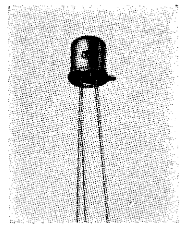
SPRAGUE® THE MARK OF RELIABILITY
Engineering Bulletin

TYPE
2N3115
2N3116

TYPE 2N3115 AND 2N3116 HIGH-SPEED, SEPT® TRANSISTORS

— N-P-N Silicon Planar Epitaxial Series



TO-18 CASE

DESIGNED for high-speed switching applications over a wide current range, Type 2N3115 and 2N3116 Transistors feature:

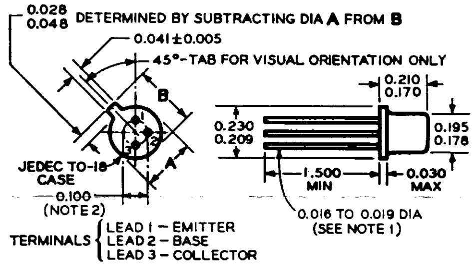
- BV_{CBO} ......60 volts min.
- BV_{CEO}......20 volts min.
- f_T...........250 Mc min.

ABSOLUTE MAXIMUM RATINGS[1]

Collector to Base Voltage, V_{CBO} ....60 volts
Collector to Emitter Voltage, V_{CEO} ....20 volts
Emitter to Base Voltage, V_{EBO} ....5 volts
Collector Current, I_C...................0.6 amperes
Total Device Dissipation at 25 C ambient.... 400 mW
Derating Factor above 25 C ambient...2.67 mW/°C
Total Device Dissipation at 25 C case temp.... 1.8 watts
Derating Factor...................... 1 2 mW/°C
Storage Temperature........... −65 C to +200 C

[1]The maximum ratings are limiting absolute values above which the serviceability may be impaired from the viewpoint of life or satisfactory performance. The breakdown voltages may be far above the maximum collector voltage ratings. To avoid permanent damage to the transistor, do not attempt to measure these characteristics above the maximum ratings.

MECHANICAL SPECIFICATIONS



NOTE 1 : THIS LEAD DIA APPLIES TO ZONE BETWEEN 0.050 AND 0.250 FROM BASE SEAT. IN ZONE BETWEEN 0.250 AND 0.500, A MAX OF 0.021 DIA IS HELD. OUTSIDE OF THESE ZONES, THE LEAD DIA IS NOT CONTROLLED.

NOTE 2: MAX DIA LEADS AT GAGING PLANE $0.054^{+0.001}_{-0.000}$ BELOW BASE SEAT TO BE WITHIN 0.007 OF TRUE LOCATION RELATIVE TO MAX WIDTH TAB AND TO 0.230 MAX DIA MEASURED WITH SUITABLE GAGE. WHEN GAGE IS NOT USED, MEASUREMENT MADE AT BASE SEAT.

DWG. NO. A-34504

ELECTRICAL CHARACTERISTICS[2] at T = 25 C

	CHARACTERISTICS	TEST CONDITIONS			MIN.	MAX.	UNITS
	D-C CHARACTERISTICS						
BV_{CBO}	Collector Breakdown Voltage	I_C = 10μA	I_E = 0		60	—	Volts
BV_{CEO}	Collector Breakdown Voltage	I_C = 10mA	I_B = 0		20	—	Volts
BV_{EBO}	Emitter Breakdown Voltage	I_E = 10μA	I_C = 0		5	—	Volts
I_{CBO}	Collector Cutoff Current	V_{CB} = 50V	I_C = 0		—	25	nA
I_{CBO}	Collector Cutoff Current	V_{CB} = 50V	I_C = 0	T_A = 150C	—	15	μA
I_{CEX}	Collector Cutoff Current	V_{CE} = 30V	V_{EB} = −0.5V		—	50	nA
I_{BEX}	Base Cutoff Current	V_{CE} = 30V	V_{EB} = −0.5V		—	50	nA
h_{FE}	Current Amplification Factor 2N3115	V_{CE} = 10V	I_C = 150mA		40	120	—
h_{FE}	Current Amplification Factor 2N3116	V_{CE} = 10V	I_C = 150mA		100	300	—
$V_{BE(SAT)}$	Base Emitter Voltage	I_C = 150mA	I_B = 15mA		—	1.3	Volts
V_{BE}	Base Emitter Voltage	I_C = 150mA	V_{CE} = 10V		—	1.2	Volts
$V_{CE(SAT)}$	Collector Saturation Voltage	I_C = 150mA	I_B = 15mA		—	0.5	Volts
	HIGH FREQUENCY CHARACTERISTICS						
f_T	Gain Bandwidth Product	V_{CE} = 20V	I_C = 20mA	f = 100Mc	250	—	Mc
C_{ob}	Output Capacitance	V_{CB} = 10V	I_E = 0		—	8	pF
	SWITCHING CHARACTERISTICS						
t_d	Turn-On Delay Time	See Figure 1				20	nsec
t_r	Rise Time	See Figure 1				75	nsec
t_s	Storage Time	See Figure 2				300	nsec
t_f	Fall Time	See Figure 2				200	nsec

[2]Typical values are for engineering guidance only.

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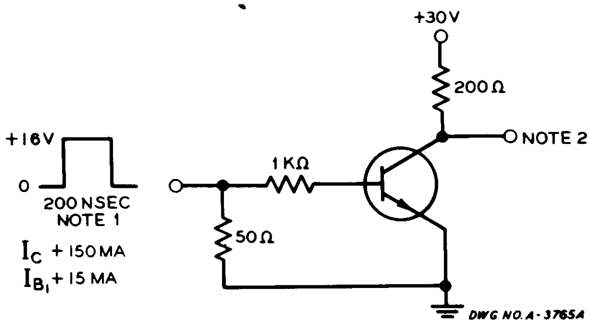


FIGURE 1

TURN-ON DELAY TIME AND RISE TIME TEST CIRCUIT

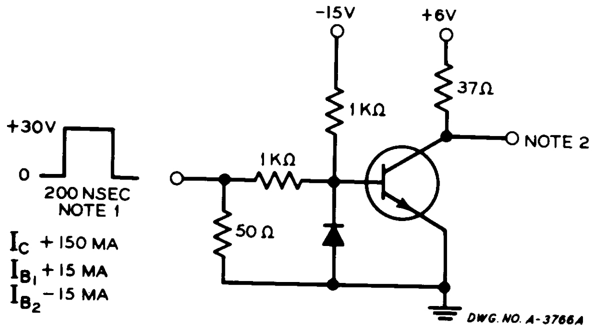


FIGURE 2

STORAGE AND FALL TIME TEST CIRCUIT

Note 1: Input rise time sufficiently fast that doubling or halving its value does not affect the measurement.

Note 2: Scope rise time and impedance are such that doubling or halving the value does not affect the measurement.

Marking. All transistors will be marked with the type number; the name SPRAGUE or the registered Sprague trademark, ②, at vendor's option; and date code of manufacture, unless otherwise specified.

