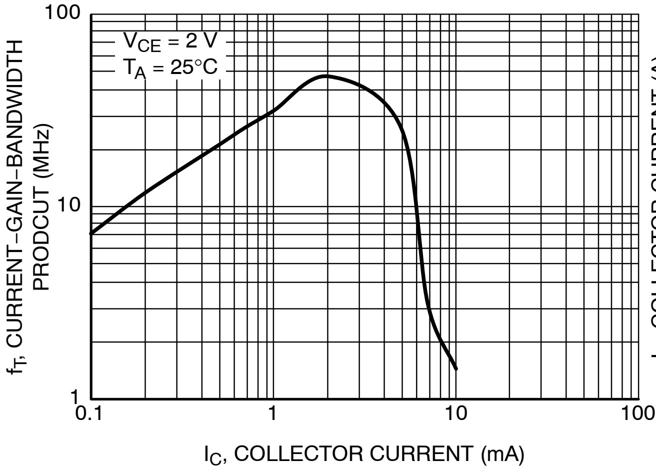


Figure 4. Current−Gain−Bandwidth Product

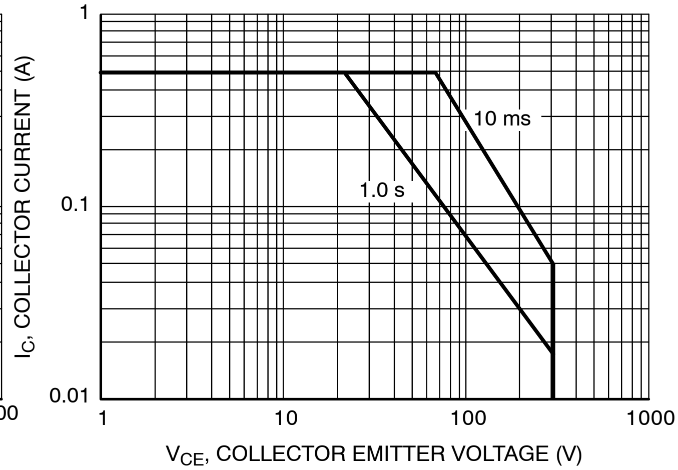
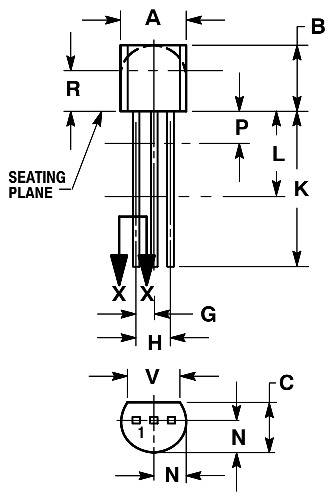


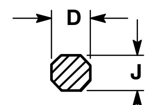
Figure 5. Safe Operating Area

PACKAGE DIMENSIONS

TO−92 (TO−226)
CASE 29−11
ISSUE AN

STRAIGHT LEAD





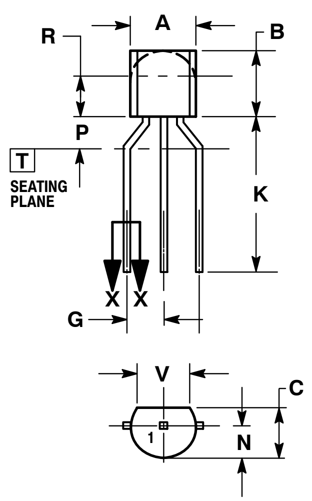
SECTION X−X

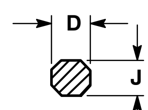
NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. CONTOUR OF PACKAGE BEYOND DIMENSION R IS UNCONTROLLED.
4. LEAD DIMENSION IS UNCONTROLLED IN P AND BEYOND DIMENSION K MINIMUM.

	INCHES		MILLIMETERS	
DIM	MIN	MAX	MIN	MAX
A	0.175	0.205	4.45	5.20
B	0.170	0.210	4.32	5.33
C	0.125	0.165	3.18	4.19
D	0.016	0.021	0.407	0.533
G	0.045	0.055	1.15	1.39
H	0.095	0.105	2.42	2.66
J	0.015	0.020	0.39	0.50
K	0.500	---	12.70	---
L	0.250	---	6.35	---
N	0.080	0.105	2.04	2.66
P	---	0.100	---	2.54
R	0.115	---	2.93	---
V	0.135	---	3.43	---

STYLE 1:
PIN 1. EMITTER
2. BASE
3. COLLECTOR

BENT LEAD





SECTION X−X

NOTES:
1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: MILLIMETERS.
3. CONTOUR OF PACKAGE BEYOND DIMENSION R IS UNCONTROLLED.
4. LEAD DIMENSION IS UNCONTROLLED IN P AND BEYOND DIMENSION K MINIMUM.

