No. 34001

SPRAGUE
THE MARK OF RELIABILITY

Engineering Bulletin

2N941
2N942
2N1917
2N1918

TYPE 2N941, 2N942, 2N1917 and 2N1918 SEPT® TRANSISTORS

—— PNP Silicon Planar Epitaxial Series

DESIGNED for industrial service chopper applications, Type 2N941, 2N942, 2N1917, and 2N1918 SEPT® Transistors offer outstanding performance for new design yet are ideal as replacements for many older silicon transistors.

TYPE 2N1917, 2N1918
(TO-5 CASE)

TYPE 2N941, 2N942
(TO-18 CASE)

ABSOLUTE MAXIMUM RATINGS[1]

Storage Temperature . . . . . −65C to +175C
Collector-Base Voltage, V_{CBO} . . . . . 25 volts
Collector-Emitter Voltage, V_{CEO} . . . . . 8 volts
Emitter-Base Voltage, V_{EBO} . . . . . 25 volts

Collector Current, I_C . . . . . 50 mA
Total Device Dissipation at 25 C Ambient . . . . . 250 mW
Derating Factor above 25 C Ambient . . . . . 1.6mW/°C
Lead Temperature (1/16" from case for 10 sec.) . . . 240 C

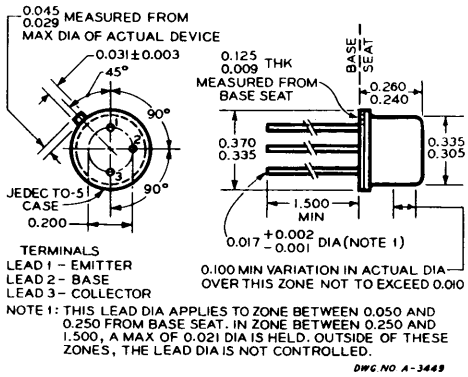
[1]The maximum ratings are limiting absolute values above which the serviceability may be impaired from the viewpoint of life or satisfactory performance. The breakdown voltages may be far above the maximum voltage ratings. To avoid permanent damage to the transistor, do not attempt to measure these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

ELECTRICAL CHARACTERISTICS at T = 25 C

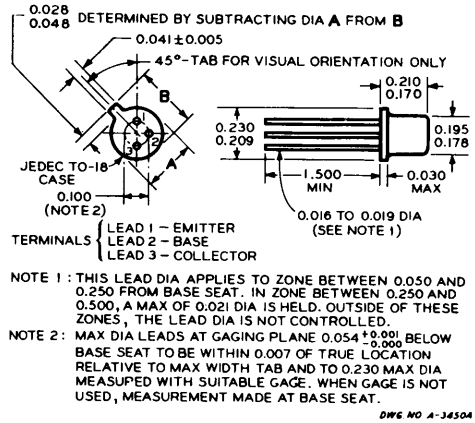
	CHARACTERISTICS	TEST CONDITIONS			MIN.	MAX.	UNITS
		D-C CHARACTERISTICS					
I_{CBO}	Collector Cutoff Current	V_{CB} = −4.5V			—	2.5	nA
I_{EBO}	Emitter Cutoff Current	V_{EB} = −4.5V			—	2.5	nA
I_{CBO}	Emitter Cutoff Current	V_{CB} = −4.5V,	T_A = 60C		—	50.0	nA
V_{OFF}	Emitter Offset Voltage	I_B = 250μA,	I_E = 0	2N941, 2N1917	—	1.0	mV
				2N942, 2N1918	—	3.0	mV
I_{OFF}	Collector Offset Current	V_{CB} = 1.5V		2N941, 2N1917	—	−1.0	nA
				2N942, 2N1918	—	−3.0	nA
V_{BE}	Base Emitter Voltage	V_{CE} = 1.5V,	I_C = 1mA		—	3	volts
h_{FE}	Forward Current Gain	V_{CE} = −1.5V,	I_C = −1mA		10	—	—
		SMALL SIGNAL CHARACTERISTICS					
h_{fe}	Forward Current Gain	V_{CB} = −6V,	I_E = −1mA,		25	—	—
		f = 1kHz					
h_{fe}	Forward Current Gain	V_{CB} = −6V,	I_E = −1mA,	2N941, 2N1917	4	—	—
		f = 4MHz		2N942, 2N1918	2.5	—	—
C_{ob}	Output Capacitance	V_{CB} = −6V,	I_E = −1mA,		—	14	pF
		f = 1MHz					

SPRAGUE ENGINEERING BULLETIN 34001

MECHANICAL SPECIFICATIONS



TYPE 2N1917, 2N1918



TYPE 2N941, 2N942

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.

No. 34002

SPRAGUE THE MARK OF RELIABILITY

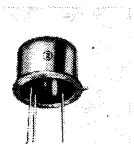
Engineering Bulletin

2N943
2N944
2N1919
2N1920

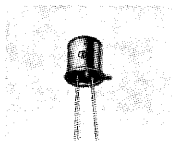
TYPE 2N943 2N944, 2N1919 and 2N1920 SEPT® TRANSISTORS

—— PNP Silicon Planar Epitaxial Series

INTENDED for general-purpose chopper applications, Type 2N943, 2N944, 2N1919, and 2N1920 SEPT® Transistors provide outstanding low-cost performance, both for new design and as economy replacements for many older types of silicon transistors.



TYPE 2N1919, 2N1920
(TO-5 CASE)



TYPE 2N943, 2N944
(TO-18 CASE)

ABSOLUTE MAXIMUM RATINGS[1]

Storage Temperature . . . . . −65C to +175C
Collector-Base Voltage . . . . . −40 volts
Collector-Emitter Voltage . . . . . −18 volts
Emitter-Base Voltage . . . . . −40 volts

Collector Current, I_C . . . . . 50 mA
Total Device Dissipation at 25 C Ambient . . . . . 250 mW
Derating Factor above 25 C Ambient . . . . . 1.66mW/°C
Lead Temperature (1/16" from case for 10 sec.) . . . 240 C

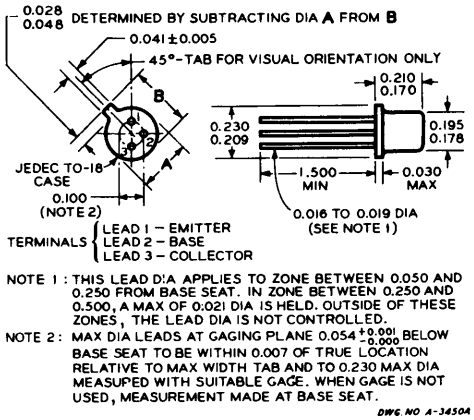
[1]The maximum ratings are limiting absolute values above which the serviceability may be impaired from the viewpoint of life or satisfactory performance. The breakdown voltages may be far above the maximum voltage ratings. To avoid permanent damage to the transistor, do not attempt to measure these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

ELECTRICAL CHARACTERISTICS at T = 25 C

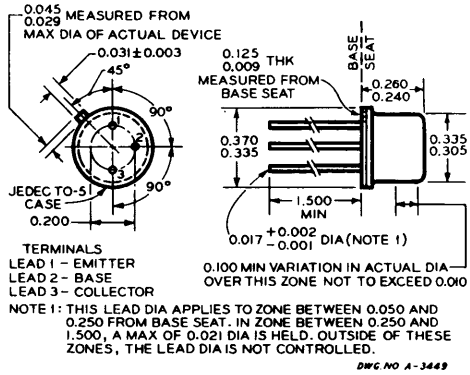
	CHARACTERISTICS	TEST CONDITIONS		MIN	MAX.	UNITS
	D-C CHARACTERISTICS					
BV_{CBO}	Collector Breakdown Voltage	$I_C = -100\mu A$		−40	—	Volts
BV_{EBO}	Emitter Breakdown Voltage	$I_E = -100\mu A$		−40	—	Volts
BV_{CEO}	Collector-Emitter Breakdown Voltage	$I_C = -100\mu A$		−18	—	Volts
I_{CBO}	Collector Cutoff Current	$V_{CB} = -30V$		—	5	nA
I_{EBO}	Emitter Cutoff Current	$V_{EB} = -30V$		—	5	nA
I_{OFF}	Collector Offset Current	$V_{BC} = 10V$	2N943, 2N1919	—	1	nA
			2N944, 2N1920	—	1.5	nA
I_{ECX}	Emitter-Collector Inverse Leakage Current	$V_{BC} = 10V$, $V_{EC} = -15V$	2N943, 2N1919	—	1.5	nA
			2N944, 2N1920	—	2.5	nA
V_{OFF}	Collector Offset Voltage	$I_B = -500\mu A$	2N943, 2N1919	—	2	mV
			2N944, 2N1920	—	3	mV
$V_{EC(SAT)}$	Emitter-Collector Saturation Voltage	$I_B = -500\mu A$, $I_E = -20\mu A$	2N943, 2N1919	—	3	mV
			2N944, 2N1920	—	4	mV
V_{BE}	Base Input Voltage	$V_{CE} = -1.5V$, $I_B = 0.1mA$		—	3	Volts
h_{FE}	Forward Current Gain	$V_{CF} = -0.5V$, $I_B = 0.1mA$		10	—	—
	HIGH FREQUENCY CHARACTERISTICS					
$f\alpha_b$	Alpha Cutoff Frequency	$V_{CB} = -6V$, $I_E = 1mA$		1.0	—	MHz
C_{ob}	Output Capacitance	$V_{CB} = -6V$, $I_E = 1mA$, f = 1MHz		—	14	pF

SPRAGUE ENGINEERING BULLETIN 34002

MECHANICAL SPECIFICATIONS



TYPE 2N943, 2N944



TYPE 2N1919, 2N1920

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.

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No. 31,104B
Supersedes No. 31,104A

SPRAGUE the mark of reliability

Engineering Bulletin

TYPE 2N1118
SECOND PRINTING

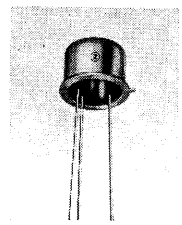
TYPE 2N1118 SILICON P-N-P PRECISION-ALLOY TRANSISTORS

DESIGNED for amplifier and oscillator applications at frequencies through 15 megacycles, Type 2N1118 hermetically-sealed P-N-P Silicon Precision-Alloy Transistors may be operated at junction temperatures up to 140 C with excellent performance.