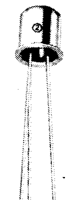
No. 31173

SPRAGUE® THE MARK OF RELIABILITY — Engineering Bulletin

TYPE 2N3317

TYPE 2N3317 SILICON PRECISION-ALLOY TRANSISTORS

DESIGNED for low-level, high-speed chopper applications, Type 2N3317 Silicon Precision-Alloy Transistors feature uniquely low storage time, ts, in the inverted chopper configuration. Type 2N3317 SPAT® transistors are available as matched pairs upon request.



ACTUAL SIZE

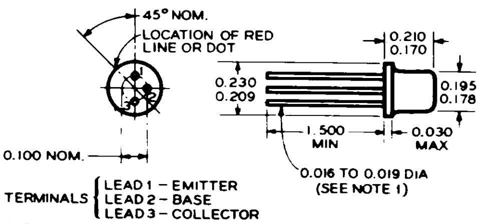
ABSOLUTE MAXIMUM RATINGS[1]

Storage Temperature .... −65 C to + 140 C
Collector Voltage, V_{CBO} .... −30 volts
Collector Voltage, V_{CEO} .... −30 volts
Emitter Voltage, V_{EBO} .... −30 volts
Emitter Voltage, V_{ECO} .... −30 volts
Collector Current, I_C .... −50 ma
Total Device Dissipation[2] at 25 C .... 150 mw
Lead Temperature at 1/16" ± 1/32" from case .... 230 C for 10 sec

[1] The maximum ratings are limiting absolute values above which the serviceability may be impaired from the viewpoint of life or satisfactory performance. The breakdown voltages may be far above the maximum voltage ratings. To avoid permanent damage to the transistors, do not attempt to measure these characteristics above the maximum ratings.

[2] Due to the nature of these transistors, the dissipation in the base emitter circuit may be appreciable under high base drive conditions and must be included in the total device dissipation. For temperatures above 25 C, derate by 1.3 mw/°C.

MECHANICAL SPECIFICATIONS



ALL LEADS ISOLATED FROM CASE

NOTE 1: THIS LEAD DIA APPLIES TO ZONE BETWEEN 0.050 AND 0.250 FROM BASE SEAT. IN ZONE BETWEEN 0.250 AND 0.050, A MAX OF 0.021 DIA IS HELD. OUTSIDE OF THESE ZONES, THE LEAD DIA IS NOT CONTROLLED.

DWG NO A-3808A

ELECTRICAL CHARACTERISTICS[3] at T = 25 C

	CHARACTERISTICS	TEST CONDITIONS		MIN.	TYP.	MAX.	UNITS
	D-C CHARACTERISTICS						
I_{CBO}	Collector Cutoff Current	V_{CB} = −10V		—	—	1	nA
I_{CBO}	Collector Cutoff Current	V_{CB} = −10V	T = +65C	—	—	15	nA
I_{EBO}	Emitter Cutoff Current	V_{EB} = −10V		—	—	1	nA
I_{EBO}	Emitter Cutoff Current	V_{EB} = −10V	T = +65C	—	—	15	nA
I_{ECO}	Emitter Current	V_{EC} = −10V		—	—	1	nA
BV_{CBO}	Collector Breakdown Voltage	I_C = −1μA		30	—	—	volts
BV_{CEO}	Collector Breakdown Voltage	I_C = −10μA		30	—	—	volts
BV_{EBO}	Emitter Breakdown Voltage	I_E = −1μA		30	—	—	volts
BV_{ECO}	Emitter Breakdown Voltage	I_E = −1μA		30	—	—	volts
V_{OFF}	Offset Voltage	I_B = −500μA		—	1.25	1.75	mV
V_{OFF}	Offset Voltage	I_B = −1mA		—	1.5	2.25	mV
V_{OFF}	Offset Voltage	I_B = −1.5mA		—	1.75	2.75	mV
	HIGH FREQUENCY CHARACTERISTICS						
r_s	Inverted Dynamic Saturation Resistance[4]	I_B = −1mA	I_E = 100μA	8	14	20	ohms
C_{ib}	Input Capacitance	V_{EB} = −6V	I_C = 0 f = 4mc	—	4	7	pF
C_{ob}	Output Capacitance	V_{CB} = −6V	I_E = 0 f = 4mc	—	6	9	pF
C_{eb}	Emitter Diode Capacitance[5]	I_E = 0.25μA	f = 10mc	—	12	16	pF
—	Emitter Diode Recovery Time[6]	I_B = −1mA nom.		—	6	15	μsec
f_T	Gain Bandwidth Product	V_{CE} = −6V	I_E = 1mA f = 4mc	6.4	10	—	mc
t_s	Storage Time (inverted)	See Circuit of Figure 4		—	150	250	nsec

[3] Typical values are for engineering guidance only.
[4] To be measured in circuit of Figure 1.
[5] To be measured in circuit of Figure 2.
[6] To be measured in circuit of Figure 3.

SPRAGUE ELECTRIC COMPANY
EXECUTIVE OFFICES: NORTH ADAMS, MASS.
SEMICONDUCTOR DIVISION
CONCORD, N.H. • WORCESTER, MASS.

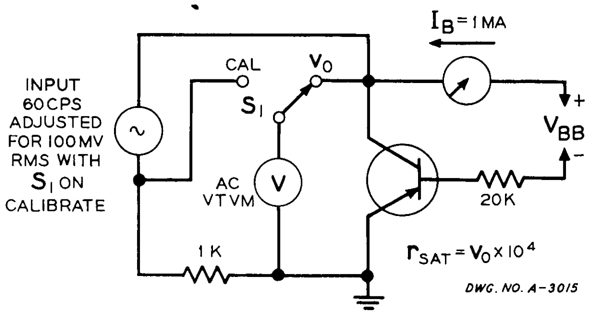


FIGURE 1
INVERTED DYNAMIC r_s TEST CIRCUIT

The inverted dynamic saturation resistance, which is the slope of the V_{OFF}, I_E characteristic at a specified base current, is measured in the circuit shown in Figure 1. The circuit reads r_s directly as the ratio of the a-c collector voltage, V_o to a calibrated a-c collector current.

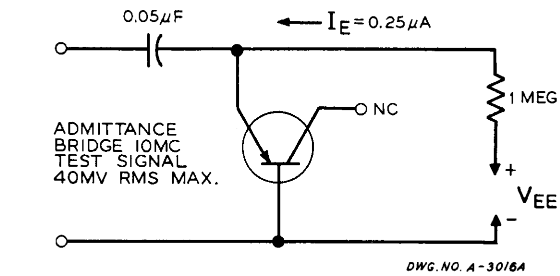


FIGURE 2
EMITTER DIODE CAPACITANCE TEST CIRCUIT

Figure 2 shows the test circuit for the measurement of the emitter diode capacitance, C_{eb}. The measurement is made with the emitter diode slightly forward biased ($I_E = 0.25\mu A$). The 10 MC test signal from the admittance bridge should be less than 40 MV RMS.

