Microwave Power Transistors

- TRW 2001 1 W, 9 dB
- TRW 2003 3 W, 8 dB
- TRW 2005 5 W, 8 dB
- TRW 2010 10 W, 6 dB
- TRW 2015 15 W, 6 dB
- TRW 2020 20 W, 5.2 dB
- ∞VSWR

HLP-11 HLP-8

The TRW « Super 2 GHz » series is the first group of GHz, common base devices offering unqualified tolerance of **complete mismatch** (∞VSWR, any phase) conditions. This feature is particularly desirable in military and space applications where multi million dollar investments (and even human lives) can be jeopardized by device failure. The « Super 2 GHz » series is characterized to 2.3 GHz and is priced to be attractive in industrial service. All units are **gold metalized** for longevity and resistance to metal migration. They are emitter ballasted with heat sinked, diffused, rather than deposited metal resistors. This series is housed in TRW's true hermetic, MIL acceptable, HLP package. The package is available with or without flange.
The « Super 2 GHz » series can be adapted readily to circuits designed around older, less reliable devices with a minimum of circuit adjustment. They are mechanically interchangeable with other similar 2 GHz devices.

Electrical Characteristics (T_{CASE} = 25 °C)

Mechanical Specifications

The following are mechanical specifications for this transistor.

Dimensions : Per outline drawing.

Solderability : Per MIL-STD-750.

Marking : Per MIL-S-19500, « TRW », 4-digit date code, type number.

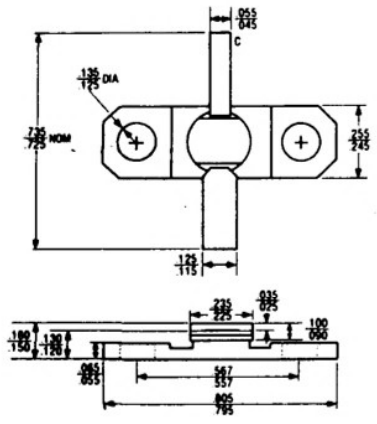
Hermaticity : Per MIL-STD-750, 10^{-7} atmospheres gross and fine leak. (Available on special order screened to 10^{-8} atmospheres.)

Acceleration : Per MIL-STD-750, 20.000 G in any plane.

Bond Pull : Per MIL-STD-750, 3 grams min.

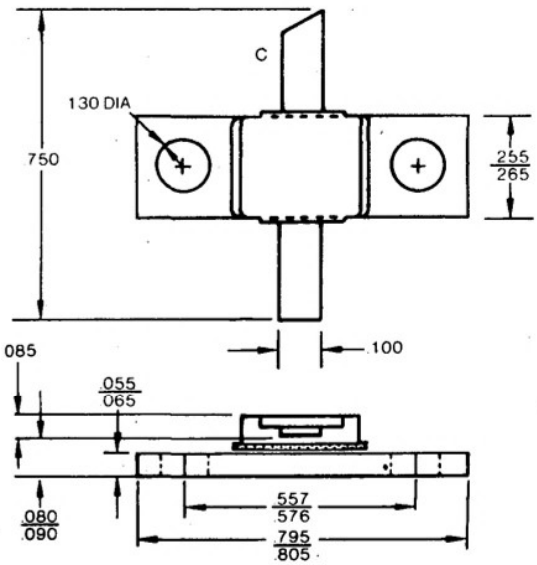
Package HLP-11 HLP-8 : A glass-free, brazed ceramic package assuring long-term integrity of hermetic seals. Leads of KOVAR base material with minimum 60 micro-inches of gold plating.

HLP-8 Normal Package



Flangeless HLP-8
Specify « F » Suffix

HLP-11 Package



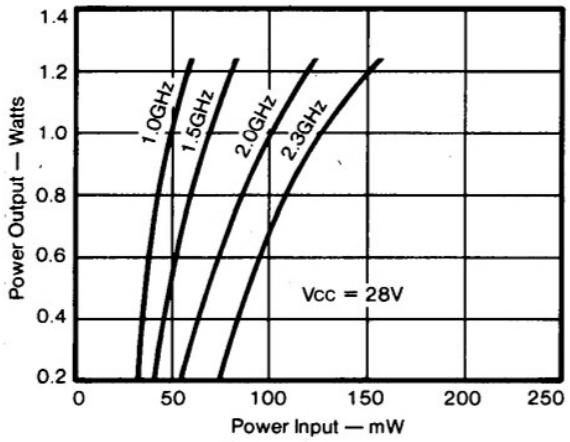
Flangeless HLP-11
Specify « F » Suffix

TRW 2001

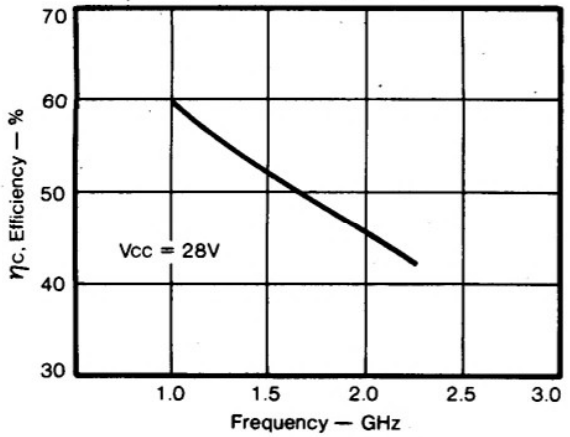
Electrical Characteristics (T_{flange} = 25°C)

