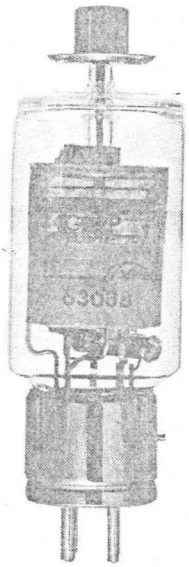
TOSHIBA

Electron Tube, Device & Equipment

TECHNICAL DATA

TOSHIBA HYDROGEN THYRATRON 1G32P

Toshiba 1G32P is a hydrogen thyratorn for switching service in rader modulators and in other pulse applications.
It is suitable for producing pulse outputs of 350 kW at an average power level of 400 watts.
1G32P is identical to the electrical characteristics of 1G35P/4C35 except for dimensions.



GENERAL DATA

	Minimum	Bogie	Maximum	
ELECTRICAL:				
Cathode: Oxide-Coated				
Heater Voltage	5.7	6.3	6.6	V
Heater Current (Ef=6.3V)	5.5	6.1	6.7	A
Heating Time	180	-	-	sec
Anode Voltage Drop	-	70	150	V
Anode Delay Time	-	-	0.6	μs
Anode Current Time Jitter	-	0.005	-	μs

MECHANICAL:

Dimensions ..... See Outline Drawing
Overall Length ..... 145±5 mm
Max. Diameter ..... 45 mm

Base Number:
Cap ..... A14S, Medium (JEDEC No. C1-5)
Base ..... D16S-2, Medium Shell Small 4-pin (JEDEC No. A4-9)

Recommended Socket:
Cap ..... Toshiba VT-29057
Base ..... Toshiba VT-21025

Base Connections ..... See Outline Drawing
Cooling ..... Natural
Mounting Position ..... Any
Net Weight (Approx.) ..... 130 g

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No ED-T100 1982-05-14

RATINGS

ABSOLUTE MAXIMUM:

Peak Anode Voltage:			
Inverse [1]		8000	V
Forward [2]	5% epy ∿	8000	V
Anode Current:			
Peak Current		90	A
Average Current		0.1	A
Averaging Time		1	cycle
Minimum DC Supply Voltage		2500	V
Negative Grid Voltage (Before Conduction)		200	V
Rate of Rise of Cathode Current		1000	A/μs
Pulse Rapetition Rate (prr)		2500	pps
Operation Factor [3]		2.0×10^9	
Pulse Duration		6	μs
Ambient Temperature		-50 ∿ +90	°C
Altitude		3000	m

GRID DRIVE [4]:

Peak Grid Voltage (Min.)	130	V
Time of Rise (Max.)	0.5	μs
Grid Pulse Duration (Min.)(70.7% Amplitude)	2	μs
Grid Drive Circuit Impedance (Max.)	500	Ω

TYPICAL OPERATION (Pulse Modulator):

DC Anode Supply Voltage	8000	V
Pulse Repetition Rate (prr)	2000	pps
Pulse Width	0.5	μs
Pulse Forming Network Impedance	47	Ω
Load Impedance	47	Ω
Peak Power Output	340	kW
DC Anode Current	85	mA

Note ([1]) In pulse operation, the peak inverse anode voltage exclusive of a spike of 0.05 microsecond maximum duration should not exceed 2500 volts during the first 25 microsecond after the pulse.

([2]) Where the anode supply voltage is applied instantaneously, the maximum value of the anode voltage shall not reach 7000 volts in less than 0.04 microsecond.

([3]) prr (pulse repetition rate. pps)$\times_{epy}$ (peak forward anode voltage. V)$\times_{ib}$ (peak anode current A)

([4]) Measurements are at the tube socket with the thyratron grid disconnected.

GENERAL OPERATIONAL RECOMMENDATION

1. High Voltage

Operating voltages for power tubes range from several hundred volts to higher than 50,000 volts. Since these voltage can be deadly, equipment must be designed so that one can not come in contact with high voltage.