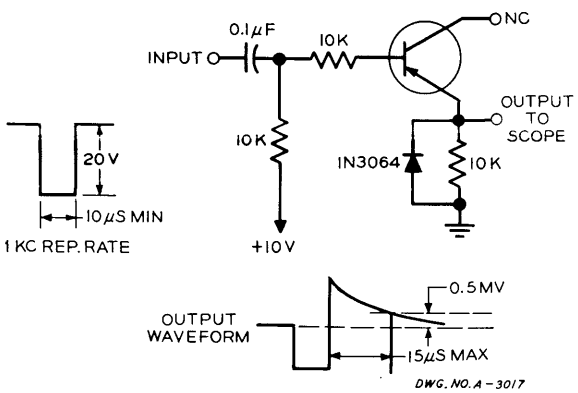


FIGURE 3
RECOVERY TIME TEST CIRCUIT

The emitter diode reverse recovery time, a measure of the transient response of the chopper, is measured in the circuit of Figure 3. The measurement is made as the time for the emitter current to recover from a specified forward value to a specified reverse value. The IN3064 diode across the 10K emitter resistance serves to clamp the emitter potential to reduce the output voltage change to a convenient level.

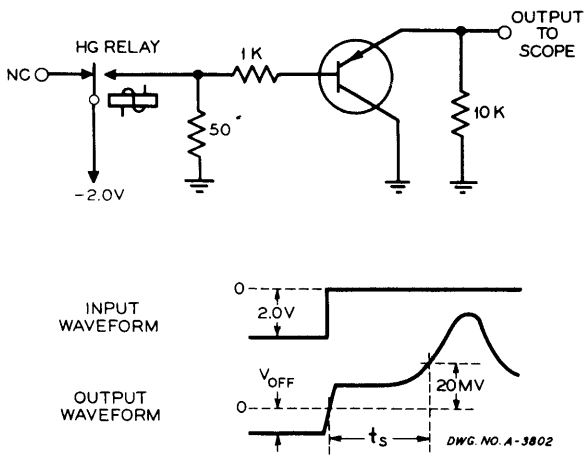


FIGURE 4
STORAGE TIME TEST CIRCUIT

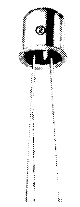
No. 31174B

SPRAGUE Engineering Bulletin

SPRAGUE THE MARK OF RELIABILITY

TYPE **2N3318**

TYPE 2N3318 P-N-P SILICON PRECISION-ALLOY TRANSISTORS



ACTUAL SIZE

TYPE 2N3318 Silicon Precision-Alloy Transistors for low-level, high-speed chopper applications, offer uniquely low storage time in the inverted chopper configuration. Type 2N3318 SPAT® transistors are available as matched pairs upon request.

"SPAT" is a registered trademark of the Philco Corp.

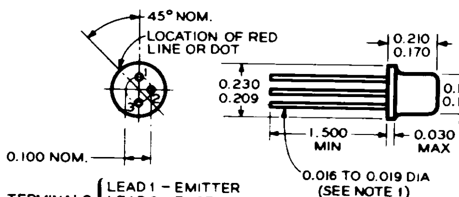
ABSOLUTE MAXIMUM RATINGS[1]

Storage Temperature . . . . −65 C to + 140 C
Collector Voltage, V_{CBO} . . . . −15 volts
Collector Voltage, V_{CEO} . . . . −15 volts
Emitter Voltage, V_{EBO} . . . . −15 volts
Emitter Voltage, V_{ECO} . . . . −15 volts
Collector Current, I_C . . . . −50 ma
Total Device Dissipation[2] at 25 C . . . . 150 mw
Lead Temperature at 1/16" ± 1/32" from case . . . . 230 C for 10 sec

[1] The maximum ratings are limiting absolute values above which the serviceability may be impaired from the viewpoint of life or satisfactory performance. The breakdown voltages may be far above the maximum voltage ratings. To avoid permanent damage to the transistors, do not attempt to measure these characteristics above the maximum ratings.

[2] Due to the nature of these transistors, the dissipation in the base emitter circuit may be appreciable under high base drive conditions and must be included in the total device dissipation. For temperatures above 25 C, derate by 1.3 mw/°C.

MECHANICAL SPECIFICATIONS



TERMINALS { LEAD 1 – EMITTER, LEAD 2 – BASE, LEAD 3 – COLLECTOR

ALL LEADS ISOLATED FROM CASE

NOTE 1: THIS LEAD DIA APPLIES TO ZONE BETWEEN 0.050 AND 0.250 FROM BASE SEAT. IN ZONE BETWEEN 0.250 AND 0.050, A MAX OF 0.021 DIA IS HELD. OUTSIDE OF THESE ZONES, THE LEAD DIA IS NOT CONTROLLED.

DWG NO A-38064

ELECTRICAL CHARACTERISTICS[3] at T = 25 C

	CHARACTERISTICS	TEST CONDITIONS	MIN.	TYP.	MAX.	UNITS
	D-C CHARACTERISTICS					
I_{CBO}	Collector Cutoff Current	V_{CB} = −10V	—	—	1	nA
I_{CBO}	Collector Cutoff Current	V_{CB} = −10V, T = +65C	—	—	15	nA
I_{EBO}	Emitter Cutoff Current	V_{EB} = −10V	—	—	1	nA
I_{EBO}	Emitter Cutoff Current	V_{EB} = −10V, T = +65C	—	—	15	nA
I_{ECO}	Emitter Cutoff Current	V_{EC} = −10V	—	—	1	nA
BV_{CBO}	Collector Breakdown Voltage	I_C = −1μA	15	—	—	Volts
BV_{CEO}	Collector Breakdown Voltage	I_C = −10μA	15	—	—	Volts
BV_{EBO}	Emitter Breakdown Voltage	I_E = −1μA	15	—	—	Volts
BV_{ECO}	Emitter Breakdown Voltage	I_E = −1μA	15	—	—	Volts
V_{OFF}	Offset Voltage	I_B = −500μA	—	1.1	1.5	mV
V_{OFF}	Offset Voltage	I_B = −1mA	—	1.3	2.0	mV
V_{OFF}	Offset Voltage	I_B = −1.5mA	—	1.6	2.5	mV
	HIGH FREQUENCY CHARACTERISTICS					
r_s	Inverted Dynamic Saturation Resistance[4]	I_B = −1mA, I_E = 100μA	7	13	18	ohms
C_{ib}	Input Capacitance	V_{EB} = −6V, I_C = 0, f = 4mc	—	4	7	pF
C_{ob}	Output Capacitance	V_{CB} = −6V, I_E = 0, f = 4mc	—	6	9	pF
C_{eb}	Emitter Diode Capacitance[5]	I_E = 0.25μA, f = 10mc	—	12	16	pF
	Emitter Diode Recovery Time[6]	I_B = −1mA nom.	—	6	15	μsec
f_T	Gain Bandwidth Product	V_{CE} = −6V, I_E = 1mA, f = 4mc	7.6	12	—	mc
t_s	Storage Time (Inverted)	See Circuit of Figure 4	—	150	250	nsec

[3] Typical values are for engineering guidance only.
[4] To be measured in circuit of Figure 1.
[5] To be measured in circuit of Figure 2.
[6] To be measured in circuit of Figure 3.

