No. 31,122A

SPRAGUE® THE MARK OF RELIABILITY

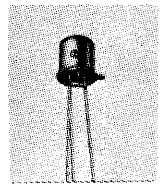
Engineering Bulletin

2N859

TYPE 2N859 SILICON PRECISION-ALLOY TRANSISTORS

TYPE 2N859 P-N-P Silicon Precision Alloy Transistors have been specifically designed for control circuits, medium-speed switching application and high-gain amplifiers. The homogeneous base of these transistors provides a high reverse bias emitter-base diode rating.

These SPAT® transistors feature low saturation resistance, high beta, and high collector voltage at low cutoff currents. High and low temperature performance are guaranteed by a saturation current test at 125 C and a beta test at −55 C.



ACTUAL SIZE

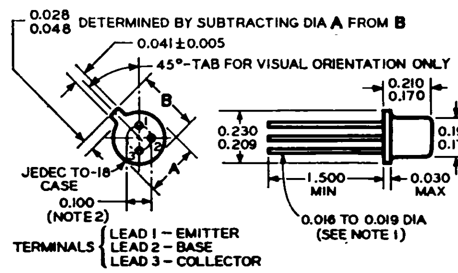
ABSOLUTE MAXIMUM RATINGS[1]

Storage Temperature . . . . −65 C to +140 C
Collector Voltage, V_{CB} . . . . −40 volts
Collector Voltage, V_{CEO} . . . . −40 volts
Emitter Voltage, V_{EB} . . . . −25 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 transistor, do not attempt to measure these characteristics above the maximum ratings.

[2]Due to the nature of SPAT 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



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-3450A

ELECTRICAL CHARACTERISTICS[3] at T = 25 C

	CHARACTERISTICS	TEST CONDITIONS	MIN.	TYPICAL	MAX.	UNITS
	D-C CHARACTERISTICS					
I_{CBO}	Collector Cutoff Current	V_{CB} = −10V			0.1	µA
I_{CBO}	Collector Cutoff Current	V_{CB} = −10V, T = 125C			15	µA
BV_{CBO}	Collector Breakdown Voltage[4]	I_C = −1µA	40			volts
BV_{CEO}	Collector Breakdown Voltage[4]	I_C = −25µA	40			volts
I_{EBO}	Emitter Current	V_{EB} = −25V			1	µA
h_{FE}	D-C Current Amplification Factor	V_{CE} = −0.5V, I_C = −5 mA	25	35	100	
h_{FE}	D-C Current Amplification Factor	V_{CE} = −0.5V, I_C = −5 mA, T = −55 C	16	23		
$V_{CE(SAT)}$	Collector Saturation Voltage	I_C = −5mA, I_B = −0.5 mA		.06	0.15	volt
V_{BE}	Base Voltage	I_C = −5mA, I_B = −0.5mA	0.75	0.81	1.0	volt
	SMALL SIGNAL PARAMETERS					
h_{ie}	Input Resistance	V_{CE} = −6V, I_E = 1 mA		2.5		KΩ
h_{oe}	Output Conductance	V_{CE} = −6V, I_E = 1 mA		50		µmhos
h_{fe}	Current Amplification Factor	V_{CE} = −6V, I_E = 1 mA	30	65	120	
h_{re}	Voltage Feedback Ratio	V_{CE} = −6V, I_E = 1 mA		3.5×10^{-4}		
	HIGH FREQUENCY CHARACTERISTICS					
C_{ob}	Output Capacitance	V_{CB} = −6V, I_E = 0, f = 4 mc		5	9	pF
C_{ib}	Input Capacitance	V_{EB} = −6V, I_C = 0, f = 4 mc		4	7	pF
f_T	Gain Bandwidth Product	V_{CE} = −6V, I_E = 1 mA	6	14		mc
$R_e(h_{ie})$	Real Part of Input Impedance	V_{CE} = −6V, I_E = 1 mA, f = 100 mc		350	700	ohms
	SWITCHING CHARACTERISTICS					
t_r	Rise Time	Circuit of Figure 1		125	250	nsec
t_s	Storage Time	Circuit of Figure 2		75	100	nsec
t_f	Fall Time	Circuit of Figure 2		125	150	nsec

[3]Typical values are for engineering guidance only.

[4]To avoid exceeding the maximum voltage ratings, the breakdown voltages must be measured by setting the voltage at the minimum specified (maximum rating). If the resultant current voltage is less than the value given as a condition of test, the breakdown voltage is within specification.

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

SPRAGUE ENGINEERING BULLETIN 31122A

TEST CIRCUITS

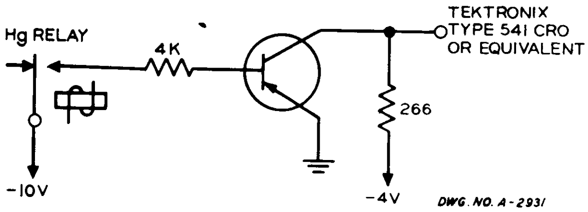


FIGURE 1
RISE TIME TEST CIRCUIT

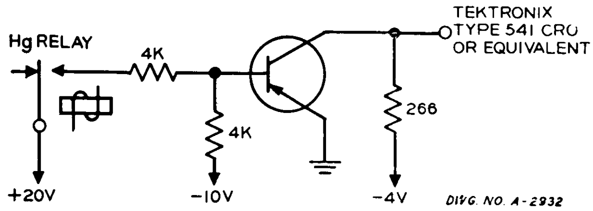
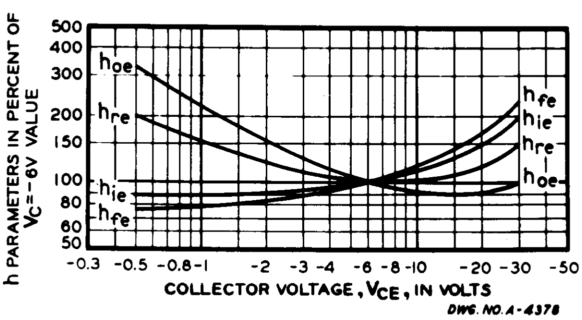
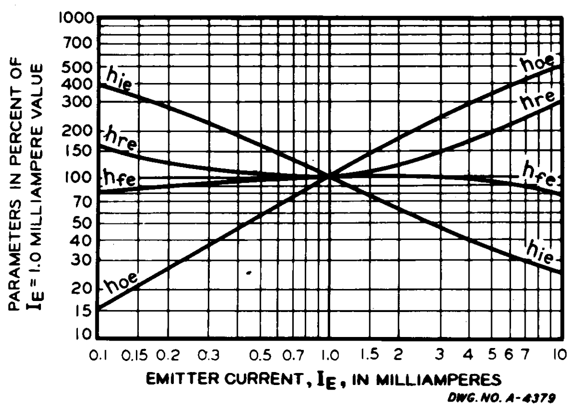


FIGURE 2
STORAGE AND FALL TIME TEST CIRCUIT

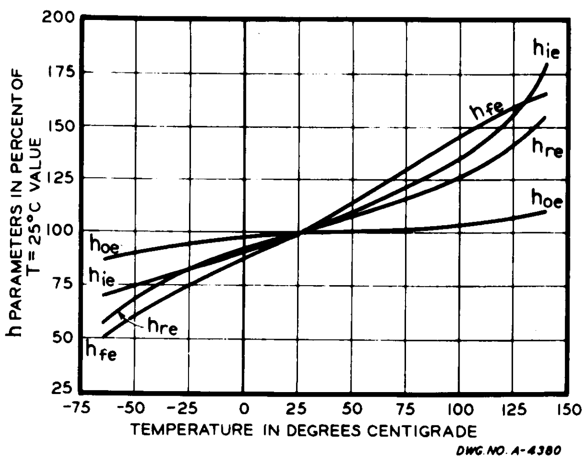
CHARACTERISTIC CURVES



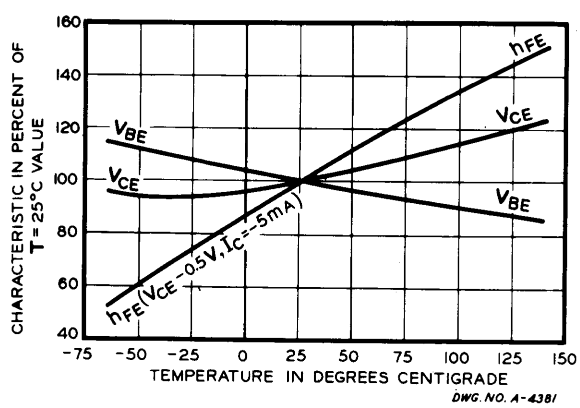
TYPICAL h PARAMETERS AS A FUNCTION OF COLLECTOR VOLTAGE AT 25 C WITH I_E = 1.0mA NORMALIZED FOR $V_C = -6V$



TYPICAL h PARAMETERS AS A FUNCTION OF EMITTER CURRENT AT 25 C WITH I_E = 1.0mA NORMALIZED FOR $V_C = -6V$

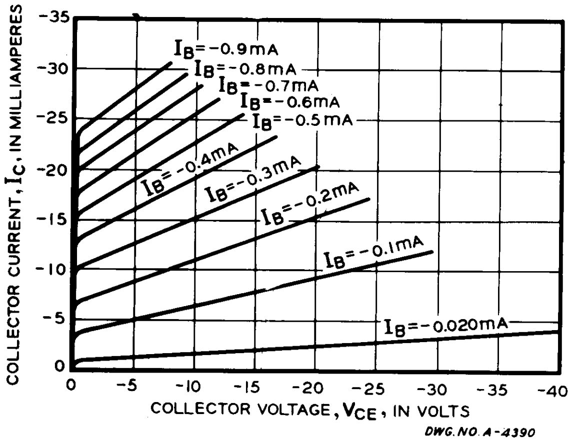


TYPICAL h PARAMETERS AS A FUNCTION OF TEMPERATURE AT 25 C WITH I_E = 1.0mA NORMALIZED FOR $V_C = -6V$

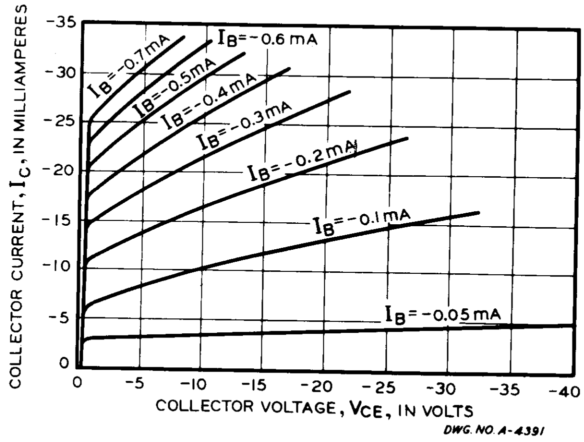


TYPICAL CHARACTERISTICS IN GROUNDED EMITTER CONFIGURATION AS A FUNCTION OF TEMPERATURE NORMALIZED FOR 25 C WITH V_{CE} AND V_{BE} AT $I_C = -5mA$, $I_B = -0.5mA$ and $I_C = -5mA$, $I_B = -0.8mA$

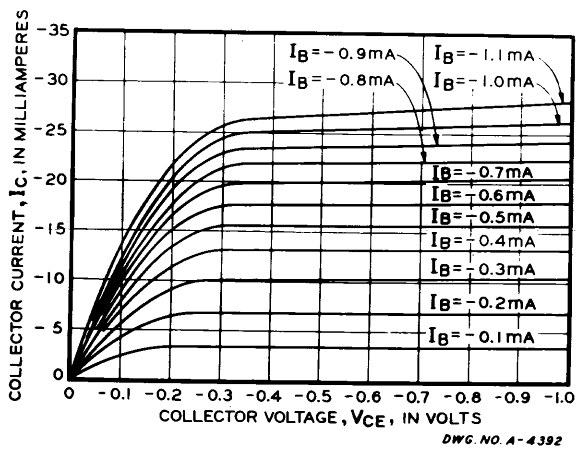
CHARACTERISTIC CURVES



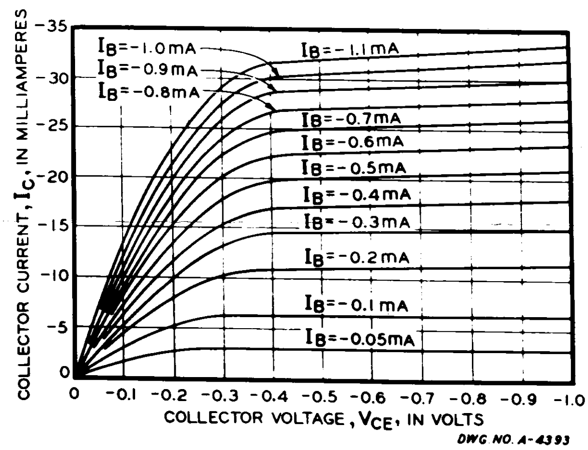
TYPICAL COLLECTOR CHARACTERISTICS IN GROUNDED EMITTER CONFIGURATION AT 25 C



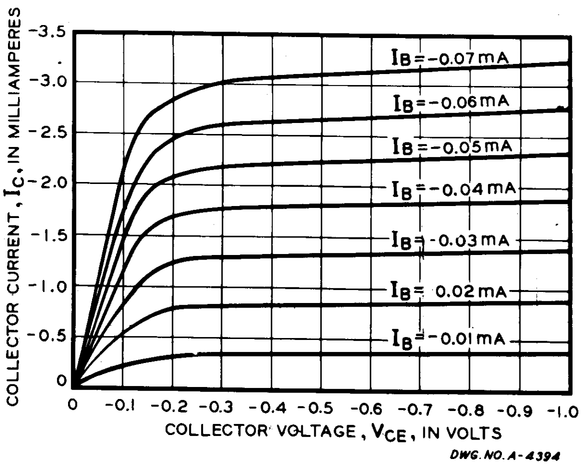
TYPICAL COLLECTOR CHARACTERISTICS IN GROUNDED EMITTER CONFIGURATION AT 125 C



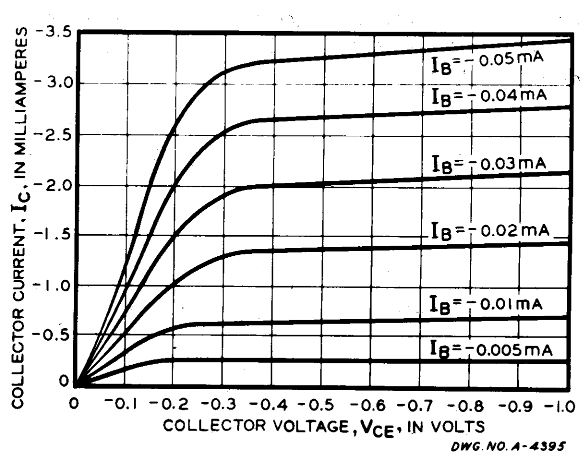
TYPICAL SATURATED REGION COLLECTOR CHARACTERISTICS IN GROUNDED EMITTER CONFIGURATION AT 25 C



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

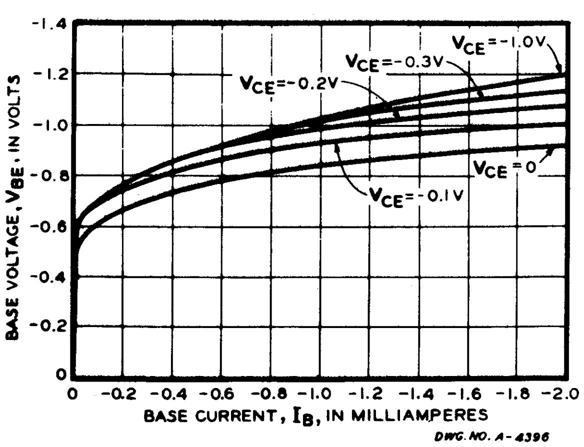


TYPICAL LOW CURRENT SATURATED REGION COLLECTOR CHARACTERISTICS IN GROUNDED EMITTER CONFIGURATION AT 25 C

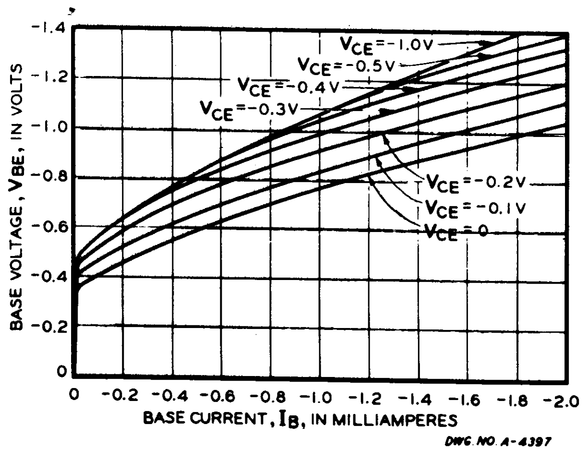


TYPICAL LOW CURRENT SATURATED REGION COLLECTOR CHARACTERISTICS IN GROUNDED EMITTER CONFIGURATION AT 125 C

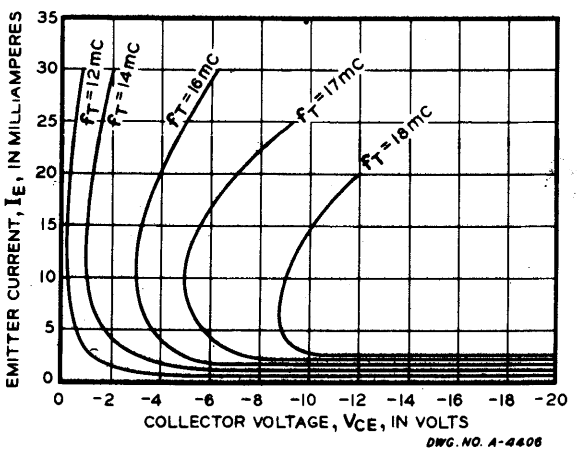
CHARACTERISTIC CURVES



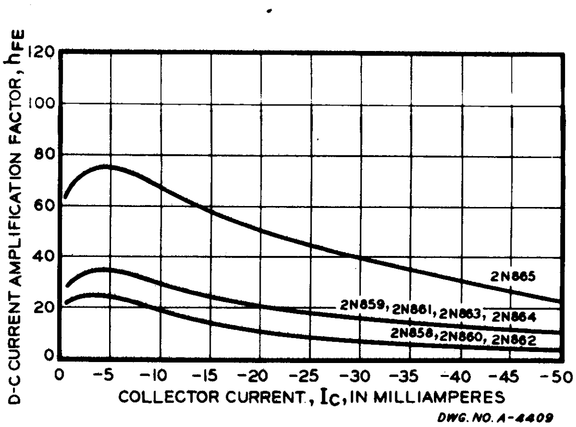
TYPICAL INPUT CHARACTERISTICS IN GROUNDED EMITTER CONFIGURATION AT 25 C



TYPICAL INPUT CHARACTERISTICS IN GROUNDED EMITTER CONFIGURATION AT 125 C



TYPICAL f_T AS A FUNCTION OF COLLECTOR VOLTAGE AND EMITTER CURRENT IN GROUNDED EMITTER CONFIGURATION AT 25 C WITH $V_{CE} = -6V$, $I_E = 1mA$



TYPICAL D-C BETA AS A FUNCTION OF COLLECTOR CURRENT IN GROUNDED EMITTER CONFIGURATION AT 25 C WITH $V_{CE} = 0.5V$

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.