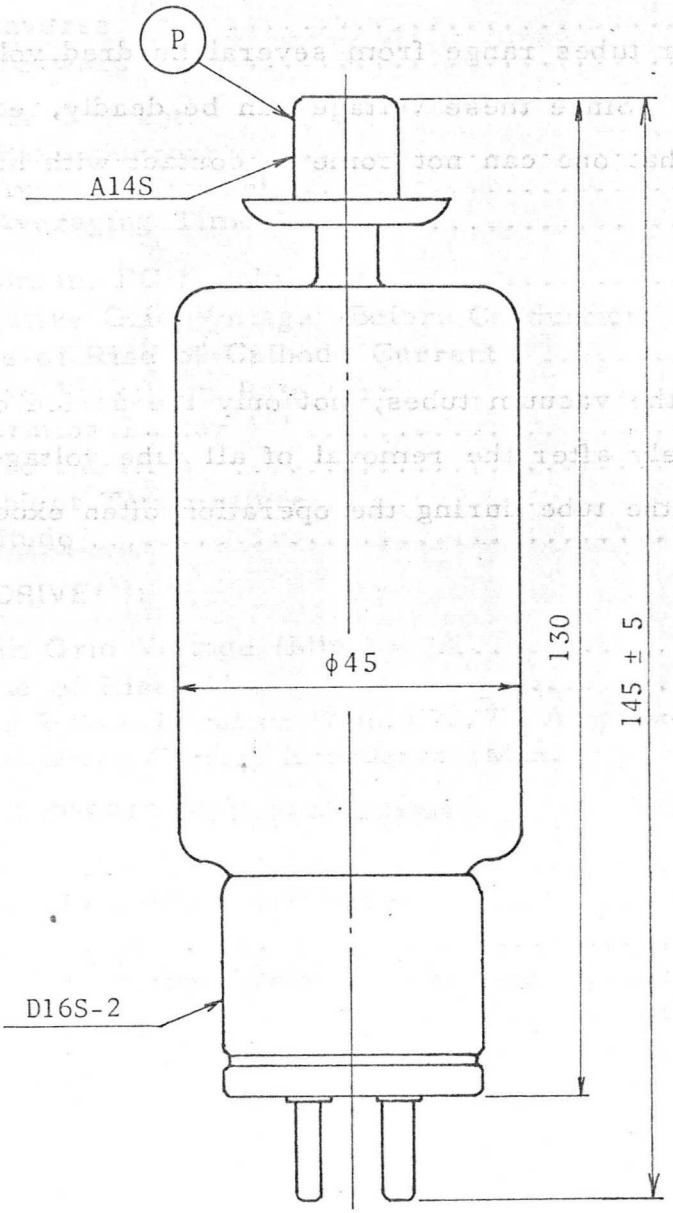
2. High Temperature

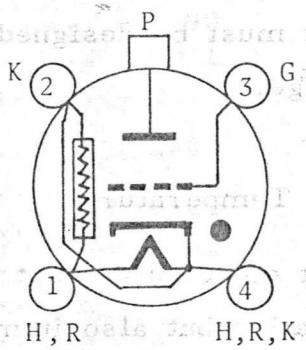
Don't come in contact with the vacuum tubes, not only the period of the operation but also immediately after the removal of all tube voltages, because the temperature of the tube during the operation often exceeds 200 °C.

DIMENSIONAL OUTLINE

1G32P

Unit : mm





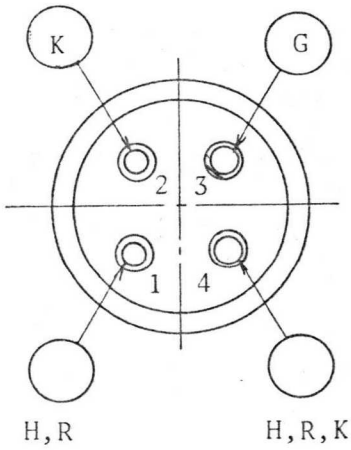
P: Anode

G: Grid

H: Heater

R: Reservoir

K: Cathode



TOSHIBA

Electron Tube, Device & Equipment

TECHNICAL DATA

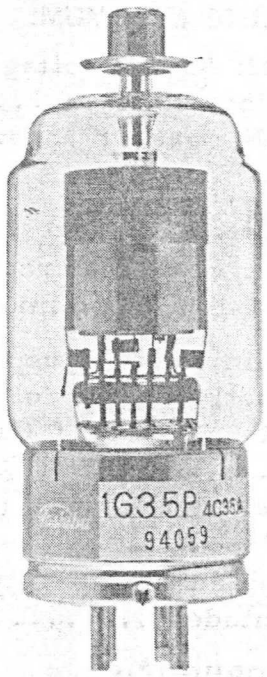
TOSHIBA HYDROGEN THYRATRON

1G35P/4C35

Toshiba 1G35P is a hydrogen thyratorn for switching service in radar modulators and in other pulse applications.

It is suitable for producing pulse outputs of 350kW at an average power level of 400 watts. Very short deionization time and precise triggering permit the generation of short-duration pulses at high repetition frequencies and with negligible time jitter.

1G35P is interchangeable with the 4C35, 4C35A.



GENERAL DATA

ELECTRICAL:	Minimum	Bogie	Maximum	
Cathode: Oxide-Coated				
Heater Voltage	5.7	6.3	6.6	V
Heater Current (Ef=6.3V)	5.5	6.1	6.7	A
Heating Time	180	-	-	sec
Anode Voltage Drop	-	70	150	V
Anode Delay Time	-	-	0.6	μs
Anode Current Time Jitter	-	0.002	0.005	μs

MECHANICAL:

Dimensions:	See Outline Drawing
Overall Length	170 ± 6 mm
Max. Diameter	65 mm
Base Number:	
Cap	A14S, Medium (JEDEC No. C1-5)
Base	D25PA-1, Large-Metal Shell Super-Jumbo 4-Pin with Bayonet (JEDEC No. A4-18)
Recommended Socket:	
Cap	Toshiba VT-29056
Base	Toshiba VT-21026
Base Connections	See Outline Drawing
Cooling	Natural
Mounting Position	Any
Net Weight (Approx.)	225 g

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NoED-T100 1982-05-14

RATINGS

ABSOLUTE MAXIMUM:

Peak Anode Voltage:			
Inverse (1)		8000	V
Forward (2)	5% epy ~	8000	V
Anode Current:			
Peak Current		90	A
Average Current		0.1	A
Averaging Time		1	cycle
Minimum DC Supply Voltage		2500	V
Negative Grid Voltage (Before Conduction)		200	V
Rate of Rise of Cathode Current		1000	A/μs
Pulse Repetition Rate (prr)		2500	pps
Operation Factor (3)		2.0×10^9	
Pulse Duration		6	μs
Ambient Temperature	-50 ~	+90	°C
Altitude		3000	m

GRID DRIVE (4):

Peak Grid Voltage (Min.)	130	V
Time of Rise (Max.)	0.5	μs
Grid Pulse Duration (Min.)(70.7% Amplitude)	2	μs
Grid Drive Circuit Impedance (Max.)	1500	Ω

TYPICAL OPERATION (Pulse Modulator):

DC Anode Supply Voltage	4000	V
Pulse Repetition Rate (prr)	2250	pps
Pulse Width	0.5	μs
Pulse Forming Network Impedance	50	Ω
Load Impedance	46	Ω
Grid Drive Voltage	200	V
Peak Power Output	310	kW
Average Power Output	350	W
DC Anode Current	94	mA
Time Jetter	0.01	μs

Note (1) In pulsed operation, the peak inverse anode voltage exclusive of a spike of 0.05 microsecond maximum duration should not exceed 2500 volts during the first 25 microsecond after the pulse.

