No. 34,017

SPRAGUE® THE MARK OF RELIABILITY

Engineering Bulletin

2N4412
2N4413

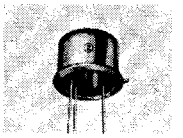
TYPE 2N4412 AND 2N4413 SEPT® TRANSISTORS

— P-N-P Silicon Planar Epitaxial Series

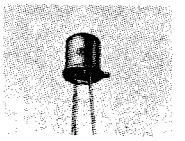
TYPE 2N4412 and 2N4413 Transistors, designed for use in low level, low noise amplifier and switching circuits, feature:

- h_{FE} at 1μA.....60 min.
- h_{FE} at 10μA.....100 min.
- N.F. (wide band)..2db max.

Type 2N4412 and 2N4413 were originally introduced under the Sprague house numbers TQ55 and TQ56, respectively.



TYPE 2N4412
(TO-5 CASE)



TYPE 2N4413
(TO-18 CASE)

ABSOLUTE MAXIMUM RATINGS[1]

Collector to Base Voltage, V_{CBO}	40 volts
Collector to Emitter Voltage, V_{CEO}	30 volts
Emitter to Base Voltage, V_{EBO}	5 volts
Collector Current, I_C	0.6 amperes
Storage Temperature	−65 C to 200 C

	TYPE 2N4412	TYPE 2N4413
Total Device Dissipation at 25 C Ambient	600mW	400mW
Derating Factor above 25 C Ambient	3.43 mW/°C	2.28 mW/°C
Total Device Dissipation at 25 C Case Temp.	.3 watts	1.8 watts
Derating Factor above 25 C Case Temp.	17.2mW/°C	10.3mW/°C

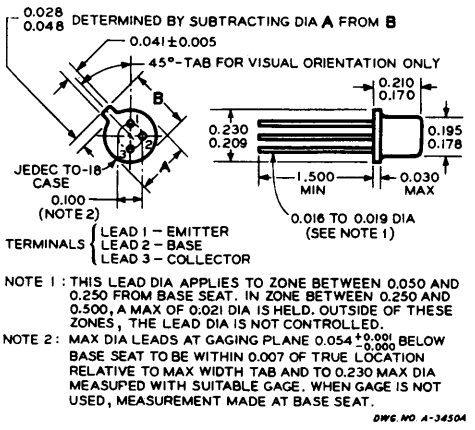
[1]The maximum ratings are limiting absolute values above which the serviceability may be impaired from the viewpoint of life or satisfactory performance. The breakdown voltages may be far above the maximum voltage ratings. To avoid permanent damage to the transistor, do not attempt to measure these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

ELECTRICAL CHARACTERISTICS at T = 25 C

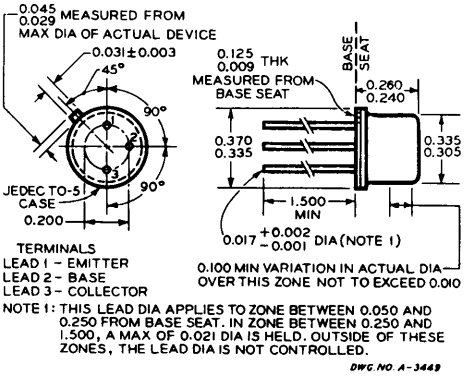
	CHARACTERISTICS	TEST CONDITIONS	MIN	TYP	MAX	UNITS
		D-C CHARACTERISTICS				
BV_{CBO}	Collector Breakdown Voltage	I_C = 10μA I_E = 0	40	—	—	Volts
BV_{CEO}	Collector Breakdown Voltage	I_C = 10mA I_B = 0	30	—	—	Volts
I_{CBO}	Collector Cutoff Current	V_{CB} = 30V I_E = 0	—	0.1	10	nA
I_{EBO}	Emitter Cutoff Current	V_{EB} = 5V I_C = 0	—	0.1	10	nA
h_{FE}	Current Amplification Factor	V_{CE} = 5V I_C = 1μA	60	100	—	—
h_{FE}	Current Amplification Factor	V_{CE} = 5V I_C = 10μA	100	200	500	—
h_{FE}	Current Amplification Factor	V_{CE} = 5V I_C = 1mA	120	300	—	—
h_{FE}	Current Amplification Factor	V_{CE} = 5V I_C = 10mA	150	350	—	—
$V_{CE(SAT)}$	Collector Saturation Voltage	I_C = 10mA I_B = 1mA	—	0.04	0.2	Volts
V_{BE}	Base Emitter Voltage	I_C = 10mA I_B = 1mA	0.65	0.71	0.80	Volts
		SMALL SIGNAL CHARACTERISTICS				
f_T	Gain Bandwidth Product	V_{CE} = 5V, I_C = 500μA, f = 10MHz	20	40	100	MHz
C_{ob}	Output Capacitance	V_{CB} = 10V, I_E = 0, f = 1MHz	—	5	10	pF
h_{fe}	Current Amplification Factor	V_{CE} = 5V, I_C = 1mA, f = 1kHz	120	350	1000	—
h_{ib}	Input Impedance	V_{CE} = 5V, I_C = 1mA, f = 1kHz	20	26	32	Ohms
h_{ob}	Output Admittance	V_{CE} = 5V, I_C = 1mA, f = 1kHz	—	0.09	0.5	μmhos
$r_b'C_c$	Collector-Base Time Constant	V_{CE} = 5V, I_C = 1mA, f = 10MHz	75	250	500	psec
N.F.	Wide Band Noise Figure	I_C = 10μA, V_{CE} = 5V, Rg = 10K Band width- 10Hz to 15.7kHz	—	0.5	2	db