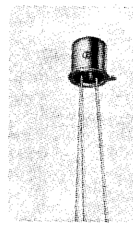
No. 31,124 A

SPRAGUE® THE MARK OF RELIABILITY *Engineering Bulletin* **2N860**

TYPE 2N860 SILICON PRECISION-ALLOY TRANSISTORS

TYPE 2N860 P-N-P Silicon Precision Alloy Transistors, which feature low saturation resistance and high collector voltage at low cutoff currents, are intended for control circuits and medium speed switching applications.

The homogeneous base of these SPAT® transistors provides a high reverse bias emitter-base diode rating. High and low temperature performance are guaranteed by a saturation current test at 125 C and a beta test at −55C.



ACTUAL SIZE

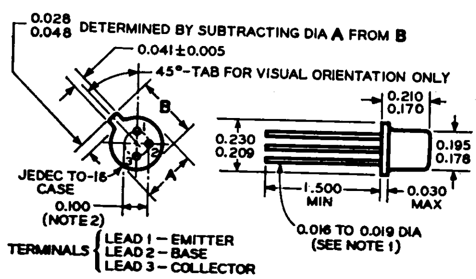
ABSOLUTE MAXIMUM RATINGS[1]

Storage Temperature . . . . −65 C to +140 C
Collector Voltage, V_{CB} . . . . −25 volts
Collector Voltage, V_{CEO} . . . . −25 volts
Emitter Voltage, V_{EB} . . . . −20 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 transistor, do not attempt to measure these characteristics above the maximum ratings.

[2]Due to the nature of SPAT 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



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-34584

ELECTRICAL CHARACTERISTICS[3] at T = 25 C

	CHARACTERISTICS	TEST CONDITIONS	MIN.	TYPICAL	MAX.	UNITS
	D-C CHARACTERISTICS					
I_{CBO}	Collector Cutoff Current	V_{CB} = −10V			0.1	μA
I_{CBO}	Collector Cutoff Current	V_{CB} = −10V, T = 125C			15	μA
BV_{CBO}	Collector Breakdown Voltage[4]	I_C = −1μA	25			volts
BV_{CEO}	Collector Breakdown Voltage[4]	I_C = −25μA	25			volts
I_{EBO}	Emitter Current	V_{EB} = −20V			1	μA
h_{FE}	D-C Current Amplification Factor	V_{CE} = −0.5V, I_C = −5 mA	10	20	40	
h_{FE}	D-C Current Amplification Factor	V_{CE} = −0.5V, I_C = −5 mA, T = −55 C	6	12		
$V_{CE(SAT)}$	Collector Saturation Voltage	I_C = −5mA, I_B = −0.8 mA		.07	0.15	volt
V_{BE}	Base Voltage	I_C = −5mA, I_B = −0.8mA	0.75	0.86	1.0	volt
	SMALL SIGNAL PARAMETERS					
h_{ie}	Input Resistance	V_{CE} = −6V, I_E = 1 mA		1.4		KΩ
h_{oe}	Output Conductance	V_{CE} = −6V, I_E = 1 mA		35		μmhos
h_{fe}	Current Amplification Factor	V_{CE} = −6V, I_E = 1 mA	15	33	45	
h_{re}	Voltage Feedback Ratio	V_{CE} = −6V, I_E = 1 mA		3.5×10^{-4}		
	HIGH FREQUENCY CHARACTERISTICS					
C_{ob}	Output Capacitance	V_{CB} = −6V, I_E = 0, f = 4 mc		5	9	pF
C_{ib}	Input Capacitance	V_{EB} = −6V, I_C = 0, f = 4 mc		4	7	pF
f_T	Gain Bandwidth Product	V_{CE} = −6V, I_E = 1 mA	6.5	14		mc
$R_e(h_{ie})$	Real Part of Input Impedance	V_{CE} = −6V, I_E = 1 mA, f = 100 mc		350	700	ohms
	SWITCHING CHARACTERISTICS					
t_r	Rise Time	Circuit of Figure 1		115	200	nsec
t_s	Storage Time	Circuit of Figure 2		75	100	nsec
t_f	Fall Time	Circuit of Figure 2		115	150	nsec

[3]Typical values are for engineering guidance only.

[4]To avoid exceeding the maximum voltage ratings, the breakdown voltages must be measured by setting the voltage at the minimum specified (maximum rating). If the resultant current voltage is less than the value given as a condition of test, the breakdown voltage is within specification.

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

TEST CIRCUITS

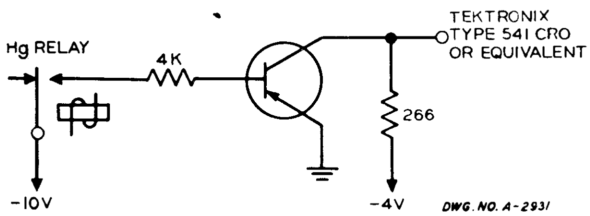


FIGURE 1

RISE TIME TEST CIRCUIT

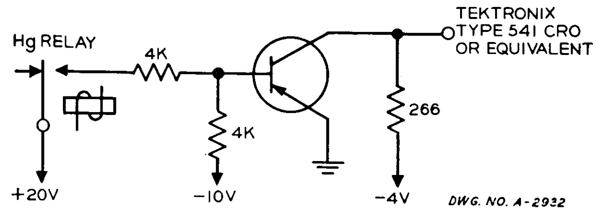
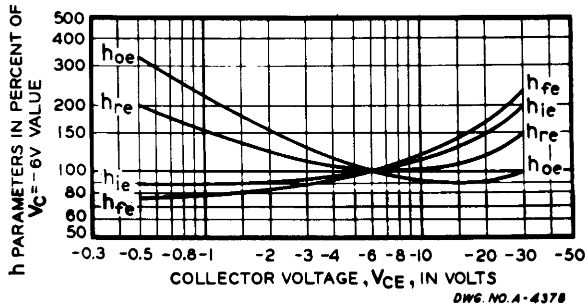


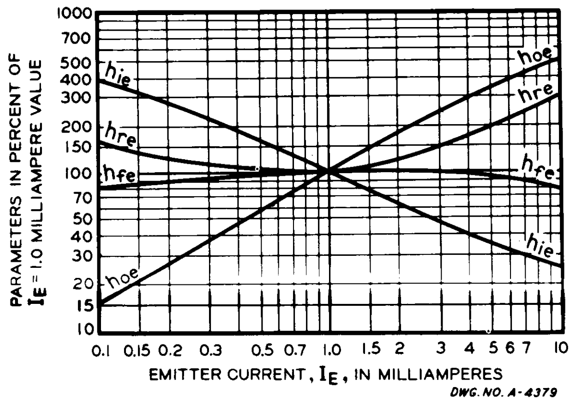
FIGURE 2

STORAGE AND FALL TIME TEST CIRCUIT

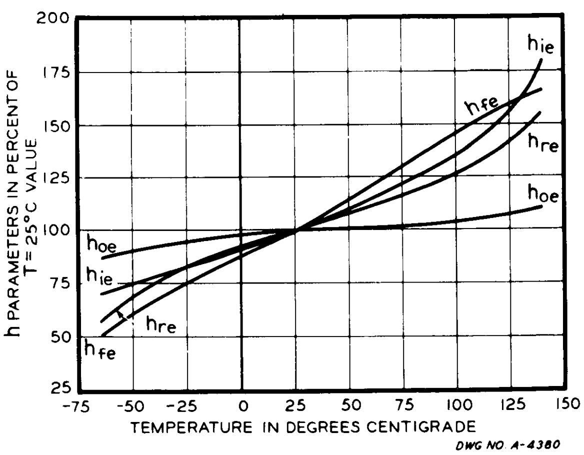
CHARACTERISTIC CURVES



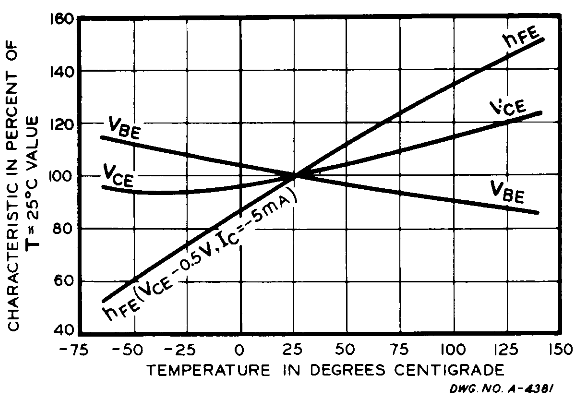
TYPICAL h PARAMETERS AS A FUNCTION OF COLLECTOR VOLTAGE AT 25 C WITH I_E = 1.0mA NORMALIZED FOR $V_C = -6V$



TYPICAL h PARAMETERS AS A FUNCTION OF EMITTER CURRENT AT 25 C WITH I_E = 1.0mA NORMALIZED FOR $V_C = -6V$

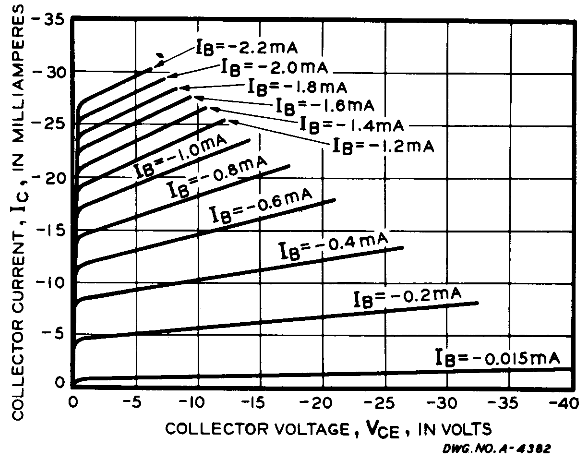


TYPICAL h PARAMETERS AS A FUNCTION OF TEMPERATURE AT 25 C WITH I_E = 1.0mA NORMALIZED FOR $V_C = -6V$

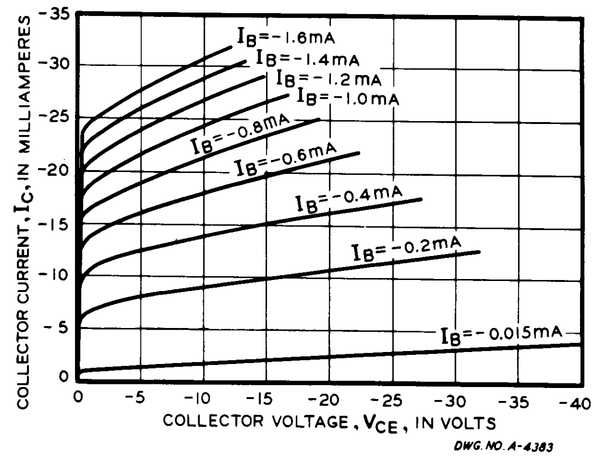


TYPICAL CHARACTERISTICS IN GROUNDED EMITTER CONFIGURATION AS A FUNCTION OF TEMPERATURE NORMALIZED FOR 25 C WITH V_{CE} AND V_{BE} AT $I_C = -5mA$, $I_B = -0.5mA$ and $I_C = -5mA$, $I_B = -0.8mA$

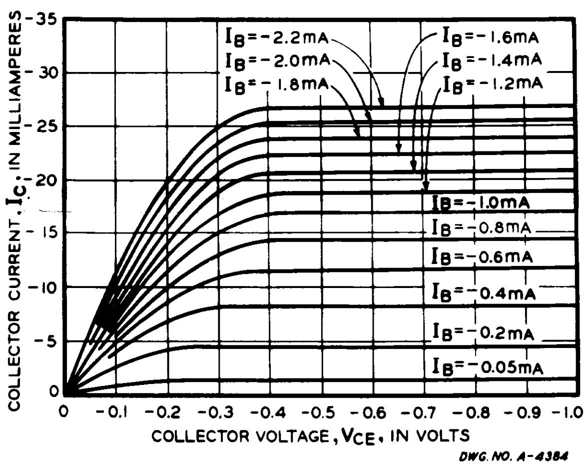
CHARACTERISTIC CURVES



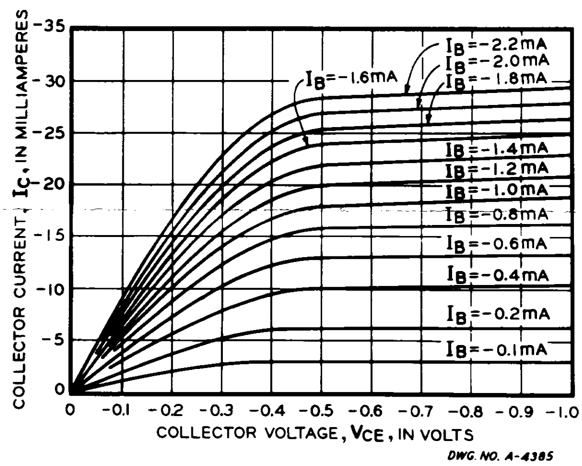
TYPICAL COLLECTOR CHARACTERISTICS IN GROUNDED EMITTER CONFIGURATION AT 25 C



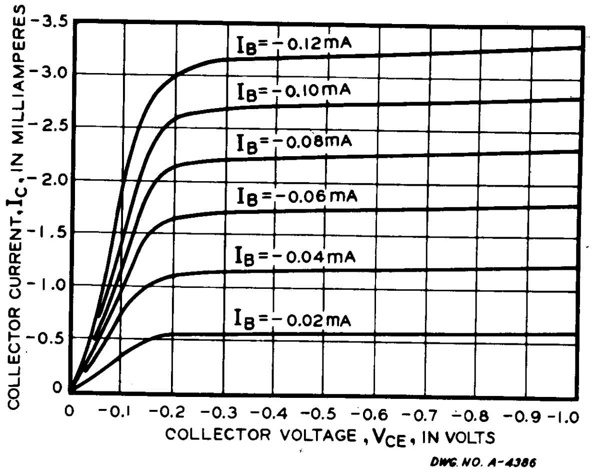
TYPICAL COLLECTOR CHARACTERISTICS IN GROUNDED EMITTER CONFIGURATION AT 125 C



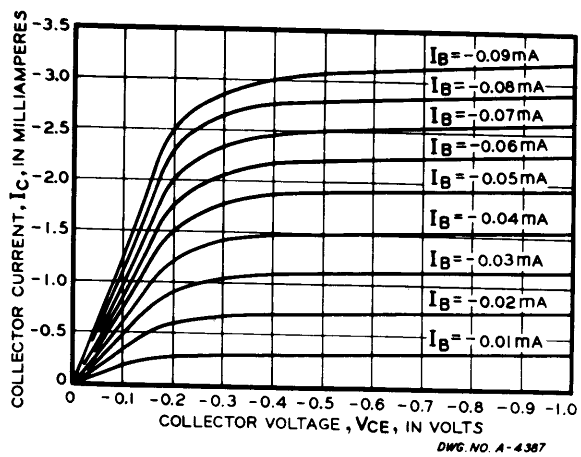
TYPICAL SATURATED REGION COLLECTOR CHARACTERISTICS IN GROUNDED EMITTER CONFIGURATION AT 25 C