Symbol	Characteristic	Conditon	Value
BV_{CER}	Collector-Base Breakdown Voltage R_{BE} = 10Ω	I_C = 10mA	50V Min
BV_{EBO}	Emitter-Base Breakdown Voltage	I_E = 1mA I_C = 0	4.0V Min
I_{CBO}	Collector Cutoff Current	V_{CB} = 28V I_E = 0 V_{CB} = 45V	500μA 1mA
I_C	Continuous Collector Current (Max)	V_{CE} = 4V	0.250A
h_{FE}	Forward Current Transfer Ratio	V_{CE} = 5V I_C = 100mA	10-120
θ_{jF}	Thermal Resistance (Junction to Flange)	—	28°C/W
C_{OB}	Collector-Base Capacitance (Max)	V_{CB} = 28V	3.0pF
P_o	Power Output @ 2000MHz	P_{in} = 0.125W	1W Min
$P_{o(sat)}$	Power Output @ 2300MHz	V_{CE} = 28Vdc	1.0W (Typ)
	Power Output @ 1500MHz		1.2W (Typ)
	Power Output @ 1000MHz		1.3W (Typ)
P_{gain}	Power Gain (dB) @ 2000MHz	P_o = 1.0W	9dB Min
VSWR	Mismatch Tolerance @ Vcc = 28V	P_o = 1.0W f = 2.0GHz	∞
MTTF	Mean-Time-to-Metal Failure (Hrs x Amps²)	T_j = 150°C	4,661
η_C	Collector Efficiency (Min)	P_o = 1.0W f = 2.0GHz	40%
T_j & T_{stg}	Max Junction and Storage Temperatures	-65 to 200°C	

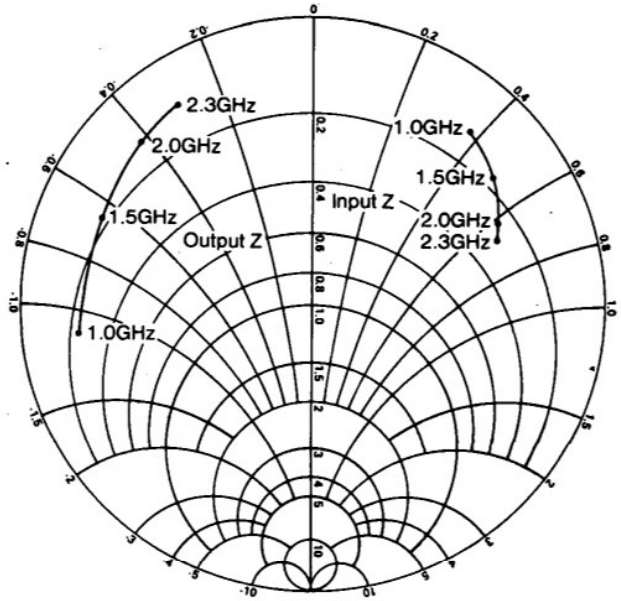
Typical Transfer Characteristics Versus Frequency



Typical ηc Versus Frequency



Impedance Data Vcc = 28V



PART DETAILS

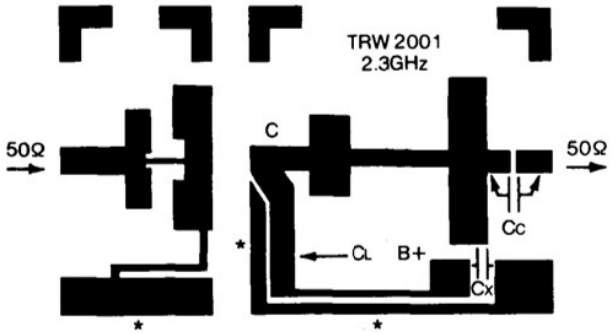
* = Foil-wrap asterisked edge to ground plane

Cc = 220pF chip on all circuits

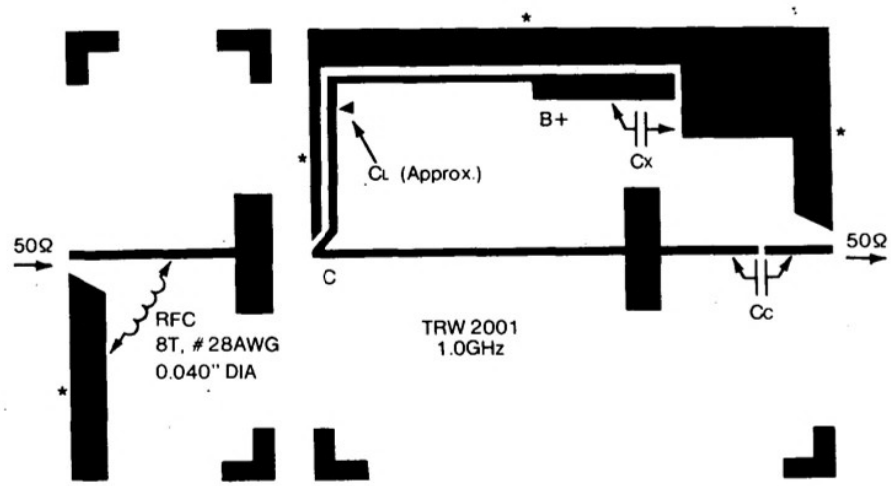
Cx = A combination of two 220pF chips, one 0.1 chip and a 25μF tantalum capacitor (35V min)

CL = Used as an AC bypass on the shunt inductor line (220pF chip) whose position can be varied

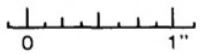
RFC = 1000MHz . . . . . 8 turns, # 28AWG, 0.040 dia
RFC = 1500MHz . . . . . 6 turns, # 28AWG, 0.040 dia
RFC = 2000 and 2300MHz . . . . 4 turns, # 28AWG, 0.040 dia