(2) Where the anode supply voltage is applied instantaneously, the maximum value of the anode voltage shall not reach 7000 volts in less than 0.04 microsecond.

(3) prr(pulse repetition rate. pps)$\times_{epy}$ (peak forward anode voltage. V)$\times_{ib}$ (peak anode current. A)

(4) Measurements are at the tube socket with the thyratron grid disconnected.

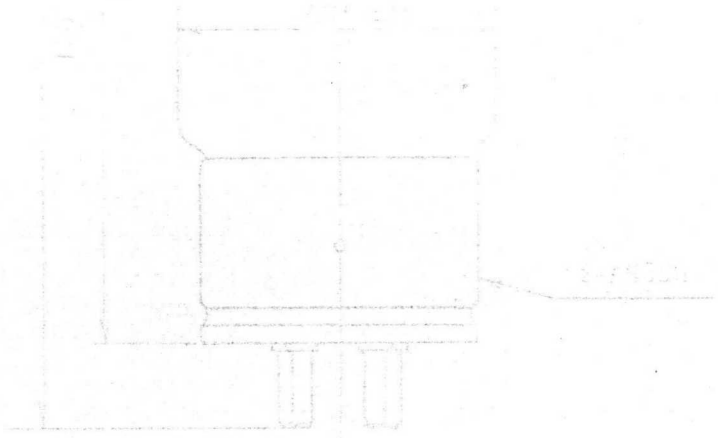
GENERAL OPERATIONAL RECOMMENDATION

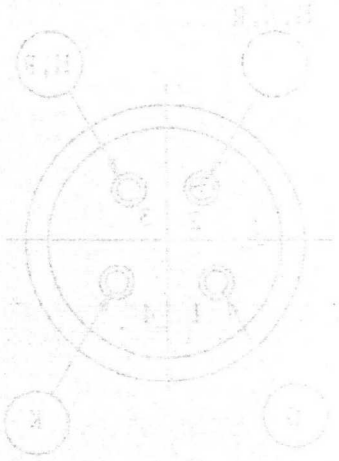
1. High Voltage

Operating voltages for power tubes range from several hundred volts to higher than 50,000 volts. Since these voltage can be deadly, equipment must be designed so that one can not come in contact with high voltage.

2. High Temperature

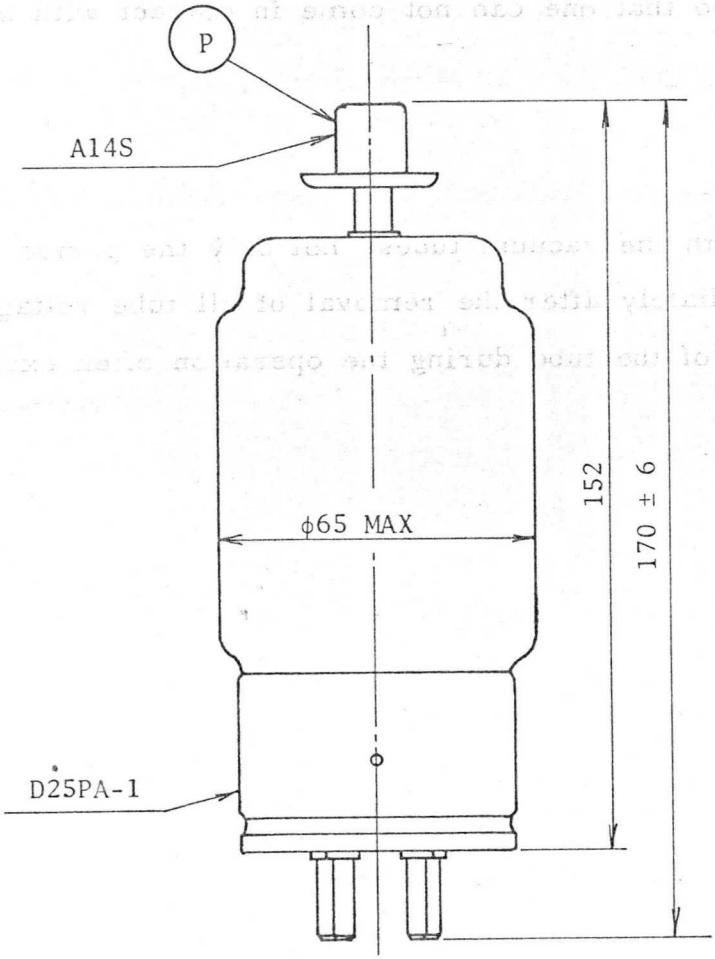
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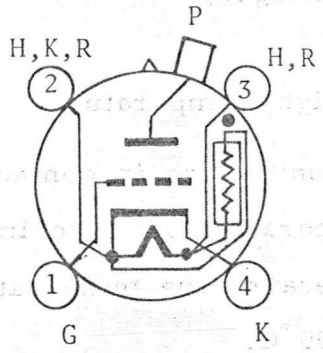




DIMENSIONAL OUTLINE
1G35P/4C35A

Unit : mm





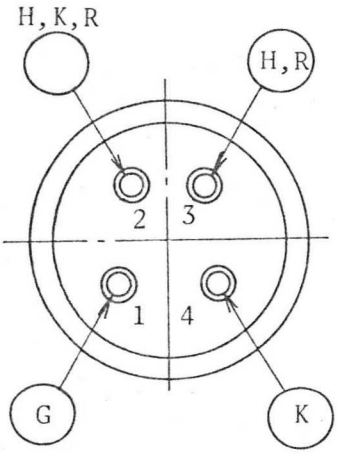
P: Anode

G: Grid

K: Cathode

H: Heater

R: Reservoir



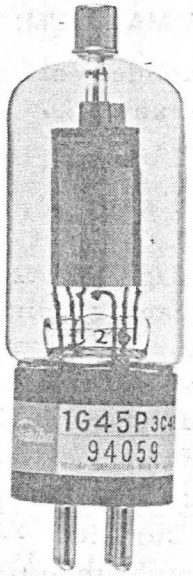
TOSHIBA

Electron Tube, Device & Equipment

TECHNICAL DATA

TOSHIBA HYDROGEN THYRATRON
1G45P/3C45

Toshiba 1G45P is a hydrogen thyratorn for switching service in radar modulators and in other pulse applications.
It is capable of switching a peak power of 50 kW at an average power level of 65 watts.
This tube is interchangeable with the 3C45.