	MILLIMETERS	
DIM	MIN	MAX
A	4.45	5.20
B	4.32	5.33
C	3.18	4.19
D	0.40	0.54
G	2.40	2.80
J	0.39	0.50
K	12.70	---
N	2.04	2.66
P	1.50	4.00
R	2.93	---
V	3.43	---

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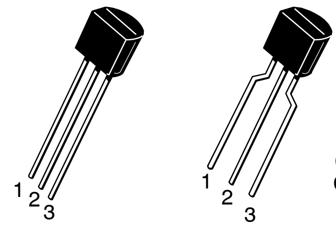
Features

- Pb−Free Packages are Available*



STRAIGHT LEAD
BULK PACK

BENT LEAD
TAPE & REEL
AMMO PACK

TO−92
(TO−226AA)
CASE 29−11

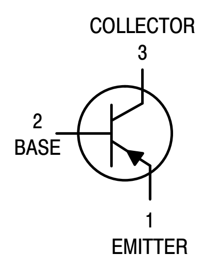
MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector−Emitter Voltage MPSA93 MPSA92	V_{CEO}	 −200 −300	Vdc
Collector−Base Voltage MPSA93 MPSA92	V_{CBO}	 −200 −300	Vdc
Emitter−Base Voltage	V_{EBO}	−5.0	Vdc
Collector Current − Continuous	I_C	−500	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	 625 5.0	 mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	 1.5 12	 W mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150	°C

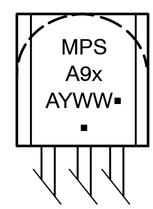
THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction−to−Ambient	$R_{\theta JA}$	200	°C/W
Thermal Resistance, Junction−to−Case	$R_{\theta JC}$	83.3	°C/W

Stresses exceeding Maximum Ratings may damage the device. Maximum Ratings are stress ratings only. Functional operation above the Recommended Operating Conditions is not implied. Extended exposure to stresses above the Recommended Operating Conditions may affect device reliability.



MARKING DIAGRAM



x = 2 or 3
A = Assembly Location
Y = Year
WW = Work Week
▪ = Pb−Free Package
(Note: Microdot may be in either location)

ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 3 of this data sheet.

*For additional information on our Pb−Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector–Emitter Breakdown Voltage (Note 1) (I_C = −1.0 mAdc, I_B = 0)	MPSA92 MPSA93	$V_{(BR)CEO}$	−300 −200	– –	Vdc
Collector–Base Breakdown Voltage (I_C = −100 μAdc, I_E = 0)	MPSA92 MPSA93	$V_{(BR)CBO}$	−300 −200	– –	Vdc
Emitter–Base Breakdown Voltage (I_E = −100 μAdc, I_C = 0)		$V_{(BR)EBO}$	−5.0	–	Vdc
Collector Cutoff Current (V_{CB} = −200 Vdc, I_E = 0) (V_{CB} = −160 Vdc, I_E = 0)	MPSA92 MPSA93	I_{CBO}	– –	−0.25 −0.25	μAdc
Emitter Cutoff Current (V_{EB} = −3.0 Vdc, I_C = 0)		I_{EBO}	–	−0.1	μAdc
ON CHARACTERISTICS (Note 1)					
DC Current Gain (I_C = −1.0 mAdc, V_{CE} = −10 Vdc) (I_C = −10 mAdc, V_{CE} = −10 Vdc) (I_C = −30 mAdc, V_{CE} = −10 Vdc)	All Types All Types MPSA92 MPSA93	h_{FE}	25 40 25 25	– – – –	–
Collector–Emitter Saturation Voltage (I_C = −20 mAdc, I_B = −2.0 mAdc)	MPSA92 MPSA93	$V_{CE(sat)}$	– –	−0.5 −0.4	Vdc
Base–Emitter Saturation Voltage (I_C = −20 mAdc, I_B = −2.0 mAdc)		$V_{BE(sat)}$	–	−0.9	Vdc
SMALL–SIGNAL CHARACTERISTICS					
Current–Gain – Bandwidth Product (I_C = −10 mAdc, V_{CE} = −20 Vdc, f = 100 MHz)		f_T	50	–	MHz
Collector–Base Capacitance (V_{CB} = −20 Vdc, I_E = 0, f = 1.0 MHz)	MPSA92 MPSA93	C_{cb}	– –	6.0 8.0	pF

1. Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2%.

ORDERING INFORMATION

Device	Package	Shipping†
MPSA92G	TO−92 (Pb−Free)	5000 Units / Box
MPSA92RL1G	TO−92 (Pb−Free)	2000 / Tape & Reel
MPSA92RLRA	TO−92	2000 / Tape & Reel
MPSA92RLRAG	TO−92 (Pb−Free)	2000 / Tape & Reel
MPSA92RLRMG	TO−92 (Pb−Free)	2000 / Ammo Pack
MPSA92RLRPG	TO−92 (Pb−Free)	2000 / Ammo Pack
MPSA92ZL1G	TO−92 (Pb−Free)	2000 / Ammo Pack
MPSA93G	TO−92 (Pb−Free)	5000 Units / Box
MPSA93RLRMG	TO−92 (Pb−Free)	2000 / Ammo Pack

†For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.