Rated at 150 mw total dissipation with a collector voltage rating of 25 volts, Type 2N1118 transistors feature very low leakage currents and low saturation voltage. The amplifier stage gain at 140 C is within a few db of the gain at room temperature.

Particularly well-suited for high-temperature applications, such as in airborne equipment, Type 2N1118 Precision-Alloy Transistors are designed to meet the environmental requirements of Military Specification MIL-S-19500.

Sprague SPAT® Transistors are fully licensed under Philco patents.



ACTUAL SIZE

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

ABSOLUTE MAXIMUM RATINGS[1]

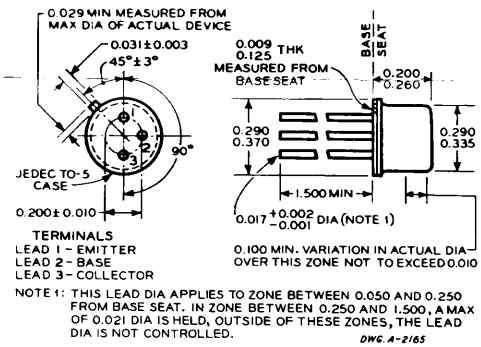
Storage Temperature . . . . . −65 C to +140 C
Junction Temperature . . . . . +140 C
Junction Temperature Rise (free air) . . . . . 0.77°C/mw
Collector Voltage[2], V_{CE} or V_{CB} . . . . . −25 volts
Collector Current, I_C . . . . . −50 ma
Total Device Dissipation[3] at 25 C . . . . . 150 mw
Lead Temperature 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.

[2] In this class of transistors, the maximum collector voltage is limited by the punchthrough phenomenon.

[3] Due to the nature of this transistor, the dissipation in the base emitter circuit may be appreciable under high base drive conditions and must be included in the total device dissipation. (See Input Characteristic Curves.)

MECHANICAL SPECIFICATIONS



ELECTRICAL CHARACTERISTICS[4] at T = 25 C

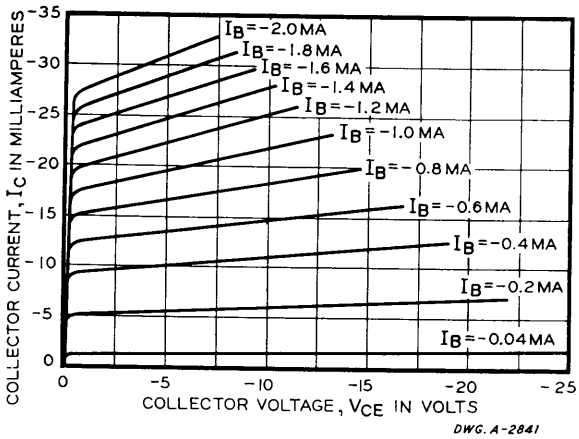
	CHARACTERISTICS	TEST CONDITIONS		MIN.	TYPICAL	MAX.	UNITS
	D-C CHARACTERISTICS						
I_{CBO}	Collector Current[5]	V_{CB} = −10 V		—	.001	0.1	μA
I_{CBO}	Collector Current	V_{CB} = −25 V		—	.002	1.0	μA
I_{EBO}	Emitter Current	V_{EB} = −10 V		—	.001	0.1	μA
V_{PT}	Punchthrough Voltage	———		25	—	—	volts
	SMALL SIGNAL PARAMETERS						
h_{fe}	Current Amplification Factor	V_C = −6 V	I_E = 1 mA	15	35	—	—
f_{max}	Maximum Frequency of Oscillation	V_C = −6 V	I_E = 1 mA	8	18	—	mc
$r_b'C_c$	Extrinsic Base Resistance Collector Capacitance Product	V_C = −6 V	I_E = 1 mA	—	1250	5000	psec
C_{ob}	Output Capacitance	V_C = −6 V	I_E = 1 mA	—	6	12	pF
h_{ib}	Input Resistance	V_C = −6 V	I_E = 1 mA	—	40	90	ohms
h_{ob}	Output Conductance	V_C = −6 V	I_E = 1 mA	—	1.5	2.5	μmhos

[4] Typical values are for engineering guidance only.

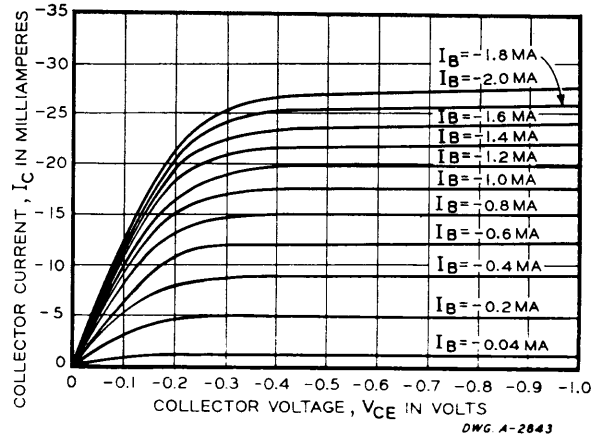
[5] The saturation current will approximately double with every 10 C of temperature. With ratings at any collector voltage then, the ICBO may be calculated for any temperature by doubling the low voltage ICBO for every 10 C and adding the difference between the room temperature ICBO at the desired voltage and the room temperature ICBO at low voltage.

SPRAGUE ENGINEERING BULLETIN 31,104B

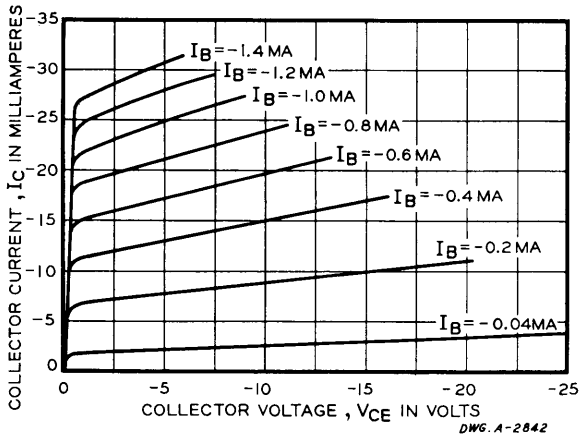
CHARACTERISTIC CURVES OF TYPE 2N1118 TRANSISTORS



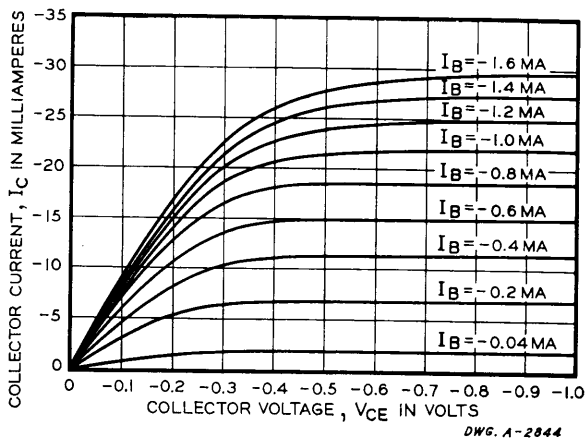
TYPICAL COLLECTOR CHARACTERISTICS
IN GROUNDED EMITTER CONFIGURATION
AT 25 C



TYPICAL SATURATED REGION COLLECTOR CHARACTERISTICS
IN GROUNDED EMITTER CONFIGURATION
AT 25 C

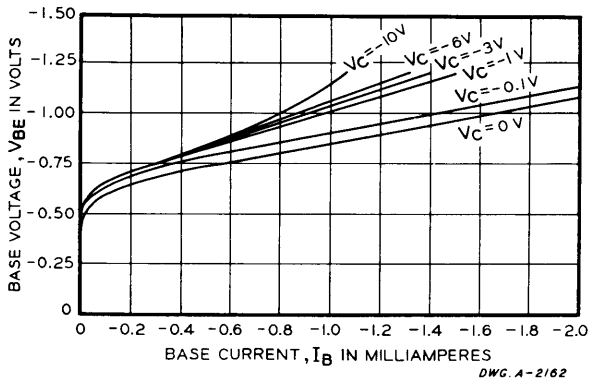


TYPICAL COLLECTOR CHARACTERISTICS
IN GROUNDED EMITTER CONFIGURATION
AT 125 C

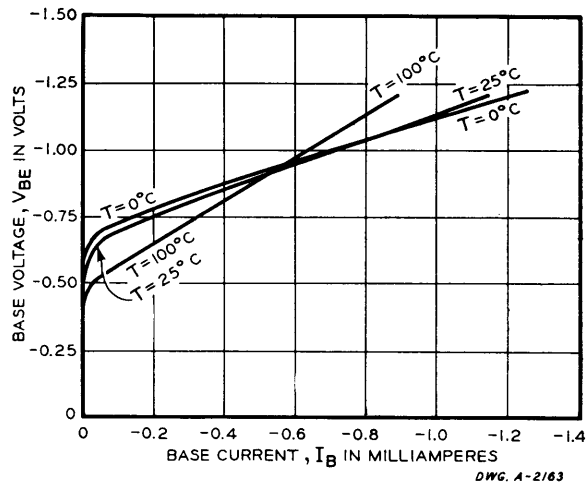


TYPICAL SATURATED REGION COLLECTOR CHARACTERISTICS
IN GROUNDED EMITTER CONFIGURATION
AT 125 C

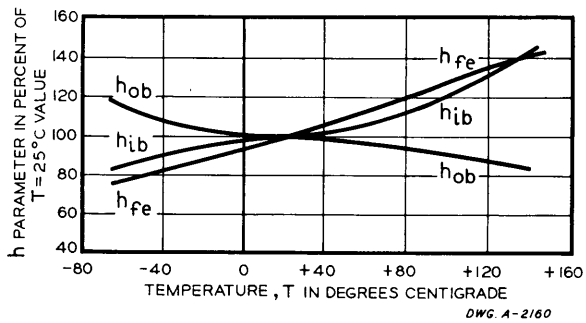
CHARACTERISTIC CURVES OF TYPE 2N1118 TRANSISTORS - - cont.