GENERAL DATA

ELECTRICAL:

	Minimum	Bogie	Maximum	
Cathode: Oxide-Coated				
Heater Voltage	5.7	6.3	6.6	V
Heater Current (Ef=6.3V)	2.0	2.25	2.50	A
Heating Time	120	-	-	sec
Anode Voltage Drop	-	60	150	V
Anode Delay Time	-	-	0.6	μs
Anode Current Time Jitter	--	0.01	0.02	μs

MECHANICAL:

Dimensions:	See Outline Drawing
Overall Length	122 ± 5 mm
Max. Diameter	40 mm
Base Number:	
Cap	A9S, Small Cap (JEDEC No. C1-1)
Base	D16S-2, Medium Shell Small 4-pin (JEDEC No. A4-9)
Recommended Socket:	
Cap	Toshiba VT-29056
Base	Toshiba VT-21025
Base Connections	See Outline Drawing
Cooling	Natural
Mounting Position	Any
Net Weight (Approx.)	60 g

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No. ED-T100 1982-05-14

RATINGS

ABSOLUTE MAXIMUM:

Peak Anode Voltage:		
Inverse (1)	3000	V
Forward (2)	5% epy ∿ 3000	V
Anode Current:		
Peak Current	35	A
Average Current	0.045	A
Averaging Time	1	cycle
Minimum DC Supply Voltage	800	V
Negative Grid Voltage (Before Conduction)	200	V
Rate of Rise of Cathode Current	750	A/μs
Puse Rapetition Rate (prr)	2500	pps
Operation Factor (3)	0.3×10^9	
Pulse Duration	6	μs
Ambient Temperature	-50 ∿ +90	°C
Altitude	3000	m

GRID DRIVE (4):

Peak Grid Voltage (Min.)	130	V
Time of Rise (Max.)	0.5	μs
Grid Pulse Duration (Min.)(70.7% Amplitude)	2	μs
Grid Drive Circuit Impedance (Max.)	1500	Ω

TYPICAL OPERATION (Pulse Modulator):

DC Anode Supply Voltage	1500	V
Pulse Repetition Rate (prr)	2500	pps
Pulse Width	0.5	μs
Grid Drive Voltage	200	V
Peak Power Output	45	kW
Average Power Output	56	W

Note (1) In pulse operation, the peak inverse anode voltage exclusive of a spike of 0.05 microsecond maximum duration should not exceed 1500 volts during the first 25 microsecond after the pulse.

(2) Where the anode supply voltage is applied instantaneously, the maximum value of the anode voltage shall not reach 3000 volts in less than 0.04 microsecond.

(3) prr(pulse repetition rate. pps)$\times_{epy}$ (peak forward anode voltage. V)$\times_{ib}$(peak anode current. A)

(4) Measurements are at the tube socket with the thyratron grid disconnected.

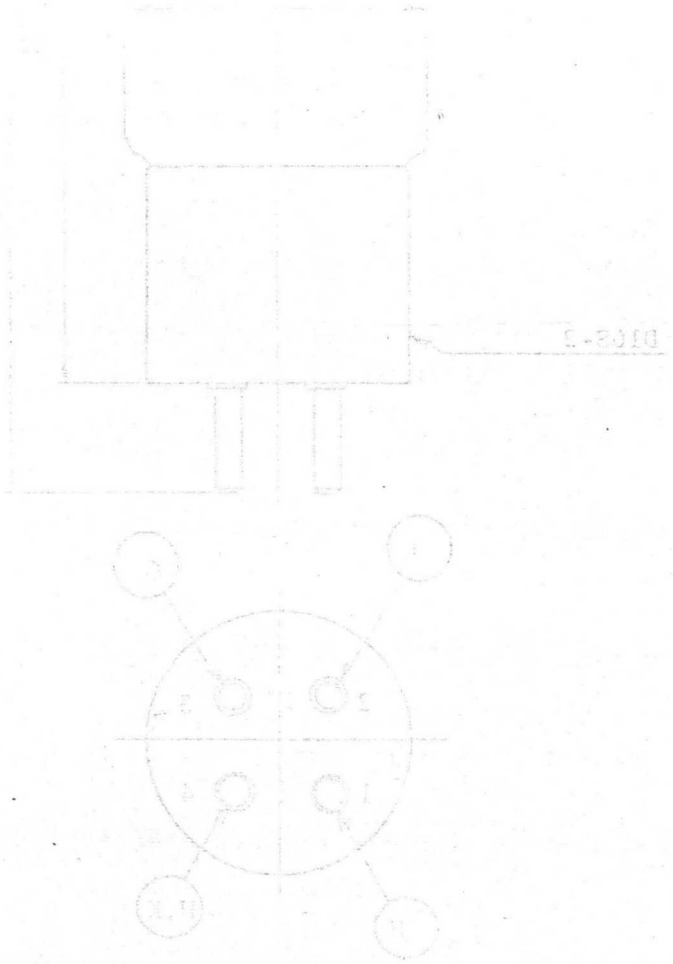
GENERAL OPERATIONAL RECOMMENDATION

1. High Voltage

Operating voltages for power tubes range from several hundred volts to higher than 50,000 volts. Since these voltage can be deadly, equipment must be designed so that one can not come in contact with high voltage.