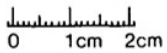


Board Material = 0.062" Glass-Teflon ε_r = 2.55

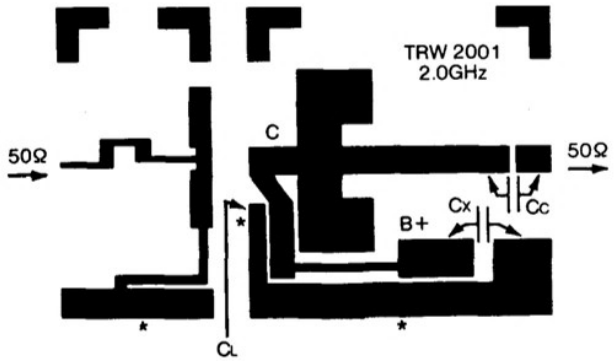


Board Material = 0.020" Glass-Teflon ε_r = 2.55

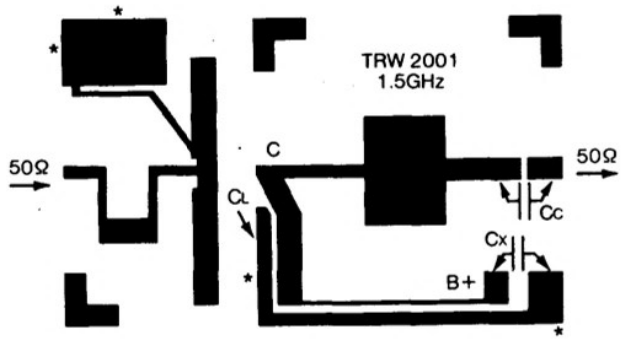




PC BOARD LAYOUT FOR TRW 2001 TEST CIRCUITS



Board Material = 0.062" Glass-Teflon ε_r = 2.55



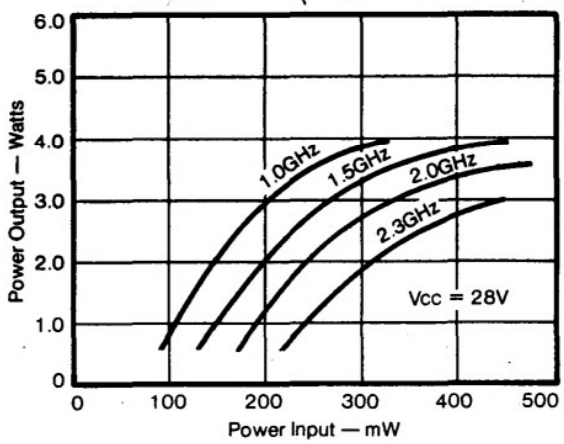
Board Material = 0.062" Glass-Teflon ε_r = 2.55

TRW 2003

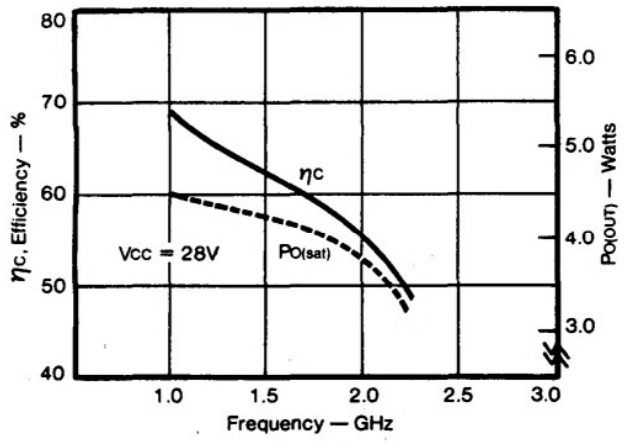
Electrical Characteristics (T_{flange} = 25°C)

Symbol	Characteristic	Conditon	Value
BV_{CER}	Collector-Base Breakdown Voltage R_{BE} = 10Ω	I_C = 20mA	50V Min
BV_{EBO}	Emitter-Base Breakdown Voltage	I_E = 0.25mA I_C = 0	3.5V Min
I_{CBO}	Collector Cutoff Current	V_{CB} = 28V I_E = 0 V_{CB} = 45V	500μA 1mA
I_C	Continuous Collector Current (Max)	V_{CE} = 4V	0.50A
h_{FE}	Forward Current Transfer Ratio	V_{CE} = 5V I_C = 100mA	10-100
θ_{jF}	Thermal Resistance (Junction to Flange)	—	15°C/W
C_{OB}	Collector-Base Capacitance (Max)	V_{CB} = 28V	5.0pF
P_o	Power Output @ 2000MHz	P_{in} = 0.47W	3.0W Min
$P_{o(sat)}$	Power Output @ 2300MHz	V_{CE} = 28Vdc	3.0W (Typ)
	Power Output @ 1500MHz		3.7W (Typ)
	Power Output @ 1000MHz		4.0W (Typ)
P_{gain}	Power Gain (dB) @ 2000MHz	P_o = 3.0W	8dB Min
VSWR	Mismatch Tolerance @ Vcc = 28V	P_o = 3.0W f = 2.0GHz	∞
MTTF	Mean-Time-to-Metal Failure (Hrs x Amps²)	T_j = 150°C	20,300
η_C	Collector Efficiency (Min)	P_o = 3.0W f = 2.0GHz	40%
T_j & T_{stg}	Max Junction and Storage Temperatures	-65 to 200°C	

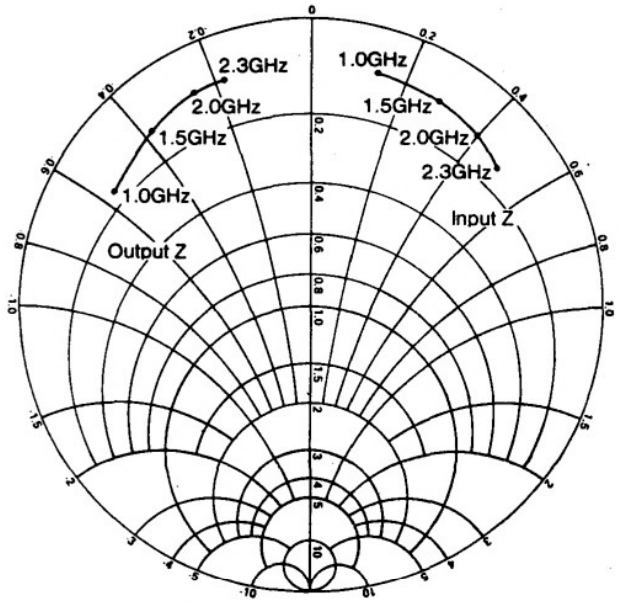
Typical Transfer Characterics Versus Frequency