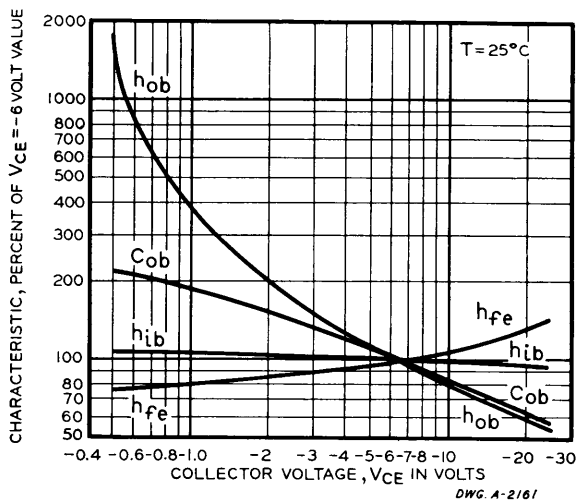
TYPICAL INPUT CHARACTERISTICS
IN GROUNDED EMITTER CONFIGURATION
AT 25 C



TYPICAL INPUT CHARACTERISTICS
IN GROUNDED EMITTER CONFIGURATION
AT 125 C

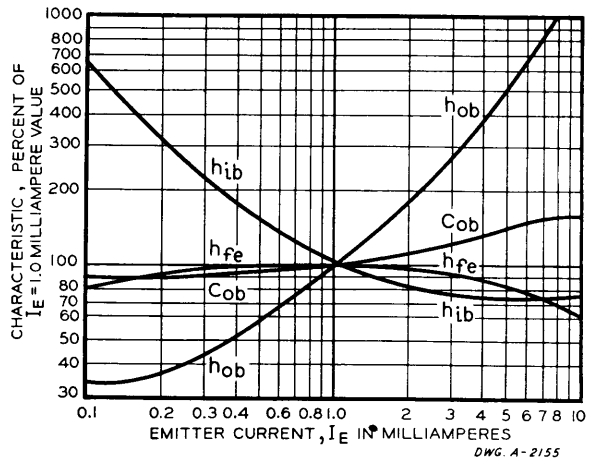


TYPICAL h PARAMETERS
AS A FUNCTION OF TEMPERATURE
NORMALIZED FOR 25 C
WITH V_{CE} = −6 VOLTS, I_E = 1.0 MA



TYPICAL CHARACTERISTICS
AS A FUNCTION OF COLLECTOR VOLTAGE
NORMALIZED FOR V_{CE} = −6 VOLTS
WITH I_E = 1.0 MA

CHARACTERISTIC CURVES OF TYPE 2N1118 TRANSISTORS - - cont.



TYPICAL CHARACTERISTICS AS A FUNCTION OF EMITTER CURRENT NORMALIZED FOR I_E=1.0 MA WITH V_{CE} = −6 VOLTS

● ● ●

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

2N1118A

TYPE 2N1118A P-N-P SILICON PRECISION-ALLOY TRANSISTORS

DESIGNED for amplifier and oscillator applications at frequencies through 15 megacycles, Type 2N1118 hermetically-sealed P-N-P silicon Surface-Alloy Transistors may be operated at junction temperatures up to 140 C with excellent performance.

Rated at 150 mw total dissipation with a collector voltage rating of 25 volts, Type 2N1118A transistors feature very low leakage currents and low saturation voltage. The amplifier stage gain at 140 C is within a few db of the gain at room temperature.

Particularly well-suited for high-temperature applications, such as in airborne equipment, Type 2N1118A SPAT® transistors are designed to meet the environmental requirements of Military Specification MIL-S-19-500A.

ACTUAL SIZE

ABSOLUTE MAXIMUM RATINGS[1]

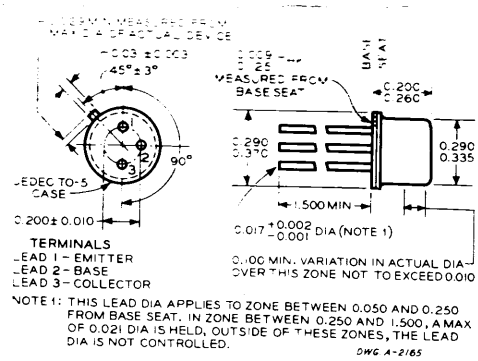
Storage Temperature	−65 C to +140 C
Junction Temperature	+140 C
Junction Temperature Rise (free air)	0.77°C mw
Collector Voltage[2], V_{CE} or V_{CB}	−25 volts
Collector Current, I_C	−50 ma
Total Device Dissipation[3] at 25 C	150 mw
Lead Temperature at 1/16" ± 1/32" from case	230 C for 10 sec

[1] The maximum ratings are limiting absolute values above which the serviceability may be impaired from the viewpoint of life or satisfactory performance.

[2] In this class of transistors, the maximum collector voltage is limited by the punchthrough phenomenon.

[3] Due to the nature of this transistor, the dissipation in the base emitter circuit may be appreciable under high base drive conditions and must be included in the total device dissipation. (See Input Characteristic Curves.)

MECHANICAL SPECIFICATIONS



ELECTRICAL CHARACTERISTICS[4] at T = 25 C

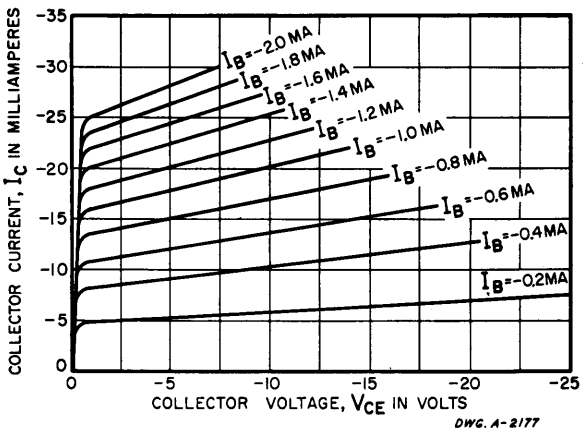
	CHARACTERISTICS	TEST CONDITIONS	MIN.	TYPICAL	MAX.	UNITS
	D-C CHARACTERISTICS					
I_{CBO}	Collector Current[5]	V_{CB} = −25 V	—	—	1.0	μA
I_{EBO}	Emitter Current	V_{EB} = −10 V	—	.001	0.1	μA
V_{PT}	Punchthrough Voltage		25	—	—	volts
	SMALL SIGNAL PARAMETERS					
h_{fe}	Current Amplification Factor	V_C = −6 V, I_E = 1 ma	15	25	35	—
f_{max}	Maximum Frequency of Oscillation	V_C = −6 V, I_E = 1 ma	8	18	—	mc
$r_b'C_c$	Extrinsic Base Resistance Collector Capacitance Product	V_C = −6 V, I_E = 1 ma	—	1250	5000	μμsec
C_{ob}	Output Capacitance	V_C = −6 V, I_E = 1 ma	—	6	12	μμF
h_{ib}	Input Resistance	V_C = −6 V, I_E = 1 ma	—	50	90	ohms
h_{ob}	Output Conductance	V_C = −6 V, I_E = 1 ma	—	1.5	2.5	μmhos

[4] Typical values are for engineering guidance only.

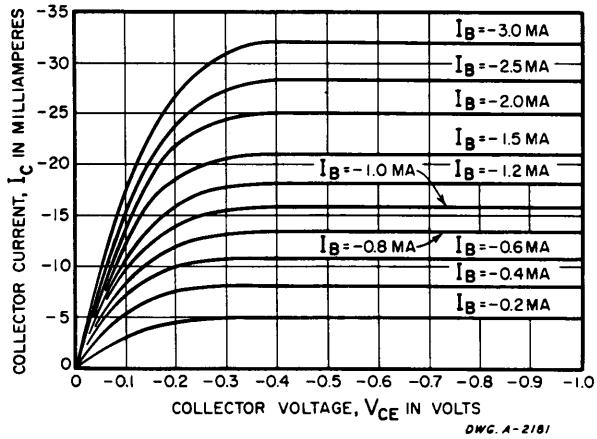
[5] The saturation current will approximately double with every 10 C of temperature. With ratings at any collector voltage then, the I_{CBO} may be calculated for any temperature by doubling the low voltage I_{CBO} for every 10 C and adding the difference between the room temperature I_{CBO} at the desired voltage and the room temperature I_{CBO} at low voltage.

SPRAGUE ENGINEERING BULLETIN 31,105

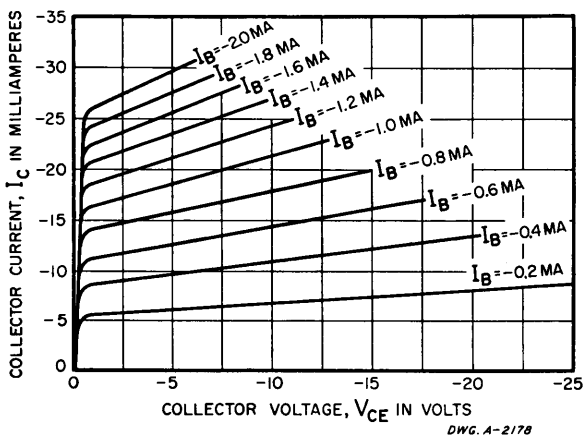
CHARACTERISTIC CURVES OF TYPE 2N1118A TRANSISTORS