SPRAGUE ENGINEERING BULLETIN 34,017

MECHANICAL SPECIFICATIONS

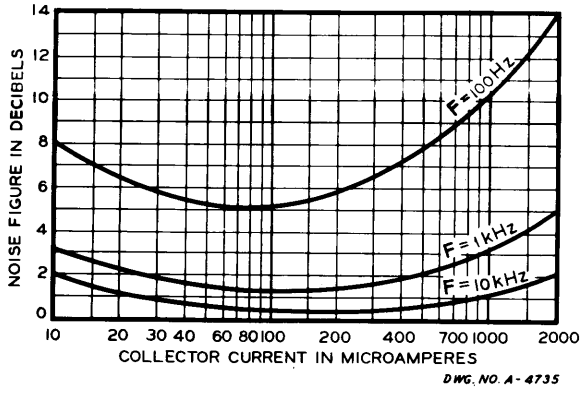


TYPE 2N4412
(TO-5 CASE)

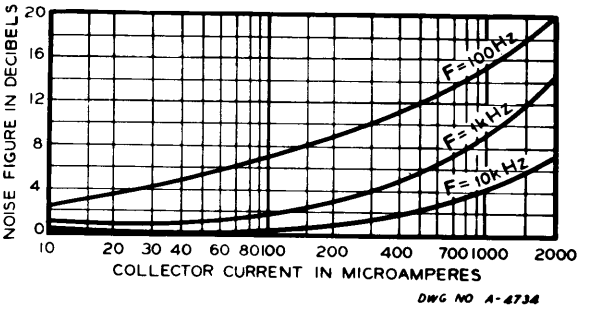


TYPE 2N4413
(TO-18 CASE)

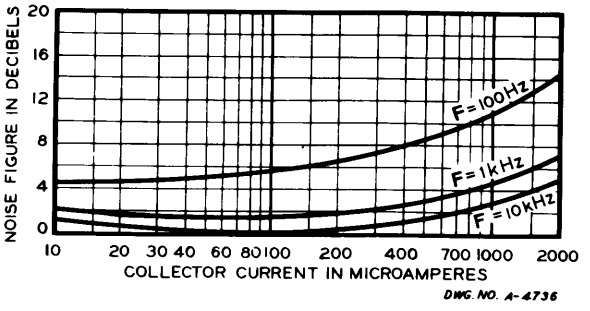
Marking. All transistors will be marked with the type number; the name SPRAGUE or the registered Sprague trademark, ②, at vendor's option; and date code of acceptance, unless otherwise specified.