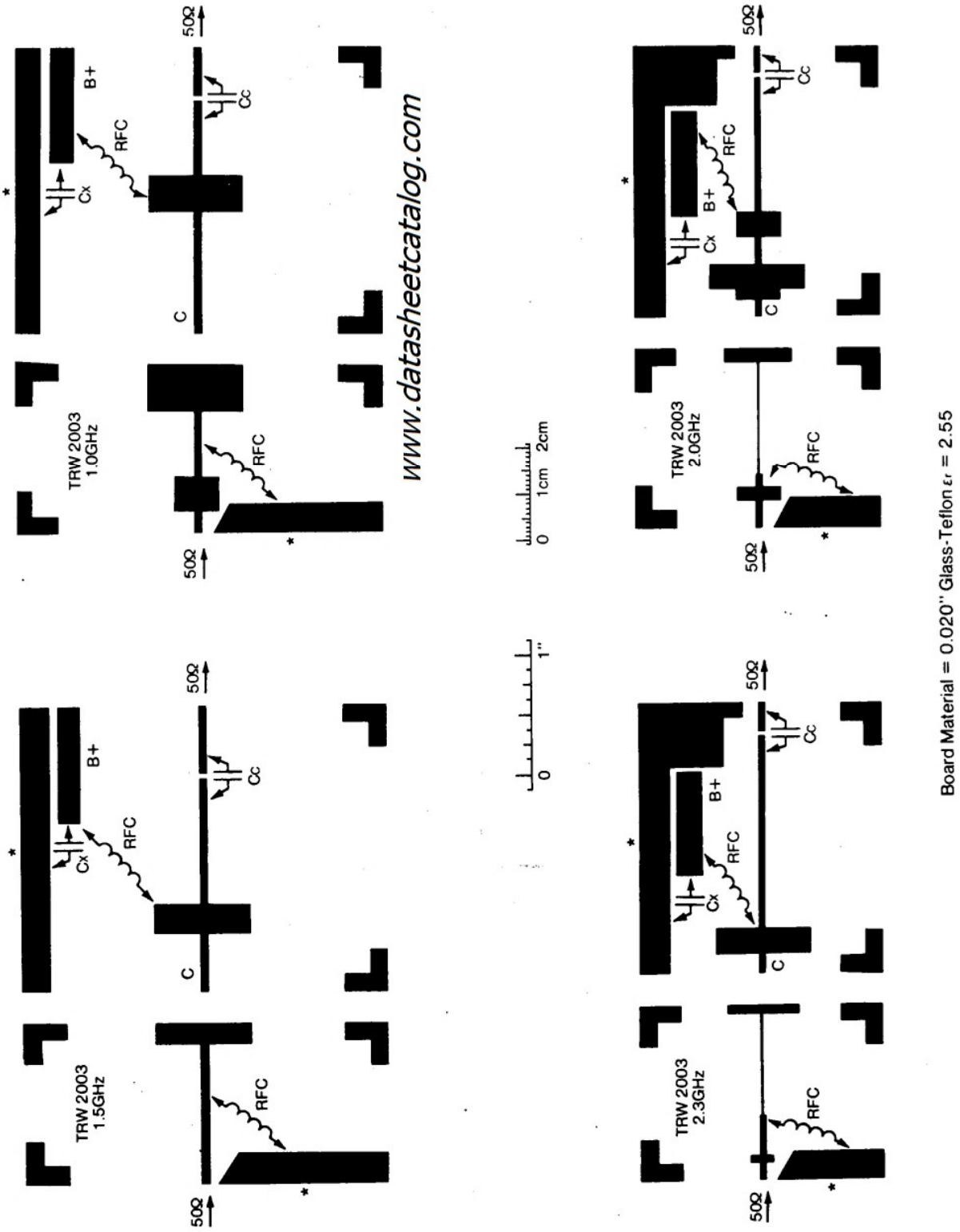
Typical ηc, Power Output Versus Frequency



Impedance Data Vcc = 28V



PC BOARD LAYOUT FOR TRW 2003 TEST CIRCUITS



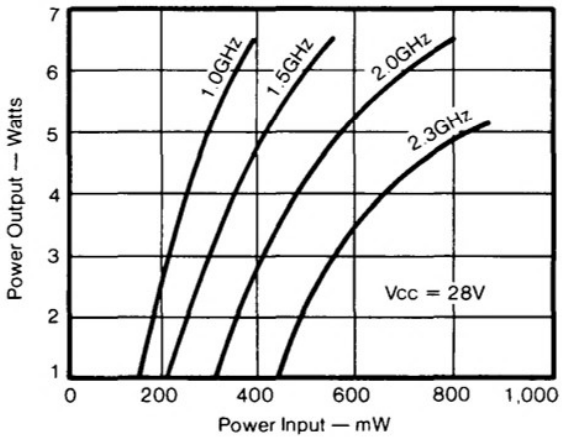
See page 3 for parts details

TRW 2005

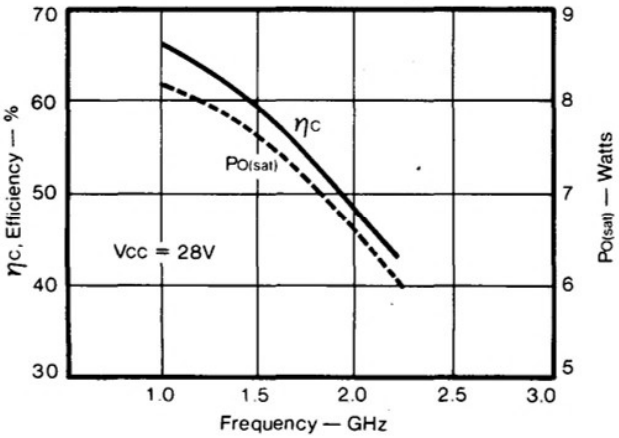
Electrical Characteristics (T_{flange} = 25°C)