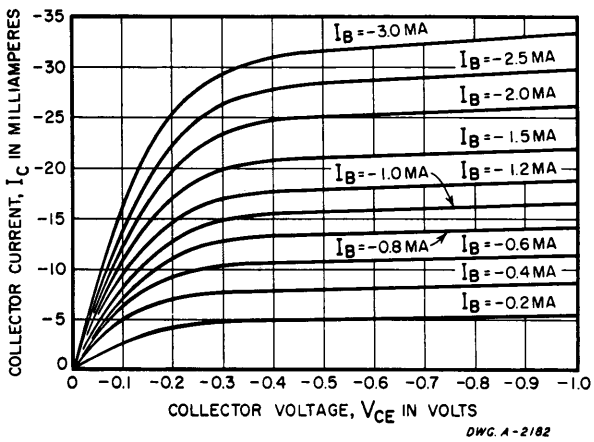
TYPICAL COLLECTOR CHARACTERISTICS
IN GROUNDED EMITTER CONFIGURATION
AT 25 C



TYPICAL SATURATED REGION COLLECTOR CHARACTERISTICS
IN GROUNDED EMITTER CONFIGURATION
AT 25 C

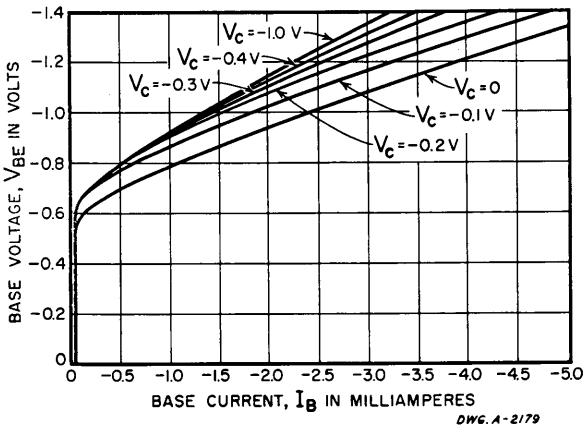


TYPICAL COLLECTOR CHARACTERISTICS
IN GROUNDED EMITTER CONFIGURATION
AT 125 C

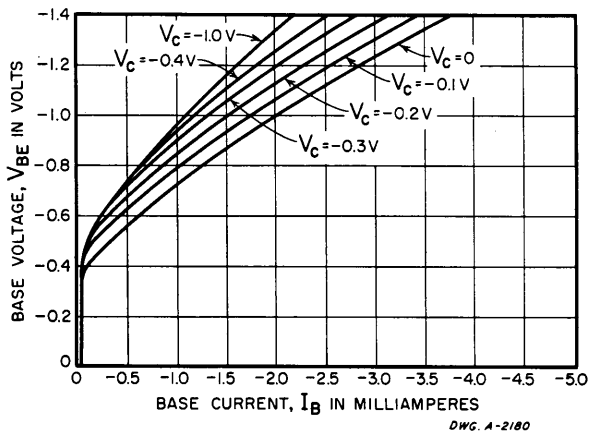


TYPICAL SATURATED REGION COLLECTOR CHARACTERISTICS
IN GROUNDED EMITTER CONFIGURATION
AT 125 C

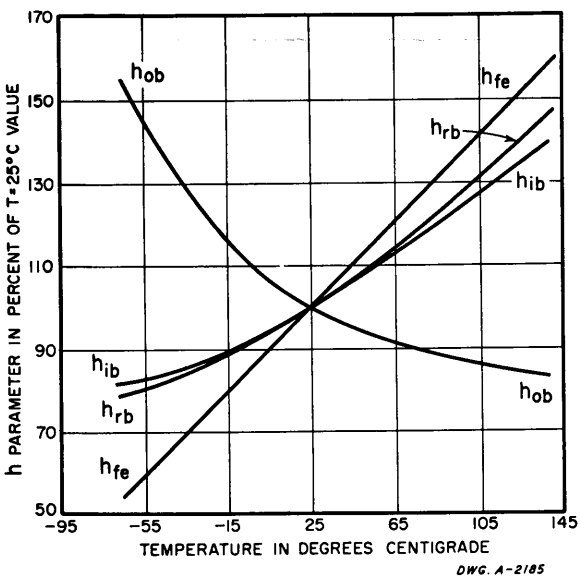
CHARACTERISTIC CURVES OF TYPE 2N1118A TRANSISTORS - - cont.



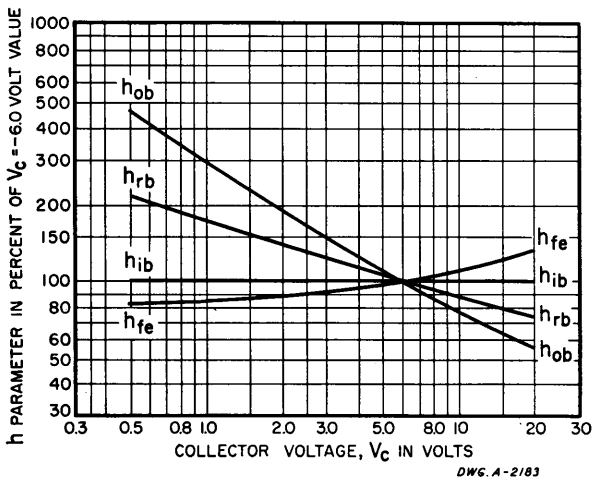
TYPICAL INPUT CHARACTERISTICS
IN GROUNDED EMITTER CONFIGURATION
AT 25 C



TYPICAL INPUT CHARACTERISTICS
IN GROUNDED EMITTER CONFIGURATION
AT 125 C

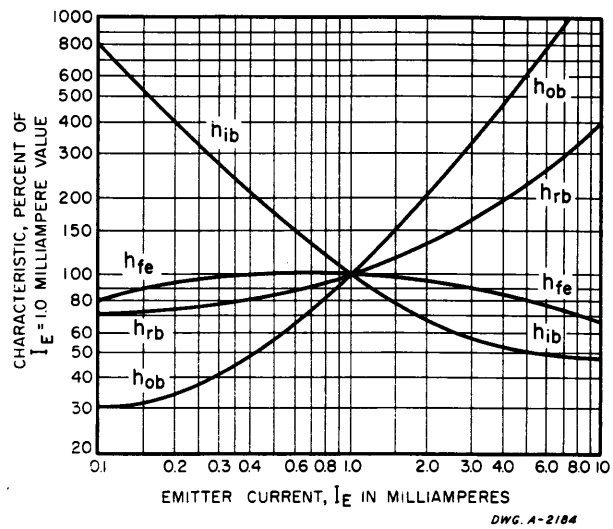


TYPICAL h PARAMETERS
AS A FUNCTION OF TEMPERATURE
NORMALIZED FOR
V_{CE} = -6 VOLTS, I_E = 1.0 MILLIAMPERE
AT 25 C



TYPICAL h PARAMETERS
AS A FUNCTION OF COLLECTOR VOLTAGE
NORMALIZED FOR
V_C = -6 VOLTS, I_E = 1.0 MILLIAMPERE
AT 25 C

CHARACTERISTIC CURVES OF TYPE 2N1118A TRANSISTORS - - cont.



TYPICAL h PARAMETERS AS A FUNCTION OF EMITTER CURRENT NORMALIZED FOR V_{CE} = −6 VOLTS, I_E = 1.0 MA AT 25 C

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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.

No. E. B. 31,106B
Supersedes No. 31,106A

SPRAGUE
THE MARK OF RELIABILITY

Engineering Bulletin

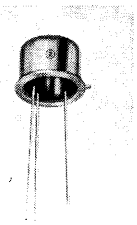
2N1119

TYPE 2N1119 SILICON P-N-P PRECISION-ALLOY TRANSISTORS

HIGH-SPEED switching at high temperatures is the major application for the Type 2N1119 hermetically-sealed silicon P-N-P Precision-Alloy Transistors. The frequency at which β equals unity (f_T) is typically about 11 megacycles.

The use of silicon permits the operation of these transistors at junction temperatures up to 140 C with excellent performance. Since the saturation resistance is typically less than 10 ohms, the voltage drop at saturation is in the order of a tenth of a volt. Consequently, there is very low power dissipation in the "on" condition. This permits the designer to gain the advantages of low voltage operation and minimum load impedance.

Because the input voltage is usually four or five times the saturation voltage even at elevated temperatures, Type 2N1119 Precision-Alloy Transistors are particularly suited for direct coupled switching circuits. They feature very low leakage currents and a 150 mw rated dissipation at 25 C ambient temperature.



ACTUAL SIZE

Type 2N1119 SPAT® Transistors may be specified to meet Military Specification MIL-S-19500.

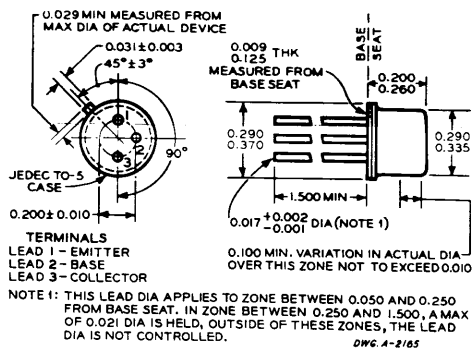
"SPAT" is a registered trademark of the Philco Corporation.

ABSOLUTE MAXIMUM RATINGS[1]

Storage Temperature	−65 C to +140 C
Junction Temperature	+140 C
Junction Temperature Rise (free air)	0.77°C/mw
Collector Voltage[2], V_{CB} or V_{CE}	−10 volts
Collector Current, I_C	−50 ma
Total Device Dissipation[3] 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 diode breakdown and punchthrough voltages may be far above the maximum collector voltage rating. For this reason it is important that the 2N1119 not be tested above the maximum voltage rating to avoid permanent damage to the transistor.

MECHANICAL SPECIFICATIONS



[2] In this class of transistor, the maximum collector voltage is limited by the punchthrough phenomenon.

[3] Due to the nature of this transistor, the dissipation in the base emitter circuit may be appreciable under high base drive conditions and must be included in the total device dissipation. (See Input Characteristic Curves).

ELECTRICAL CHARACTERISTICS[4] at T = 25 C

	CHARACTERISTICS	TEST CONDITIONS		MIN.	TYPICAL	MAX.	UNITS
	D-C CHARACTERISTICS						
I_{CBO}	Collector Current[5]	V_{CB} = −10 V		—	.001	0.1	μA
I_{EBO}	Emitter Current	V_{EB} = −10 V		—	.001	0.1	μA
h_{FE}	Current Amplification Factor	V_{CE} = −0.5 V	I_C = −15 mA	15	25	—	—
	SWITCHING CHARACTERISTICS						
	ON CONDITION						
V_{CE}	Collector Voltage	I_C = −5 ma	I_B = −0.8 mA	—	0.08	0.15	volts
V_{BE}	Base Voltage	I_C = −5 ma	I_B = −0.8 mA	0.75	0.9	1.0	volts
	OFF CONDITION						
I_C	Collector Current	V_{CE} = −4.5 V	V_{BE} = −0.45 V	—	5	25	μA
	SMALL SIGNAL PARAMETERS						
h_{fe}	Current Amplification Factor	V_C = −6 V f = 4 mc	I_E = 1 mA	1.8	5.0	—	—
$r_b'C_c$	Extrinsic Base Resistance Collector Capacitance Product	V_C = −6 V	I_E = 1 mA	—	1500	5000	psec
C_{ob}	Output Capacitance	V_C = −6 V	I_E = 1 mA	—	6	12	pF
K'_s	Hole Storage[6]	I_B = −1 mA		—	90	175	nsec

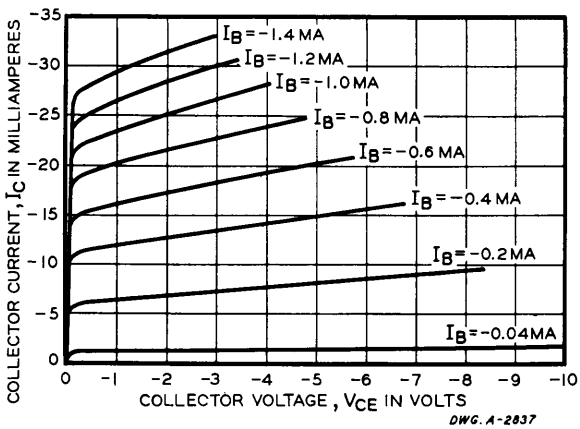
[4] Typical values are for engineering guidance only.

