

# TYPES 2N456B, 2N457B, 2N458B, 2N1021A AND 2N1022A P-N-P ALLOY-JUNCTION GERMANIUM POWER TRANSISTORS

## High-Power Transistors for Military and Industrial Applications

TYPES 2N456B, 2N457B, 2N458B, 2N1021A, AND 2N1022A  
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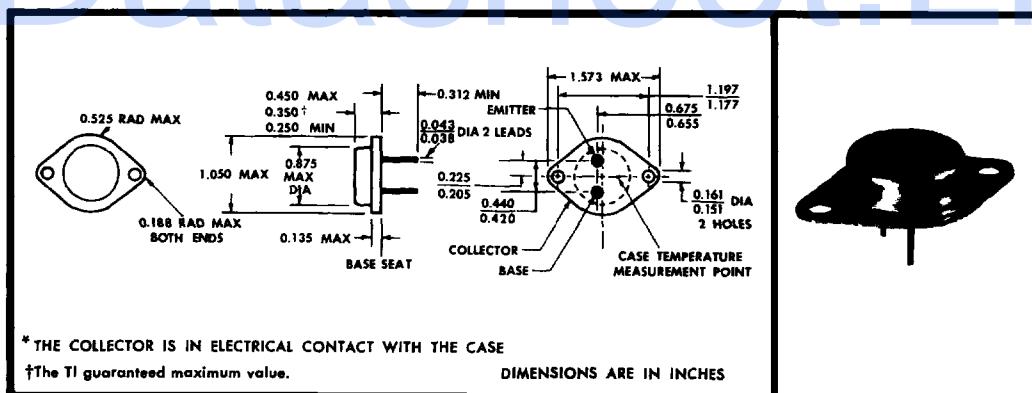
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### mechanical data

The use of silver alloy to assemble the mounting base and the use of resistance welding to seal the can, provide a hermetically sealed enclosure. During the assembly process the absence of flux, combined with extreme cleanliness, prevents sealed-in contamination.

The mounting base provides an excellent heat path from the collector junction to a heat sink which must be in intimate contact to permit operation at maximum rated dissipation.

\*The transistors are in a JEDEC TO-3 case.



### \*absolute maximum ratings at 25°C case temperature (unless otherwise noted)

	2N456B	2N457B	2N458B	2N1021A	2N1022A
Collector-Base Voltage . . . . .	40 v	60 v	80 v	100 v	120 v
Collector-Emitter Voltage (see Note 1) . . . . .	30 v	40 v	45 v	50 v	55 v
Emitter-Base Voltage . . . . .	30 v				
Collector Current . . . . .	7 a				
Base Current . . . . .	3 a				
Total Device Dissipation at (or below) 25°C Case Temperature (see Note 2) . . . . .	150 w				
Collector Junction Temperature . . . . .	100°C				
Storage Temperature Range . . . . .	-55°C to + 100°C				

\*Indicates JEDEC registered data

NOTES: 1. This value applies when the base-emitter diode is open-circuited.  
2. Derate linearly to + 100°C case temperature at the rate of 2w/C°.