Symbol	Characteristic	Conditon	Value
BV_{CER}	Collector-Base Breakdown Voltage R_{BE} = 10Ω	I_C = 40mA	50V Min
BV_{EBO}	Emitter-Base Breakdown Voltage	I_E = 0.5mA I_C = 0	3.5V Min
I_{CBO}	Collector Cutoff Current	V_{CB} = 28V I_E = 0 V_{CB} = 45V	500μA 2mA
I_C	Continuous Collector Current (Max)	V_{CE} = 4V	1.0A
h_{FE}	Forward Current Transfer Ratio	V_{CE} = 5V I_C = 200mA	10-100
θ_{jF}	Thermal Resistance (Junction to Flange)	—	8.5°C/W
C_{OB}	Collector-Base Capacitance (Max)	V_{CB} = 28V	7.0pF
P_o	Power Output @ 2000MHz	P_{in} = 0.80W	5W Min
$P_{o(sat)}$	Power Output @ 2300MHz	V_{CE} = 28Vdc	5.0W (Typ)
	Power Output @ 1500MHz		6.5W (Typ)
	Power Output @ 1000MHz		7.5W (Typ)
P_{gain}	Power Gain (dB) @ 2000MHz	P_o = 5.0W	8dB Min
VSWR	Mismatch Tolerance @ Vcc = 28V	P_o = 5.0W f = 2.0GHz	∞
MTTF	Mean-Time-to-Metal Failure (Hrs x Amps²)	T_j = 150°C	81,200
η_C	Collector Efficiency (Min)	P_o = 5.0W f = 2.0GHz	40%
T_j & T_{stg}	Max Junction and Storage Temperatures	-65 to 200°C	

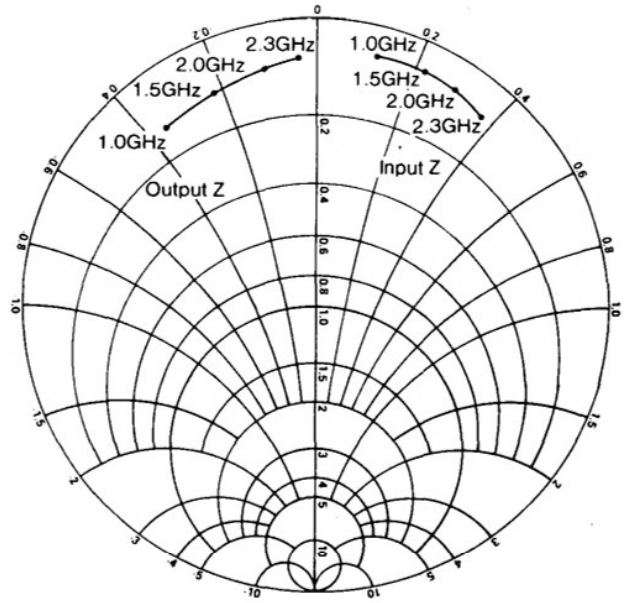
Typical Transfer Characteristics Versus Frequency



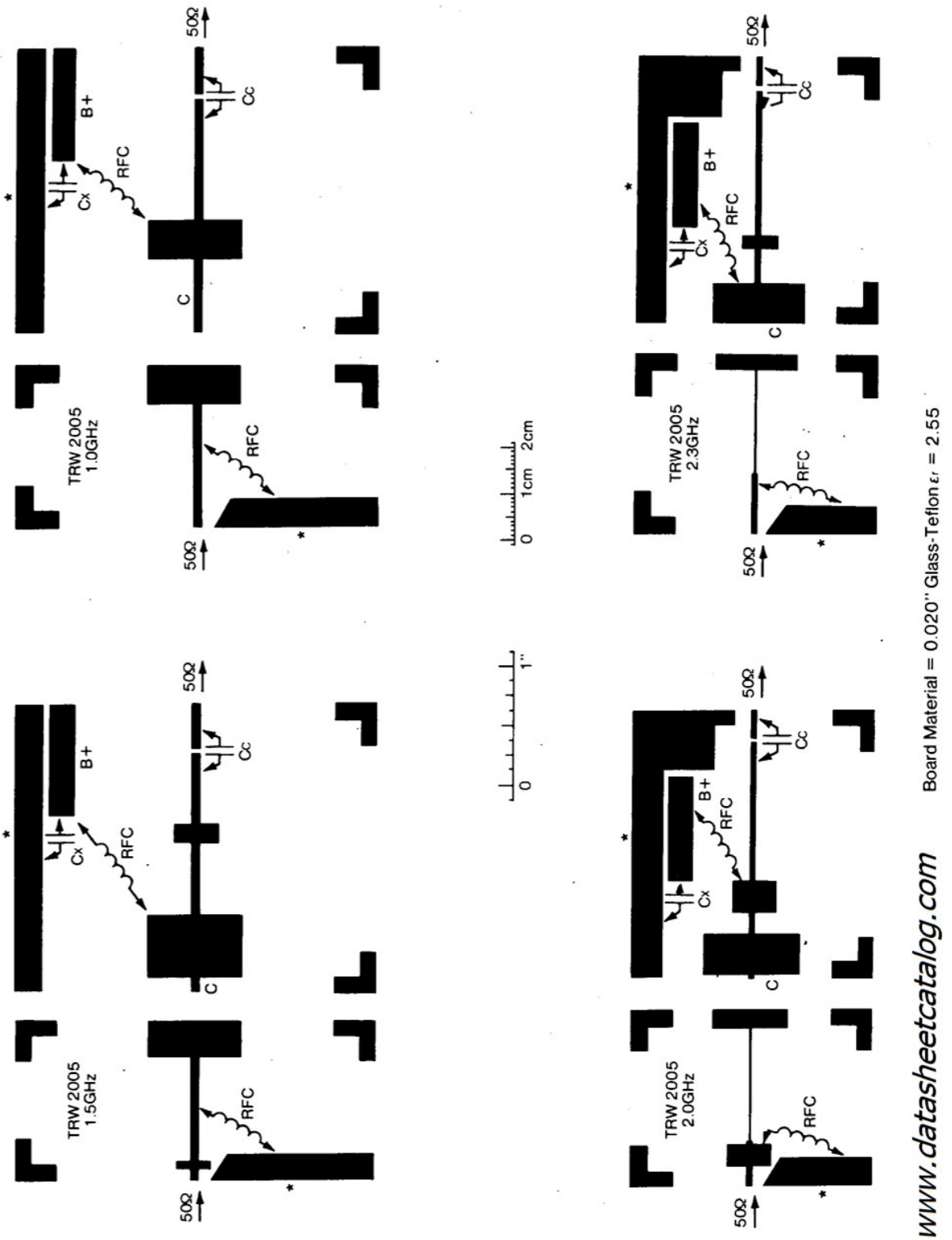
Typical ηc, Power Output Versus Frequency