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

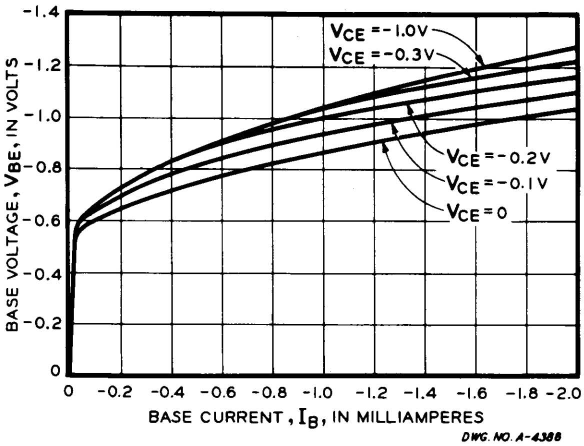


TYPICAL LOW CURRENT SATURATED REGION COLLECTOR CHARACTERISTICS IN GROUNDED EMITTER CONFIGURATION AT 25 C

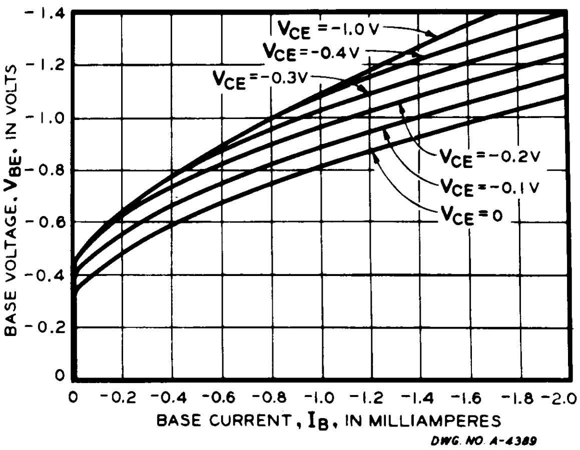


TYPICAL LOW CURRENT SATURATED REGION COLLECTOR CHARACTERISTICS IN GROUNDED EMITTER CONFIGURATION AT 125 C

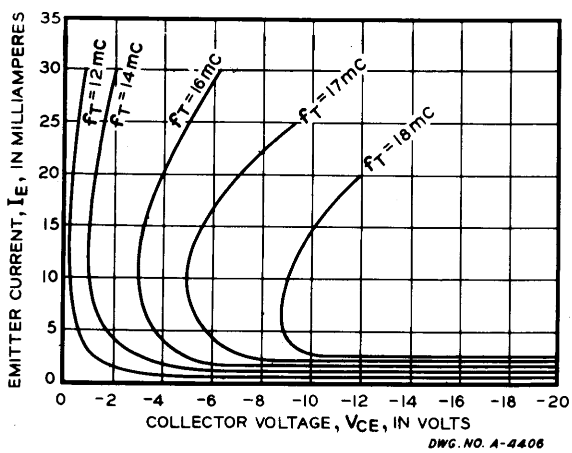
CHARACTERISTIC CURVES



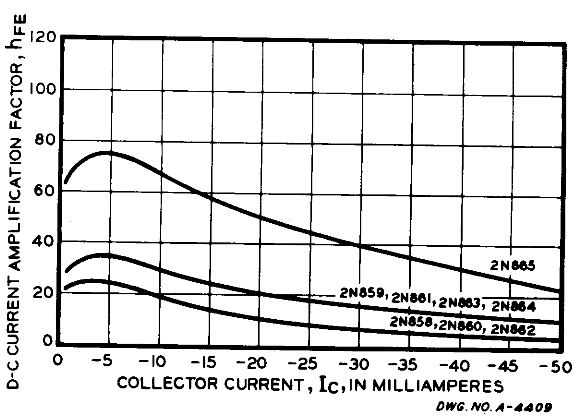
TYPICAL INPUT CHARACTERISTICS IN GROUNDED EMITTER CONFIGURATION AT 25 C



TYPICAL INPUT CHARACTERISTICS IN GROUNDED EMITTER CONFIGURATION AT 125 C



TYPICAL f_T AS A FUNCTION OF COLLECTOR VOLTAGE AND EMITTER CURRENT IN GROUNDED EMITTER CONFIGURATION AT 25 C WITH $V_{CE} = -6V$, $I_E = 1mA$



TYPICAL D-C BETA AS A FUNCTION OF COLLECTOR CURRENT IN GROUNDED EMITTER CONFIGURATION AT 25 C WITH $V_{CE} = 0.5V$

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.

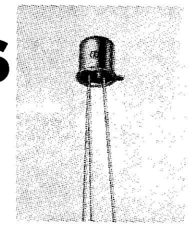
No. 31,126 A

SPRAGUE Engineering Bulletin

THE MARK OF RELIABILITY

2N861

TYPE 2N861 SILICON PRECISION ALLOY TRANSISTORS



ACTUAL SIZE

THE 2N861 P-N-P Silicon Precision Alloy Transistors are intended for control circuits, medium speed switching applications and high gain amplifiers. The homogeneous base of these SPAT® transistors provides a high reverse bias emitter-base diode rating. The unit features low saturation resistance, high beta and high collector voltage at low cutoff currents. High and low temperature performance are guaranteed by a saturation current test at 125C and a beta test at −55C.

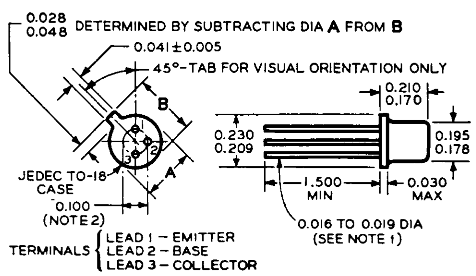
ABSOLUTE MAXIMUM RATINGS[1]

Storage Temperature . . . . −65 C to +140 C
Collector Voltage, V_{CB} . . . . −25 volts
Collector Voltage, V_{CEO} . . . . −25 volts
Emitter Voltage, V_{EB} . . . . −20 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 transistor, do not attempt to measure these characteristics above the maximum ratings.

[2]Due to the nature of SPAT 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



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[3] at T = 25 C

	CHARACTERISTICS	TEST CONDITIONS	MIN.	TYPICAL	MAX.	UNITS
	D-C CHARACTERISTICS					
I_{CBO}	Collector Cutoff Current	V_{CB} = −10V			0.1	µA
I_{CBO}	Collector Cutoff Current	V_{CB} = −10V, T = 125C			15	µA
BV_{CBO}	Collector Breakdown Voltage[4]	I_C = −1µA	25			volts
BV_{CEO}	Collector Breakdown Voltage[4]	I_C = −25µA	25			volts
I_{EBO}	Emitter Current	V_{EB} = −20V			1	µA
h_{FE}	D-C Current Amplification Factor	V_{CE} = −0.5V, I_C = −5 mA	25	35	75	
h_{FE}	D-C Current Amplification Factor	V_{CE} = −0.5V, I_C = −5 mA, T = −55 C	16	23		
$V_{CE\,(SAT)}$	Collector Saturation Voltage	I_C = −5mA, I_B = −0.5 mA		.06	0.15	volt
V_{BE}	Base Voltage	I_C = −5mA, I_B = −0.5mA	0.75	0.81	1.0	volt
	SMALL SIGNAL PARAMETERS					
h_{ie}	Input Resistance	V_{CE} = −6V, I_E = 1 mA		2.5		KΩ
h_{oe}	Output Conductance	V_{CE} = −6V, I_E = 1 mA		50		µmhos
h_{fe}	Current Amplification Factor	V_{CE} = −6V, I_E = 1 mA	30	65	100	
h_{re}	Voltage Feedback Ratio	V_{CE} = −6V, I_E = 1 mA		3.5×10^{-4}		
	HIGH FREQUENCY CHARACTERISTICS					
C_{ob}	Output Capacitance	V_{CE} = −6V, I_E = 0, f = 4 mc		5	9	pF
C_{ib}	Input Capacitance	V_{EB} = −6V, I_C = 0, f = 4 mc		4	7	pF
f_T	Gain Bandwidth Product	V_{CE} = −6V, I_E = 1 mA	7.5	22		mc
$R_e(h_{ie})$	Real Part of Input Impedance	V_{CE} = −6V, I_E = 1 mA, f = 100 mc		350	700	ohms
	SWITCHING CHARACTERISTICS					
t_r	Rise Time	Circuit of Figure 1		105	150	nsec
t_s	Storage Time	Circuit of Figure 2		75	100	nsec
t_f	Fall Time	Circuit of Figure 2		105	150	nsec

[3]Typical values are for engineering guidance only.

[4]To avoid exceeding the maximum voltage ratings, the breakdown voltages must be measured by setting the voltage at the minimum specified (maximum rating). If the resultant current voltage is less than the value given as a condition of test, the breakdown voltage is within specification.

SPRAGUE ENGINEERING BULLETIN 31126A

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

TEST CIRCUITS

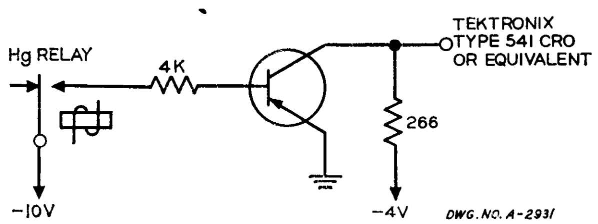


FIGURE 1

RISE TIME TEST CIRCUIT

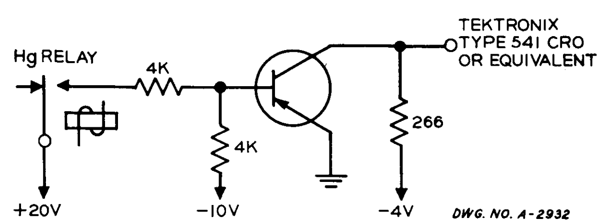
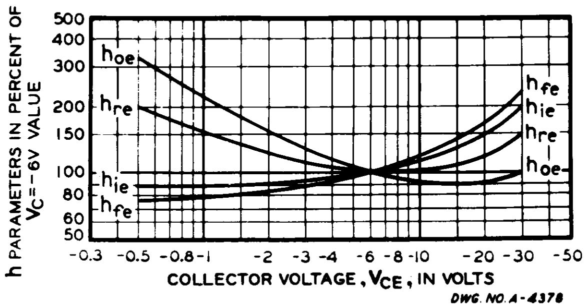


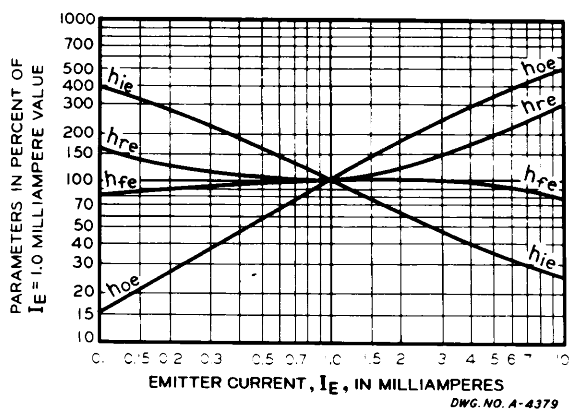
FIGURE 2

STORAGE AND FALL TIME TEST CIRCUIT

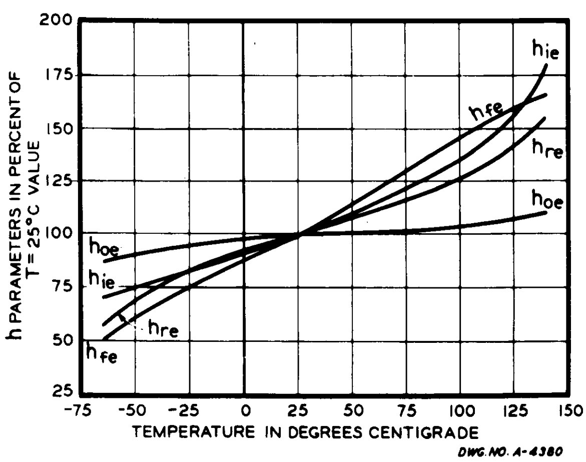
CHARACTERISTIC CURVES



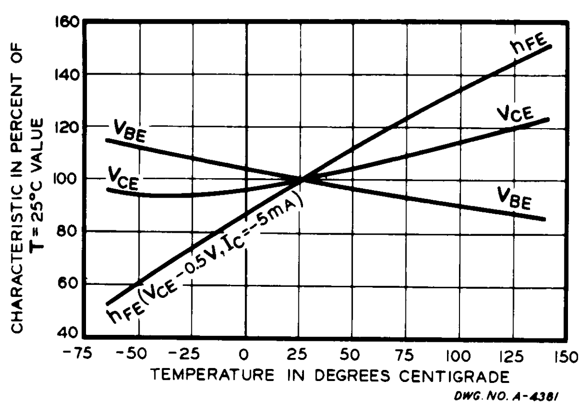
TYPICAL h PARAMETERS AS A FUNCTION OF COLLECTOR VOLTAGE AT 25 C WITH I_E = 1.0mA NORMALIZED FOR V_C = −6V



TYPICAL h PARAMETERS AS A FUNCTION OF EMITTER CURRENT AT 25 C WITH I_E = 1.0mA NORMALIZED FOR V_C = −6V

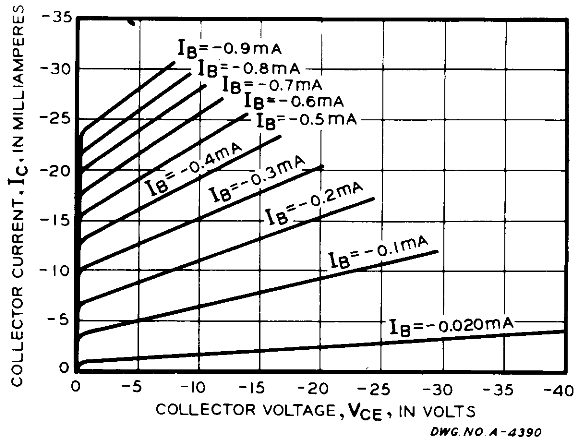


TYPICAL h PARAMETERS AS A FUNCTION OF TEMPERATURE AT 25 C WITH I_E = 1.0mA NORMALIZED FOR V_C = −6V

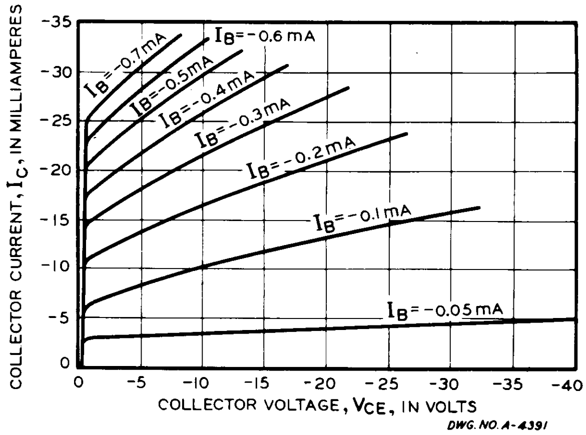


TYPICAL CHARACTERISTICS IN GROUNDED EMITTER CONFIGURATION AS A FUNCTION OF TEMPERATURE NORMALIZED FOR 25 C WITH V_{CE} AND V_{BE} AT I_C = −5mA, I_B = −0.5mA and I_C = −5mA, I_B = −0.8mA