2. High Temperature

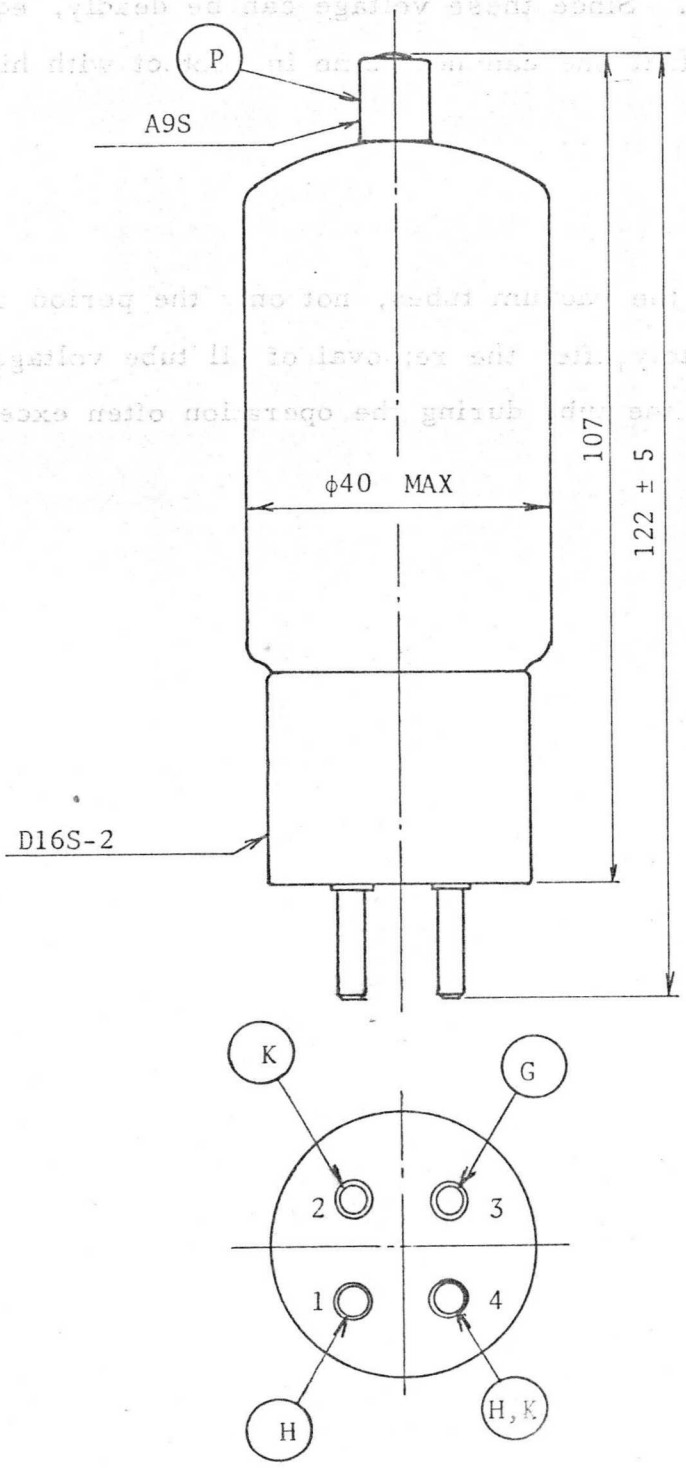
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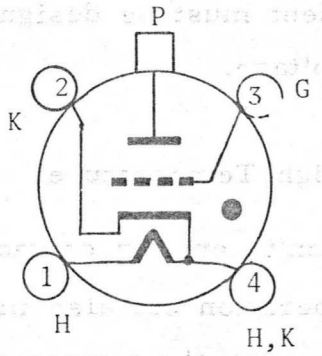


DIMENSIONAL OUTLINE

1G45P/3C45

Unit : mm





P: Anode

G: Grid

K: Cathode

H: Heater

Toshiba

電子管技術資料

TOSHIBA TWT

東芝進行波管 IW80

1W80は集束磁界内蔵の進行波管で，連続波動作の電力増幅に使用されます。動作周波数は590MHz から 770MHz で，650MHz において飽和出力は約2kW，小信号時利得は約35dBです。高周波入出力部はそれぞれ同軸により構成され，冷却は強制空冷によって行なわれます。この進行波管は特にUHF 帯振幅変調波増幅を行なう放送装置および通信機の送信用に適するよう設計されています。

TV放送出力が 500Wまでのときは混変調が少なく直線性の良い状態で映像信号と音声信号を共通増幅することができます。また映像信号のみを増幅する場合は，放送出力が1 kWまでの出力増幅管として安定に動作します。

なお電磁石を除いた1W80(T)も用意されています。

特　　長：

(1) 広帯域特性です。

UHF テレビジョン帯のどのチャンネルでも規定の電圧を印加するだけで動作し空胴の調整などは全く必要ありません。

(2) 利得が高く，安定度がよい。

利得が35dB と高く，励振段は固体装置で構成できます。また非励振のときは負荷をどの位相で短絡しても発振などの不安定動作を起しませんから炉波器，分波器等を自由に使用できます。電源変動や周囲温度の変化に対しても安定であります。