SPRAGUE ENGINEERING BULLETIN 31,174B

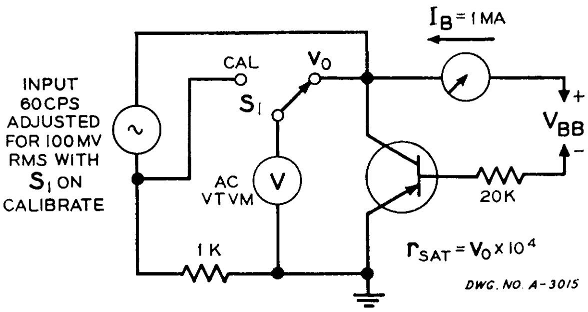


FIGURE 1
INVERTED DYNAMIC r_S TEST CIRCUIT

The inverted dynamic saturation resistance, which is the slope of the V_{OFF}, I_E characteristic at a specified base current, is measured in the circuit shown in Figure 1. The circuit reads r_S directly as the ratio of the a-c collector voltage, V_O to a calibrated a-c collector current.

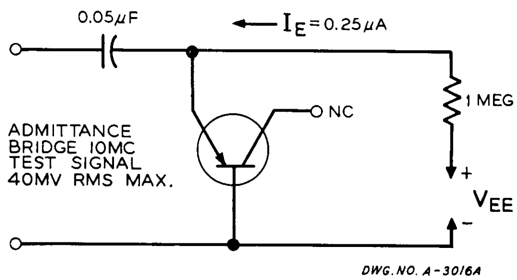


FIGURE 2
EMITTER DIODE CAPACITANCE TEST CIRCUIT

Figure 2 shows the test circuit for the measurement of the emitter diode capacitance, C_{eb}. The measurement is made with the emitter diode slightly forward biased ($I_E = 0.25\mu A$). The 10 MC test signal from the admittance bridge should be less than 40 MV RMS.

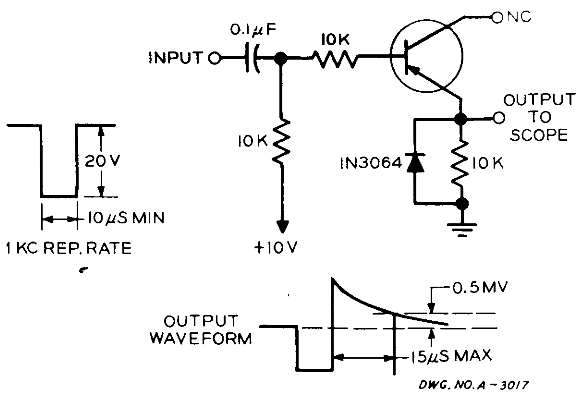


FIGURE 3
RECOVERY TIME TEST CIRCUIT

The emitter diode reverse recovery time, a measure of the transient response of the chopper, is measured in the circuit of Figure 3. The measurement is made as the time for the emitter current to recover from a specified forward value to a specified reverse value. The IN3064 diode across the 10K emitter resistance serves to clamp the emitter potential to reduce the output voltage change to a convenient level.

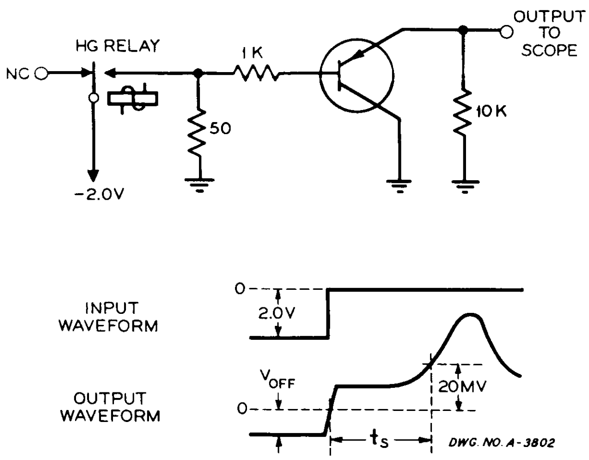


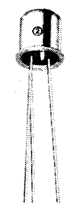
FIGURE 4
STORAGE TIME TEST CIRCUIT

SPRAGUE the mark of reliability

Engineering Bulletin

TYPE **2N3319**

TYPE 2N3319 P-N-P SILICON PRECISION-ALLOY TRANSISTORS



ACTUAL SIZE

DESIGNED for low-level, high-speed chopper applications, Type 2N3319 Silicon Precision-Alloy Transistors feature uniquely low storage time, ts, in the inverted chopper configuration. Matched pairs of Type 2N3319 SPAT® transistors are available upon request.

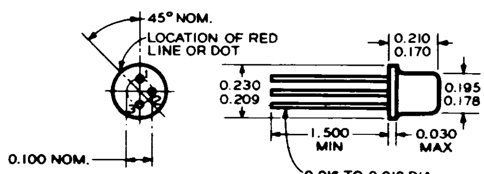
ABSOLUTE MAXIMUM RATINGS[1]

Storage Temperature	−65 C to + 140 C
Collector Voltage, V_{CBO}	−10 volts
Collector Voltage, V_{CEO}	−6 volts
Emitter Voltage, V_{EBO}	−10 volts
Emitter Voltage, V_{ECO}	−6 volts
Collector Current, I_C	−50 ma
Total Device Dissipation[2] at 25 C	150 mw
Lead Temperature at 1/16" ± 1/32" from case	230 C for 10 sec

[1] The maximum ratings are limiting absolute values above which the serviceability may be impaired from the viewpoint of life or satisfactory performance. The breakdown voltages may be far above the maximum voltage ratings. To avoid permanent damage to the transistors, do not attempt to measure these characteristics above the maximum ratings.

[2] Due to the nature of these transistors, the dissipation in the base emitter circuit may be appreciable under high base drive conditions and must be included in the total device dissipation. For temperatures above 25 C, derate by 1.3 mw/°C.

MECHANICAL SPECIFICATIONS



TERMINALS { LEAD 1 – EMITTER, LEAD 2 – BASE, LEAD 3 – COLLECTOR

ALL LEADS ISOLATED FROM CASE

NOTE 1: THIS LEAD DIA APPLIES TO ZONE BETWEEN 0.050 AND 0.250 FROM BASE SEAT. IN ZONE BETWEEN 0.250 AND 0.050, A MAX OF 0.021 DIA IS HELD. OUTSIDE OF THESE ZONES, THE LEAD DIA IS NOT CONTROLLED.