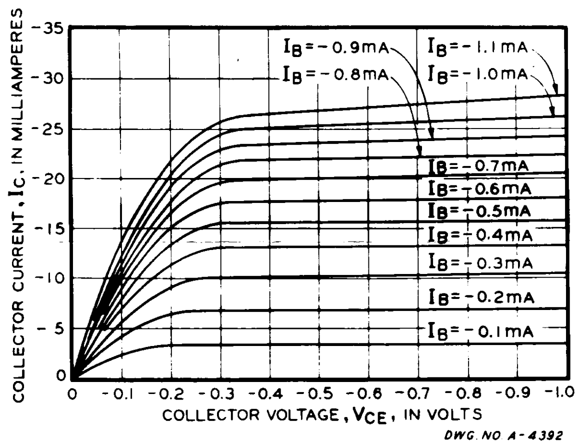
CHARACTERISTIC CURVES



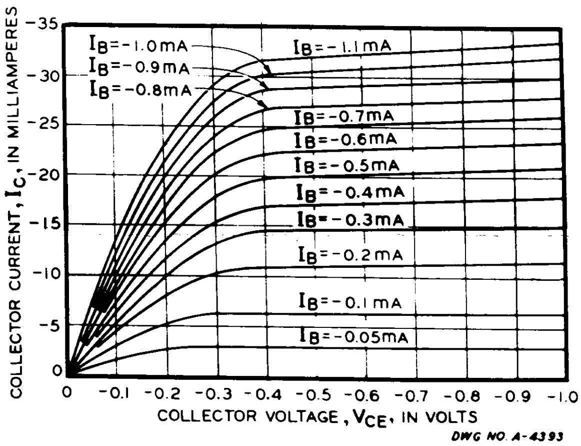
TYPICAL COLLECTOR CHARACTERISTICS IN GROUNDED EMITTER CONFIGURATION AT 25 C



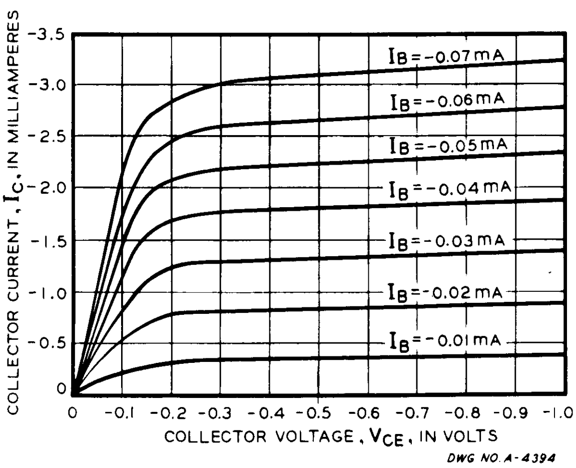
TYPICAL COLLECTOR CHARACTERISTICS IN GROUNDED EMITTER CONFIGURATION AT 125 C



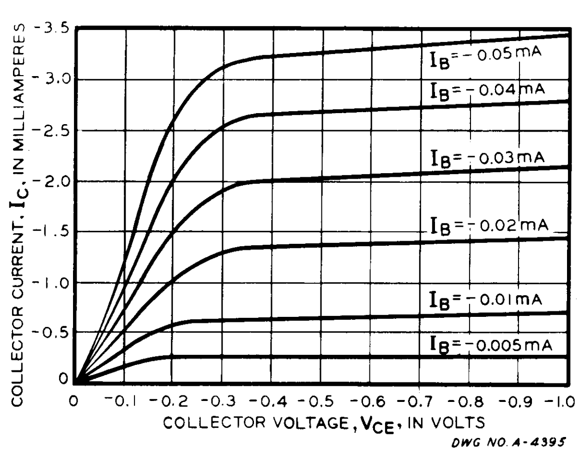
TYPICAL SATURATED REGION COLLECTOR CHARACTERISTICS IN GROUNDED EMITTER CONFIGURATION AT 25 C



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

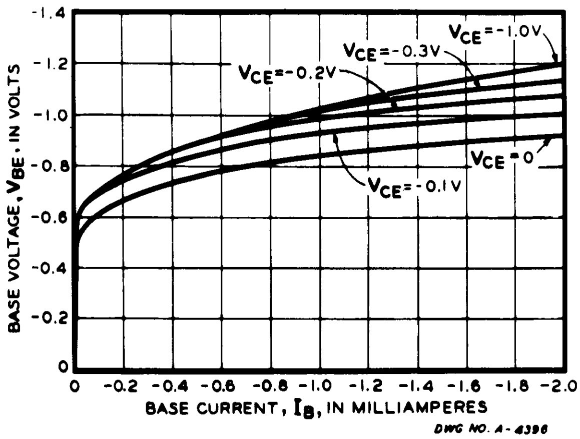


TYPICAL LOW CURRENT SATURATED REGION COLLECTOR CHARACTERISTICS IN GROUNDED EMITTER CONFIGURATION AT 25 C

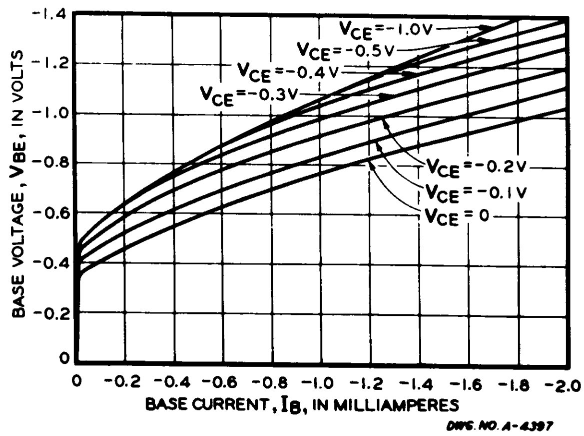


TYPICAL LOW CURRENT SATURATED REGION COLLECTOR CHARACTERISTICS IN GROUNDED EMITTER CONFIGURATION AT 125 C

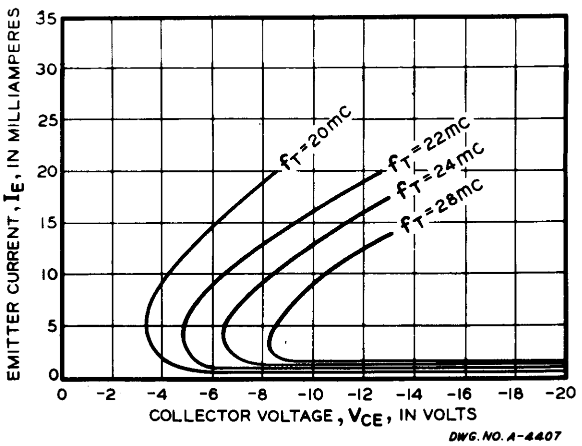
CHARACTERISTIC CURVES



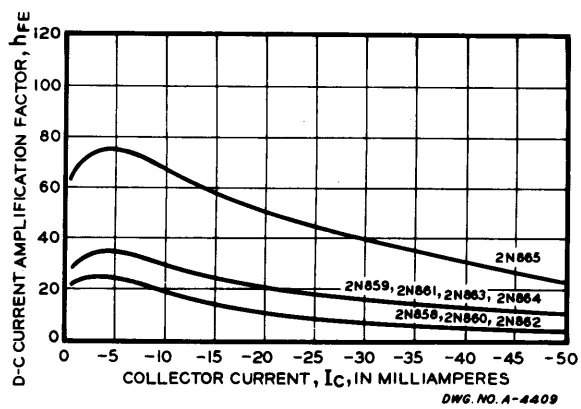
TYPICAL INPUT CHARACTERISTICS IN GROUNDED EMITTER CONFIGURATION AT 25 C



TYPICAL INPUT CHARACTERISTICS IN GROUNDED EMITTER CONFIGURATION AT 125 C



TYPICAL f_T AS A FUNCTION OF COLLECTOR VOLTAGE AND EMITTER CURRENT IN GROUNDED EMITTER CONFIGURATION AT 25 C WITH $V_{CE} = -6V$, $I_E = 1mA$



TYPICAL D-C BETA AS A FUNCTION OF COLLECTOR CURRENT IN GROUNDED EMITTER CONFIGURATION AT 25 C WITH $V_{CE} = 0.5V$

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.

The information included herein is believed to be accurate and reliable. However, the Sprague Electric Company assumes no responsibility for its use; nor for any infringements of patents or other rights of third parties which may result from it use.

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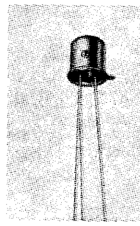
SPRAGUE the mark of reliability

Engineering Bulletin

2N862

TYPE 2N862 SILICON PRECISION ALLOY TRANSISTORS


ACTUAL SIZE

INTENDED FOR USE in control circuits and medium speed switching application, Type 2N862 P-N-P Silicon Precision Alloy Transistors feature low saturation resistance and high collector voltage at low cutoff currents. Their homogeneous base of these SPAT® transistors provides a high reverse bias emitter-base diode rating. High and low temperature performance are guaranteed by a saturation current test at 125C and a beta test at −55C.

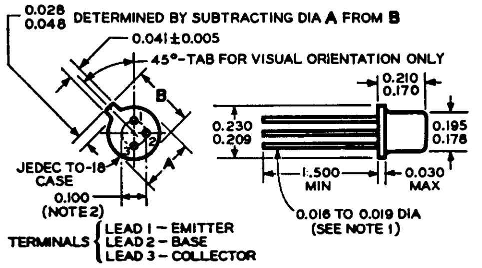
ABSOLUTE MAXIMUM RATINGS[1]

Storage Temperature .... −65 C to +140 C
Collector Voltage, V_{CB} .... −15 volts
Collector Voltage, V_{CEO} .... −15 volts
Emitter Voltage, V_{EB} .... −10 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 transistor, do not attempt to measure these characteristics above the maximum ratings.

[2]Due to the nature of SPAT 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



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-34584

ELECTRICAL CHARACTERISTICS[3] at T = 25 C

	CHARACTERISTICS	TEST CONDITIONS	MIN.	TYPICAL	MAX.	UNITS
	D-C CHARACTERISTICS					
I_{CBO}	Collector Cutoff Current	V_{CB} = −10V			0.1	μA
I_{CBO}	Collector Cutoff Current	V_{CB} = −10V, T = 125C			15	μA
BV_{CBO}	Collector Breakdown Voltage[4]	I_C = −1μA	15			volts
BV_{CEO}	Collector Breakdown Voltage[4]	I_C = −25μA	15			volts
I_{EBO}	Emitter Current	V_{EB} = −10V			0.1	μA
h_{FE}	D-C Current Amplification Factor	V_{CE} = −0.5V, I_C = −5 mA	12	20	48	
h_{FE}	D-C Current Amplification Factor	V_{CE} = −0.5V, I_C = −5 mA, T = −55 C	8	14		
$V_{CE(SAT)}$	Collector Saturation Voltage	I_C = −5mA, I_B = −0.8 mA		.07	0.15	volt
V_{BE}	Base Voltage	I_C = −5mA, I_B = −0.8mA	0.75	0.86	0.95	volt
	SMALL SIGNAL PARAMETERS					
h_{ie}	Input Resistance	V_{CE} = −6V, I_E = 1 mA		1.4		KΩ
h_{oe}	Output Conductance	V_{CE} = −6V, I_E = 1 mA		35		μmhos
h_{fe}	Current Amplification Factor	V_{CE} = −6V, I_E = 1 mA	20	33	60	
h_{re}	Voltage Feedback Ratio	V_{CE} = −6V, I_E = 1 mA		3.5×10^{-4}		
	HIGH FREQUENCY CHARACTERISTICS					
C_{ob}	Output Capacitance	V_{CB} = −6V, I_E = 0, f = 4 mc		5	9	pF
C_{ib}	Input Capacitance	V_{EB} = −6V, I_C = 0, f = 4 mc		4	7	pF
f_T	Gain Bandwidth Product	V_{CE} = −6V, I_E = 1 mA	8	14		mc
$R_e(h_{ie})$	Real Part of Input Impedance	V_{CE} = −6V, I_E = 1 mA, f = 100 mc		350	700	ohms
	SWITCHING CHARACTERISTICS					
t_r	Rise Time	Circuit of Figure 1		100	200	nsec
t_s	Storage Time	Circuit of Figure 2		75	100	nsec
t_f	Fall Time	Circuit of Figure 2		100	200	nsec

[3]Typical values are for engineering guidance only.

[4]To avoid exceeding the maximum voltage ratings, the breakdown voltages must be measured by setting the voltage at the minimum specified (maximum rating). If the resultant current voltage is less than the value given as a condition of test, the breakdown voltage is within specification.

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

SPRAGUE ENGINEERING BULLETIN 31128A

TEST CIRCUITS

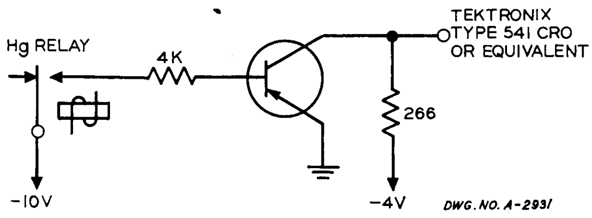


FIGURE 1
RISE TIME TEST CIRCUIT

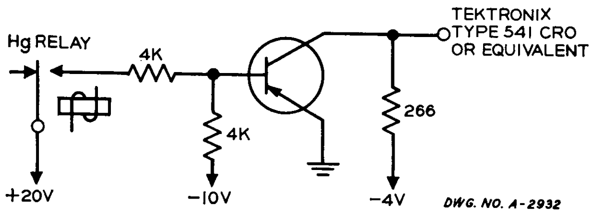
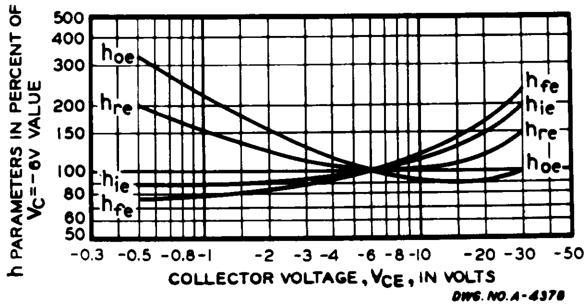
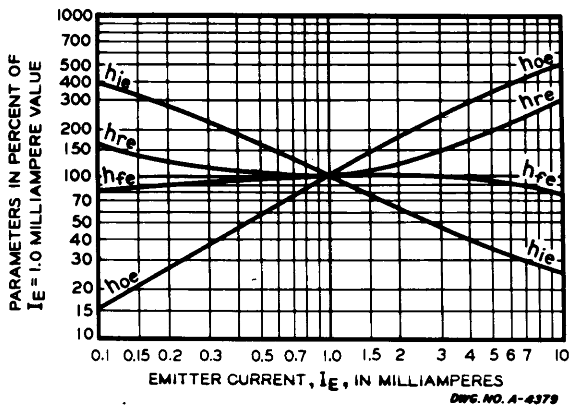


FIGURE 2
STORAGE AND FALL TIME TEST CIRCUIT

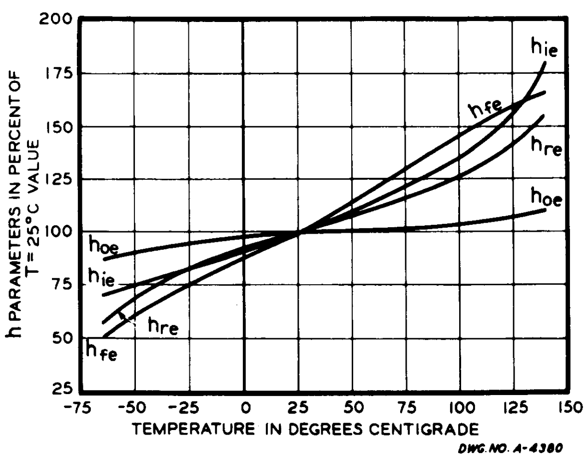
CHARACTERISTIC CURVES



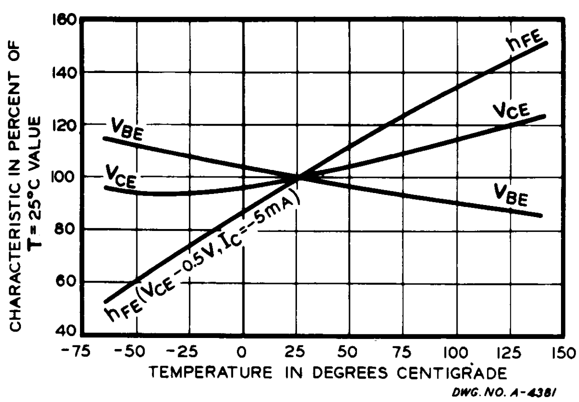
TYPICAL h PARAMETERS AS A FUNCTION OF COLLECTOR VOLTAGE AT 25 C WITH I_E = 1.0mA NORMALIZED FOR V_C = −6V