# TYPES 2N456B, 2N457B, 2N458B, 2N1021A AND 2N1022A

## P-N-P ALLOY-JUNCTION GERMANIUM POWER TRANSISTORS

**electrical characteristics at 25°C case temperature (unless otherwise noted)**

PARAMETER	TEST CONDITIONS	TYPE	MIN	TYP	MAX	UNIT
$BV_{CEO}$ Collector-Base Breakdown Voltage	$I_C = -2 \text{ mA}, I_E = 0$	2N456B 2N457B 2N458B 2N1021A 2N1022A	-40 -60 -80 -100 -120			V
$BV_{CEO}$ Collector-Emitter Breakdown Voltage	$I_C = -500 \text{ mA}, I_B = 0$ (see Note 3)	2N456B 2N457B 2N458B 2N1021A 2N1022A	-30* -40* -45* -50* -55*			V
$BV_{CES}$ Collector-Emitter Breakdown Voltage	$I_C = -200 \text{ mA}, V_{BE} = 0$ (see Note 3)	2N456B 2N457B 2N458B 2N1021A 2N1022A	-50* -60* -65* -70* -75*			V
$BV_{CEX}$ Collector-Emitter Breakdown Voltage	$I_C = -2 \text{ mA}, V_{BE} = +0.2 \text{ v}$	2N456B 2N457B 2N458B 2N1021A 2N1022A	-40* -60* -80* -100* -120*			V
$BV_{EBO}$ Emitter-Base Breakdown Voltage	$I_E = -2 \text{ mA}, I_C = 0$	All	-30			V
$I_{CBO}$ Collector Cutoff Current	$V_{CB} = -20 \text{ v}, I_E = 0$	2N456B			-0.5*	
	$V_{CB} = -40 \text{ v}, I_E = 0$				-2.0*	ma
	$V_{CB} = -40 \text{ v}, I_E = 0, T_C = 70^\circ\text{C}$				-7.0*	
	$V_{CB} = -30 \text{ v}, I_E = 0$				-0.5*	
	$V_{CB} = -60 \text{ v}, I_E = 0$	2N457B			-2.0*	ma
	$V_{CB} = -60 \text{ v}, I_E = 0, T_C = 70^\circ\text{C}$				-7.0*	
	$V_{CB} = -40 \text{ v}, I_E = 0$				-0.5*	
	$V_{CB} = -80 \text{ v}, I_E = 0$				-2.0*	ma
	$V_{CB} = -80 \text{ v}, I_E = 0, T_C = 70^\circ\text{C}$				-7.0*	
	$V_{CB} = -50 \text{ v}, I_E = 0$	2N1021A			-0.5*	
	$V_{CB} = -100 \text{ v}, I_E = 0$				-2.0*	ma
	$V_{CB} = -100 \text{ v}, I_E = 0, T_C = 70^\circ\text{C}$				-7.0*	
	$V_{CB} = -60 \text{ v}, I_E = 0$	2N1022A			-0.5*	
	$V_{CB} = -120 \text{ v}, I_E = 0$				-2.0*	ma
	$V_{CB} = -120 \text{ v}, I_E = 0, T_C = 70^\circ\text{C}$				-7.0*	
	$V_{EB} = -30 \text{ v}, I_C = 0$				-2.0*	ma
$I_{FET}$ Emitter Cutoff Current	$V_{CE} = -1.5 \text{ v}, I_C = -7 \text{ a}$	All	22*	45		
	$V_{CE} = -1.5 \text{ v}, I_C = -5 \text{ a}$		30*	55	90*	—
	$V_{CE} = -1.5 \text{ v}, I_C = -3 \text{ a}$		35*	60		
	$V_{CE} = -1.5 \text{ v}, I_C = -1 \text{ a}$		40*	100		
$V_{BE}$ Base-Emitter Voltage	$V_{CE} = -1.5 \text{ v}, I_C = -7 \text{ a}$	All		-1.2		
	$V_{CE} = -1.5 \text{ v}, I_C = -5 \text{ a}$			-0.9		
	$V_{CE} = -1.5 \text{ v}, I_C = -3 \text{ a}$			-0.7	-1.5*	V
	$V_{CE} = -1.5 \text{ v}, I_C = -1 \text{ a}$			-0.4		
$V_{CE(sat)}$ Collector-Emitter Saturation Voltage	$I_B = -700 \text{ mA}, I_C = -7 \text{ a}$ $I_B = -500 \text{ mA}, I_C = -5 \text{ a}$ $I_B = -300 \text{ mA}, I_C = -3 \text{ a}$ $I_B = -100 \text{ mA}, I_C = -1 \text{ a}$	All		-0.3		
				-0.2	-0.5*	V
				-0.1		
				-.05		
$f_T$ Transition Frequency	$V_{CE} = -2 \text{ v}, I_C = -1 \text{ a}$ (see Note 4)	All	200*			kc

\*Indicates JEDEC registered data.

NOTES: 3. If the transistor is tested without a heat sink, perform this test with a 100 msec current pulse and a duty cycle less than 2%.

4. To obtain  $f_T$ , the  $|h_{fe}|$  response with frequency is extrapolated at the rate of -6 db/octave from  $f = 100 \text{ kc}$  to the frequency at which  $|h_{fe}| = 1$ .