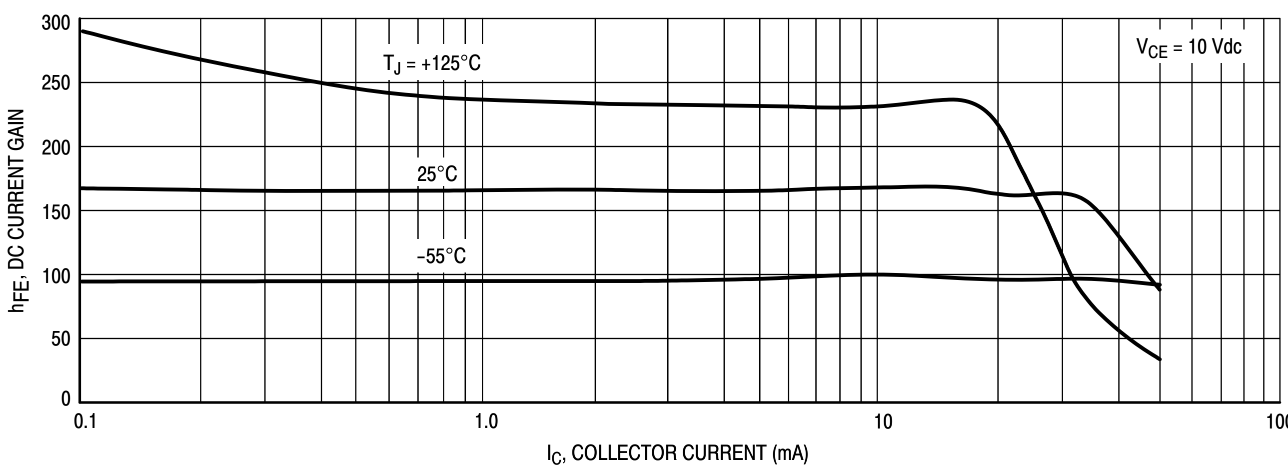


Figure 1. DC Current Gain

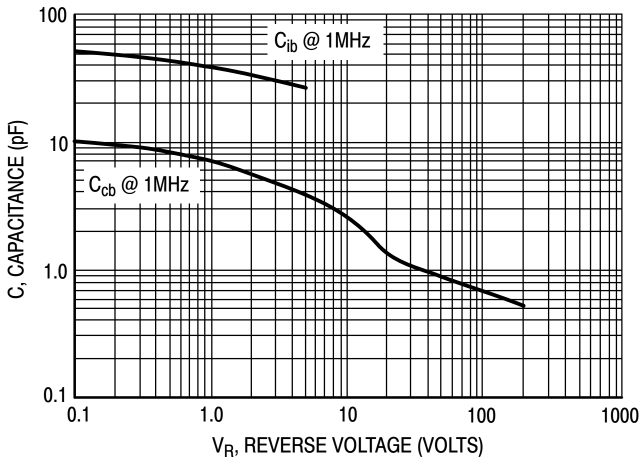


Figure 2. Capacitance

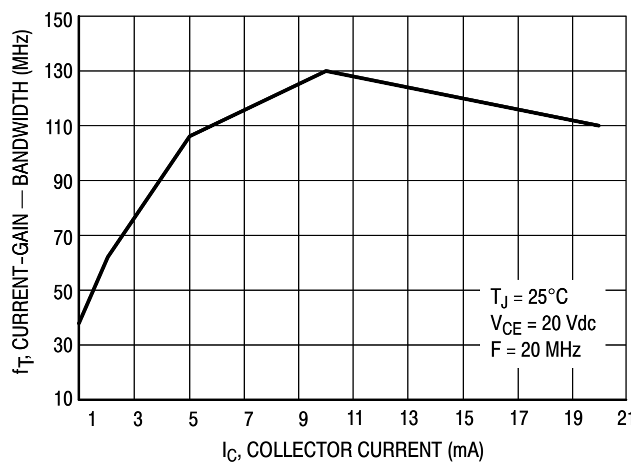


Figure 3. Current−Gain − Bandwidth

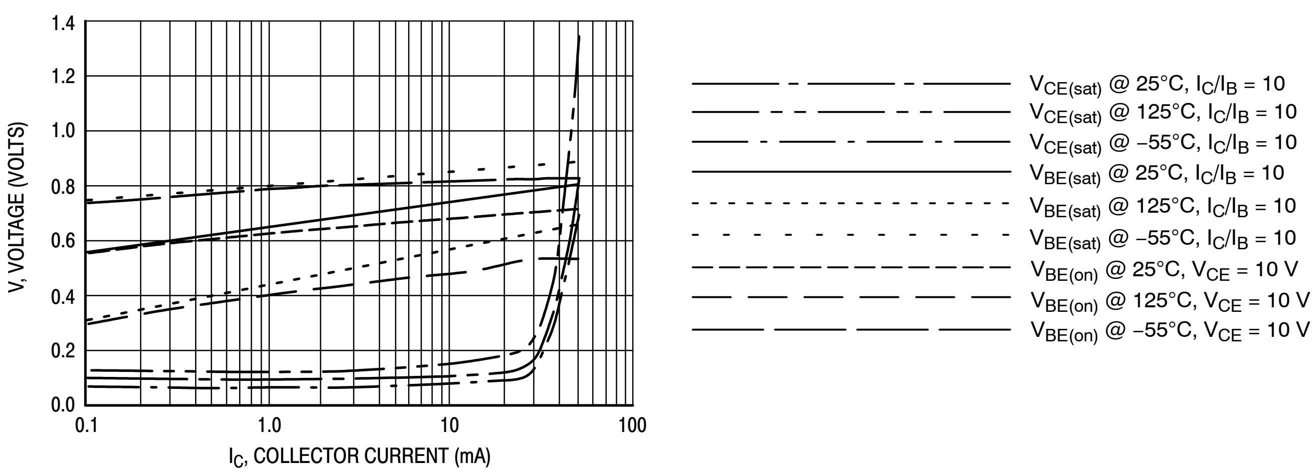


Figure 4. ”ON” Voltages

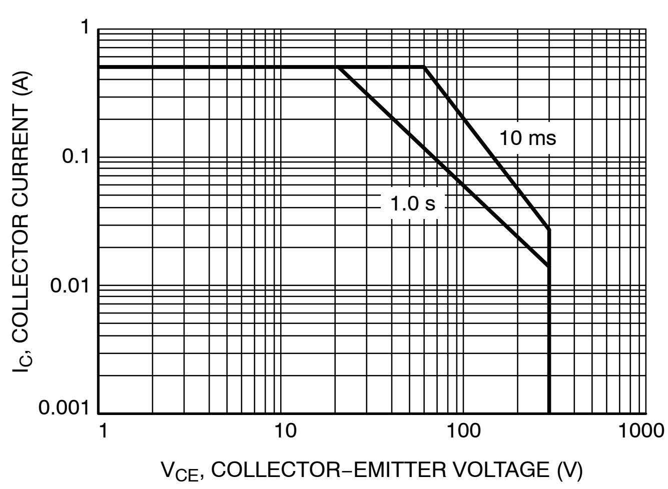
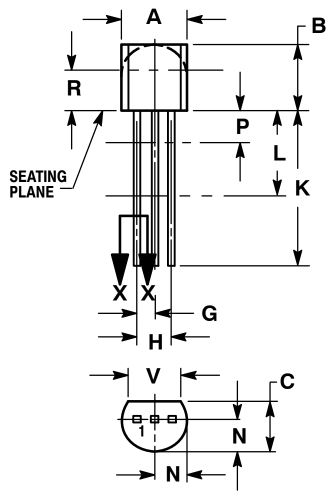


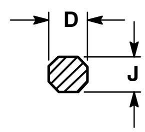
Figure 5. Safe Operating Area

PACKAGE DIMENSIONS

TO−92 (TO−226)
CASE 029−11
ISSUE AM



STRAIGHT LEAD
BULK PACK

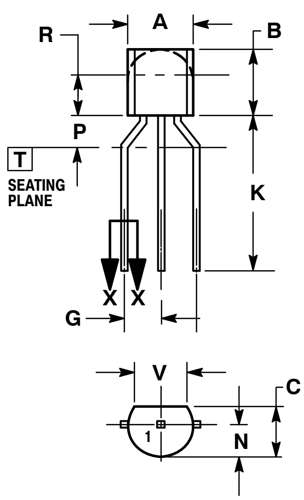


SECTION X−X

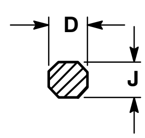
NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. CONTOUR OF PACKAGE BEYOND DIMENSION R IS UNCONTROLLED.
4. LEAD DIMENSION IS UNCONTROLLED IN P AND BEYOND DIMENSION K MINIMUM.

	INCHES		MILLIMETERS	
DIM	**MIN**	**MAX**	**MIN**	**MAX**
A	0.175	0.205	4.45	5.20
B	0.170	0.210	4.32	5.33
C	0.125	0.165	3.18	4.19
D	0.016	0.021	0.407	0.533
G	0.045	0.055	1.15	1.39
H	0.095	0.105	2.42	2.66
J	0.015	0.020	0.39	0.50
K	0.500	---	12.70	---
L	0.250	---	6.35	---
N	0.080	0.105	2.04	2.66
P	---	0.100	---	2.54
R	0.115	---	2.93	---
V	0.135	---	3.43	---

STYLE 14:
PIN 1. EMITTER
2. COLLECTOR
3. BASE



BENT LEAD
TAPE & REEL
AMMO PACK



SECTION X−X

NOTES:
1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: MILLIMETERS.
3. CONTOUR OF PACKAGE BEYOND DIMENSION R IS UNCONTROLLED.
4. LEAD DIMENSION IS UNCONTROLLED IN P AND BEYOND DIMENSION K MINIMUM.