DWG NO A-38084

ELECTRICAL CHARACTERISTICS[3] at T = 25 C

	CHARACTERISTICS	TEST CONDITIONS		MIN.	TYP.	MAX.	UNITS
	D-C CHARACTERISTICS						
I_{CBO}	Collector Cutoff Current	V_{CB} = − 6V		—	—	3	nA
I_{CBO}	Collector Cutoff Current	V_{CB} = − 6V	T = +65C	—	—	50	nA
I_{EBO}	Emitter Cutoff Current	V_{EB} = − 6V		—	—	3	nA
I_{EBO}	Emitter Cutoff Current	V_{EB} = − 6V	T = +65C	—	—	50	nA
BV_{CBO}	Collector Breakdown Voltage	I_C = − 1 μA		10	—	—	volts
BV_{CEO}	Collector Breakdown Voltage	I_C = −10 μA		6	—	—	volts
BV_{EBO}	Emitter Breakdown Voltage	I_E = − 1 μA		10	—	—	volts
BV_{ECO}	Emitter Breakdown Voltage	I_E = − 1 μA		6	—	—	volts
V_{OFF}	Offset Voltage	I_B = −0.5mA		—	1.0	1.5	mV
V_{OFF}	Offset Voltage	I_B = −1mA		—	1.2	1.75	mV
V_{OFF}	Offset Voltage	I_B = −1.5mA		—	1.7	2.25	mV
	HIGH FREQUENCY CHARACTERISTICS						
r_S	Inverted Dynamic Saturation Resistance[4]	I_B = −1 mA	I_E = 100μA	5	10	18	ohms
C_{ib}	Input Capacitance	V_{EB} = −3V	I_C = 0 f = 4mc	—	5	8	pF
C_{ob}	Output Capacitance	V_{CB} = −3V	I_E = 1mA f = 4mc	—	7	10	pF
	Emitter Diode Recovery Time[5]	I_B = −1mA nom.		—	6	15	μsec
f_T	Gain Bandwidth Product	V_{CE} = −3V	I_E = 1mA f = 4mc	12	24	—	mc
t_s	Storage Time (Inverted)	See Circuit of Figure 3		—	150	250	nsec

[3] Typical values are for engineering guidance only.

[4] To be measured in circuit of Figure 1.

[5] To be measured in circuit of Figure 2.

"SPAT" is a registered trademark of the Philco Corp.

SPRAGUE ENGINEERING BULLETIN 31,175A

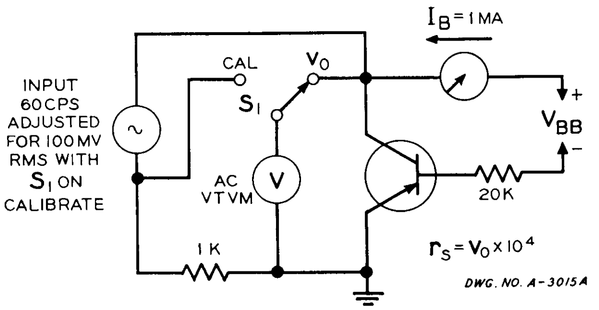


FIGURE 1

INVERTED DYNAMIC r_S TEST CIRCUIT

The inverted dynamic saturation resistance, which is the slope of the V_{EC}, I_E characteristic at a specified base current, is measured in the circuit shown in Figure 1. The circuit reads r_S directly as the ratio of the a-c collector voltage, V_o to a calibrated a-c collector current.

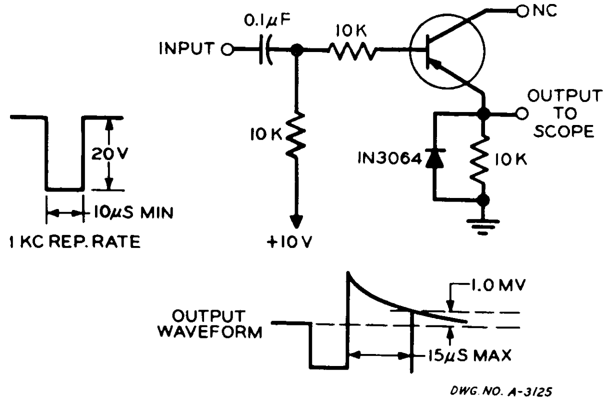


FIGURE 2

EMITTER DIODE RECOVERY TIME TEST CIRCUIT

The emitter diode reverse recovery time, a measure of the transient response of the chopper, is measured in the circuit of Figure 2. The measurement is made as the time for the emitter current to recover from a specified forward value to a specified reverse value. The IN3064 diode across the 10K emitter resistance serves to clamp the emitter potential to reduce the output voltage change to a convenient level.

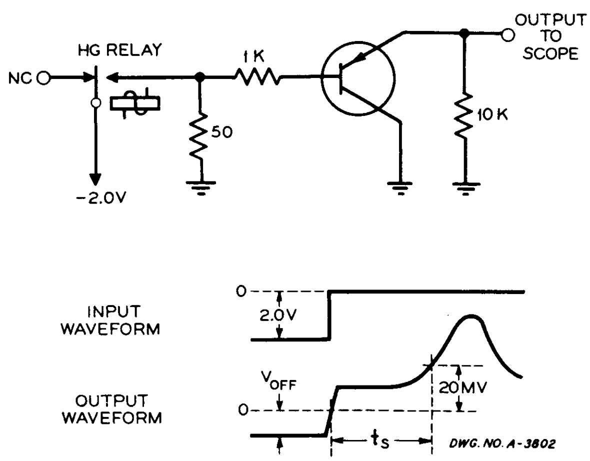


FIGURE 3

STORAGE TIME TEST CIRCUIT

No. 32033

SPRAGUE® THE MARK OF RELIABILITY

Engineering Bulletin

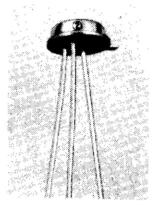
2N3840

TYPE 2N3840 SEPT® TRANSISTORS

— P-N-P Silicon Planar Epitaxial Series

DESIGNED FOR general purpose switching, amplifying, and chopping applications, Type 2N3840 Transistors feature:

- BV_{EBO} .... 50 volts
- I_{CBO} .... 0.5 nA
- h_{FE} 50
- V_{OFF} .... 0.8 mV

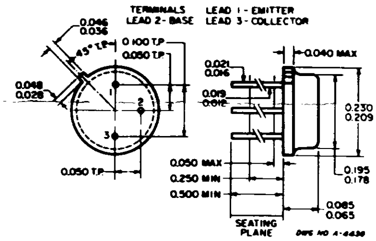


ABSOLUTE MAXIMUM RATINGS[1]

Storage Temperature	−65 to 200°C
Emitter-Base Voltage, V_{EBO}	50 volts
Emitter-Collector Voltage, V_{ECO}	50 volts
Collector-Base Voltage, V_{CBO}	50 volts
Collector-Emitter Voltage, V_{CEO}	50 volts
Collector Current, I_C	100 mA
Power Dissipation at 25°C ambient	400 mw
Derating Factor above 25°C ambient	2.3 mw/°C
Lead Temperature 1/16″ from case for 10 sec.	240°C

[1]The maximum ratings are limiting absolute values above which the serviceability may be impaired from the viewpoint of life or satisfactory performance. The breakdown voltages may be far above the maximum voltage ratings. To avoid permanent damage to the transistor, do not attempt to measure these characteristics above the maximum ratings.