[5] The saturation current will approximately double with every 10 C of temperature. At any collector voltage, then, the I_{CBO} may be calculated for any temperature by doubling the low voltage I_{CBO} for every 10 C and adding the difference between the room temperature I_{CBO} at the desired voltage and the room temperature I_{CBO} at low voltage.

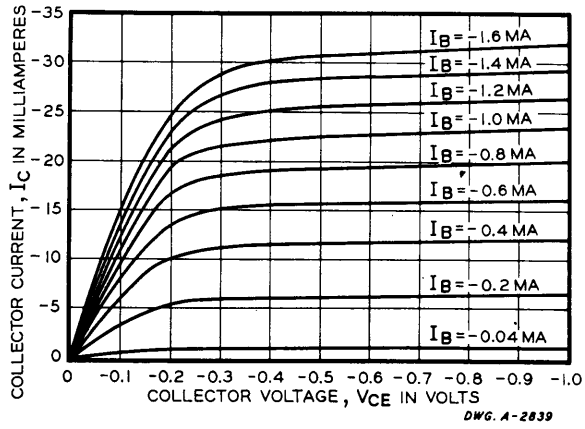
[6] To be tested in hole storage circuit. See page 4.

SPRAGUE ENGINEERING BULLETIN 31,106B

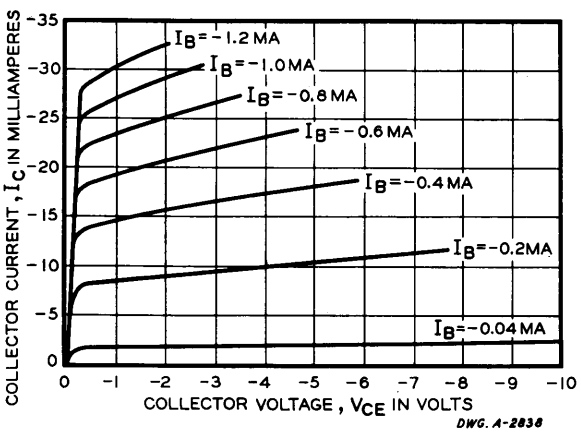
CHARACTERISTIC CURVES OF TYPE 2N1119 TRANSISTORS



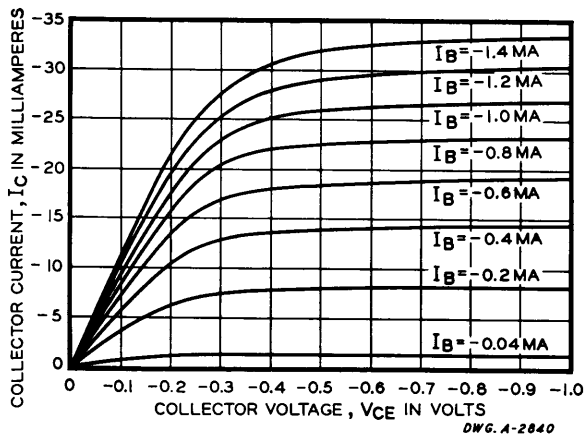
TYPICAL COLLECTOR CHARACTERISTICS
IN GROUNDED EMITTER CONFIGURATION
AT 25 C



TYPICAL SATURATED REGION COLLECTOR CHARACTERISTICS
IN GROUNDED EMITTER CONFIGURATION
AT 25 C

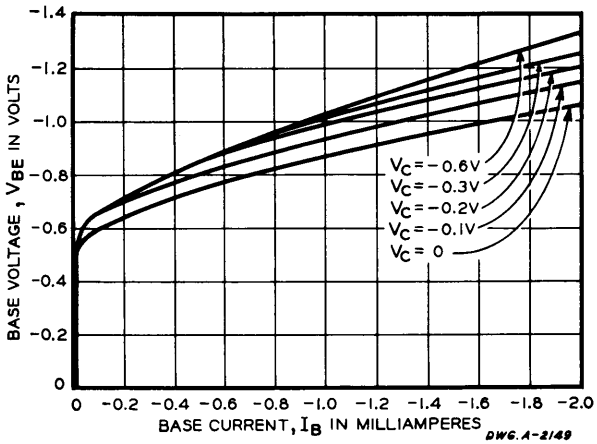


TYPICAL COLLECTOR CHARACTERISTICS
IN GROUNDED EMITTER CONFIGURATION
AT 125 C

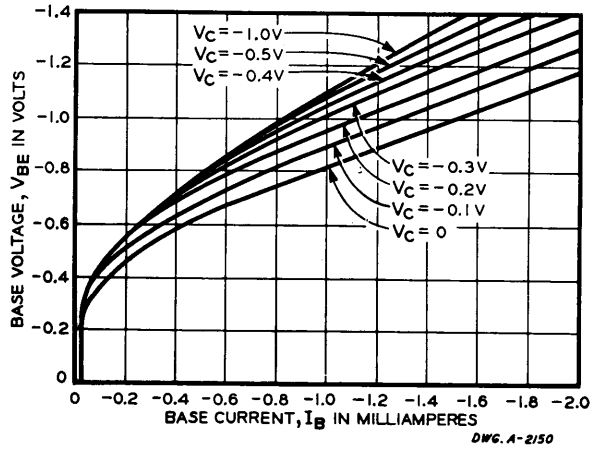


TYPICAL SATURATED REGION COLLECTOR CHARACTERISTICS
IN GROUNDED EMITTER CONFIGURATION
AT 125 C

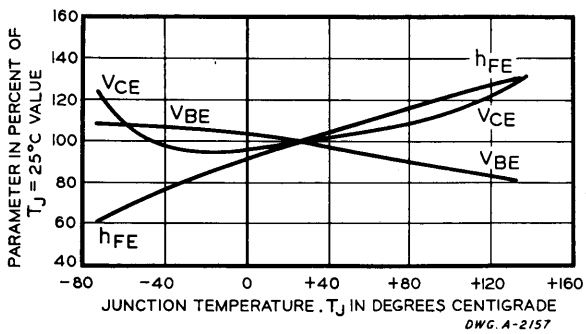
CHARACTERISTIC CURVES OF TYPE 2N1119 TRANSISTORS - - cont.



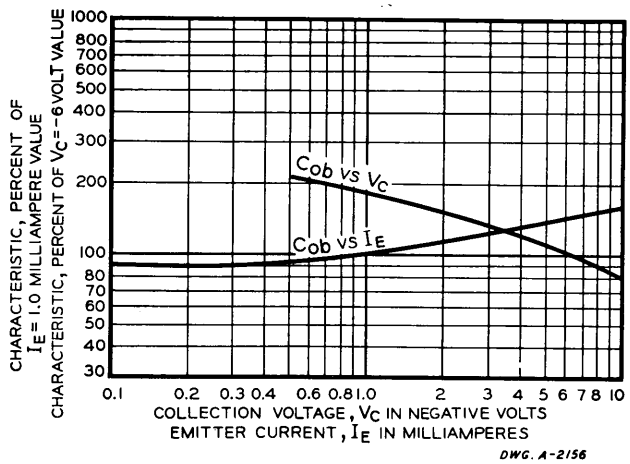
TYPICAL INPUT CHARACTERISTICS
IN GROUNDED EMITTER CONFIGURATION
AT 25 C



TYPICAL INPUT CHARACTERISTICS
IN GROUNDED EMITTER CONFIGURATION
AT 125 C

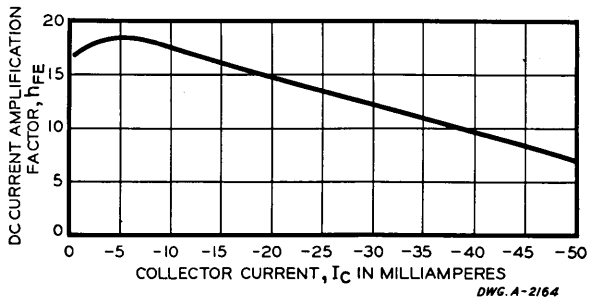


TYPICAL PARAMETERS
AS A FUNCTION OF JUNCTION TEMPERATURE
NORMALIZED FOR 25 C



TYPICAL CHARACTERISTICS AS A FUNCTION OF
COLLECTOR VOLTAGE AND EMITTER CURRENT
AT 25 C

CHARACTERISTIC CURVES OF TYPE 2N1119 TRANSISTORS - - cont.



TYPICAL D-C β
AS A FUNCTION OF COLLECTOR CURRENT
IN GROUNDED EMITTER CONFIGURATION
AT 25 C

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HOLE STORAGE MEASUREMENT OF TYPE 2N1119 TRANSISTORS

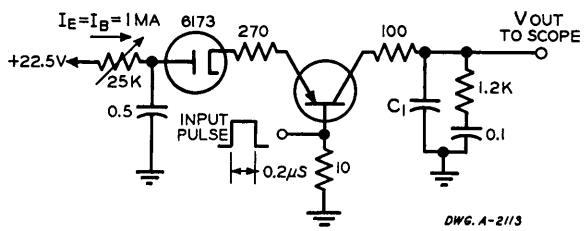
The hole storage factor K_s' is a device constant defined as the excess stored charge (in saturation) per unit excess base current, where excess base current is the amount of current supplied to the base in excess of that required to just keep the transistor in saturation. While the hole storage factor may be expressed in units of time, this is not a time measurement and does not imply that the storage time in any particular circuit is that specified.