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



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



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

No. 34,018

SPRAGUE
THE MARK OF RELIABILITY

Engineering Bulletin

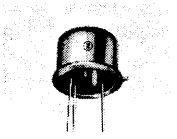
2N4412A
2N4413A

TYPE 2N4412A AND 2N4413A SEPT® TRANSISTORS

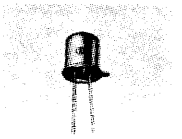
—P-N-P Silicon Planar Epitaxial Series

TYPE 2N4412A and 2N4413A Transistors, designed for use in low level, low noise amplifier and switching circuits, feature:

- h_{FE} at 1μA.....60 min.
- h_{FE} at 10μA.....100 min.
- N.F. (wide band)..2db max.



TYPE 2N4412A
(TO-5 CASE)



TYPE 2N4413A
(TO-18 CASE)

ABSOLUTE MAXIMUM RATINGS[1]

	TYPE 2N4412A	TYPE 2N4413A
Collector to Base Voltage, V_{CBO}.....60 volts		
Collector to Emitter Voltage, V_{CEO}.....60 volts		
Emitter to Base Voltage, V_{EBO}.....5 volts		
Collector Current, I_C.....0.6 amperes		
Storage Temperature.....—65 C to 200 C		
Total Device Dissipation at 25 C Ambient....	600mW	400mW
Derating Factor above 25 C Ambient.....	3.43mW/°C	2.28mW/°C
Total Device Dissipation at 25 C Case Temp..	3 watts	1.8 watts
Derating Factor above 25 C Case Temp.....	17.2mW/°C	10.3mW/°C

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

ELECTRICAL CHARACTERISTICS at T = 25 C

	CHARACTERISTICS	TEST CONDITIONS	MIN	TYP	MAX	UNITS
		D-C CHARACTERISTICS				
BV_{CBO}	Collector Breakdown Voltage	I_C = 10μA, I_E = 0	60	—	—	Volts
BV_{CEO}	Collector Breakdown Voltage	I_C = 10mA, I_B = 0	60	—	—	Volts
I_{CBO}	Collector Cutoff Current	V_{CB} = 30V, I_E = 0	—	0.1	10	nA
I_{EBO}	Emitter Cutoff Current	V_{EB} = 5V, I_C = 0	—	0.1	10	nA
h_{FE}	Current Amplification Factor	V_{CE} = 5V, I_C = 1μA	60	100	—	—
h_{FE}	Current Amplification Factor	V_{CE} = 5V, I_C = 10μA	100	200	500	—
h_{FE}	Current Amplification Factor	V_{CE} = 5V, I_C = 1mA	120	300	—	—
h_{FE}	Current Amplification Factor	V_{CE} = 5V, I_C = 10mA	150	350	—	—
$V_{CE(SAT)}$	Collector Saturation Voltage	I_C = 10mA, I_B = 1mA	—	0.04	0.2	Volts
V_{BE}	Base Emitter Voltage	I_C = 10mA, I_B = 1mA	0.65	0.71	0.80	Volts
		SMALL SIGNAL CHARACTERISTICS				
f_T	Gain Bandwidth Product	V_{CE} = 5V, I_C = 500μA, f = 10MHz	20	40	100	MHz
C_{ob}	Output Capacitance	V_{CB} = 10V, I_E = 0, f = 1MHz	—	5	10	pF
h_{fe}	Current Amplification Factor	V_{CE} = 5V, I_C = 1mA, f = 1kHz	120	350	1000	—
h_{ib}	Input Impedance	V_{CE} = 5V, I_C = 1mA, f = 1kHz	20	26	32	Ohms
h_{ob}	Output Admittance	V_{CE} = 5V, I_C = 1mA, f = 1kHz	—	0.09	0.5	μmhos
$r_b'C_c$	Collector-Base Time Constant	V_{CE} = 5V, I_C = 1mA, f = 10MHz	75	250	500	psec
N.F.	Wide Band Noise Figure	I_C = 10μA, V_{CE} = 5V, Rg = 10K Band width- 10Hz to 15.7kHz	—	0.5	2	db

SPRAGUE ENGINEERING BULLETIN 34,018

SPRAGUE®
THE MARK OF RELIABILITY

SPRAGUE ELECTRIC COMPANY

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Newton, Mass. 02158
Tel. (617) 969-7640

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Seattle, Wash. 98103
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□ □ □

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Sprague Electric of Canada, Ltd.
860 Decarie Blvd.
Ville St. Laurent
Montreal 9, P. Q. Canada
Tel. (514) 747-7811

EUROPE
Sprague Electric (U. K.) Ltd.
126 Coldharbour Lane
Coldharbour Lane House
Hayes, Middlesex, England
Tel. HAYes 8833, Telex 261524

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

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

*Airconditioning and Refrigeration Components Only.