MECHANICAL SPECIFICATIONS



ELECTRICAL CHARACTERISTICS at T = 25 C

		CONDITIONS		MIN.	MAX	UNITS
		D-C CHARACTERISTICS				
I_{EBO}	Emitter Cutoff Current	V_{EB} = −40 V			0.5	nA
I_{EBO}	Emitter Cutoff Current	V_{EB} = −40 V	T = 100C		20.0	nA
I_{CBO}	Collector Cutoff Current	V_{CB} = −40 V			0.5	nA
I_{CBO}	Collector Cutoff Current	V_{CB} = −40 V	T = 100C		20.0	nA
I_{ECO}	Emitter Cutoff Current	V_{EC} = −40 V			0.5	nA
I_{CEO}	Collector Cutoff Current	V_{CE} = −40 V			0.5	nA
BV_{CBO}	Collector-Base Voltage	I_C = −1 μA		50		Volts
BV_{EBO}	Emitter Base Voltage	I_E = −1 μA		50		Volts
BV_{CEO}	Collector-Emitter Voltage	I_C = −1 μA		50		Volts
BV_{ECO}	Emitter-Collector Voltage	I_E = −1 μA		50		Volts
V_{off}	Offset Voltage	I_B = −200 μA			0.8	mV
V_{off}	Offset Voltage	I_B = −1.0 mA			2.0	mV
V_{off}	Offset Voltage	I_B = −2.0 mA			2.5	mV
h_{FE}	Forward Current Gain	V_{CE} = −0.5V,	I_C = −200 μA	30		
h_{FE}	Forward Current Gain	V_{CE} = −0.5V,	I_C = −1.0 mA	50		
h_{FE} (Inv.)	Inverse Current Gain	V_{EC} = −0.5V,	I_E = −1.0 mA	1.5		
V_{BE}	Input Voltage	I_B = −0.5 mA,	I_C = −5.0 mA	0.60	0.85	Volts
V_{CE}	Saturation Voltage	I_B = −0.5 mA	I_C = −5.0 mA		0.1	Volts
r_s	Series Resistance	I_B = −1.0 mA,	I_e = −100 μA nominal		20	Ohms
		HIGH FREQUENCY CHARACTERISTICS				
C_{ob}	Collector Capacitance	V_{CB} = −6 V	I_E = 0		9	pF
C_{ib}	Emitter Capacitance	V_{EB} = −6 V	I_C = 0		6	pF
f_t	Gain-Bandwidth Product	V_{CE} = −6 V	I_E = 1.0 mA	6		Mc

SPRAGUE®
THE MARK OF RELIABILITY

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□ □ □

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EUROPE
Sprague Electric (U. K.) Ltd.
Trident House
Station Road
Hayes, Middlesex, England
Tel. 01.573-8833, Telex 261524

Sprague World Trade Corp.
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8008 Zurich, Switzerland
Tel. 051 47-01-33, Telex 53876

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Telex Sprague 25697F

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HONG-KONG
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P. O. Box 14289
Hong Kong
Tel. 70-5254

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In the construction of the components described, the full intent of the specification will be met. The Sprague Electric Company, however, reserves the right to make, from time to time, such departures from the detail specifications as may be required to permit improvements in the design of its products. Components made under military approvals will be in accordance with the approval requirements.

SPRAGUE THE MARK OF RELIABILITY Engineering Bulletin

2N4385
2N4386

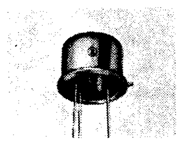
TYPE 2N4385 AND 2N4386 SEPT® TRANSISTORS

—— N-P-N Silicon Planar Epitaxial Series

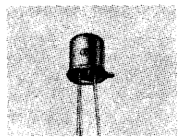
DESIGNED for use in low-level amplifier and switching circuits, Types 2N4385 and 2N-4386 high-gain, low-level, low noise transistors feature:

- h_{FE} at 10μA.........40 min.
- N.F. (wideband)...3 db max.

Type 2N4385 and 2N4386 were originally introduced under the Sprague house numbers TN57 and TN58, respectively.



TYPE 2N4385
(TO-5 CASE)



TYPE 2N4386
(TO-18 CASE)

ABSOLUTE MAXIMUM RATINGS[1]

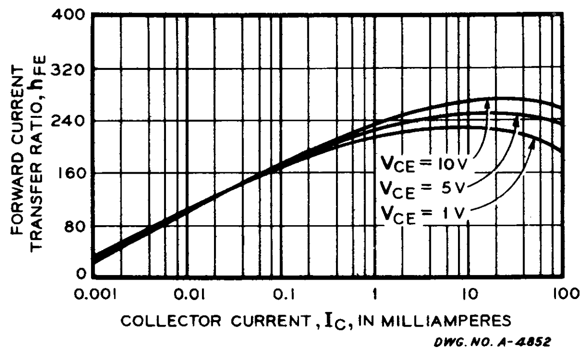
Collector to Base Voltage, V_{CBO}	40 volts
Collector to Emitter Voltage, V_{CEO}	30 volts
Emitter to Base Voltage, V_{EBO}	5 volts
Collector Current, I_C	0.8 amperes
Storage Temperature	−65 C to 200 C

	TYPE 2N4385	TYPE 2N4386
Total Device Dissipation at 25 C Ambient	800mW	500mW
Derating Factor above 25 C Ambient	4.57mW/°C	2.86mW/°C
Total Device Dissipation at 25 C Case Temp.	3 watts	1.8 watts
Derating Factor above 25 C Case Temp.	17.2mW/°C	10.3mW/°C

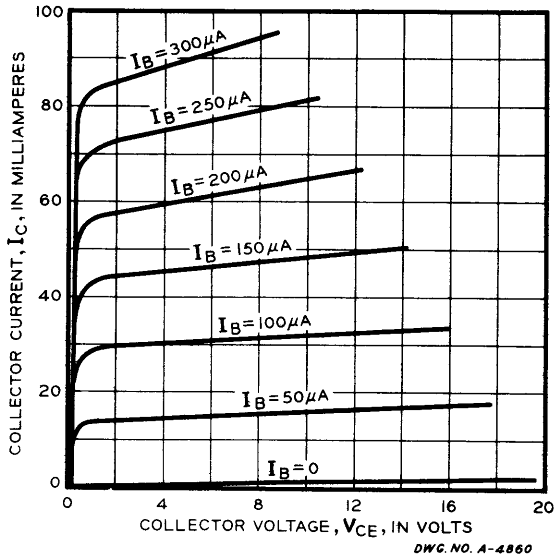
[1]The maximum ratings are limiting absolute values above which the serviceability may be impaired from the viewpoint of life or satisfactory performance. The breakdown voltages may be far above the maximum voltage ratings. To avoid permanent damage to the transistor, do not attempt to measure these characteristics above the maximum ratings.