TYPICAL h PARAMETERS AS A FUNCTION OF TEMPERATURE AT 25 C WITH I_E = 1.0mA NORMALIZED FOR V_C = −6V

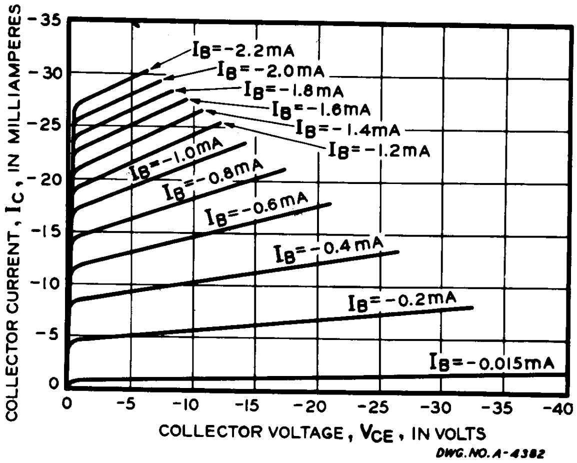


TYPICAL h PARAMETERS AS A FUNCTION OF EMITTER CURRENT AT 25 C WITH I_E = 1.0mA NORMALIZED FOR V_C = −6V

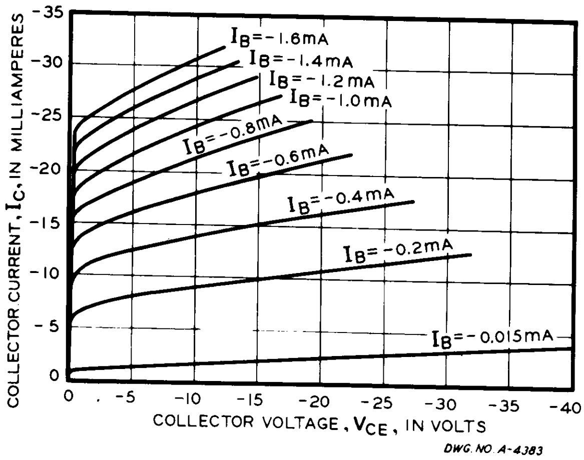


TYPICAL CHARACTERISTICS IN GROUNDED EMITTER CONFIGURATION AS A FUNCTION OF TEMPERATURE NORMALIZED FOR 25 C WITH V_{CE} AND V_{BE} AT I_C = −5mA, I_B = −0.5mA and I_C = −5mA, I_B = −0.8mA

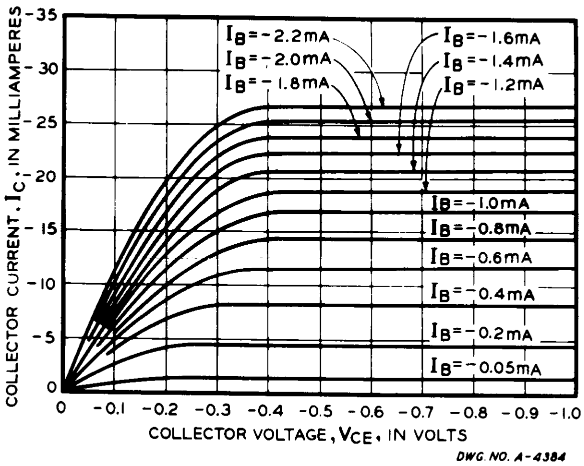
CHARACTERISTIC CURVES



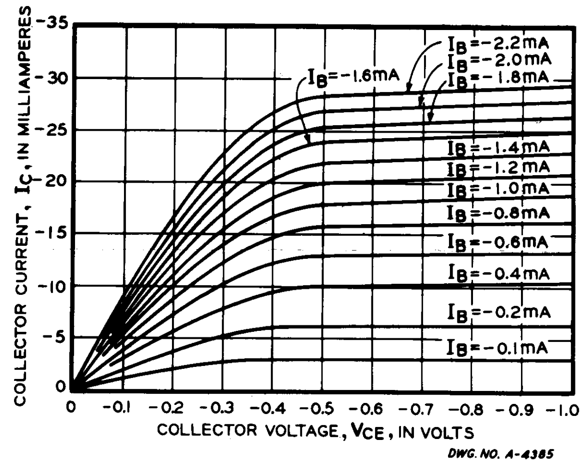
TYPICAL COLLECTOR CHARACTERISTICS IN GROUNDED EMITTER CONFIGURATION AT 25 C



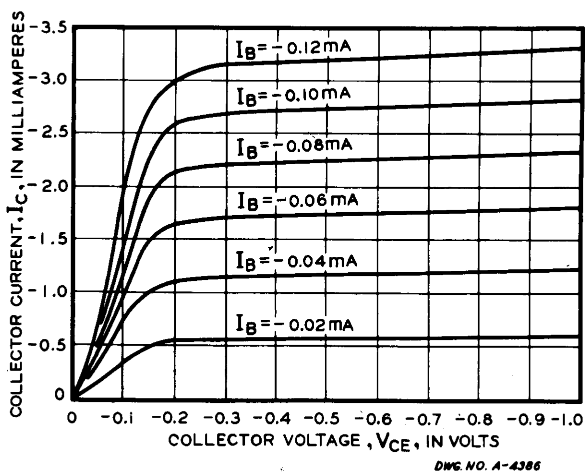
TYPICAL COLLECTOR CHARACTERISTICS IN GROUNDED EMITTER CONFIGURATION AT 125 C



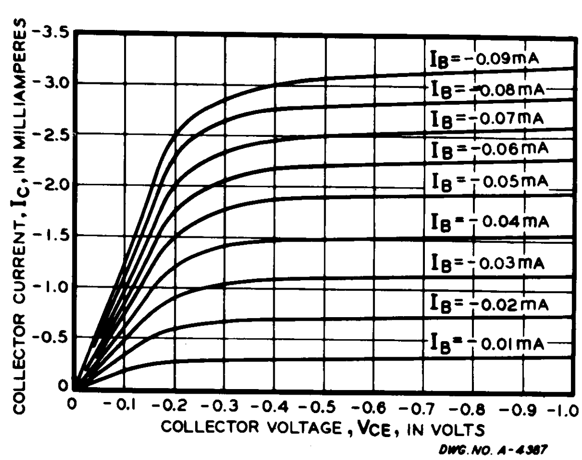
TYPICAL SATURATED REGION COLLECTOR CHARACTERISTICS IN GROUNDED EMITTER CONFIGURATION AT 25 C



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

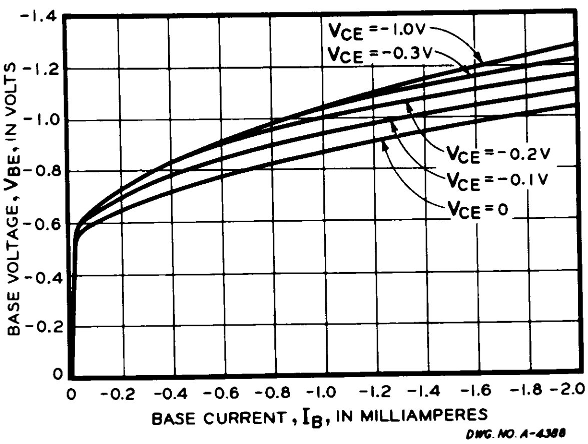


TYPICAL LOW CURRENT SATURATED REGION COLLECTOR CHARACTERISTICS IN GROUNDED EMITTER CONFIGURATION AT 25 C

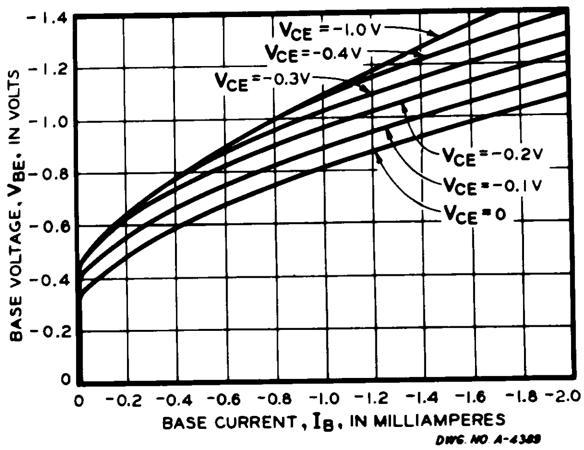


TYPICAL LOW CURRENT SATURATED REGION COLLECTOR CHARACTERISTICS IN GROUNDED EMITTER CONFIGURATION AT 125 C

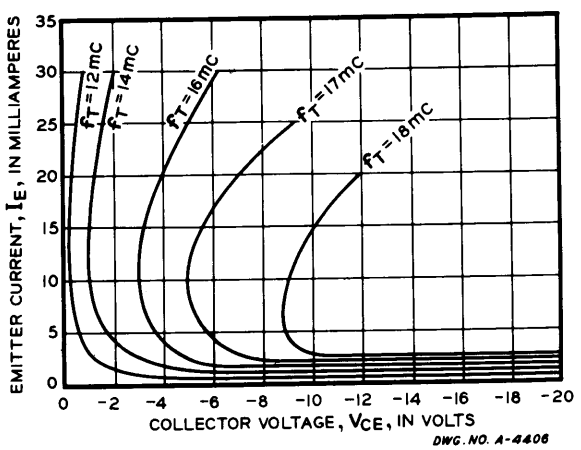
CHARACTERISTIC CURVES



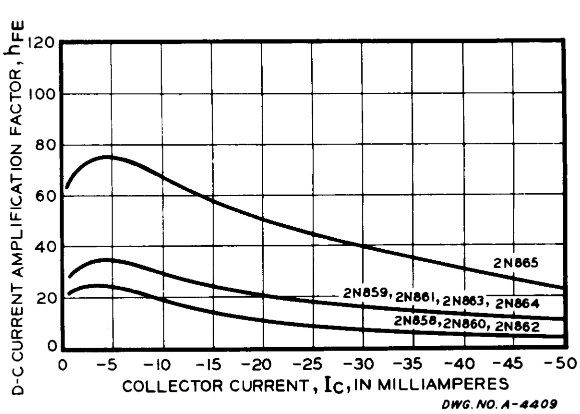
TYPICAL INPUT CHARACTERISTICS IN GROUNDED EMITTER CONFIGURATION AT 25 C



TYPICAL INPUT CHARACTERISTICS IN GROUNDED EMITTER CONFIGURATION AT 125 C



TYPICAL f_T AS A FUNCTION OF COLLECTOR VOLTAGE AND EMITTER CURRENT IN GROUNDED EMITTER CONFIGURATION AT 25 C WITH $V_{CE} = -6V$, $I_E = 1mA$



TYPICAL D-C BETA AS A FUNCTION OF COLLECTOR CURRENT IN GROUNDED EMITTER CONFIGURATION AT 25 C WITH $V_{CE} = 0.5V$

ISSUE OF APRIL, 1965

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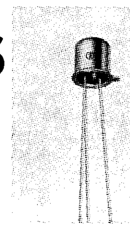
No. 31,130A

SPRAGUE® THE MARK OF RELIABILITY

Engineering Bulletin

2N863

TYPE 2N863 SILICON PRECISION ALLOY TRANSISTORS


ACTUAL SIZE

TYPE 2N863 P-N-P Silicon Precision Alloy Transistors have been specifically designed for control circuits, medium-speed switching application and high-gain amplifiers. The homogeneous base of these SPAT® transistors provides a high reverse bias emitter-base diode rating.

These transistors feature low saturation resistance, high beta, and high collector voltage at low cutoff currents. High and low temperature performance are guaranteed by a saturation current test at 125C and a beta test at −55C.

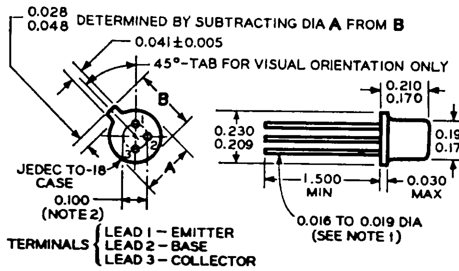
ABSOLUTE MAXIMUM RATINGS[1]

Storage Temperature .... −65 C to +140 C
Collector Voltage, V_{CB} .... −25 volts
Collector Voltage, V_{CEO} .... −25 volts
Emitter Voltage, V_{EB} .... −20 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 transistor, do not attempt to measure these characteristics above the maximum ratings.

[2]Due to the nature of SPAT 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



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-3450A

ELECTRICAL CHARACTERISTICS[3] at T = 25 C

	CHARACTERISTICS	TEST CONDITIONS	MIN.	TYPICAL	MAX.	UNITS
	D-C CHARACTERISTICS					
I_{CBO}	Collector Cutoff Current	$V_{CB} = -10V$			0.1	μA
I_{CBO}	Collector Cutoff Current	$V_{CB} = -10V, T = 125C$			15	μA
BV_{CBO}	Collector Breakdown Voltage[4]	$I_C = -1\mu A$	15			volts
BV_{CEO}	Collector Breakdown Voltage[4]	$I_C = -25\mu A$	15			volts
I_{EBO}	Emitter Current	$V_{EB} = -10V$			0.1	μA
h_{FE}	D-C Current Amplification Factor	$V_{CE} = -0.5V, I_C = -5$ mA	25	35	100	
h_{FE}	D-C Current Amplification Factor	$V_{CE} = -0.5V, I_C = -5$ mA, $T = -55$ C	16	23		
$V_{CE\ (SAT)}$	Collector Saturation Voltage	$I_C = -5mA, I_B = -0.5$ mA		.06	0.15	volt
V_{BE}	Base Voltage	$I_C = -5mA, I_B = -0.5mA$	0.75	0.81	0.95	volt
	SMALL SIGNAL PARAMETERS					
h_{ie}	Input Resistance	$V_{CE} = -6V, I_E = 1$ mA		2.5		KΩ
h_{oe}	Output Conductance	$V_{CE} = -6V, I_E = 1$ mA		50		μmhos
h_{fe}	Current Amplification Factor	$V_{CE} = -6V, I_E = 1$ mA	40	65	120	
h_{re}	Voltage Feedback Ratio	$V_{CE} = -6V, I_E = 1$ mA		3.5×10^{-4}		
	HIGH FREQUENCY CHARACTERISTICS					
C_{ob}	Output Capacitance	$V_{CB} = -6V, I_E = 0, f = 4$ mc		5	9	pF
C_{ib}	Input Capacitance	$V_{EB} = -6V, I_C = 0, f = 4$ mc		4	7	pF
f_T	Gain Bandwidth Product	$V_{CE} = -6V, I_E = 1$ mA	10	22		mc
$R_{e(hie)}$	Real Part of Input Impedance	$V_{CE} = -6V, I_E = 1$ mA, $f = 100$ mc		350	700	ohms
	SWITCHING CHARACTERISTICS					
t_r	Rise Time	Circuit of Figure 1		90	125	nsec
t_s	Storage Time	Circuit of Figure 2		75	100	nsec
t_f	Fall Time	Circuit of Figure 2		90	100	nsec

[3]Typical values are for engineering guidance only.

[4]To avoid exceeding the maximum voltage ratings, the breakdown voltages must be measured by setting the voltage at the minimum specified (maximum rating). If the resultant current voltage is less than the value given as a condition of test, the breakdown voltage is within specification.

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EXECUTIVE OFFICES: NORTH ADAMS, MASS. CONCORD, N.H. • WORCESTER, MASS.

TEST CIRCUITS

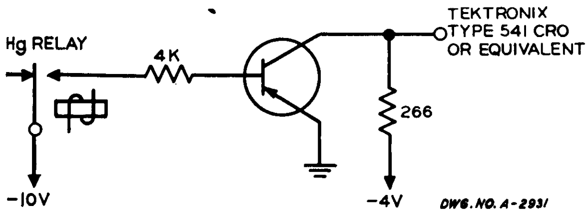


FIGURE 1
RISE TIME TEST CIRCUIT

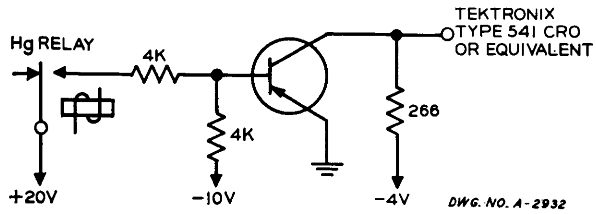
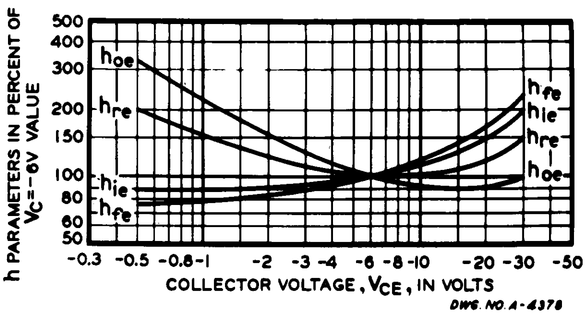
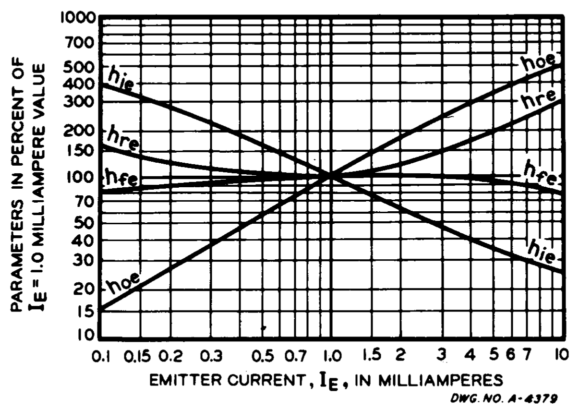