The storage time in an actual circuit is a function of the ratio of both the "turn-on" base current and the "turn-off" base current to the "on" collector current. The storage time will be approximately

$$t_s \simeq K_s' \ln \frac{I_{B1} + I_{B2}}{\frac{I_{CS}}{h_{FE}} + I_{B2}},$$

where I_{B1} is the "turn-on" base current, I_{B2} is the "turn-off" base current (assumed to be reverse current) and I_{CS} is the "on" collector current.

HOLE STORAGE TEST CIRCUIT



C_1, rated at 500 pF, includes probe or scope capacitance. This value should be measured with the differentiating network disconnected.

$$K'_s = \frac{C_1 V_{OUT}}{I_E} = \frac{500}{1} V_{OUT} \frac{\mu\mu\text{coulombs}}{\text{mA}}$$ (These units are the equivalent of nsec.)

No. 31,116

SPRAGUE THE MARK OF RELIABILITY

Engineering Bulletin

2N1676

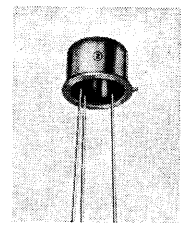
TYPE 2N1676 SILICON SURFACE-ALLOY TRANSISTORS

HERMETICALLY-SEALED Type 2N1676 P-N-P Silicon Surface-Alloy Transistors are especially designed for low-level chopper applications. The critical parameter, offset voltage, is typically 0.5 mv at a forward base current of 250μA.

These transistors feature low saturation current and excellent temperature stability, which make it possible to design choppers for satisfactory operation over a wide temperature range. In addition, the high f_T, typically 42 mc, permits operation at chopping rates in excess of 50 kc.

Sprague SAT® Transistors are fully licensed under Philco patents.

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



ACTUAL SIZE

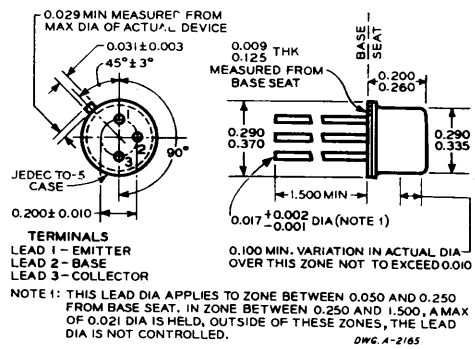
ABSOLUTE MAXIMUM RATINGS[1]

Storage Temperature . . . . . −65 C to + 140 C
Collector Voltage[2], V_{CB} or V_{CEO} . . . . . −4.5 volts
Collector Current, I_C . . . . . −50 ma
Total Device Dissipation[3] at 25 C . . . . . 100 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 diode breakdown and punchthrough voltages may be far above the maximum collector voltage rating. To avoid permanent damage to the transistor, do not attempt to measure these characteristics above the maximum ratings.

[2] In this class of transistors, the maximum collector voltage is limited by the punchthrough phenomenon.

MECHANICAL SPECIFICATIONS



[3] Due to the nature of silicon 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 0.87 mw/°C.

ELECTRICAL CHARACTERISTICS at T = 25 C[4]

	CHARACTERISTICS	TEST CONDITIONS	MIN.	TYPE	MAX	UNITS
	D-C CHARACTERISTICS					
I_{CBO}	Collector Cutoff Current[5]	V_{CB} = −4.5V	—	0.001	0.1	μA
I_{EBO}	Emitter Current	V_{EB} = −4.5V	—	0.001	0.1	μA
	SWITCHING CHARACTERISTICS					
V_{CE} (Sat)	Collector Saturation Voltage	I_C = −5 ma, I_B = −0.8 ma	—	0.04	0.1	volt
V_{EC}	Offset Voltage	I_B = −250μA, I_E = 0	—	0.55	1.0	mv
	SMALL SIGNAL PARAMETERS					
h_{fe}	Current Amplification Factor[6]	V_{CE} = −3 V, f = −4 mc, I_E = −1 ma	4	10.5	—	—
C_{ob}	Output Capacitance	V_{CE} = −3 V, I_E = −1 ma	—	7	14	μμF

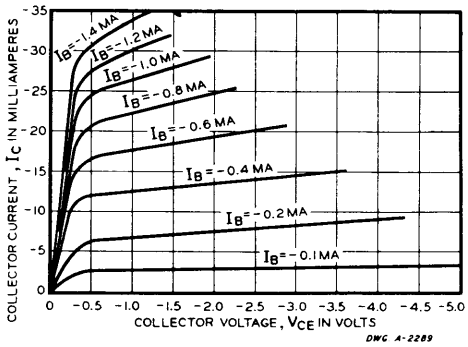
[4] Typical values are for engineering guidance only.

[5] The saturation current will approximately double with every 10°C of temperature. At any collector voltage then, the I_{CBO} may be calculated for any temperature by doubling the low voltage I_{CBO} for every 10°C and adding the difference between the room temperature I_{CBO} at the desired-voltage and the room temperature I_{CBO} at low voltage.

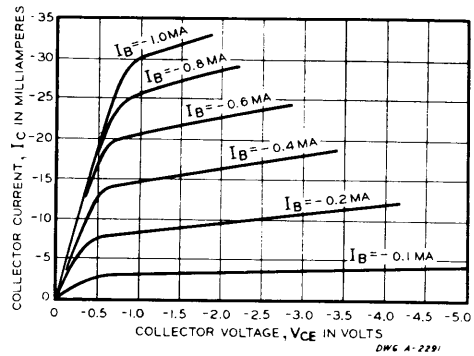
[6] The product of high frequency β times the frequency of measurement gives the frequency f_T, at which β s unity. This is a measure of the gain band width product of the transistor. In the 2N1676, f_T is approximately 0.82 times the alpha cutoff frequency.

SPRAGUE ENGINEERING BULLETIN 31,116

CHARACTERISTIC CURVES OF TYPE 2N1676 TRANSISTORS



TYPICAL COLLECTOR CHARACTERISTIC
IN GROUNDED EMITTER CONFIGURATION AT 25 C



TYPICAL COLLECTOR CHARACTERISTIC
IN GROUNDED EMITTER CONFIGURATION AT 140 C

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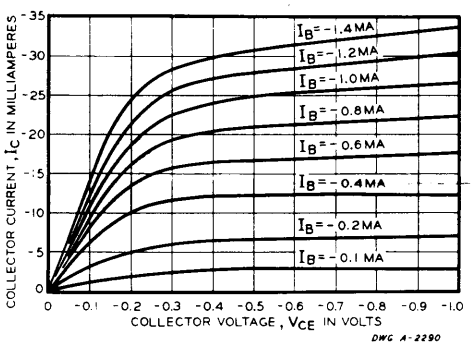
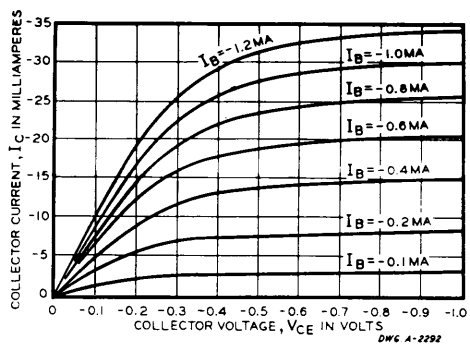


TYPICAL SATURATED REGION COLLECTOR CHARACTERISTIC
IN GROUNDED EMITTER CONFIGURATION AT 25 C



TYPICAL SATURATED REGION COLLECTOR CHARACTERISTIC
IN GROUNDED EMITTER CONFIGURATION AT 140 C

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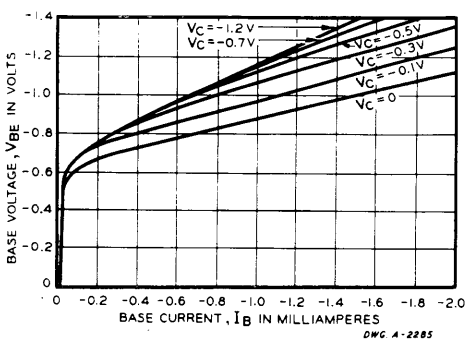
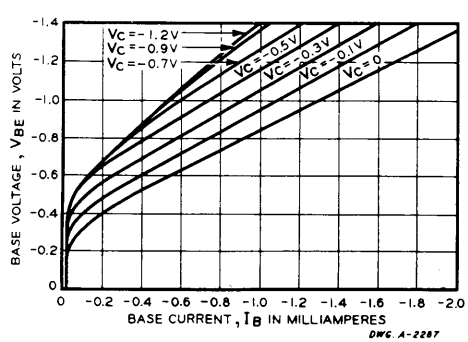
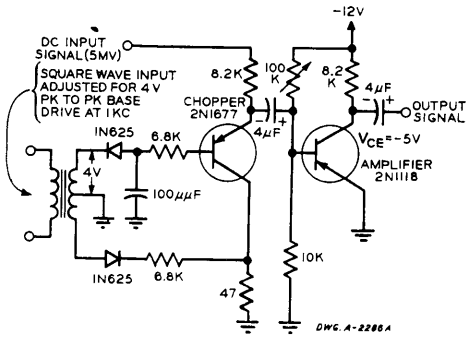


TYPICAL INPUT CHARACTERISTIC
IN GROUNDED EMITTER CONFIGURATION AT 25 C

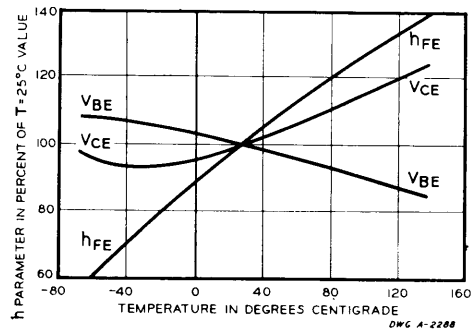


TYPICAL INPUT CHARACTERISTIC
IN GROUNDED EMITTER CONFIGURATION AT 140 C

CHARACTERISTIC CURVES OF TYPE 2N1676 TRANSISTORS -- cont.