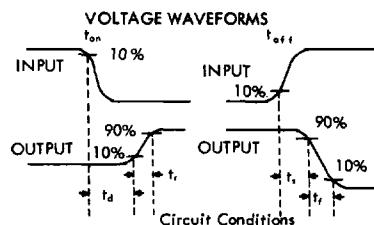
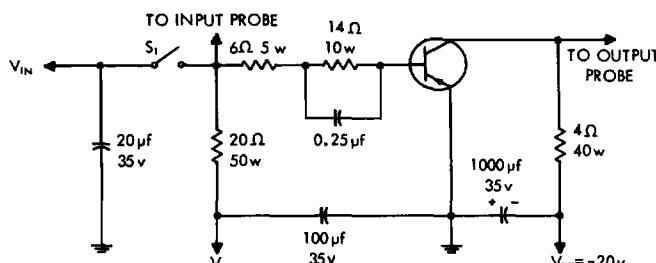
# TYPES 2N456B, 2N457B, 2N458B, 2N1021A AND 2N1022A P-N-P ALLOY-JUNCTION GERMANIUM POWER TRANSISTORS

## switching characteristics at 25°C case temperature

PARAMETER	TEST CONDITIONS†	2N456B, 2N457B, 2N458B, 2N1021A, 2N1022A			UNIT
		MIN	TYP	MAX	
$t_d$ Delay Time			0.7		μsec
$t_r$ Rise Time			5		μsec
$t_s$ Storage Time			2		μsec
$t_f$ Fall Time			15		μsec
$t_T$ Total Switching Time			22.7		μsec

†Voltage and current values shown are nominal; exact values vary slightly with device parameters.

## PARAMETER MEASUREMENT INFORMATION



Test	$V_{bb}$	$V_{in}$
Turn-On ( $t_{d}, t_r$ )	+9v	-11v
Turn-Off ( $t_s, t_f$ )	-21v	+9v

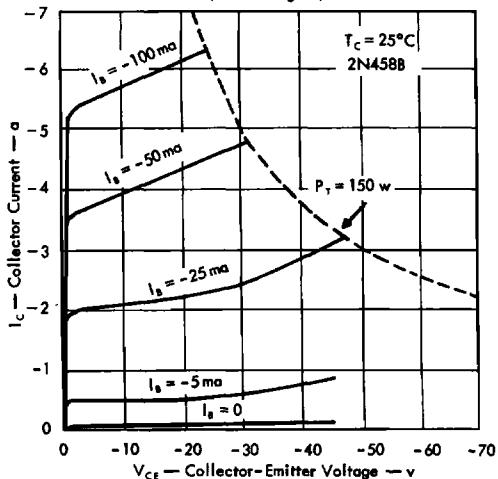
### NOTES:

1. Relay  $S_1$  has mercury wetted contacts and provides rise times less than 1/10 of the switching times measured.
2. Duty cycle of  $S_1$  is such that the transistor is ON 4 msec and OFF 12 msec in both turn-on and turn-off tests.
3. Waveforms monitored on scope with following characteristics: (a) Rise time 14 nsec max, (b) Input capacitance 11.5 pF max, (c) Input resistance 10 megohms min.
4. All resistors 5% tolerance, noninductive type.

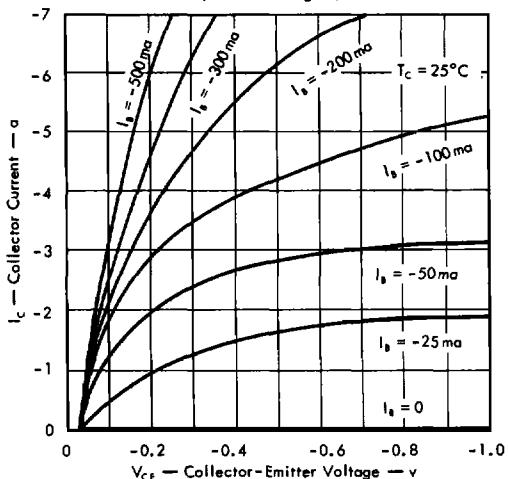
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## TYPICAL CHARACTERISTICS

COMMON-EMITTER COLLECTOR  
CHARACTERISTICS  
(Active Region)