Impedance Data Vcc = 28V



PC BOARD LAYOUT FOR TRW 2005 TEST CIRCUITS



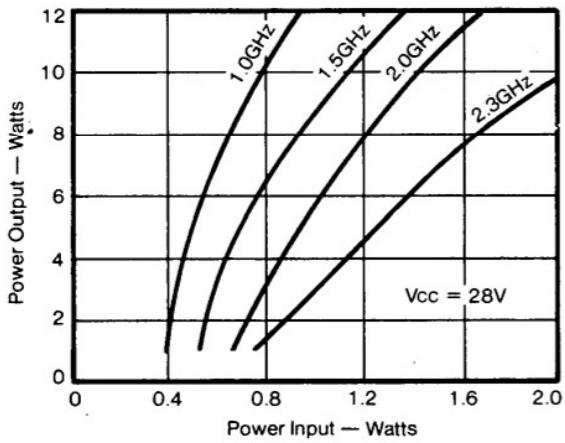
See page 3 for parts details

TRW 2010

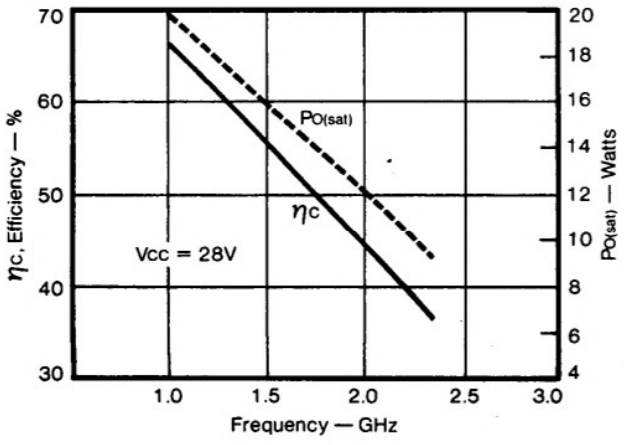
Electrical Characteristics (T_{flange} = 25°C)

Symbol	Characteristic	Conditon	Value
BV_{CER}	Collector-Base Breakdown Voltage R_{BE} = 10Ω	I_C = 80mA	50V Min
BV_{EBO}	Emitter-Base Breakdown Voltage	I_E = 1.0mA I_C = 0	3.5V Min
I_{CBO}	Collector Cutoff Current	V_{CB} = 28V I_E = 0 V_{CB} = 45V	500μA 4mA
I_C	Continuous Collector Current (Max)	V_{CE} = 4V	2.0A
h_{FE}	Forward Current Transfer Ratio	V_{CE} = 5V I_C = 400mA	10-100
θ_{jF}	Thermal Resistance (Junction to Flange)	—	6°C/W
C_{OB}	Collector-Base Capacitance (Max)	V_{CB} = 28V	12.0pF
P_o	Power Output @ 2000MHz	P_{in} = 2.5W	10.0W Min
$P_{o(sat)}$	Power Output @ 2300MHz	V_{CE} = 28Vdc	10.0W (Typ)
	Power Output @ 1500MHz		13.0W (Typ)
	Power Output @ 1000MHz		15.0W (Typ)
P_{gain}	Power Gain (dB) @ 2000MHz	P_o = 10W	6dB Min
VSWR	Mismatch Tolerance @ Vcc = 28V	P_o = 10.0W f = 2.0GHz	∞
MTTF	Mean-Time-to-Metal Failure (Hrs x Amps²)	T_j = 150°C	324,800
η_C	Collector Efficiency (Min)	P_o =10.0W f = 2.0GHz	40%
T_j & T_{stg}	Max Junction and Storage Temperatures	-65 to 200°C	

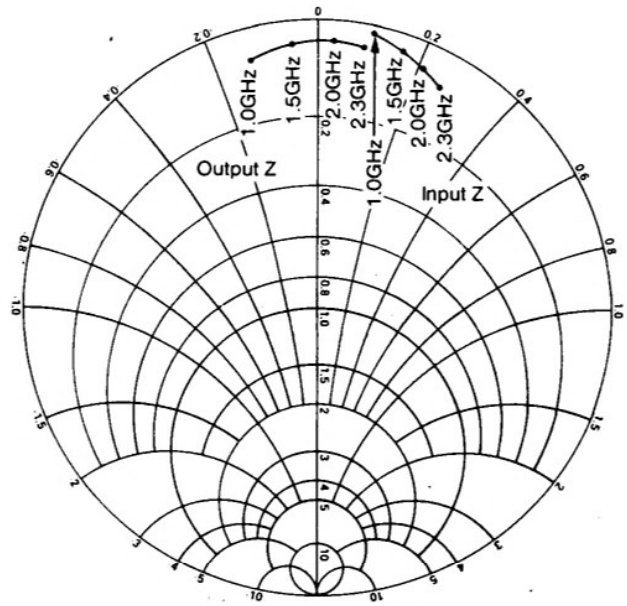
Typical Transfer Characteristics Versus Frequency