TYPICAL CHOPPER CIRCUIT



TYPICAL PARAMETERS AS A FUNCTION OF TEMPERATURE NORMALIZED FOR 25 C

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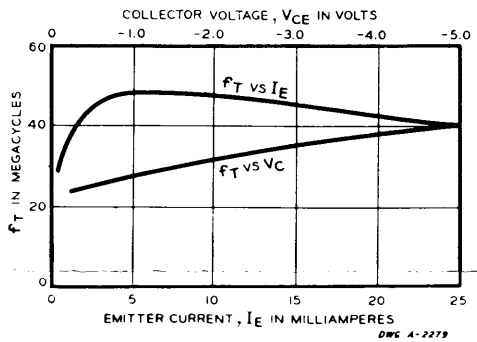
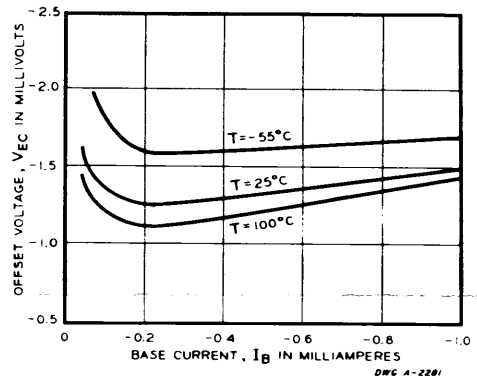


f_T AS A FUNCTION OF EMITTER CURRENT AND COLLECTOR VOLTAGE IN GROUNDED EMITTER CONFIGURATION AT 25 C WITH $V_C = -3V, I_E = 1MA$



OFFSET VOLTAGE, V_{EC}, AS A FUNCTION OF BASE CURRENT AT 25C

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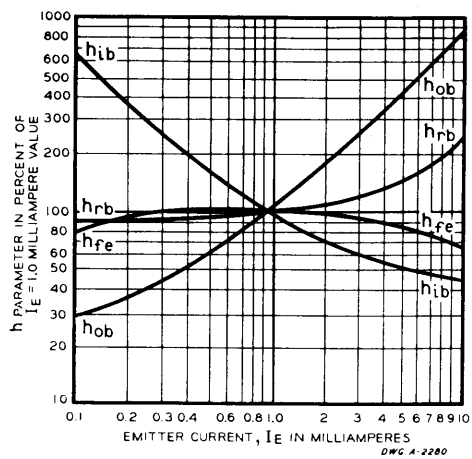
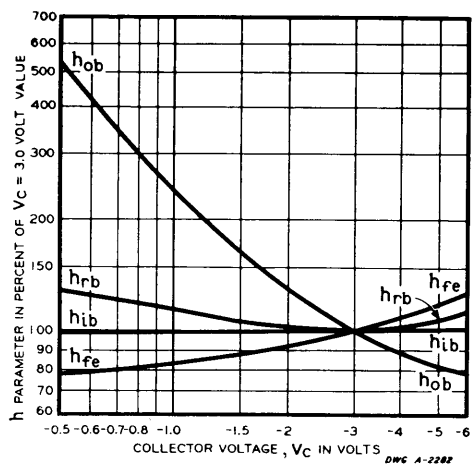
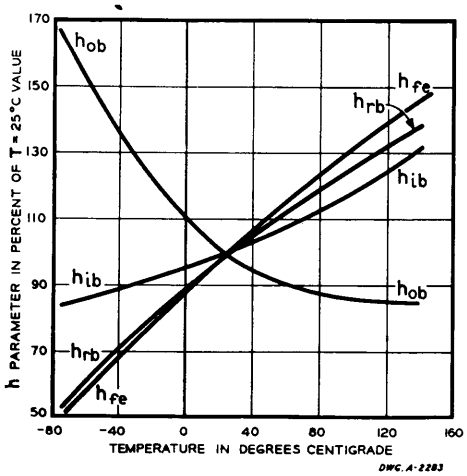


TYPICAL h PARAMETERS AS A FUNCTION OF EMITTER CURRENT AT 25 C, NORMALIZED FOR $V_C = -3$ VOLTS, $I_E = 1$ MA

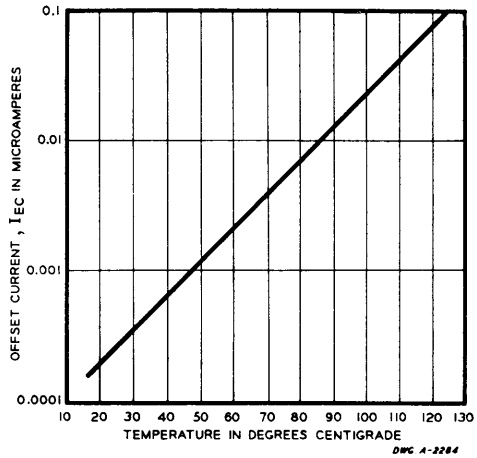


TYPICAL h PARAMETERS AS A FUNCTION OF COLLECTOR VOLTAGE AT 25C, NORMALIZED FOR $V_C = -3$ VOLTS, $I_E = 1$ MA

CHARACTERISTIC CURVES OF TYPE 2N1676 TRANSISTORS -- Cont.



TYPICAL h PARAMETERS AS A FUNCTION OF TEMPERATURE NORMALIZED FOR $V_C = -3$ VOLTS, $I_E = 1$ MA



OFFSET CURRENT AS A FUNCTION OF TEMPERATURE WITH $V_{BC} = 1$ VOLT

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No. 31,118

SPRAGUE
THE MARK OF RELIABILITY

Engineering Bulletin

2N1677

TYPE 2N1677 SILICON SURFACE-ALLOY TRANSISTORS

HERMETICALLY-SEALED Type 2N1677 P-N-P Silicon Surface-Alloy Transistors are especially designed for low-level chopper applications. The critical parameter, offset voltage, is typically 1.5 mv at a forward base current of 1 ma.

These transistors feature low saturation current and excellent temperature stability, which make it possible to design choppers for satisfactory operation over a wide temperature range. In addition, the high f_T, typically 32 mc, permits operation at chopping rates in excess of 40 kc.

Sprague SAT® Transistors are fully licensed under Philco patents.

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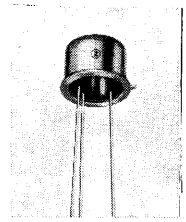


ACTUAL SIZE

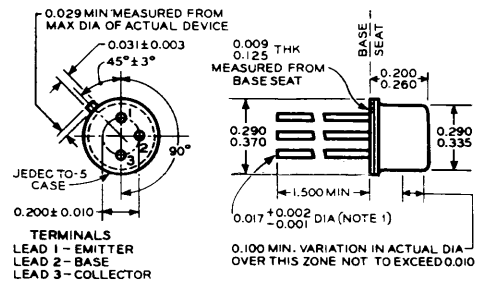
ABSOLUTE MAXIMUM RATINGS[1]

Storage Temperature . . . . . −65 C to + 140 C
Collector Voltage[2], V_{CB} or V_{CEO} . . . . . −4.5 volts
Collector Current, I_C . . . . . −50 ma
Total Device Dissipation[3] at 25 C . . . . . 100 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 diode breakdown and punchthrough voltages may be far above the maximum collector voltage rating. To avoid permanent damage to the transistor, do not attempt to measure these characteristics above the maximum ratings.

[2] In this class of transistor, the maximum collector voltage is limited by the punchthrough phenomenon.

MECHANICAL SPECIFICATIONS



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

0.100 MIN. VARIATION IN ACTUAL DIA OVER THIS ZONE NOT TO EXCEED 0.010

NOTE 1: THIS LEAD DIA APPLIES TO ZONE BETWEEN 0.050 AND 0.250 FROM BASE SEAT. IN ZONE BETWEEN 0.250 AND 1.500, A MAX OF 0.021 DIA IS HELD, OUTSIDE OF THESE ZONES, THE LEAD DIA IS NOT CONTROLLED.

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[3] Due to the nature of silicon 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 0.87 mw/°C.

ELECTRICAL CHARACTERISTICS[4] at T = 25 C

	CHARACTERISTICS	TEST CONDITIONS	MIN	TYPE	MAX	UNITS
	D-C CHARACTERISICS					
I_{CBO}	Collector Current[5]	V_{CB} = −4.5 V	—	.001	0.1	μA
I_{EBO}	Emitter Current	V_{EB} = −4.5 V	—	.001	0.1	μA
	SWITCHING CHARACTERISTICS					
V_{CE} (Sat)	Collector Saturation Voltage	I_C = −5 ma, I_B = −0.8 ma	—	.055	0.1	volt
V_{BE}	Base Voltage	I_C = −5 ma, I_B = −0.8 ma	—	.88	1.35	volts
V_{EC}	Offset Voltage	I_B = −1 ma, I_E = −0	—	1.5	3	mv
	SMALL SIGNAL PARAMETERS					
h_{fe}	Current Amplification Factor	V_C = −3V, I_E = −1 ma	25	50	—	—
h_{fe}	Current Amplification Factor[6]	V_C = −3 V, f = −4 mc, I_E = −1 ma	4	8	—	—
f_{max}	Maximum Frequency of Oscillation	V_C = −3 V, I_E = −1 ma	18	23	—	mc
$r_b'C_c$	Extrinsic Base Resistance Collector Capacitance Product	V_C = −3 V, I_E = −1 ma	—	2300	10000	psec
C_{ob}	Output Capacitance	V_C = −3 V, I_E = −1 ma	—	7	14	μμF
h_{ib}	Input Resistance	V_C = −3 V, I_E = −1 ma	—	40	70	ohms
h_{ob}	Output Conductance	V_C = −3 V, I_E = −1 ma	—	1.5	5	μmhos

[4] Typical values are for engineering guidance only.

[5] The saturation current will approximately double with every 10°C of temperature. At any collector voltage then, the I_{CBO} may be calculated for any temperature by doubling the low voltage I_{CBO} for every 10°C and adding the difference between the room temperature I_{CBO} at the desired voltage and the room temperature I_{CBO} at low voltage.

[6] The product of high frequency β times the frequency of measurement gives the frequency f_T, at which β is unity. This is a measure of the gain bandwidth product of the transistor. In the 2N1677, f_T is approximately 0.82 times the alpha cutoff frequency.