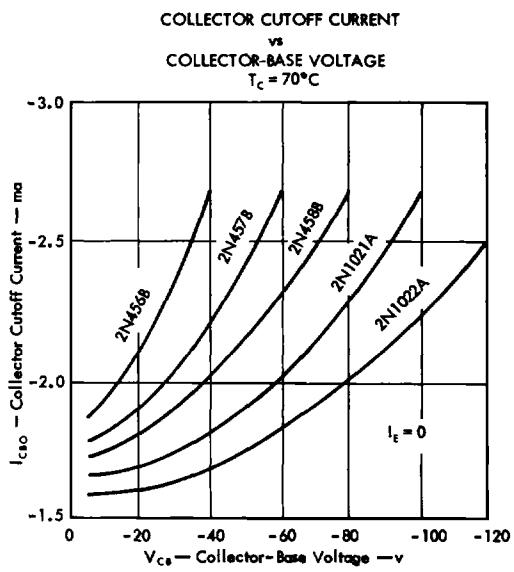
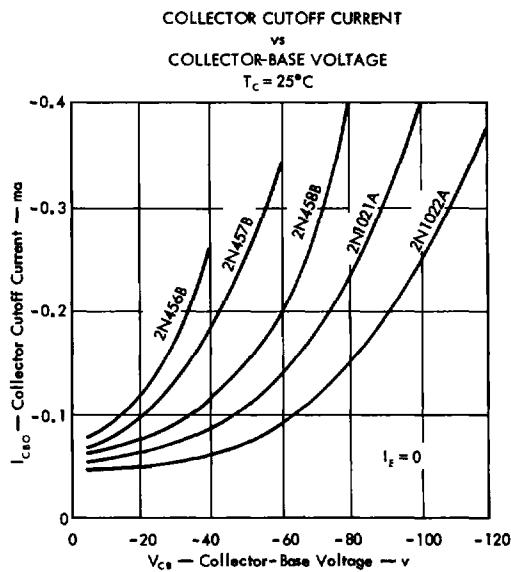
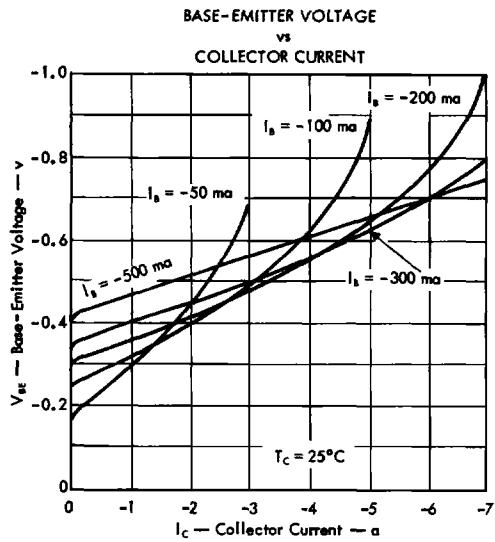
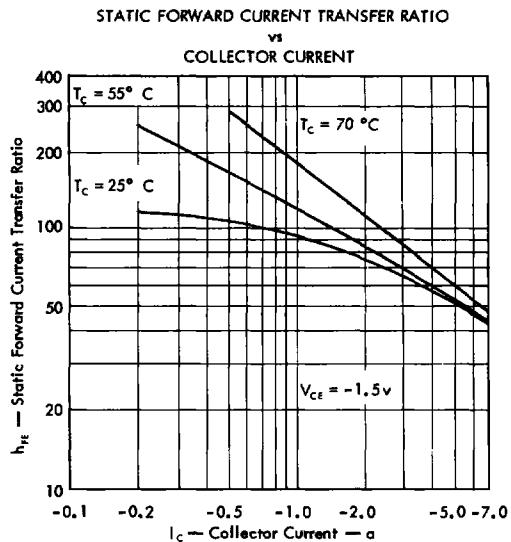


COMMON-EMITTER COLLECTOR  
CHARACTERISTICS  
(Saturation Region)