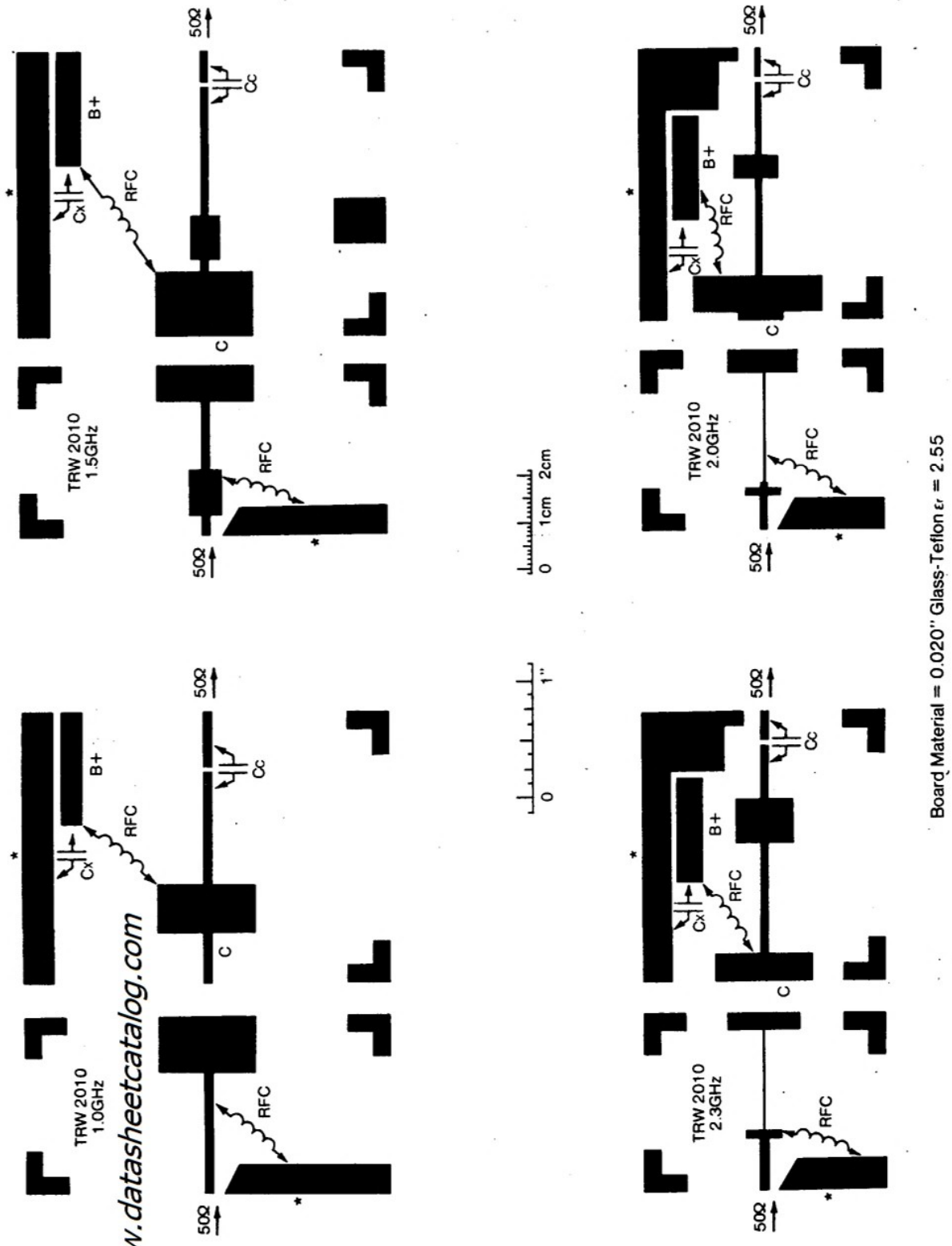
Typical η_C, Power Output Versus Frequency



Impedance Data Vcc = 28V



PC BOARD LAYOUT FOR TRW 2010 TEST CIRCUITS



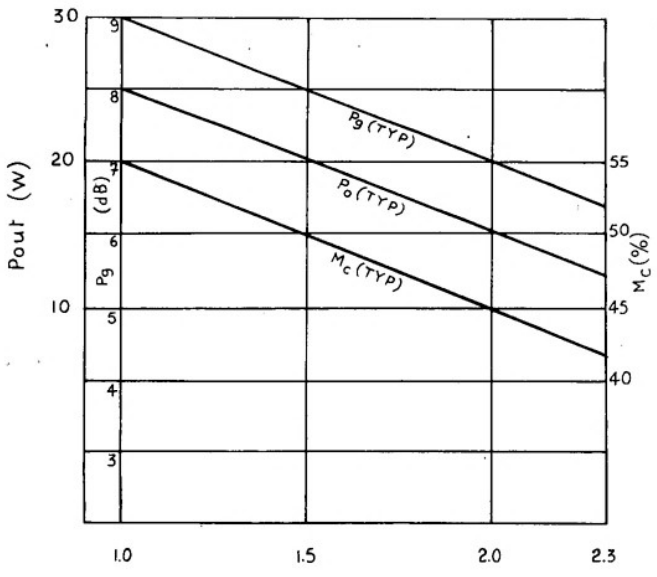
See page 3 for parts details

TRW 2015

Electrical Characteristics (T_{FLANGE} = 25°C)

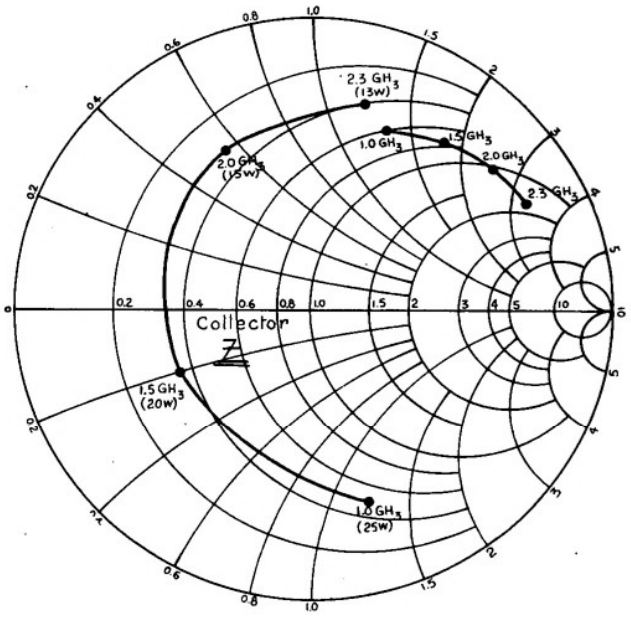
Symbol	Characteristic	Condition	Value
BV_{CER}	Collector-Base Breakdown Voltage R_{BF} = 10 Ω	I_C = 120 mA	50 V Min
BV_{EBO}	Emitter-Base Breakdown Voltage	I_E = 1,5 mA I_C = 0	3.5 V Min
I_{CBO}	Collector Cutoff Current	V_{CB} = 28 V I_E = 0	1.0 mA Max
I_C	Continuous Collector Current (Max)	V_{CE} = 4 V	3.0 A
h_{FE}	Forward Current Transfer Ratio	V_{CE} = 5 V I_C = 600 mA	10-100
θ_{jF}	Thermal Resistance (Junction to Flange)	—	4 °C/W
C_{OB}	Collector-Base Capacitance (Max)	V_{CB} = 28 V	21 pF
P_o	Power Output 2000 MHz	P_{in} = 3.75 W	15.0 W Min
$P_{o(sat)}$	Power Output 1500 MHz	V_{CE} = 28 V	22 W Typ
	Power Output 1000 MHz		30 W Typ
P_{gain}	Power Gain (dB) 2000 MHz	P_o = 15 W	6 dB Min
VSWR	Mismatch Tolerance V_{CC} = 28 V	P_o = 15 W f = 2 GHz	∞
MTTF	Mean Time-to-Metal Failure (Hrs × $Amps^2$)	T_j = 150 °C	780,000
η_C	Collector Efficiency (Min)	P_o = 15 W f = 2 GHz	40 %
T_j & T_{stg}	Max Junction and Storage Temperature		— 65 °C to + 200 °C