	MILLIMETERS	
DIM	**MIN**	**MAX**
A	4.45	5.20
B	4.32	5.33
C	3.18	4.19
D	0.40	0.54
G	2.40	2.80
J	0.39	0.50
K	12.70	---
N	2.04	2.66
P	1.50	4.00
R	2.93	---
V	3.43	---

PUBLICATION ORDERING INFORMATION

LITERATURE FULFILLMENT:
Literature Distribution Center for ON Semiconductor
P.O. Box 5163, Denver, Colorado 80217 USA
Phone: 303−675−2175 or 800−344−3860 Toll Free USA/Canada
Fax: 303−675−2176 or 800−344−3867 Toll Free USA/Canada
Email: orderlit@onsemi.com

N. American Technical Support: 800−282−9855 Toll Free USA/Canada
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Phone: 421 33 790 2910
Japan Customer Focus Center
Phone: 81−3−5773−3850

ON Semiconductor Website: **www.onsemi.com**

Order Literature: http://www.onsemi.com/orderlit

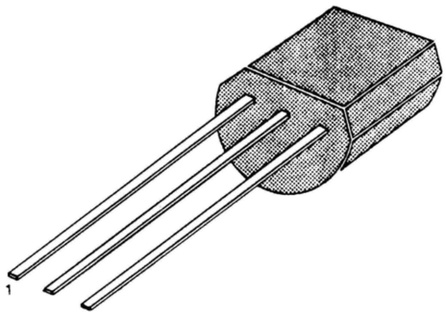
For additional information, please contact your local Sales Representative

A1015
PNP Epitaxial Silicon Transistor

LOW FREQUENCY AMPLIFIER

- Collection Dissipation : P_C(max) = 400mW
- Collector-Emitter Voltage : V_{CEO} = -50V

TO - 92



1. Emitter 2. Collector 3. Base

Absolute Maximum Ratings (TA=25^{o}C)

Characteristic	Symbol	Rating	Unit
Collector-Base Voltage	V_{CBO}	-50	V
Collector-Emitter Voltage	V_{CEO}	-50	V
Collector Current	I_C	-150	mA
Collector Dissipation	P_C	400	mW
Junction Temperature	T_J	150	^{o}C
Storage Temperature	T_{STG}	-55~+150	^{o}C

Electrical Characteristics (TA=25^{o}C)

Characteristic	Symbol	Test Conditions	Min	Max	Unit
Collector-Base Breakdown Voltage	BV_{CBO}	I_C= -100μA, I_E=0	-50		V
Collector-Emitter Breakdown Voltage	BV_{CEO}	I_C= -0.1mA, I_B=0	-50		V
Collector Cut-off Current	I_{CBO}	V_{CB}= -50V, I_E=0		-0.1	μA
Emitter Cut-off Current	I_{EBO}	V_{EB}= -5V, I_C=0		-0.1	μA
DC Current Gain	h_{FE}	V_{CE}= -6V, I_C= -2mA	70	400	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	I_C= -100mA, I_B= -10mA		-0.3	V
Base-Emitter Saturation Voltage	$V_{BE(sat)}$	I_C= -100mA, I_B= -10mA		-1.1	V
Base-Emitter Voltage	V_{BE}	I_E= -310mA		-1.45	V
Transition Frequency	f_T	V_{CE}= -10V, I_C= -1mA f=30MHz	80		MHz

h_{FE} CLASSIFICATION

Classification	O	Y	GR
h_{FE}	70-140	120-240	200-400

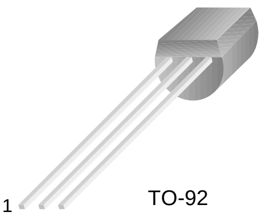
Elite Enterprises (H.K.) Co., Ltd.
Flat 2505, 25/F., Nanyang Plaza, 57 Hung To Road, Kwun Tong, H.K.
Tel: (852) 2723-3122 Fax: (852) 2723-3990 Email: info@elite-ent.com.hk

FAIRCHILD SEMICONDUCTOR®

KSC1815

Audio Frequency Amplifier & High Frequency OSC

- Complement to KSA1015
- Collector-Base Voltage : V_{CBO}= 50V



1 TO-92

1. Emitter 2. Collector 3. Base

NPN Epitaxial Silicon Transistor

Absolute Maximum Ratings T_a=25°C unless otherwise noted

Symbol	Parameter	Value	Units
V_{CBO}	Collector-Base Voltage	60	V
V_{CEO}	Collector-Emitter Voltage	50	V
V_{EBO}	Emitter-Base Voltage	5	V
I_C	Collector Current	150	mA
I_B	Base Current	50	mA
P_C	Collector Power Dissipation	400	mW
T_J	Junction Temperature	125	°C
T_{STG}	Storage Temperature	-55 ~ 150	°C