(3) 直線性が良く雑音が少ない。

AM信号を含む多周波増幅を行なうことを主目的としておりますから直線性が良くS/Nも50dB 以上です。

(4) 取付け，調整が容易です。

管の取付けには独特の工夫をしてありますから管の交換などが容易で調整個所は全くありません。

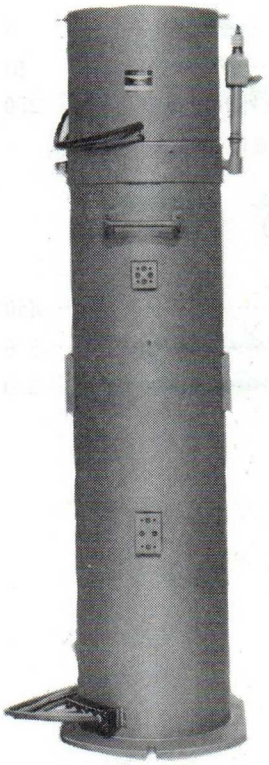
(5) 長寿命です。

他の東芝進行波管や東芝大電力クライストロンの設計，製造技術が生かされており長寿命です。

一般定格 GENERAL SPECIFICATIONS

電気的特性： Electrical

周波数 Frequency	最小 min	590	MHz
	最大 max	770	MHz
ヒータ電圧 Heater Voltage		6.0	Vdc
ヒータ電流 Heater Current		12.5	Adc
陰極予熱時間 Cathode heating time		300	sec



機械的特性： Mechanical

外形寸法 outlines	外形図参照	see
口金および電極接続	外形図参照	
取付に関する事項 mounting position	垂直（コレクタ 上）	vertical (Collector end up)
高周波結合器 RF connectors 入力側 input	N型接せん	
高周波結合器 出力側 output	WX－39D	
磁界 magnet. field	電磁石	electrical magnet
冷却方式 cooling	強制空冷	forced Air
重量 weight 管本体 tube	約30 kg	about
重量 weight 電磁石 magnet	約70 kg	about
陰極の種類 cathode	傍熱含浸形	indirectly

最大定格 MAXIMUM RATINGS

	min 最小	max 最大	
ヒータ電圧 Heater Voltage	5.4	6.6	V
陰極予熱時間 cathode heating time	240	—	sec
陰極電流 cathode current	—	2.5	Adc
コレクタ電圧 collector voltage	4	7	kVdc
コレクタ電流 collector current	—	2.5	Adc
コレクタ損失 collector loss	—	14	kW
ヘリックス電圧 Helix voltage	4	7	kVdc
ヘリックス電流 Helix current	—	75	mAdc注
ヘリックス損失 Helix loss	—	400	W

加速電極電圧 Anode Voltage	−	7	kVdc
加速電極電流 Anode Current	−	10	mAdc
コレクタ温度 Collector Temperature（測定点外形図参照）	−	250	℃