Typical Performance Characteristics



Impedance Data

Vcc = 28V Zo = 5.0Ω

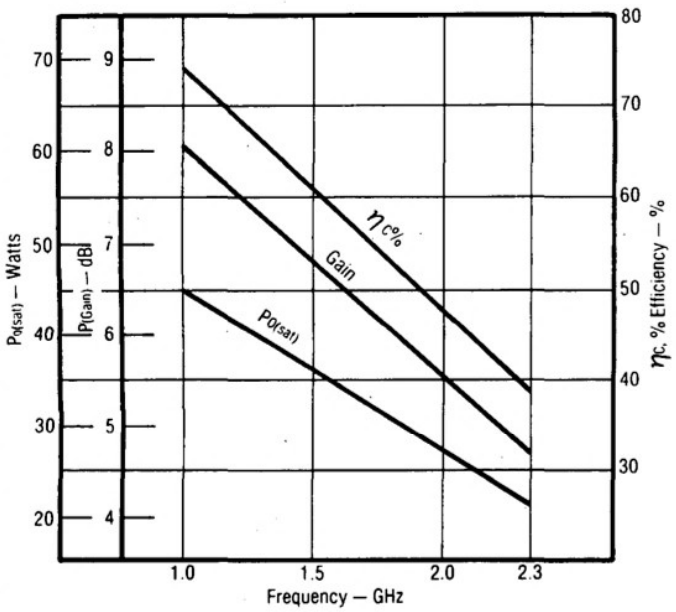


TRW 2020

Electrical Characteristics (T_{FLANGE} = 25°C)

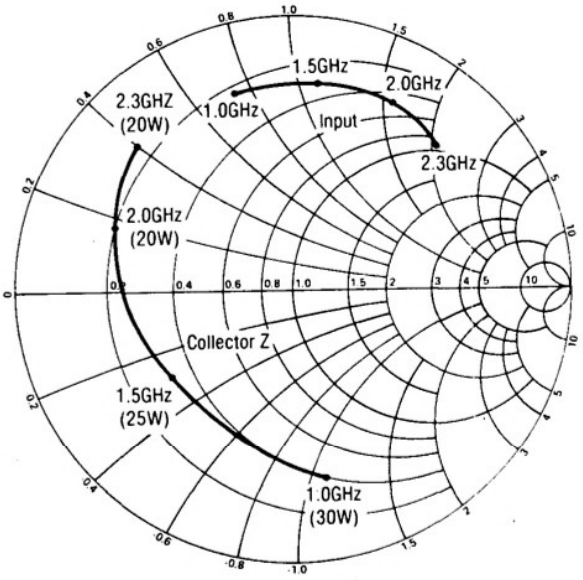
Symbol	Characteristic	Condition	Value
BV_{CER}	Collector-Base Breakdown Voltage R_{BE} = 10Ω	I_C = 160mA	50V Min
BV_{EBO}	Emitter-Base Breakdown Voltage	I_E = 2.0mA I_C = 0	3.5V Min
I_{CBO}	Collector Cutoff Current	V_{CB} = 28V I_E = 0 V_{CB} = 45V	1.0mA 8mA
I_C	Continuous Collector Current (Max)	V_{CE} = 4V	4.0A
h_{FE}	Forward Current Transfer Ratio	V_{CE} = 5V I_C = 800mA	10-100
θ_{JF}	Thermal Resistance (Junction to Flange)	—	3°C/W
C_{OB}	Collector-Base Capacitance (Max)	V_{CB} = 28V	24.0pF
P_O	Power Output @ 2000MHz	P_{in} = 6.0W	20.0W Min
$P_{O(sat)}$	Power Output @ 1500MHz	V_{CE} = 28Vdc	30.0W (Typ)
	Power Output @ 1000MHz		40.0W (Typ)
P_{gain}	Power Gain (dB) @ 2000MHz	P_O = 20W	5.2dB Min
VSWR	Mismatch Tolerance @ V_{CC} = 28V	P_O = 20.0W f = 2.0GHz	∞
MTTF	Mean-Time-to-Metal Failure (Hrs x Amps²)	T_j = 150°C	1,588,000
η_C	Collector Efficiency (Min)	P_O = 20.0W f = 2.0GHz	40%
T_j & T_{stg}	Max Junction and Storage Temperature	-65 to 200°C	

Typical Performance Characteristics



Impedance Data

V_{CC} = 28V Z_O = 5.0Ω



MTTF FACTOR (Normalized to 1 ampere² Continuous Duty)

The graph shown below displays MTTF in hours x ampere² emitter current for each of the "Super 2GHz" devices. Life tests at elevated temperatures have correlated to better than ±10% to the theoretical prediction for metal failure. Sample MTTF calculations based on operating conditions are included on the graph.