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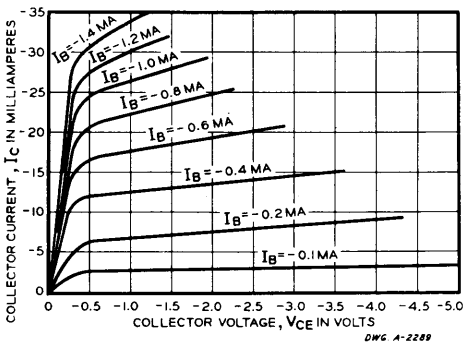
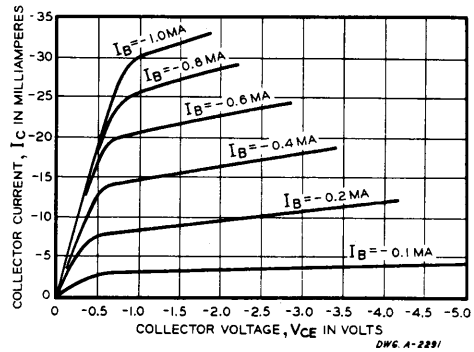
CHARACTERISTIC CURVES OF TYPE 2N1677 TRANSISTORS



TYPICAL COLLECTOR CHARACTERISTIC
IN GROUNDED EMITTER CONFIGURATION AT 25 C



TYPICAL COLLECTOR CHARACTERISTIC
IN GROUNDED EMITTER CONFIGURATION AT 140 C

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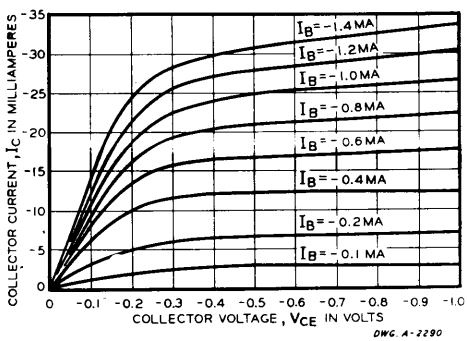
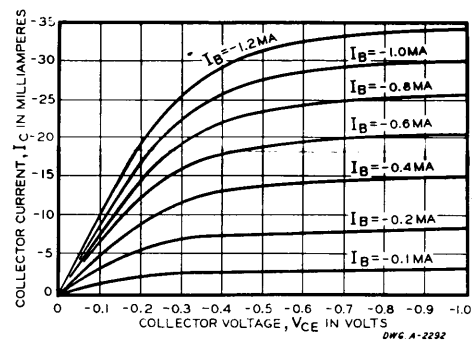


TYPICAL SATURATED REGION COLLECTOR CHARACTERISTIC
IN GROUNDED EMITTER CONFIGURATION AT 25 C



TYPICAL SATURATED REGION COLLECTOR CHARACTERISTIC
IN GROUNDED EMITTER CONFIGURATION AT 140 C

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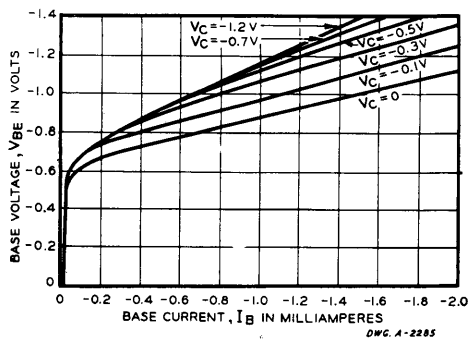
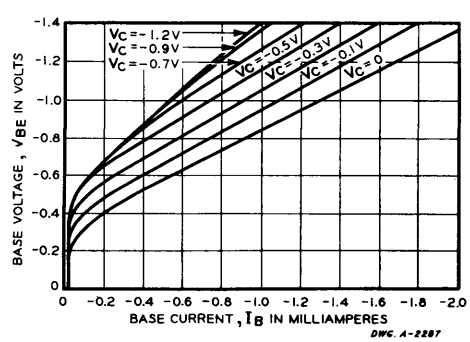
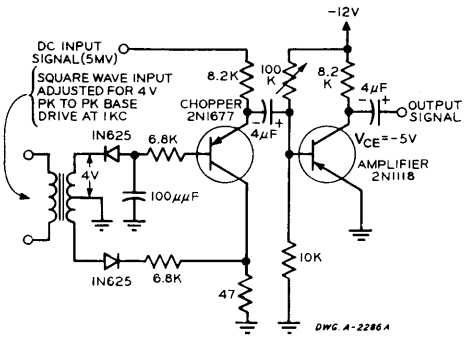


TYPICAL INPUT CHARACTERISTIC
IN GROUNDED EMITTER CONFIGURATION AT 25 C

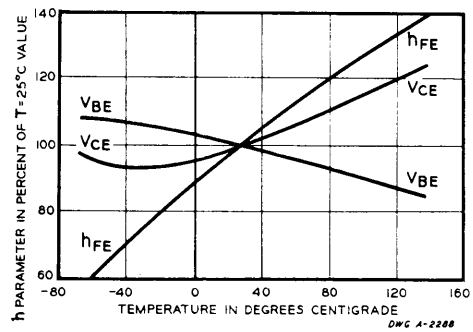


TYPICAL INPUT CHARACTERISTIC
IN GROUNDED EMITTER CONFIGURATION AT 140 C

CHARACTERISTIC CURVES OF TYPE 2N1677 TRANSISTORS -- cont.



TYPICAL CHOPPER CIRCUIT



TYPICAL PARAMETERS AS A FUNCTION OF TEMPERATURE NORMALIZED FOR 25 C

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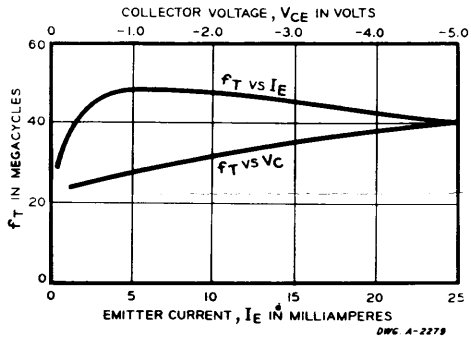
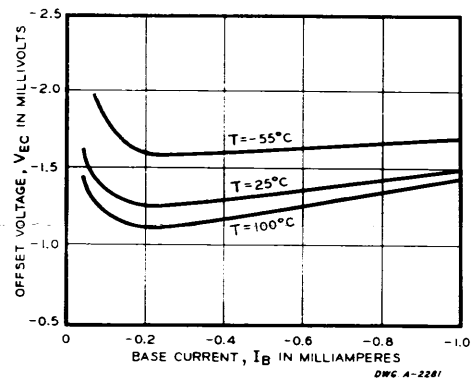


f_T AS A FUNCTION OF EMITTER CURRENT IN GROUNDED EMITTER CONFIGURATION AT 25 C, WITH $V_C = -3V$, $I_E = 1MA$



OFFSET VOLTAGE, V_{EC}, AS A FUNCTION OF BASE CURRENT AT 25 C

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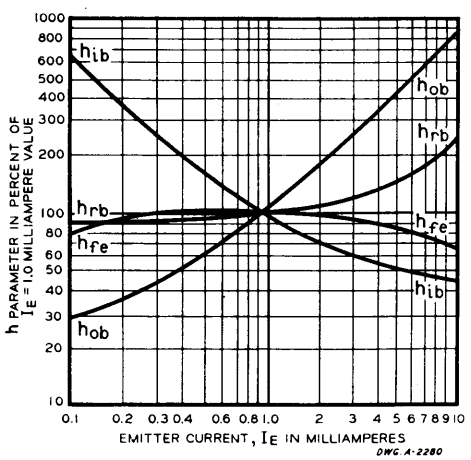
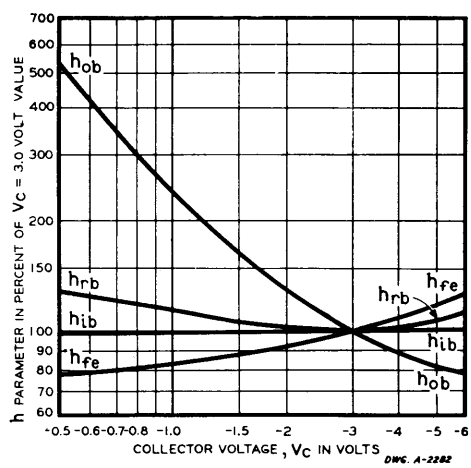
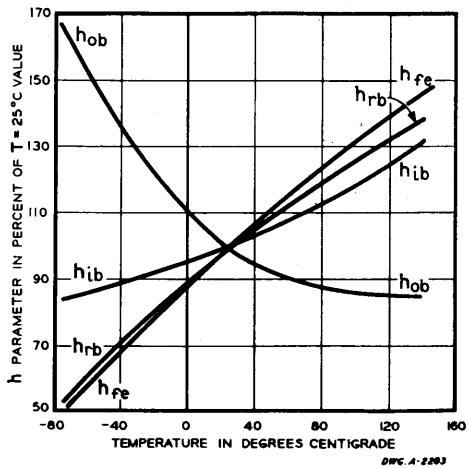


TYPICAL h PARAMETERS AS A FUNCTION OF EMITTER CURRENT AT 25 C, NORMALIZED FOR $V_C = -3$ VOLTS, $I_E = 1MA$

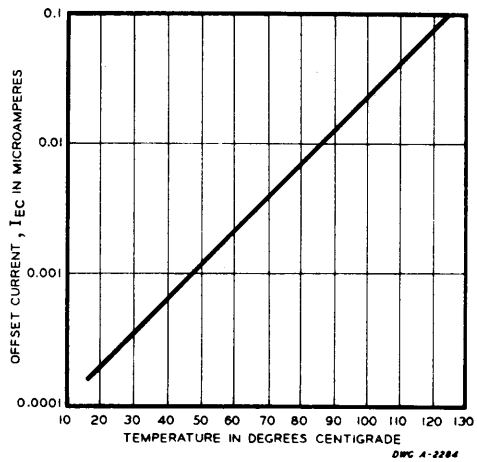


TYPICAL h PARAMETERS AS A FUNCTION OF COLLECTOR VOLTAGE AT 25 C, NORMALIZED FOR $V_C = -3$ VOLTS, $I_E = 1$ MA

CHARACTERISTIC CURVES OF TYPE 2N1677 TRANSISTORS -- cont.



TYPICAL h PARAMETERS AS A FUNCTION OF TEMPERATURE NORMALIZED FOR $V_C = -3$ VOLTS, $I_E = 1$ MA



OFFSET CURRENT AS A FUNCTION OF TEMPERATURE WITH $V_{BC} = 1$ VOLT

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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