FIGURE 2
STORAGE AND FALL TIME TEST CIRCUIT

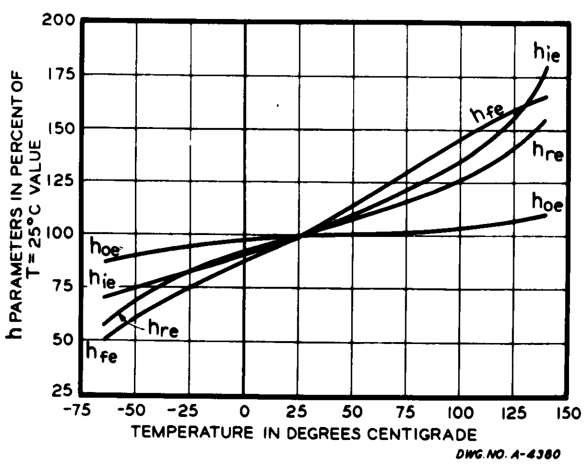
CHARACTERISTIC CURVES



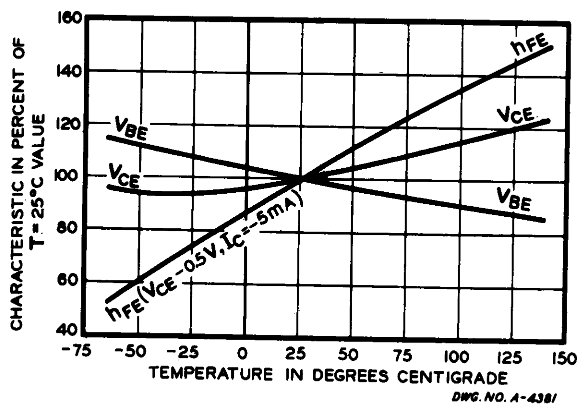
TYPICAL h PARAMETERS AS A FUNCTION OF COLLECTOR VOLTAGE AT 25 C WITH I_E = 1.0mA NORMALIZED FOR V_C = −6V



TYPICAL h PARAMETERS AS A FUNCTION OF EMITTER CURRENT AT 25 C WITH I_E = 1.0mA NORMALIZED FOR V_C = −6V

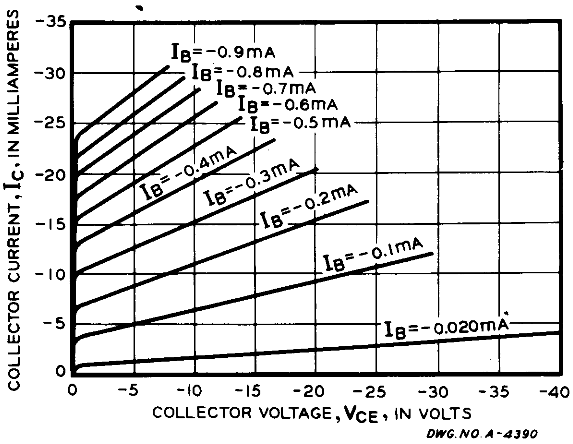


TYPICAL h PARAMETERS AS A FUNCTION OF TEMPERATURE AT 25 C WITH I_E = 1.0mA NORMALIZED FOR V_C = −6V

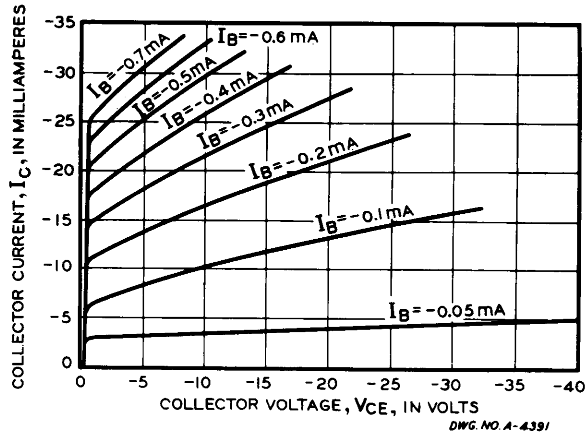


TYPICAL CHARACTERISTICS IN GROUNDED EMITTER CONFIGURATION AS A FUNCTION OF TEMPERATURE NORMALIZED FOR 25 C WITH V_{CE} AND V_{BE} AT I_C = −5mA, I_B = −0.5mA and I_C = −5mA, I_B = −0.8mA

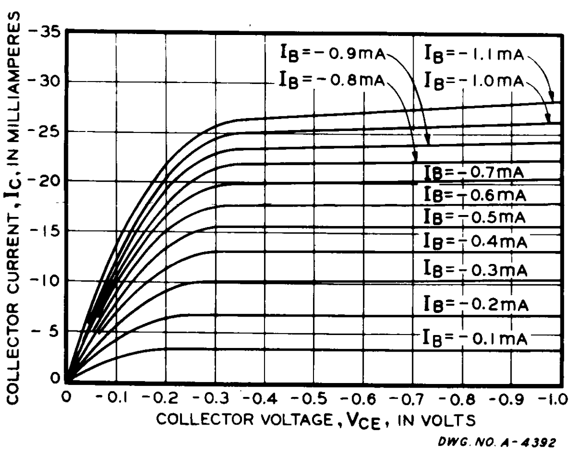
CHARACTERISTIC CURVES



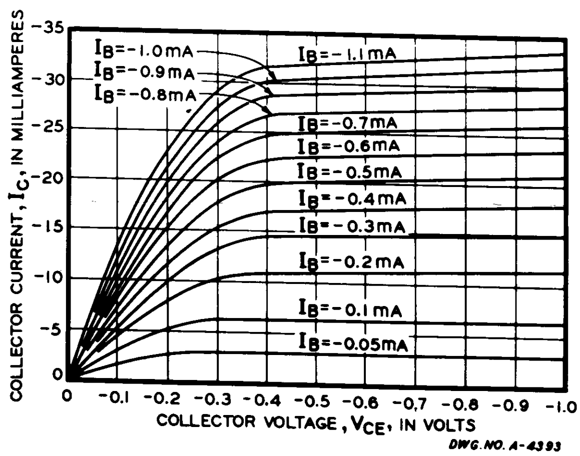
TYPICAL COLLECTOR CHARACTERISTICS IN GROUNDED EMITTER CONFIGURATION AT 25 C



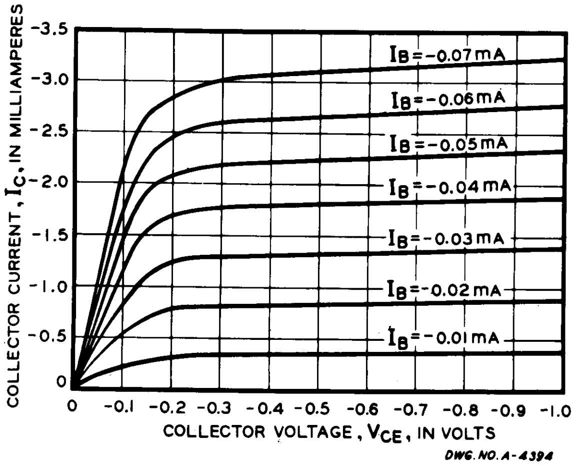
TYPICAL COLLECTOR CHARACTERISTICS IN GROUNDED EMITTER CONFIGURATION AT 125 C



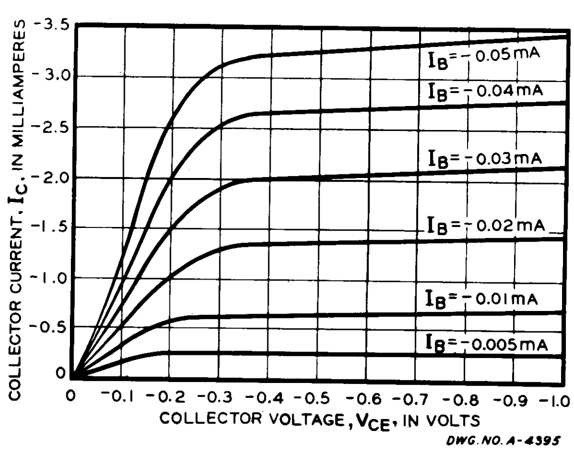
TYPICAL SATURATED REGION COLLECTOR CHARACTERISTICS IN GROUNDED EMITTER CONFIGURATION AT 25 C



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

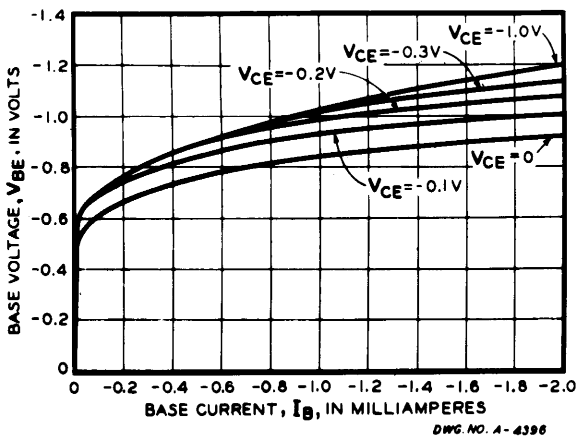


TYPICAL LOW CURRENT SATURATED REGION COLLECTOR CHARACTERISTICS IN GROUNDED EMITTER CONFIGURATION AT 25 C

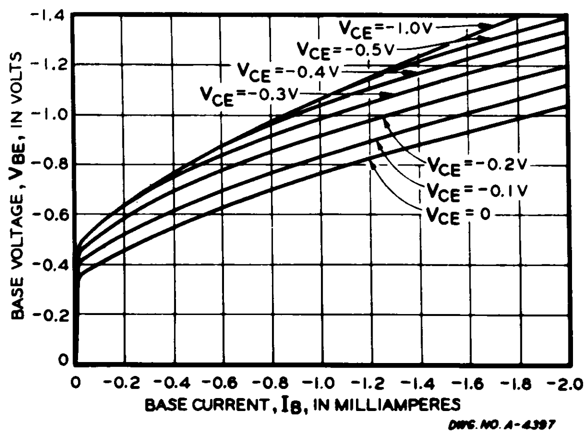


TYPICAL LOW CURRENT SATURATED REGION COLLECTOR CHARACTERISTICS IN GROUNDED EMITTER CONFIGURATION AT 125 C

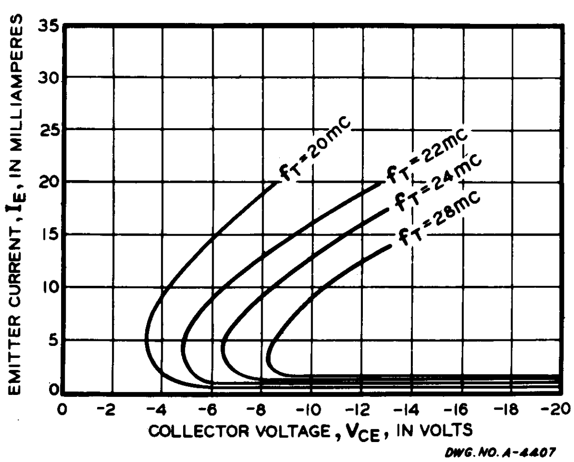
CHARACTERISTIC CURVES



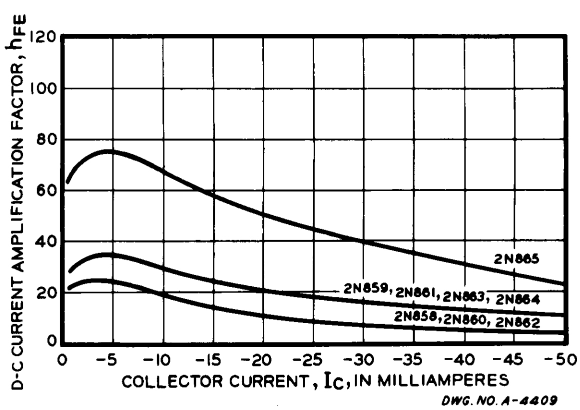
TYPICAL INPUT CHARACTERISTICS IN GROUNDED EMITTER CONFIGURATION AT 25 C



TYPICAL INPUT CHARACTERISTICS IN GROUNDED EMITTER CONFIGURATION AT 125 C



TYPICAL f_T AS A FUNCTION OF COLLECTOR VOLTAGE AND EMITTER CURRENT IN GROUNDED EMITTER CONFIGURATION AT 25 C WITH $V_{CE} = -6V$, $I_E = 1mA$



TYPICAL D-C BETA AS A FUNCTION OF COLLECTOR CURRENT IN GROUNDED EMITTER CONFIGURATION AT 25 C WITH $V_{CE} = 0.5V$

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2N864

TYPE 2N864 SILICON PRECISION ALLOY TRANSISTORS

ACTUAL SIZE

TYPE 2N864 P-N-P Silicon Precision Alloy Transistors are intended for control circuits, medium speed switching applications and chopper circuits. The homogeneous base of these SPAT® transistors makes possible equal ratings for both the emitter and collector diodes. The unit features low saturation resistance, low offset voltage and low cutoff currents. High and low temperature performance are guaranteed by a saturation current test at 125C and a beta test at −55C.

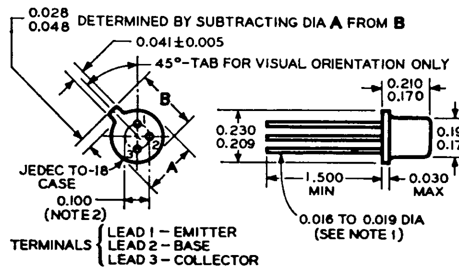
ABSOLUTE MAXIMUM RATINGS[1]

Storage Temperature	−65 C to +140 C
Collector Voltage, V_{CB}	−6 volts
Collector Voltage, V_{CEO}	−6 volts
Emitter Voltage, V_{EB}	−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 transistor, do not attempt to measure these characteristics above the maximum ratings.

[2]Due to the nature of SPAT 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



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[3] at T = 25 C

	CHARACTERISTICS	TEST CONDITIONS	MIN.	TYPICAL	MAX.	UNITS
	D-C CHARACTERISTICS					
I_{CBO}	Collector Cutoff Current	V_{CB} = −6V			0.1	μA
I_{CBO}	Collector Cutoff Current	V_{CB} = −6V, T = 125C			15	μA
BV_{CEO}	Collector Breakdown Voltage[4]	I_C = −25μA	6			volts
I_{EBO}	Emitter Current	V_{EB} = −6V			0.1	μA
h_{FE}	D-C Current Amplification Factor	V_{CE} = −0.5V, I_C = −5 mA	20	35	100	
h_{FE}	D-C Current Amplification Factor	V_{CE} = −0.5V, I_C = −5 mA, T = −55 C	14	20		
$V_{CE\,(SAT)}$	Collector Saturation Voltage	I_C = −5mA, I_B = −0.5 mA		.06	0.1	volt
V_{BE}	Base Voltage	I_C = −5mA, I_B = −0.5mA	0.75	0.81	1.0	volt
V_{OFF}	Offset Voltage	I_B = −1mA			3	mv
	SMALL SIGNAL PARAMETERS					
h_{ie}	Input Resistance	V_{CE} = −6V, I_E = 1 mA		2.5		KΩ
h_{oe}	Output Conductance	V_{CE} = −6V, I_E = 1 mA		50		μmhos
h_{fe}	Current Amplification Factor	V_{CE} = −6V, I_E = 1 mA	25	65	125	
h_{re}	Voltage Feedback Ratio	V_{CE} = −6V, I_E = 1 mA		3.5×10^{-4}		
	HIGH FREQUENCY CHARACTERISTICS					
C_{ob}	Output Capacitance	V_{CB} = −6V, I_E = 0, f = 4 mc		5	9	pF
C_{ib}	Input Capacitance	V_{EB} = −6V, I_C = 0, f = 4 mc		4	7	pF
f_T	Gain Bandwidth Product	V_{CE} = −6V, I_E = 1 mA	16	22		mc
$R_e\,(h_{ie})$	Real Part of Input Impedance	V_{CE} = −6V, I_E = 1 mA, f = 100 mc		350	700	ohms
	SWITCHING CHARACTERISTICS					
t_r	Rise Time	Circuit of Figure 1		75	100	nsec
t_s	Storage Time	Circuit of Figure 2		75	100	nsec
t_f	Fall Time	Circuit of Figure 2		75	100	nsec

[3]Typical values are for engineering guidance only.

[4]To avoid exceeding the maximum voltage ratings, the breakdown voltages must be measured by setting the voltage at the minimum specified (maximum rating). If the resultant current voltage is less than the value given as a condition of test, the breakdown voltage is within specification.