注）サージ電流は100mAdc以下

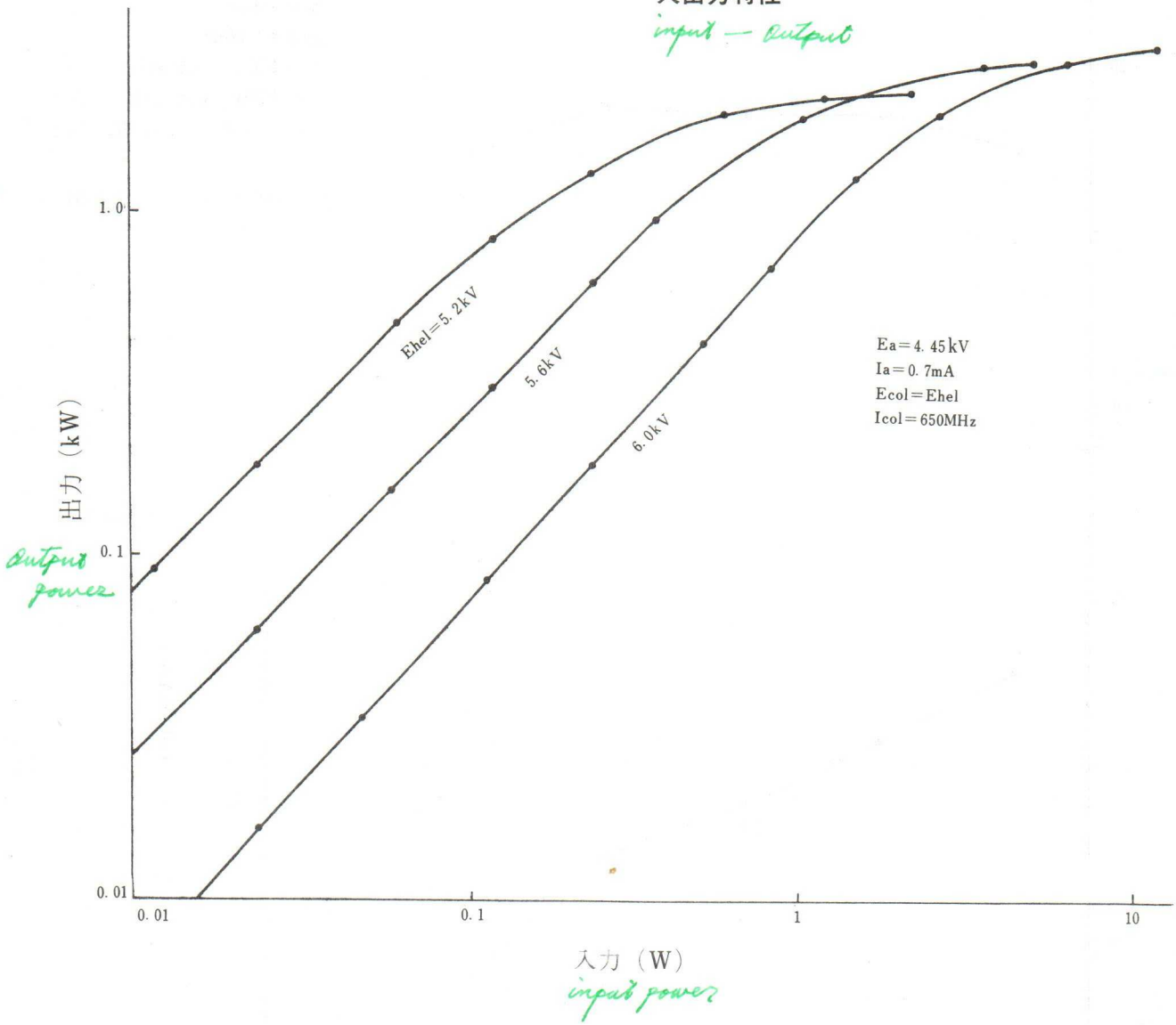
TYPICAL OPERATION 動作例

周波数 Frequency	650	MHz
コレクタ電圧 Collector Voltage	5.6	kVdc
コレクタ電流 Collector Current	2.0	Adc
ヘリックス電圧 Helix Voltage	5.6	kVdc
ヘリックス電流 Helix Current	15	mAdc
加速電極電圧 Anode Voltage	4.3	kVdc
加速電極電流 Anode Current	1.0	mAdc
励振電力 input power	0.63	W
出　力 output power	1.26	kW
利　得 Gain	33	dB
小信号時利得 Gain (at small input)	35	dB
飽和出力 Minimum saturation output	2.0	kW
冷却風量 Air flow	17	m^3/min

Typical performance

入出力特性

input — output

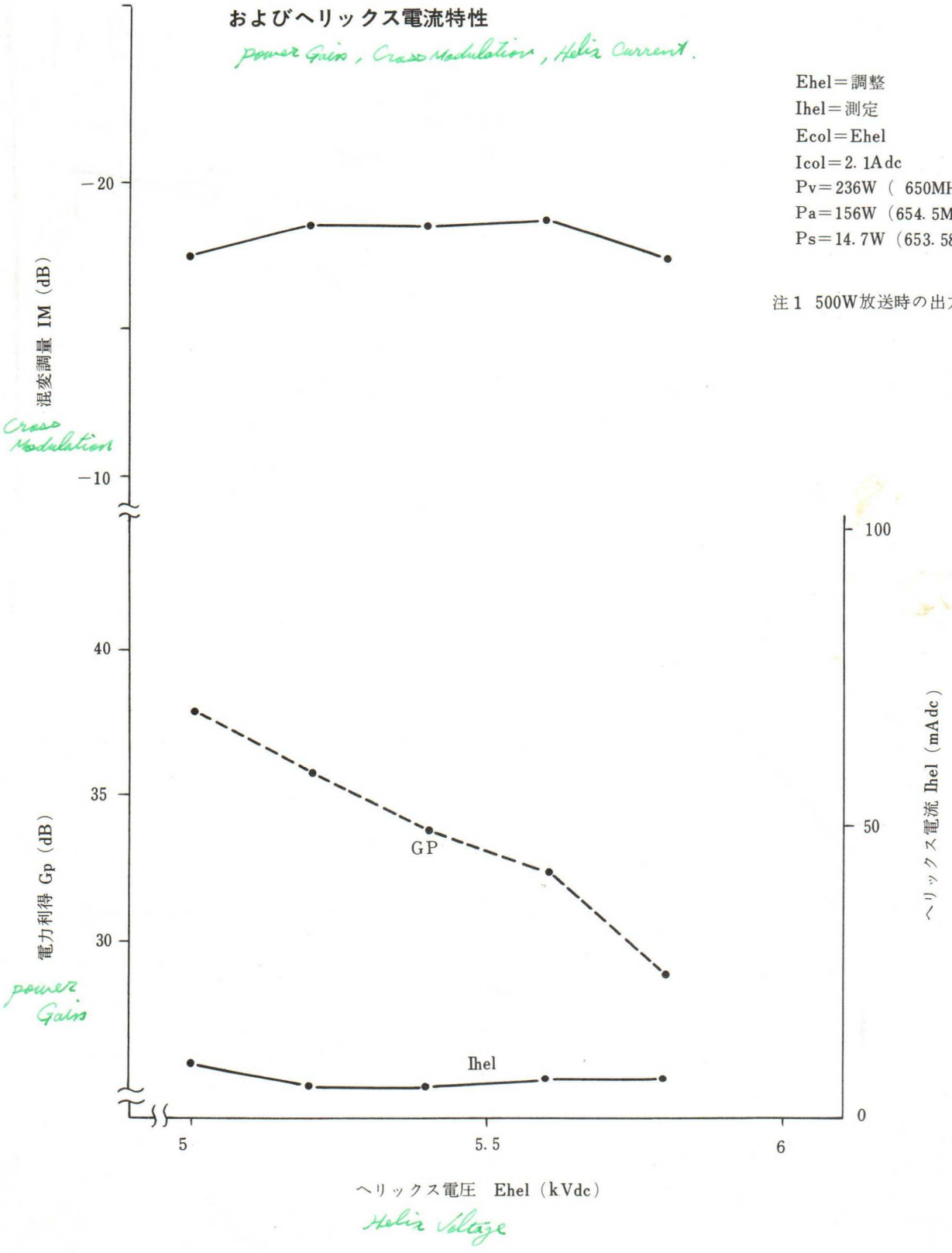


ヘリックス電圧に対する，電力利得，混変調量およびヘリックス電流特性

power Gain, Cross Modulation, Helix Current.

Ehel＝調整
Ihel＝測定
Ecol＝Ehel
Icol＝2.1Adc
Pv＝236W（ 650MHz） 注1
Pa＝156W（654.5MHz） 注1
Ps＝14.7W（653.58MHz）注1

注1 500W放送時の出力＋1dB.