Electrical Characteristics T_a=25°C unless otherwise noted

Symbol	Parameter	Test Condition	Min.	Typ.	Max.	Units
I_{CBO}	Collector Cut-off Current	V_{CB}=60V, I_E=0			0.1	µA
I_{EBO}	Emitter Cut-off Current	V_{EB}=5V, I_C=0			0.1	µA
h_{FE1} h_{FE2}	DC Current Gain	V_{CE}=6V, I_C=2mA V_{CE}=6V, I_C=150mA	70 25		700	
V_{CE} (sat)	Collector-Emitter Saturation Voltage	I_C=100mA, I_B=10mA		0.1	0.25	V
V_{BE} (sat)	Base-Emitter Saturation Voltage	I_C=100mA, I_B=10mA			1.0	V
f_T	Current Gain Bandwidth Product	V_{CE}=10V, I_C=1mA	80			MHz
C_{ob}	Output Capacitance	V_{CB}=10V, I_E=0, f=1MHz		2.0	3.0	pF
NF	Noise Figure	V_{CE}=6V, I_C=0.1mA R_S=10kΩ, f=1Hz		1.0	1.0	dB

h_{FE} Classification

Classification	O	Y	GR	L
h_{FE1}	70 ~ 140	120 ~ 240	200 ~ 400	350 ~ 700

Typical Characteristics

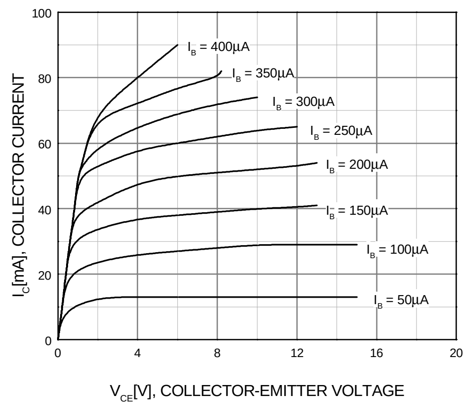


Figure 1. Static Characteristic

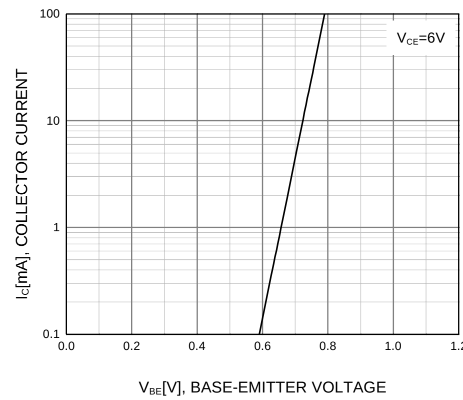


Figure 2. Transfer Characteristic

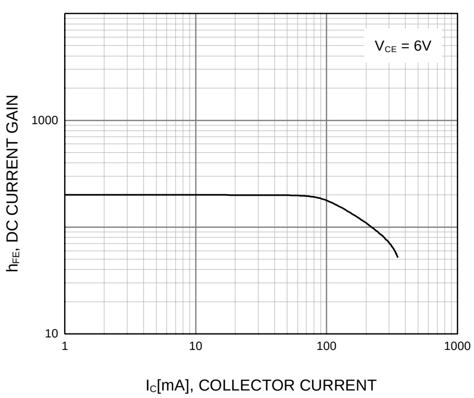


Figure 3. DC current Gain

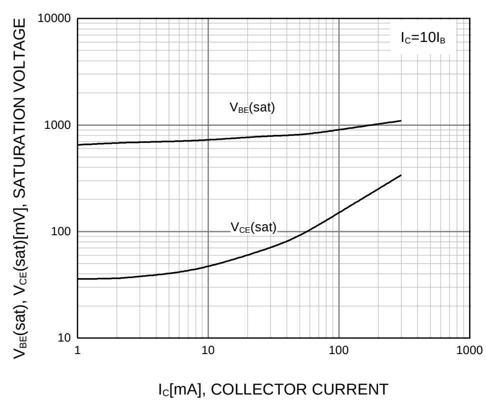


Figure 4. Base-Emitter Saturation Voltage Collector-Emitter Saturation Voltage

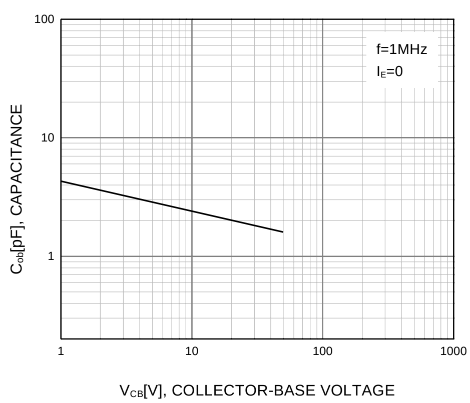


Figure 5. Output Capacitance

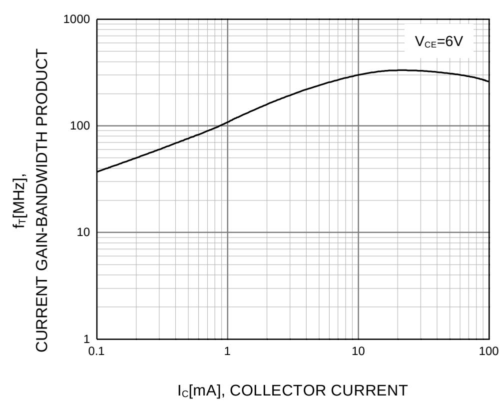
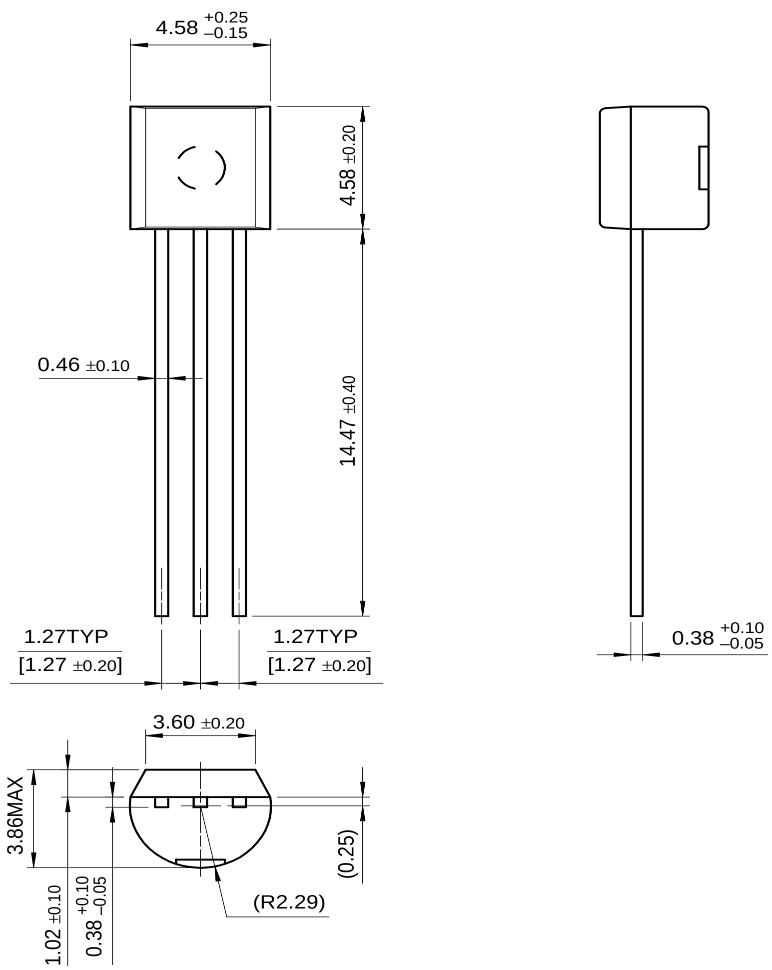


Figure 6. Current Gain Bandwidth Product

Package Dimensions

TO-92



Dimensions in Millimeters

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ActiveArray™	FACT Quiet series™	ISOPLANAR™	POP™	Stealth™
Bottomless™	FAST®	LittleFET™	Power247™	SuperSOT™-3
CoolFET™	FASTr™	MicroFET™	PowerTrench®	SuperSOT™-6
CROSSVOLT™	FRFET™	MicroPak™	QFET™	SuperSOT™-8
DOME™	GlobalOptoisolator™	MICROWIRE™	QS™	SyncFET™
EcoSPARK™	GTO™	MSX™	QT Optoelectronics™	TinyLogic™