ELECTRICAL CHARACTERISTICS at T = 25 C

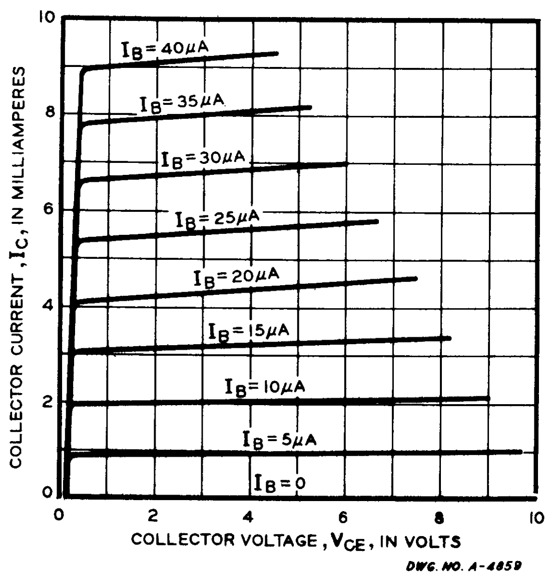
	CHARACTERISTICS	TEST CONDITIONS	MIN	TYP	MAX	UNITS
	D-C CHARACTERISTICS					
BV_{CBO}	Collector Breakdown Voltage	I_C = 10μA, I_E = 0	40	—	—	Volts
BV_{CEO}	Collector Breakdown Voltage	I_C = 10mA, I_B = 0	30	—	—	Volts
BV_{EBO}	Emitter Breakdown Voltage	I_E = 100nA, I_C = 0	5	—	—	Volts
I_{CBO}	Collector Cutoff Current	V_{CB} = 30V, I_E = 0	—	0.1	10	nA
h_{FE}	Current Amplification Factor	V_{CE} = 5V, I_C = 10μA	40	100	500	—
h_{FE}	Current Amplification Factor	V_{CE} = 5V, I_C = 1mA	100	200	—	—
h_{FE}	Current Amplification Factor	V_{CE} = 5V, I_C = 10mA	120	250	—	—
$V_{CE(SAT)}$	Collector Saturation Voltage	I_C = 10mA, I_B = 1mA	—	0.04	0.2	Volts
V_{BE}	Base Emitter Voltage	I_C = 10mA, I_B = 1mA	0.65	0.71	0.80	Volts
	SMALL SIGNAL CHARACTERISTICS					
f_T	Gain Bandwidth Product	V_{CE} = 5V, I_C = 500μA, f = 10MHz	30	50	120	MHz
C_{ob}	Output Capacitance	V_{CB} = 10V, I_E = 0, f = 1 MHz	—	5	8	pF
h_{fe}	Current Amplification Factor	V_{CE} = 5V, I_C = 1mA, f = 1kHz	100	250	1000	—
h_{ib}	Input Impedance	V_{CE} = 5V, I_C = 1mA, f = 1kHz	20	26	32	Ohms
h_{ob}	Output Admittance	V_{CE} = 5V, I_C = 1mA, f = 1kHz	—	0.09	0.2	μmhos
$r_{b'}C_c$	Collector-Base Time Constant	V_{CE} = 5V, I_C = 1mA, f = 10MHz	100	250	500	psec
N.F.	Wide Band Noise Figure	I_C = 10μA, V_{CE} = 5V, Rg = 10K, Band width- 10Hz to 15.7kHz	—	1	3	db



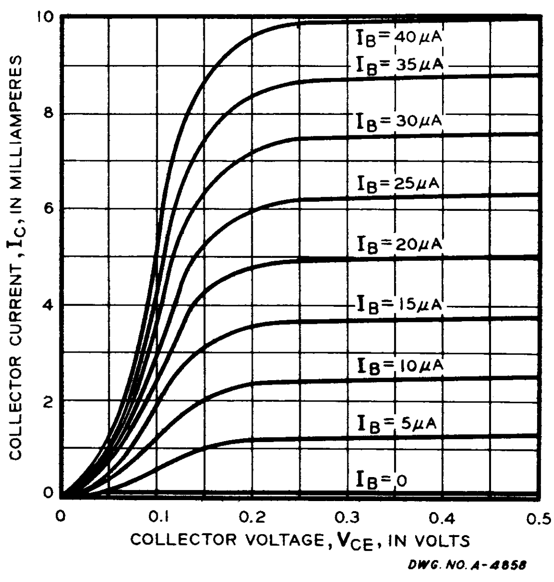
TYPICAL BETA AS A FUNCTION OF COLLECTOR CURRENT AT 25 C



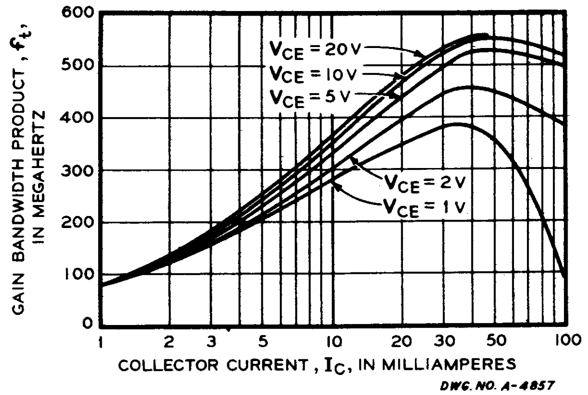
TYPICAL COLLECTOR CHARACTERISTICS AT 25 C



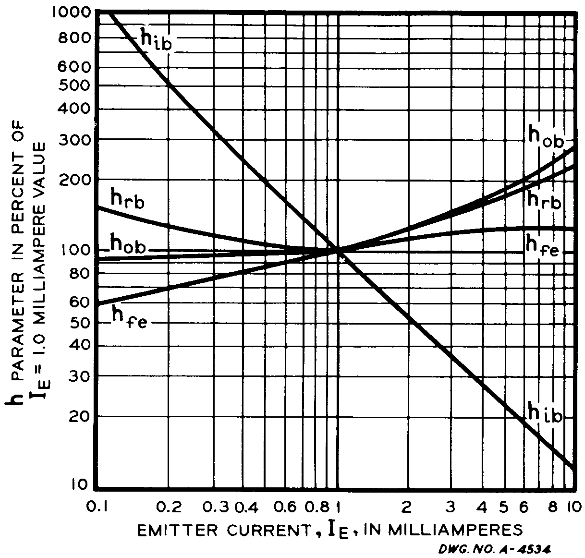
TYPICAL COLLECTOR CHARACTERISTICS AT 25 C