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

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ISSUE OF JANUARY, 1967

Litho in U. S. Amer.

No. 34,019

SPRAGUE
THE MARK OF RELIABILITY

Engineering Bulletin

2N4414
2N4415

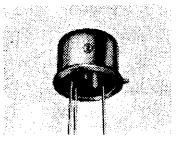
TYPE 2N4414 AND 2N4415 SEPT® TRANSISTORS

— P-N-P Silicon Planar Epitaxial Series

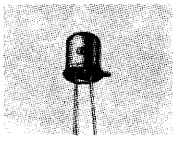
DESIGNED for use in low-level amplifier and switching circuits, Types 2N4414 and 2N-4415 high-gain, low-level, low noise transistors feature:

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

Type 2N4414 and 2N4415 were originally introduced under the Sprague house numbers TQ57 and TQ58, respectively.



TYPE 2N4414
(TO-5 CASE)



TYPE 2N4415
(TO-18 CASE)

ABSOLUTE MAXIMUM RATINGS[1]

	TYPE 2N4414	TYPE 2N4415
Collector to Base Voltage, V_{CBO} . . . . . 40 volts		
Collector to Emitter Voltage, V_{CEO} . . . . . 30 volts		
Emitter to Base Voltage, V_{EBO} . . . . . 5 volts		
Collector Current, I_C . . . . . 0.6 amperes		
Storage Temperature . . . . . −65 C to 200 C		
Total Device Dissipation at 25 C Ambient	600mW	400mW
Derating Factor above 25 C Ambient	3.43 mW/°C	2.28mW/°C
Total Device Dissipation at 25 C Case Temp. .	3 watts	1.8 watts
Derating Factor above 25 C Case Temp.	17.2mW/°C	10.3mW/°C

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ELECTRICAL CHARACTERISTICS at T = 25 C

	CHARACTERISTICS	TEST CONDITIONS	MIN	TYP	MAX	UNITS
		D-C CHARACTERISTICS				
BV_{CBO}	Collector Breakdown Voltage	I_C = 10μA I_E = 0	40	—	—	Volts
BV_{CEO}	Collector Breakdown Voltage	I_C = 10mA I_B = 0	30	—	—	Volts
BV_{EBO}	Emitter Breakdown Voltage	I_E = 100nA I_C = 0	5	—	—	Volts
I_{CBO}	Collector Cutoff Current	V_{CB} = 30V I_E = 0	—	0.1	10	nA
h_{FE}	Current Amplification Factor	V_{CE} = 5V I_C = 10μA	40	100	500	—
h_{FE}	Current Amplification Factor	V_{CE} = 5V I_C = 1mA	100	200	—	—
h_{FE}	Current Amplification Factor	V_{CE} = 5V I_C = 10mA	120	250	—	—
$V_{CE(SAT)}$	Collector Saturation Voltage	I_C = 10mA I_B = 1mA	—	0.04	0.2	Volts
V_{BE}	Base Emitter Voltage	I_C = 10mA I_B = 1mA	0.65	0.71	0.80	Volts
		SMALL SIGNAL CHARACTERISTICS				
f_T	Gain Bandwidth Product	V_{CE} = 5V, I_C = 500μA, f = 10MHz	20	40	100	MHz
C_{ob}	Output Capacitance	V_{CB} = 10V, I_E = 0, f = 1 MHz	—	5	10	pF
h_{fe}	Current Amplification Factor	V_{CE} = 5V, I_C = 1mA, f = 1kHz	100	250	1000	—
h_{ib}	Input Impedance	V_{CE} = 5V, I_C = 1mA, f = 1kHz	20	26	32	Ohms
h_{ob}	Output Admittance	V_{CE} = 5V, I_C = 1mA, f = 1kHz	—	0.09	0.5	μmhos
$r_b'C_c$	Collector-Base Time Constant	V_{CE} = 5V, I_C = 1mA, f = 10MHz	75	250	500	psec
N.F.	Wide Band Noise Figure	I_C = 10μA, V_{CE} = 5V, R_g = 10K Band width- 10Hz to 15.7kHz	—	1	3	db