E^2CMOS™	HiSeC™	MSXPro™	Quiet Series™	TruTranslation™
EnSigna™	I^2C™	OCX™	RapidConfigure™	UHC™
Across the board. Around the world.™		OCXPro™	RapidConnect™	UltraFET®
The Power Franchise™		OPTOLOGIC®	SILENT SWITCHER®	VCX™
Programmable Active Droop™		OPTOPLANAR™	SMART START™	

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As used herein:

1. Life support devices or systems are devices or systems which, (a) are intended for surgical implant into the body, or (b) support or sustain life, or (c) whose failure to perform when properly used in accordance with instructions for use provided in the labeling, can be reasonably expected to result in significant injury to the user.

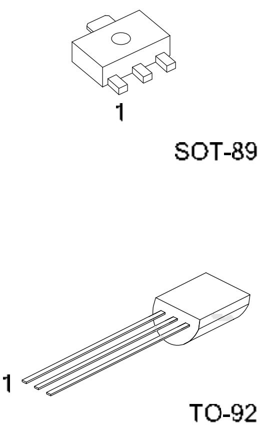
2. A critical component is any component of a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.

PRODUCT STATUS DEFINITIONS

Definition of Terms

Datasheet Identification	Product Status	Definition
Advance Information	Formative or In Design	This datasheet contains the design specifications for product development. Specifications may change in any manner without notice.
Preliminary	First Production	This datasheet contains preliminary data, and supplementary data will be published at a later date. Fairchild Semiconductor reserves the right to make changes at any time without notice in order to improve design.
No Identification Needed	Full Production	This datasheet contains final specifications. Fairchild Semiconductor reserves the right to make changes at any time without notice in order to improve design.
Obsolete	Not In Production	This datasheet contains specifications on a product that has been discontinued by Fairchild semiconductor. The datasheet is printed for reference information only.