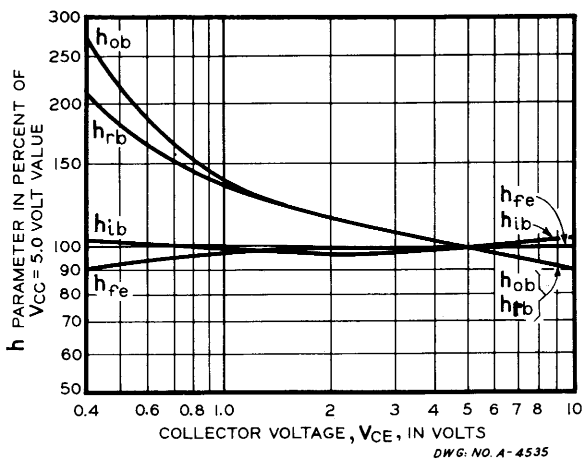
TYPICAL SATURATED REGION COLLECTOR CHARACTERISTICS AT 25 C



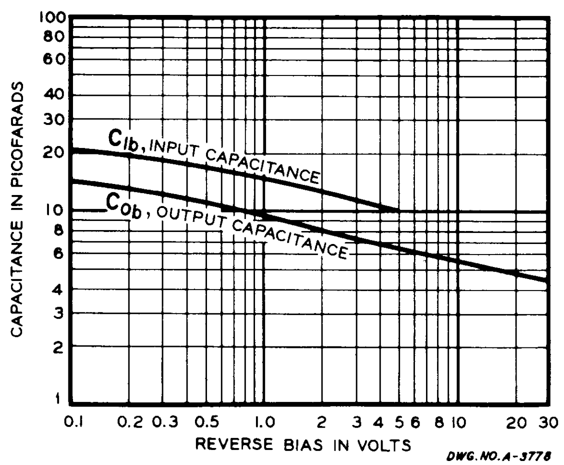
TYPICAL f_T AS A FUNCTION OF COLLECTOR CURRENT AT 25 C



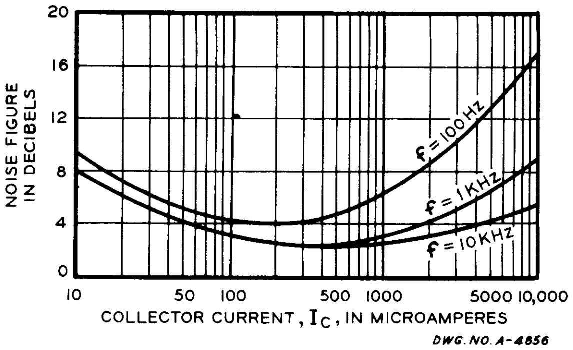
TYPICAL h PARAMETERS AS A FUNCTION OF EMITTER CURRENT AT 25 C, NORMALIZED FOR V_C = 5V, I_E = 1 mA



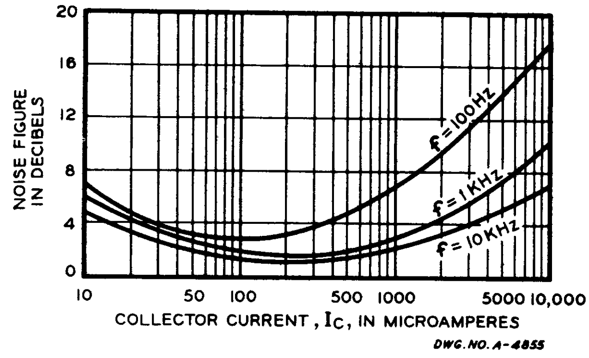
TYPICAL h PARAMETERS AS A FUNCTION OF COLLECTOR VOLTAGE AT 25 C, NORMALIZED FOR V_C = 5V, I_E = 1mA



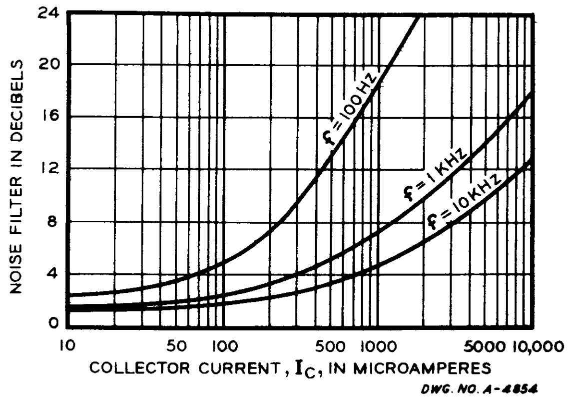
OUTPUT CAPACITANCE AS A FUNCTION OF COLLECTOR-BASE VOLTAGE AND INPUT CAPACITANCE AS A FUNCTION OF EMITTER BASE VOLTAGE AT 25 C



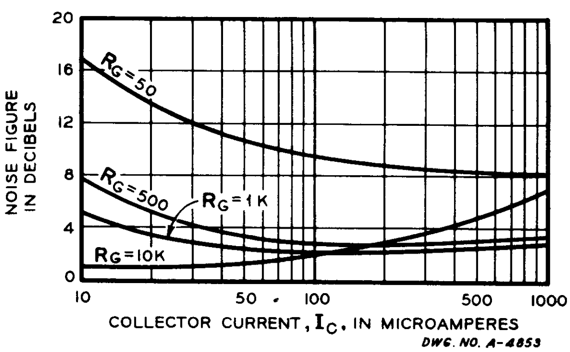
TYPICAL SPOT NOISE FIGURE CURVES AT 25 C
WITH R_G = 500, V_{CE} = 5V



TYPICAL SPOT NOISE FIGURE CURVES AT 25 C
WITH R_G = 1K, V_{CE} = 5V

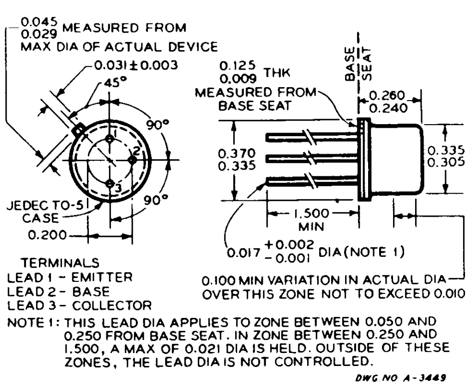


TYPICAL SPOT NOISE FIGURE CURVES AT 25 C
WITH R_G = 10K, V_{CE} = 5 V

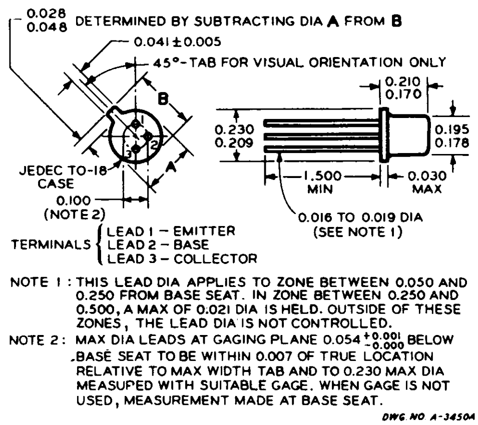


TYPICAL WIDEBAND (10Hz to 15.7kHz) NOISE
FIGURE CURVES AT 25C WITH V_{CE}=5V

MECHANICAL SPECIFICATIONS



Type 2N4385



Type 2N4386

Marking. All transistors will be marked with the type number; the name SPRAGUE or the registered Sprague trademark, ②, at vendor's option; and date code of acceptance, unless otherwise specified.

In the construction of the components described, the full intent of the specification will be met. The Sprague Electric Company, however, reserves the right to make, from time to time, such departures from the detail specifications as may be required to permit improvements in the design of its products. Components made under military approvals will be in accordance with the approval requirements.

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