SPRAGUE ENGINEERING BULLETIN 34,019

No. 34,020

SPRAGUE
THE MARK OF RELIABILITY

Engineering Bulletin

2N4414A
2N4415A

TYPE 2N4414A AND 2N4415A SEPT® TRANSISTORS

—P-N-P Silicon Planar Epitaxial Series

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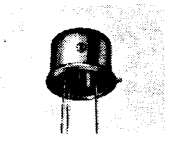
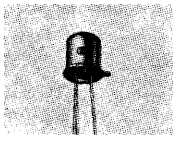
- N.F. (wideband)...3 db max.



TYPE 2N4414A
(TO-5 CASE)



TYPE 2N4415A
(TO-18 CASE)

ABSOLUTE MAXIMUM RATINGS[1]

	TYPE 2N4414A	TYPE 2N4415A
Collector to Base Voltage, V_{CBO}	60 volts	
Collector to Emitter Voltage, V_{CEO}	60 volts	
Emitter to Base Voltage, V_{EBO}	5 volts	
Collector Current, I_C	0.6 amperes	
Storage Temperature	−65 C to 200 C	
Total Device Dissipation at 25 C Ambient	600mW	400mW
Derating Factor above 25 C Ambient	3.43mW/°C	2.28mW/°C
Total Device Dissipation at 25 C Case Temp.	3 watts	1.8 watts
Derating Factor above 25 C Case Temp.	17.2mW/°C	10.3mW/°C

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

ELECTRICAL CHARACTERISTICS at T = 25 C

	CHARACTERISTICS	TEST CONDITIONS	MIN	TYP	MAX	UNITS
	D-C CHARACTERISTICS					
BV_{CBO}	Collector Breakdown Voltage	I_C = 10μA, I_E = 0	60	—	—	Volts
BV_{CEO}	Collector Breakdown Voltage	I_C = 10mA, I_B = 0	60	—	—	Volts
BV_{EBO}	Emitter Breakdown Voltage	I_E = 100nA, I_C = 0	5	—	—	Volts
I_{CBO}	Collector Cutoff Current	V_{CB} = 30V, I_E = 0	—	0.1	10	nA
h_{FE}	Current Amplification Factor	V_{CE} = 5V, I_C = 10μA	40	100	500	—
h_{FE}	Current Amplification Factor	V_{CE} = 5V, I_C = 1mA	100	200	—	—
h_{FE}	Current Amplification Factor	V_{CE} = 5V, I_C = 10mA	120	250	—	—
$V_{CE(SAT)}$	Collector Saturation Voltage	I_C = 10mA, I_B = 1mA	—	0.04	0.2	Volts
V_{BE}	Base Emitter Voltage	I_C = 10mA, I_B = 1mA	0.65	0.71	0.80	Volts
	SMALL SIGNAL CHARACTERISTICS					
f_T	Gain Bandwidth Product	V_{CE} = 5V, I_C = 500μA, f = 10MHz	20	40	100	MHz
C_{ob}	Output Capacitance	V_{CB} = 10V, I_E = 0, f = 1 MHz	—	5	10	pF
h_{fe}	Current Amplification Factor	V_{CE} = 5V, I_C = 1mA, f = 1kHz	100	250	1000	—
h_{ib}	Input Impedance	V_{CE} = 5V, I_C = 1mA, f = 1kHz	20	26	32	Ohms
h_{ob}	Output Admittance	V_{CE} = 5V, I_C = 1mA, f = 1kHz	—	0.09	0.5	μmhos
$r_b'C_c$	Collector-Base Time Constant	V_{CE} = 5V, I_C = 1mA, f = 10MHz	75	250	500	psec
N.F.	Wide Band Noise Figure	I_C = 10μA, V_{CE} = 5V, Rg = 10K Band width- 10Hz to 15.7kHz	—	1	3	db

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