NPN SILICON POWER TRANSISTOR



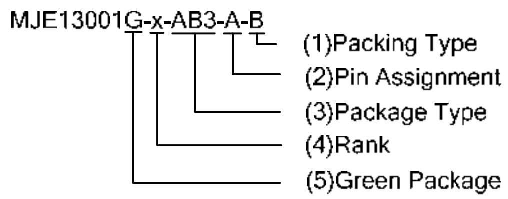
FEATURES

* Collector-base voltage: $V_{(BR)CBO}$=600V
* Collector current: I_C=0.2A

ORDERING INFORMATION

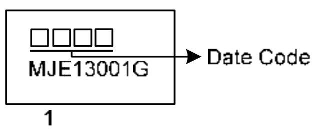
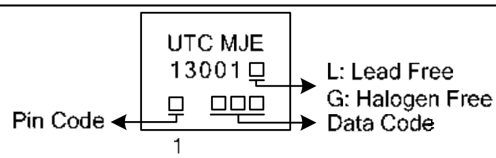
Ordering Number		Package	Pin Assignment			Packing
Lead Free	Halogen Free		1	2	3	
-	MJE13001G-x-AB3-A-R	SOT-89	E	C	B	Tape Reel
-	MJE13001G-x-AB3-F-R	SOT-89	B	C	E	Tape Reel
MJE13001L-x-T92-B	MJE13001G-x-T92-B	TO-92	B	C	E	Tape Box
MJE13001L-x-T92-K	MJE13001G-x-T92-K	TO-92	B	C	E	Bulk
MJE13001L-x-T92-A-B	MJE13001G-x-T92-A-B	TO-92	E	C	B	Tape Box
MJE13001L-x-T92-A-K	MJE13001G-x-T92-A-K	TO-92	E	C	B	Bulk

Note: Pin Assignment: C: Collector B: Base E: Emitter



(1) B: Tape Box, K: Bulk, R: Tape Reel
(2) refer to Pin Assignment
(3) AB3: SOT-89, T92: TO-92
(4) x: refer to Classification of h_{FE1}
(5) G: Halogen Free and Lead Free, L: Lead Free

MARKING

SOT-89	TO-92
	

■ ABSOLUTE MAXIMUM RATINGS

PARAMETER		SYMBOL	RATINGS	UNIT
Collector-Emitter Voltage		V_{CEO}	400	V
Collector-Base Voltage		V_{CBO}	600	V
Emitter Base Voltage		V_{EBO}	7	V
Collector Current		I_C	200	mA
Collector Power Dissipation	SOT-89	P_C	550	mW
	TO-92		750	
Junction Temperature		T_J	+150	°C
Storage Temperature		T_{STG}	-55 ~ +150	°C

Note: Absolute maximum ratings are those values beyond which the device could be permanently damaged. Absolute maximum ratings are stress ratings only and functional device operation is not implied.

■ ELECTRICAL CHARACTERISTICS (T_A=25°C, unless otherwise specified)

PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNIT
Collector-Base Breakdown Voltage	BV_{CBO}	I_C=100μA, I_E=0	600			V
Collector-Emitter Breakdown Voltage	BV_{CEO}	I_C=1mA, I_B=0	400			V
Emitter-Base Breakdown Voltage	BV_{EBO}	I_E=100μA, I_C=0	7			V
Base-Emitter Voltage	V_{BE}	I_E=100 mA			1.1	V
Collector Cutoff Cut-Off Current	I_{CBO}	V_{CB}=600V, I_E=0A			100	μA
Collector Emitter Cut-Off Current	I_{CEO}	V_{CE}=400V, I_B=0			200	μA
Emitter Cutoff Cut-Off Current	I_{EBO}	V_{EB}=7V, I_C=0A			100	μA
ON CHARACTERISTICS						
DC Current Gain	h_{FE1}*	V_{CE}=20 V, I_C=20mA	10		70	
	h_{FE2}	V_{CE}=10V, I_C=0.25mA	5			
Collector-Emitter Saturation Voltage	$V_{CE(SAT)}$	I_C=50mA, I_B=10mA			0.5	V
Base-Emitter Saturation Voltage	$V_{BE(SAT)}$	I_C=50mA, I_B=10mA			1.2	V
SMALL-SIGNAL CHARACTERISTICS						
Current Gain Bandwidth Product	f_T	I_C=20mA,V_{CE}=20V,f=1MHz	8			MHz
Resistive Load						
Storage Time	t_S	I_C=50mA, I_{B1}=-I_{B2}=5mA, V_{CC}=45V			1.5	μs
Fall Time	t_F				0.3	μs

■ CLASSIFICATION OF h_{FE1}*

RANK	A	B	C	D	E	F	G	H	I	J	K	L
RANGE	10-15	15-20	20-25	25-30	30-35	35-40	40-45	45-50	50-55	55-60	60-65	65-70

■ TYPICAL CHARACTERISTICS