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TEST CIRCUITS

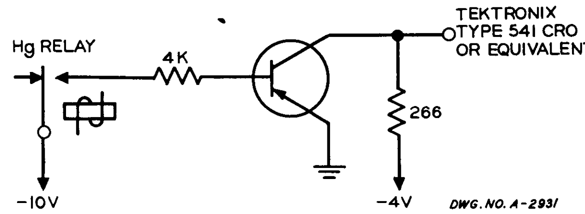


FIGURE 1
RISE TIME TEST CIRCUIT

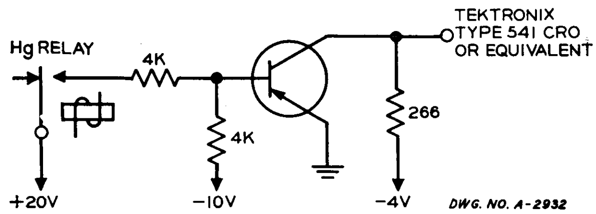
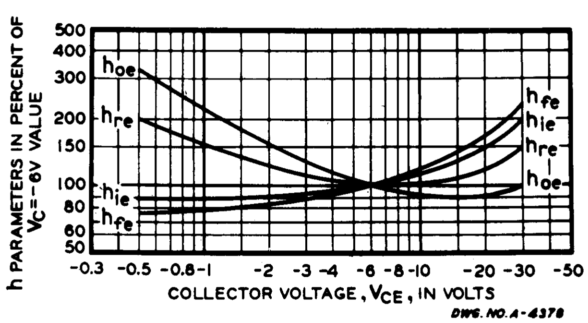
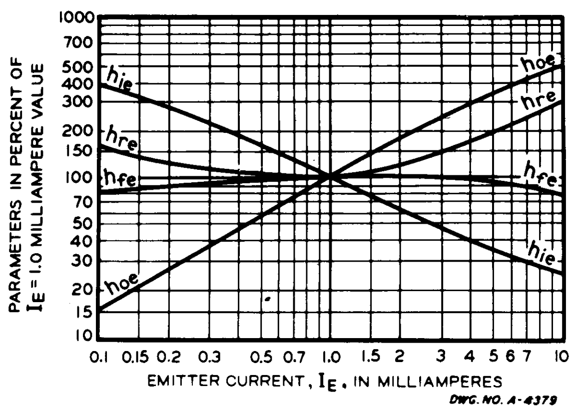


FIGURE 2
STORAGE AND FALL TIME TEST CIRCUIT

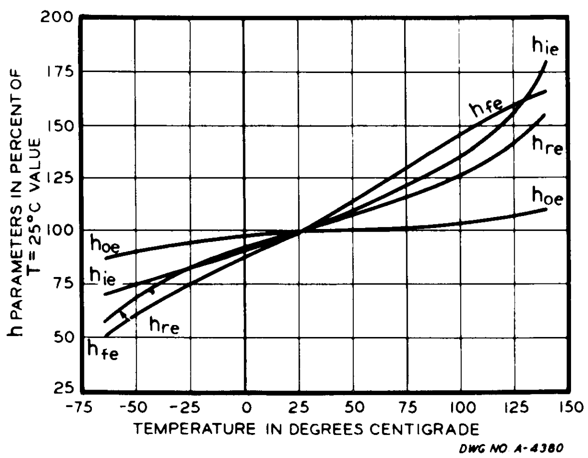
CHARACTERISTIC CURVES



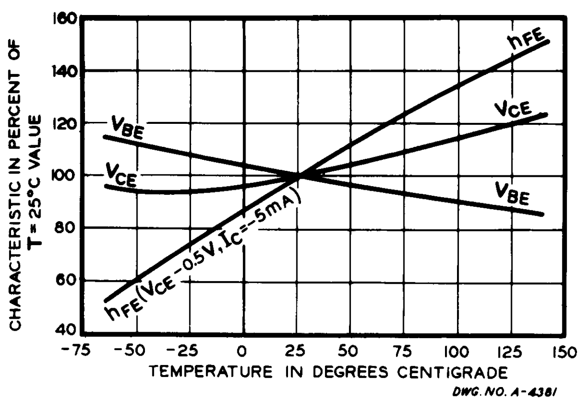
TYPICAL h PARAMETERS AS A FUNCTION OF COLLECTOR VOLTAGE AT 25 C WITH I_E = 1.0mA NORMALIZED FOR V_C = −6V



TYPICAL h PARAMETERS AS A FUNCTION OF EMITTER CURRENT AT 25 C WITH I_E = 1.0mA NORMALIZED FOR V_C = −6V

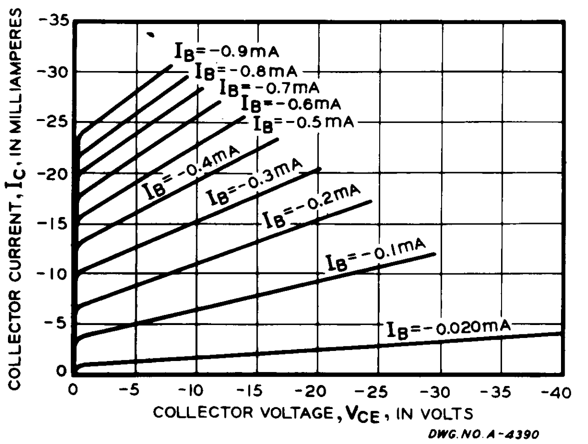


TYPICAL h PARAMETERS AS A FUNCTION OF TEMPERATURE AT 25 C WITH I_E = 1.0mA NORMALIZED FOR V_C = −6V

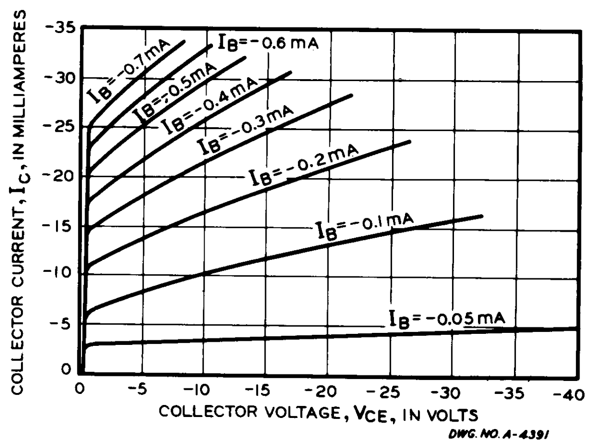


TYPICAL CHARACTERISTICS IN GROUNDED EMITTER CONFIGURATION AS A FUNCTION OF TEMPERATURE NORMALIZED FOR 25 C WITH V_{CE} AND V_{BE} AT I_C = −5mA, I_B = −0.5mA and I_C = −5mA, I_B = −0.8mA

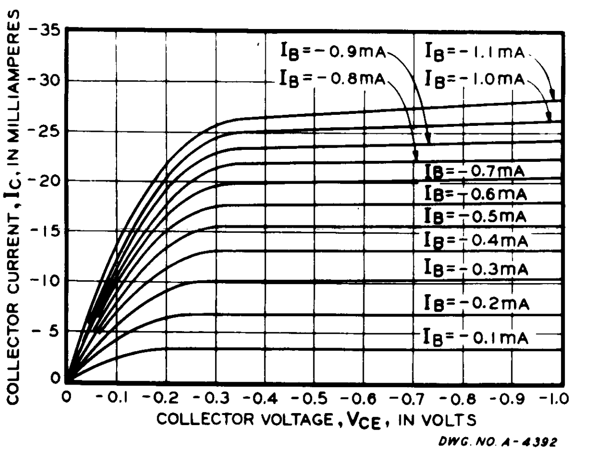
CHARACTERISTIC CURVES



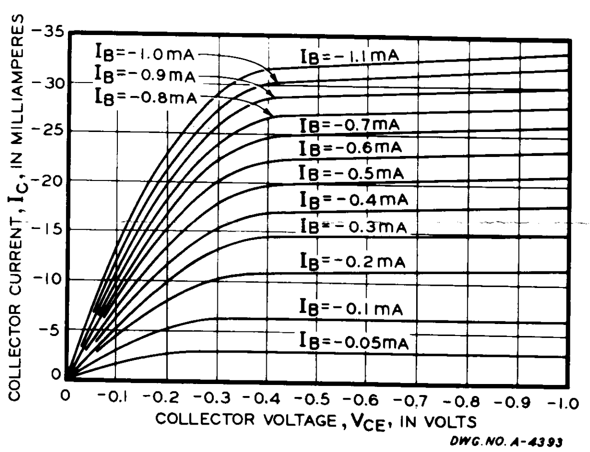
TYPICAL COLLECTOR CHARACTERISTICS IN GROUNDED EMITTER CONFIGURATION AT 25 C



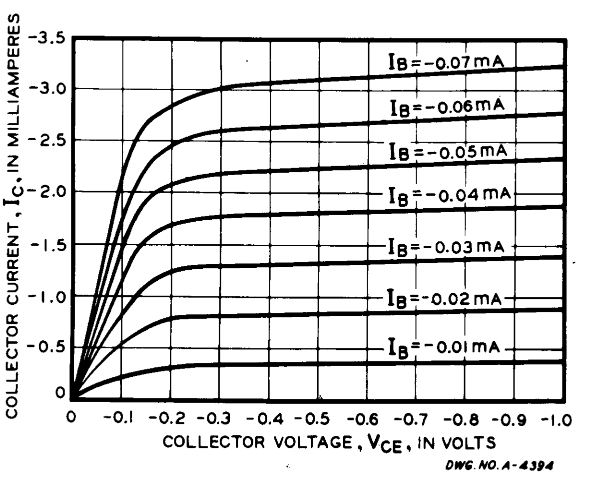
TYPICAL COLLECTOR CHARACTERISTICS IN GROUNDED EMITTER CONFIGURATION AT 125 C



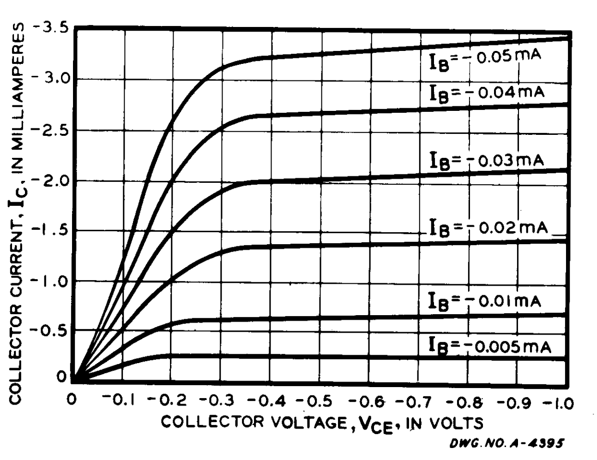
TYPICAL SATURATED REGION COLLECTOR CHARACTERISTICS IN GROUNDED EMITTER CONFIGURATION AT 25 C



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

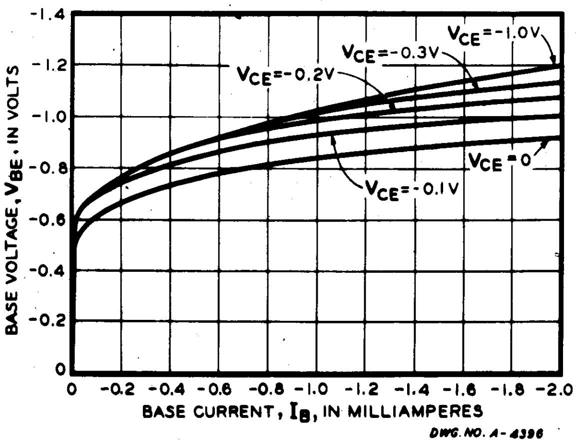


TYPICAL LOW CURRENT SATURATED REGION COLLECTOR CHARACTERISTICS IN GROUNDED EMITTER CONFIGURATION AT 25 C

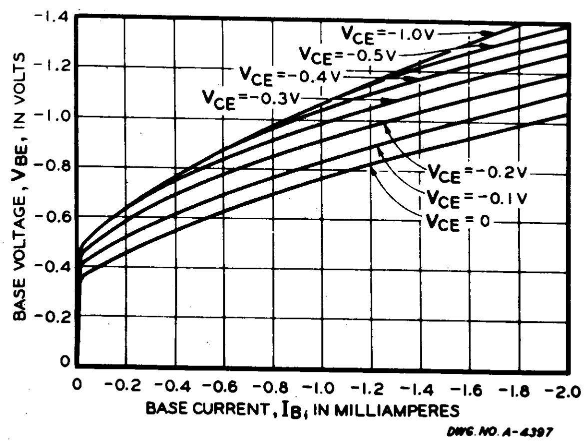


TYPICAL LOW CURRENT SATURATED REGION COLLECTOR CHARACTERISTICS IN GROUNDED EMITTER CONFIGURATION AT 125 C

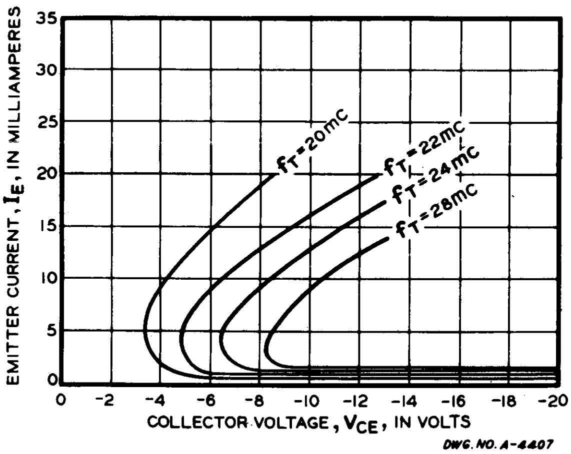
CHARACTERISTIC CURVES



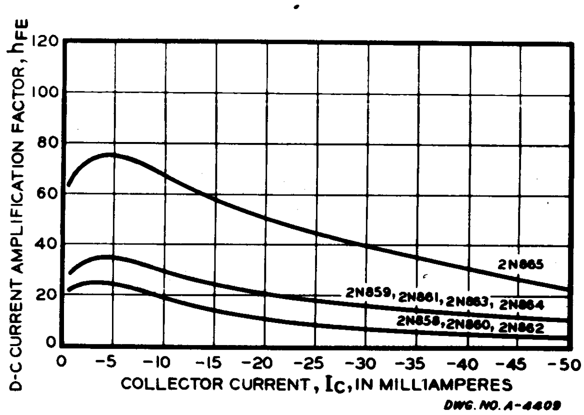
TYPICAL INPUT CHARACTERISTICS IN GROUNDED EMITTER CONFIGURATION AT 25 C



TYPICAL INPUT CHARACTERISTICS IN GROUNDED EMITTER CONFIGURATION AT 125 C



TYPICAL f_T AS A FUNCTION OF COLLECTOR VOLTAGE AND EMITTER CURRENT IN GROUNDED EMITTER CONFIGURATION AT 25 C WITH $V_{CE} = -6V$, $I_E = 1mA$



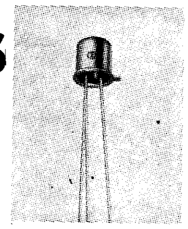
TYPICAL D-C BETA AS A FUNCTION OF COLLECTOR CURRENT IN GROUNDED EMITTER CONFIGURATION AT 25 C WITH $V_{CE} = 0.5V$

No. 31,134 A

SPRAGUE Engineering Bulletin — 2N865

SPRAGUE THE MARK OF RELIABILITY

TYPE 2N865 SILICON PRECISION ALLOY TRANSISTORS



ACTUAL SIZE

ESPECIALLY-DESIGNED for high-gain d-c and audio amplifiers and control circuits, Type 2N865 P-N-P Silicon Precision Alloy Transistors feature very high beta with low saturation resistance and low cutoff currents. The homogeneous base of these SPAT® transistors makes possible equal ratings for both the emitter-base diode ratings. High and low temperature performance are guaranteed by a saturation current test at 125C and a beta test at −55C.

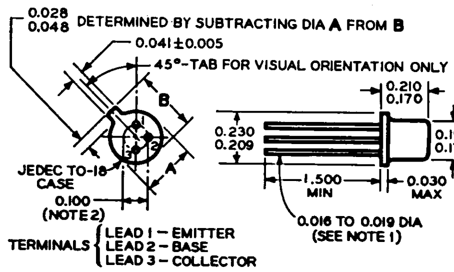
ABSOLUTE MAXIMUM RATINGS[1]

Storage Temperature .... −65 C to +140 C
Collector Voltage, V_{CB} .... −15 volts
Collector Voltage, V_{CEO} .... −15 volts
Emitter Voltage, V_{EB} .... −10 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 transistor, do not attempt to measure these characteristics above the maximum ratings.