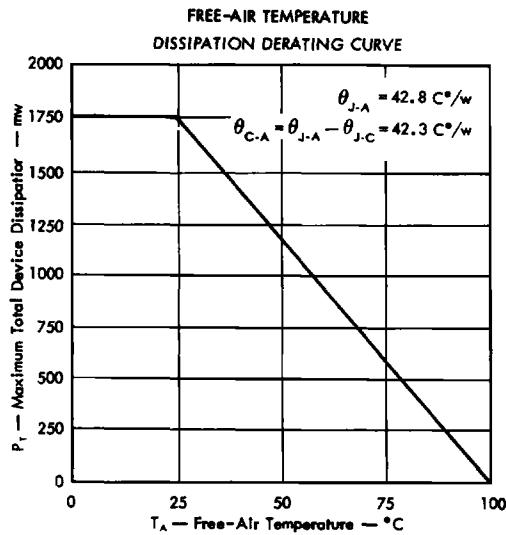
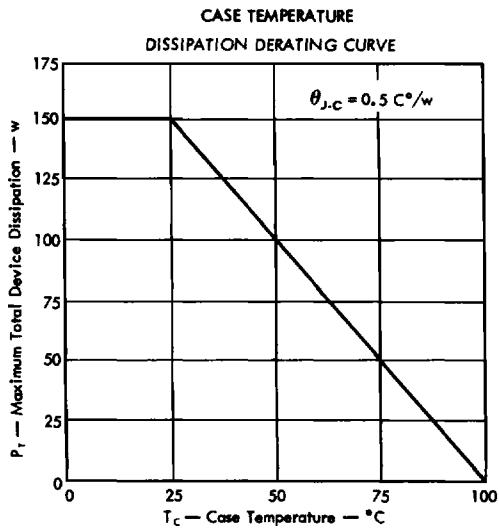
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## TYPICAL CHARACTERISTICS



# TYPES 2N456B, 2N457B, 2N458B, 2N1021A AND 2N1022A P-N-P ALLOY-JUNCTION GERMANIUM POWER TRANSISTORS

## THERMAL CHARACTERISTICS



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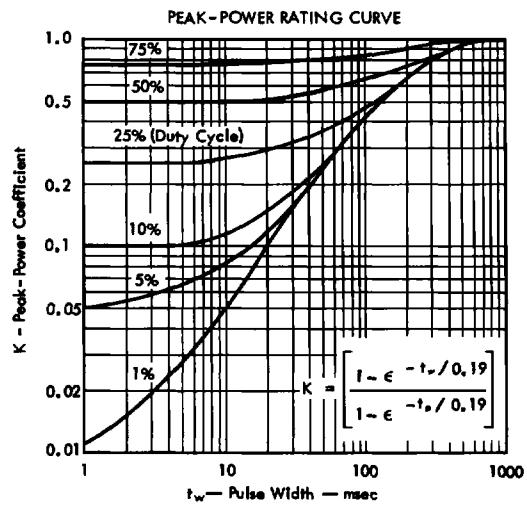


Figure 1

# TYPES 2N456B, 2N457B, 2N458B, 2N1021A AND 2N1022A P-N-P ALLOY-JUNCTION GERMANIUM POWER TRANSISTORS

## THERMAL INFORMATION

**TABLE I**

Type	Dimensions	$\dagger \theta_{HS-A}$
		$\text{C}^\circ/\text{w}$
Bright Copper	4" x 4" x 1/8"	3.8 $\text{C}^\circ/\text{w}$
	6" x 6" x 1/8"	2.2 $\text{C}^\circ/\text{w}$
	8" x 8" x 1/8"	1.8 $\text{C}^\circ/\text{w}$
	10" x 10" x 1/8"	1.4 $\text{C}^\circ/\text{w}$
Bright Aluminum	4" x 4" x 1/8"	6.5 $\text{C}^\circ/\text{w}$
	6" x 6" x 1/8"	4.5 $\text{C}^\circ/\text{w}$
	8" x 8" x 1/8"	3.5 $\text{C}^\circ/\text{w}$
	10" x 10" x 1/8"	2.8 $\text{C}^\circ/\text{w}$
Delbert Blinn #113 or Modine 1E1155B, Unfinished (or Equivalents)		3.7 $\text{C}^\circ/\text{w}$
Delbert Blinn #113 or Modine 1E1155B, Black Anodized (or Equivalents)		3.2 $\text{C}^\circ/\text{w}$

$\dagger \theta_{HS-A}$  are typical values based on convection cooling; plates and fins mounted in vertical position.

All transistors mounted in the center of the heat sink with two 4-32 screws at 6 inch-pounds of torque.

**TABLE II**  
**DEFINITION OF TERMS**

Symbol	Definition	Unit	Value
$P_T$	Average Power Dissipation	w	
$P_T$	Peak Power Dissipation	w	
$\theta_{J-C}$	Junction-to-Case Thermal Resistance	$\text{C}^\circ/\text{w}$	0.5
$\theta_{J-A}$	Junction-to-Ambient Thermal Resistance	$\text{C}^\circ/\text{w}$	42.8
$\theta_{C-A}$	Case-to-Ambient Thermal Resistance	$\text{C}^\circ/\text{w}$	42.3
$\theta_{HS-HS}$	Case-to-Heat Sink Thermal Resistance —	$\text{C}^\circ/\text{w}$	
	Typical w/o DC-11 Grease	$\text{C}^\circ/\text{w}$	0.65
	Typical with DC-11 Grease	$\text{C}^\circ/\text{w}$	0.45
$\theta_{HS-A}$	Heat-Sink Thermal Resistance	$\text{C}^\circ/\text{w}$	see Table I
$T_A$	Ambient Temperature	$\text{C}^\circ$	
$T_J$	Average Junction Temperature	$\text{C}^\circ$	
$T_J$	Peak Junction Temperature	$\text{C}^\circ$	
$T_c$	Case Temperature	$\text{C}^\circ$	
K	Peak-Power Coefficient		see Fig. 1
$t_w$	Pulse Width	msec	
$t_p$	Pulse Period	msec	
d	Duty Cycle ( $t_w/t_p$ )		

The PEAK-POWER RATING CURVE shows the ratio of maximum instantaneous junction-to-case temperature rise at any pulse width and duty cycle to the rise which occurs at 100% duty cycle. Use of this curve is best explained by the equations and examples below. See Table II for a definition of terms.

Equation No. 1 — Application: D.C. power dissipation, heat sink used.

$$P_T = \frac{T_J - T_A}{\theta_{J-C} + \theta_{C-HS} + \theta_{HS-A}}$$

Equation No. 2 — Application: D.C. power dissipation, no heat sink used.

$$P_T = \frac{T_J - T_A}{\theta_{J-A}}$$

Example A — Find  $P_{T(\max)}$

OPERATING CONDITIONS:

Heat Sink = 4" x 4" x 1/8" copper,  $\theta_{HS-A} = 3.8 \text{ C}^\circ/\text{w}$

$T_{J(\max)}$  (design limit) = 100  $\text{C}^\circ$

$T_A = 30 \text{ C}^\circ$

d = 100% (1.0)

with DC-11 grease,  $\theta_{C-HS} = 0.45 \text{ C}^\circ/\text{w}$

Equation No. 3 — Application: Peak power dissipation, heat sink used.

$$P_T = \frac{T_J - T_A}{d (\theta_{C-HS} + \theta_{HS-A}) + K \theta_{J-C}}$$

Equation No. 4 — Application: Peak power dissipation, no heat sink used.

$$P_T = \frac{T_J - T_A}{d \theta_{C-A} \times \theta_{J-C}}$$

SOLUTION:

By use of equation No. 1

$$P_{T(\max)} = \frac{T_{J(\max)} - T_A}{\theta_{J-C} + \theta_{C-HS} + \theta_{HS-A}}$$

$$P_{T(\max)} = \frac{100 - 30}{0.5 + 0.45 + 3.8} = 14.7 \text{ w}$$

Example B — Find  $P_{T(\max)}$

OPERATING CONDITIONS:

Heat Sink = 8" x 8" x 1/8" copper,

$\theta_{HS-A} = 1.8 \text{ C}^\circ/\text{w}$

with DC-11 grease,  $\theta_{C-HS} = 0.45 \text{ C}^\circ/\text{w}$

$T_{J(\max)}$  (design limit) = 100  $\text{C}^\circ$

$T_A = 35 \text{ C}^\circ$

d = 5% (0.05)

$t_w = 40 \text{ msec}$

SOLUTION:

From Figure 1, Peak-Power Coefficient,

K = 0.2, and by use of equation No. 3

$$P_{T(\max)} = \frac{T_{J(\max)} - T_A}{d (\theta_{C-HS} + \theta_{HS-A}) + K \theta_{J-C}}$$

$$P_{T(\max)} = \frac{100 - 35}{0.05 (0.45 + 1.8) + 0.2 (0.5)} = 306 \text{ w}$$