[2]Due to the nature of SPAT 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



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[3] at T = 25 C

	CHARACTERISTICS	TEST CONDITIONS	MIN.	TYPICAL	MAX.	UNITS
	D-C CHARACTERISTICS					
I_{CBO}	Collector Cutoff Current	$V_{CB} = -10V$			0.1	μA
I_{CBO}	Collector Cutoff Current	$V_{CB} = -10V, T = 125C$			15	μA
BV_{CEO}	Collector Breakdown Voltage[4]	$I_C = -25\mu A$	6			volts
I_{EBO}	Emitter Current	$V_{EB} = -10V$			0.1	μA
h_{FE}	D-C Current Amplification Factor	$V_{CE} = -0.5V, I_C = -5$ mA	45	75	125	
h_{FE}	D-C Current Amplification Factor	$V_{CE} = -0.5V, I_C = -5$ mA, T = −55 C	35	55		
V_{CE} (SAT)	Collector Saturation Voltage	$I_C = -5mA, I_B = -0.5$ mA		.05	0.10	volt
V_{BE}	Base Voltage	$I_C = -5mA, I_B = -0.5mA$	0.75	0.8	1.0	volt
	SMALL SIGNAL PARAMETERS					
h_{ie}	Input Resistance	$V_{CE} = -6V, I_E = 1$ mA		5		KΩ
h_{oe}	Output Conductance	$V_{CE} = -6V, I_E = 1$ mA		110		μmhos
h_{fe}	Current Amplification Factor	$V_{CE} = -6V, I_E = 1$ mA	100	150	350	
h_{re}	Voltage Feedback Ratio	$V_{CE} = -6V, I_E = 1$ mA		6.5×10^{-4}		
	HIGH FREQUENCY CHARACTERISTICS					
C_{ob}	Output Capacitance	$V_{CB} = -6V, I_E = 0, f = 4$ Mc		5	9	pF
C_{ib}	Input Capacitance	$V_{EB} = -6V, I_C = 0, f = 4$ Mc		4	7	pF
f_T	Gain Bandwidth Product	$V_{CE} = -6V, I_E = 1$ mA	24	52		Mc
$R_e(h_{ie})$	Real Part of Input Impedance	$V_{CE} = -6V, I_E = 1$ mA, f = 100 mc		350	700	ohms
	SWITCHING CHARACTERISTICS					
t_r	Rise Time	Circuit of Figure 1		50	75	nsec
t_s	Storage Time	Circuit of Figure 2		75	100	nsec
t_f	Fall Time	Circuit of Figure 2		50	75	nsec

[3]Typical values are for engineering guidance only.

[4]To avoid exceeding the maximum voltage ratings, the breakdown voltages must be measured by setting the voltage at the minimum specified (maximum rating). If the resultant current voltage is less than the value given as a condition of test, the breakdown voltage is within specification.

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SPRAGUE ENGINEERING BULLETIN 31134A

TEST CIRCUITS

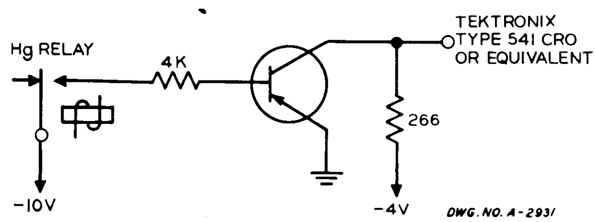


FIGURE 1
RISE TIME TEST CIRCUIT

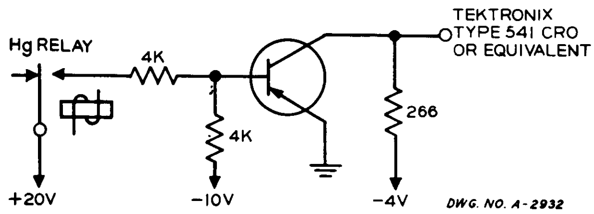
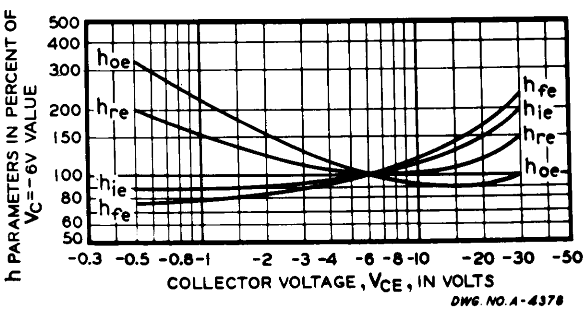
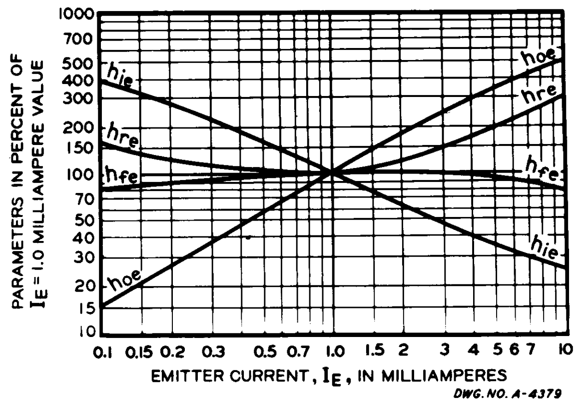


FIGURE 2
STORAGE AND FALL TIME TEST CIRCUIT

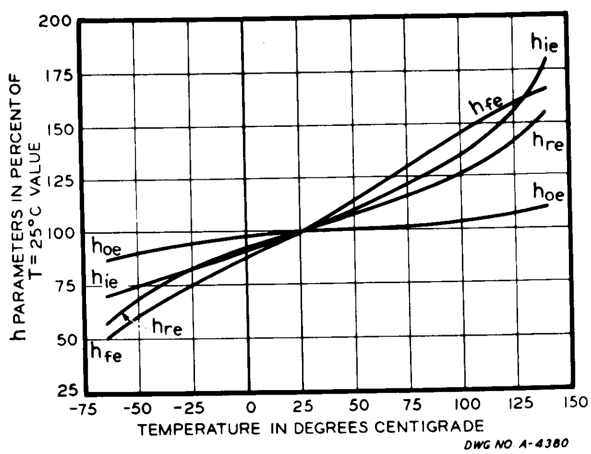
CHARACTERISTIC CURVES



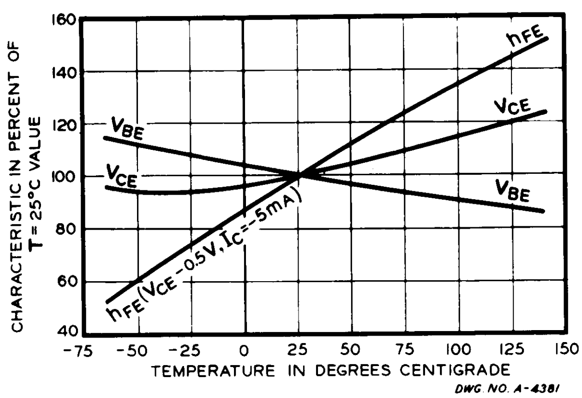
TYPICAL h PARAMETERS AS A FUNCTION OF COLLECTOR VOLTAGE AT 25 C WITH I_E = 1.0mA NORMALIZED FOR V_C = −6V



TYPICAL h PARAMETERS AS A FUNCTION OF EMITTER CURRENT AT 25 C WITH I_E = 1.0mA NORMALIZED FOR V_C = −6V

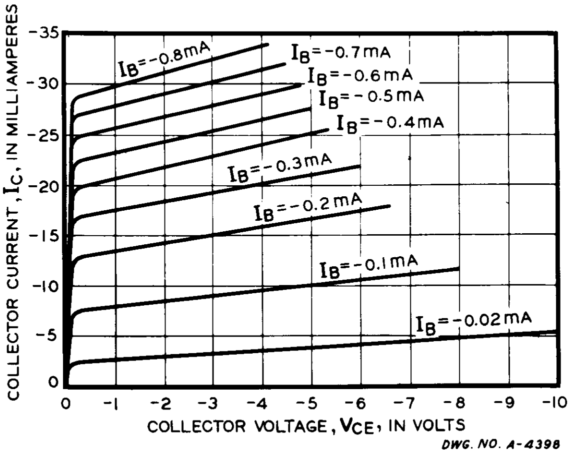


TYPICAL h PARAMETERS AS A FUNCTION OF TEMPERATURE AT 25 C WITH I_E = 1.0mA NORMALIZED FOR V_C = −6V

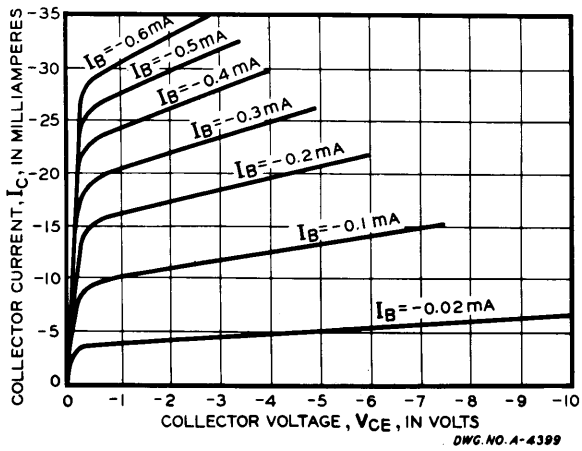


TYPICAL CHARACTERISTICS IN GROUNDED EMITTER CONFIGURATION AS A FUNCTION OF TEMPERATURE NORMALIZED FOR 25 C WITH V_{CE} AND V_{BE} AT I_C = −5mA, I_B = −0.5mA and I_C = −5mA, I_B = −0.8mA

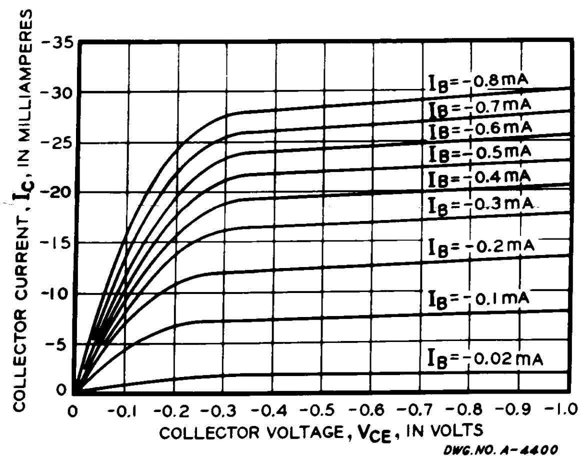
CHARACTERISTIC CURVES



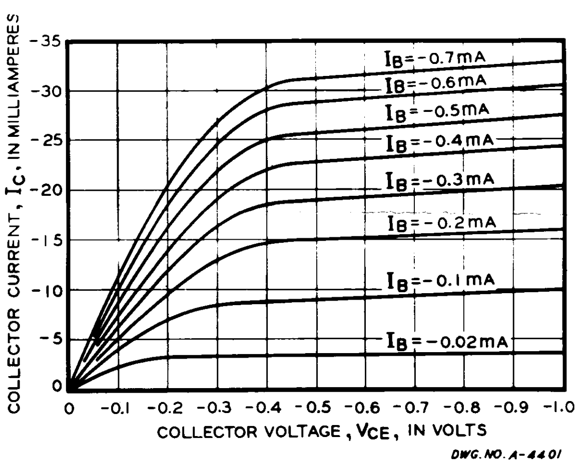
TYPICAL COLLECTOR CHARACTERISTICS IN GROUNDED EMITTER CONFIGURATION AT 25 C



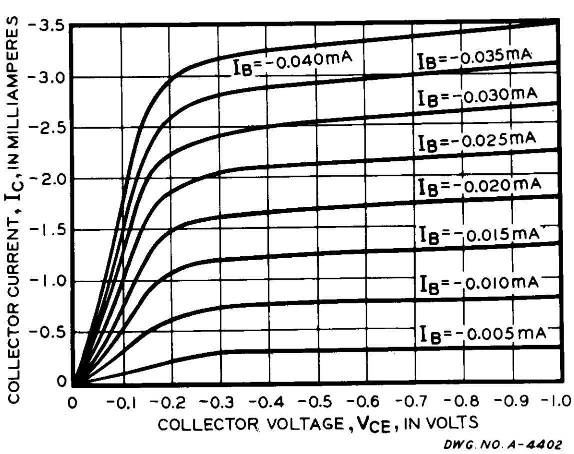
TYPICAL COLLECTOR CHARACTERISTICS IN GROUNDED EMITTER CONFIGURATION AT 125 C



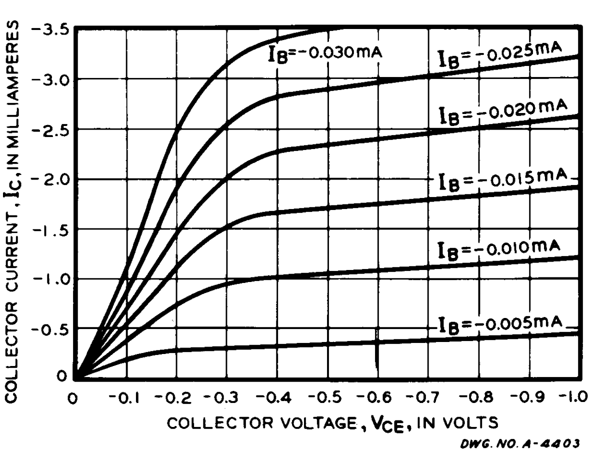
TYPICAL SATURATED REGION COLLECTOR CHARACTERISTICS IN GROUNDED EMITTER CONFIGURATION AT 25 C



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

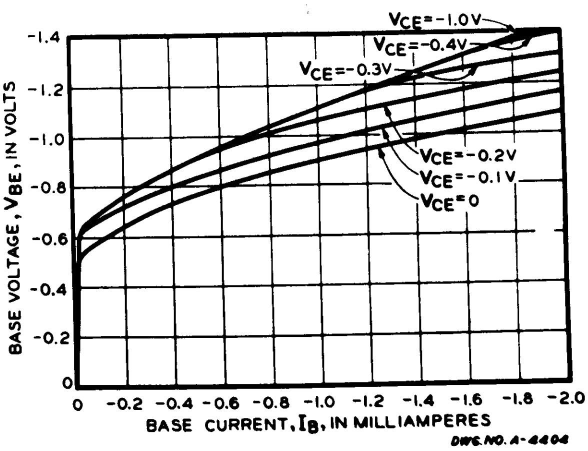


TYPICAL LOW CURRENT SATURATED REGION COLLECTOR CHARACTERISTICS IN GROUNDED EMITTER CONFIGURATION AT 25 C

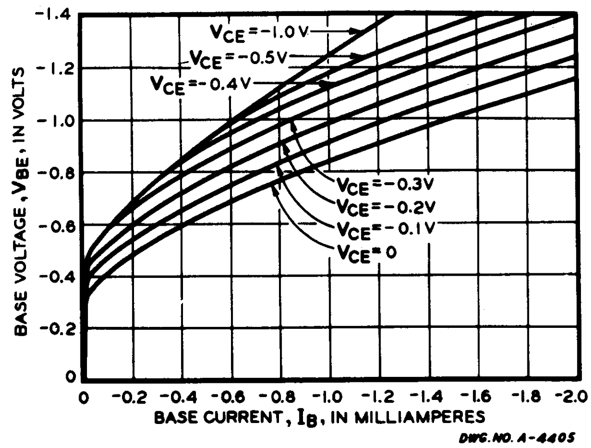


TYPICAL LOW CURRENT SATURATED REGION COLLECTOR CHARACTERISTICS IN GROUNDED EMITTER CONFIGURATION AT 125 C

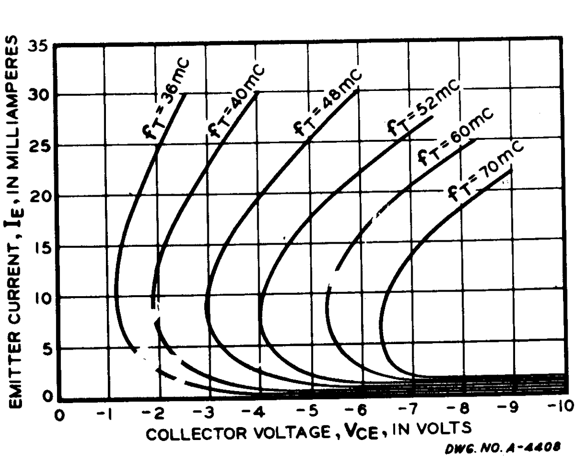
CHARACTERISTIC CURVES



TYPICAL INPUT CHARACTERISTICS IN GROUNDED EMITTER CONFIGURATION AT 25 C



TYPICAL INPUT CHARACTERISTICS IN GROUNDED EMITTER CONFIGURATION AT 125 C



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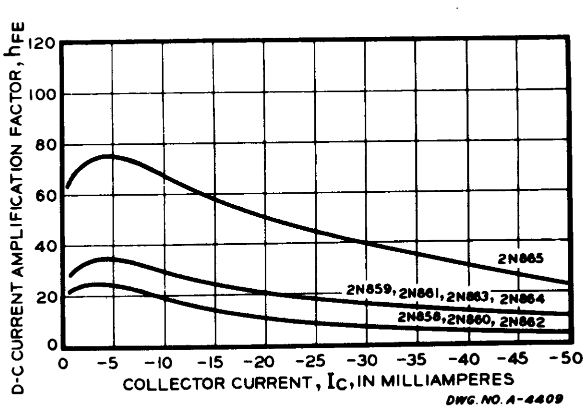

TYPICAL D-C BETA AS A FUNCTION OF COLLECTOR CURRENT IN GROUNDED EMITTER CONFIGURATION AT 25 C WITH $V_{CE} = 0.5V$

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.