機器設計上の注意

装　　着：

(1) この進行波管は通常コレクタを上にして垂直の状態で使用し，管の交換時には水平にして管の装着が容易に行なえるようになっています。管が電磁石装置に装着されている状態では平衡がとれていて回転が容易ですが，管を抜いた状態では，不平衡となりますから，水平にしたとき電磁石を確実に固定する装置を設けてください。

(2) 電磁石には,高圧ケーブルおよび電磁石用配線端子を設けておりますが電磁石を回転させるとき，無理な力が加わらないようにしてください。

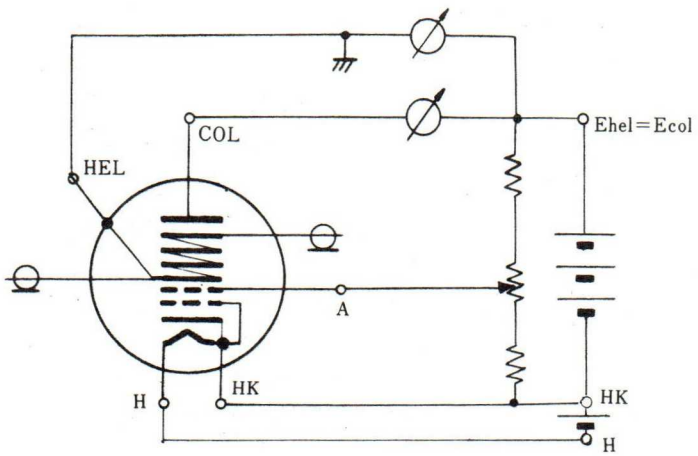
(3) 電磁石および管本体の重さ（約 100 kg ）に耐える丈夫な架台を使用してください。

接　　続：

(1) 管球と電源の接続例を図1に示します。この技術資料では，管本体に印加する電圧はすべてカソードを基準にしております。またヘリックス電極は接地される構造になっていますから充分ご注意ください。

(2) この進行管管は負荷の変化に対し安定に動作するよう設計してありますが負荷側に大きな反射があると反射電力は管内で消費され，管の劣化を早くし，また周波数特性が悪くなりますので出力側にはサーキュレータまたはアイソレータを使用されることをおすすめします。入力側にも励振段への影響を少なくするためサーキュレータまたはアイソレータを使用されることをおすすめします。

図1



冷　　却：

(1) 本管を長時間安定に動作させるには非励振時状態でコレクタ部の温度（測定点外形図参照）が 250℃ 以下になるよう強制空冷をする必要があります。

(2) 装置の設計に当っては十分な風量が得られるように送風機を選定するとともに送風機の入口には適当なフィルタを設けてください。

(3) 冷却装置に異状が起り，送風機が停止したり，規定の風量以下になった場合に進行波管の電源および電磁石電源を自動的に遮断する保護回路を設けることをおすすめします。

動　　作：

(1) 進行波管を動作させるときは次の順序で行なってください。

送風機の動作 → 電磁石電源印加 ┐
　　　　　　 → ヒータ電源印加 ┘→ 高圧電源印加

(2) 進行波管の動作をやめる場合は上記と逆の順序で停止させヒータ電源，電磁石電源を断にしてから送風機は5分間以上動作させた後，全電源が断になるようご考慮ください。

(3) ヒータ電源動作後規定の予熱時間を経過しないと高圧が印加できないようタイマなどの使用をお願いします。

(4) ヘリックス電圧，コレクタ電圧にくらべて加速電極電圧は最も遅く印加され，動作を中止するときは加速電極電圧が最も早く切れるよう設計してください。

(5) 高圧を印加する場合は，コレクタ電圧，ヘリックス電圧，加速電極電圧の順に印加を行ない，高圧を断にする場合は，逆に加速電極電圧，ヘリックス電圧，コレクタ電圧の順に行なうのが理想的ですがヘリックス，コレクタ間に高電圧が加わらないようにヘリックス，コレクタは同時に印加または断にするようお願いします。高圧を同時印加または断にする場合には，各電極電圧の立上り特性の差により，加速電極電圧が他の電圧より早くかかることのないようにまた高圧断のときはコレクタ，ヘリックス電圧が加速電極電圧より先に下がることのないようにご考慮ください。各電極の電圧の印加または断の順序が変りますと加速電極，ヘリックスに過大の電流が流れて短時間で進行波管が不良となります。

取扱いおよび使用上の注意事項

取　　扱：

(1) 1W80は進行波管として要求される十分な機械的強度を持つよう設計されておりますが内部構造は精密であるため，取扱い上の不注意で破損または性能劣化を起す恐れがあります。従っていかなる場合も進行波管に20G以上の振動や衝撃を与えないようお願いします。

(2) 管の輸送及び保管には正規の包装箱を使用されるようお願いします。

装　　着：

(1) 管の装着を行なう場合にはまず，電磁石を水平に回転して，管の本体部およびコレクタ部の取手を持ち，静かに管を電磁石にさし込んでください。管をさし込んでいる途中では必らず管を水平に保ち，絶対に途中で手をはなすことのないようお願いします。

(2) 管を装着後，イオンポンプ電源，コレクタヘリックス，リード，入出力接栓を確実に接続してください。

(3) 管を取外すときは，ヒータ電源を切ってから5分間以上送風機を動作させた後にしてください。

動　　作：

(1) 高圧を印加する前に次の事項を確認してください

(a) イオンポンプ電流が1μ A以下であるかどうか。ただし長期間（3ヶ月以上）保管した管ではイオンポンプ電流が一時的に増加することがあっても数分間予熱することによって1μ A以下になるはずです。

(b) 高周波入力が入っていないかどうか。

通常AGC 回路のある励振段であるとか管の利得の差で進行波管に実質的に過大な入力があると，高圧印加後に非常に大きな出力で動作することになります。できるだけ高周波入力がない状態で高圧を印加してください。

(2) 高圧印加時にはアノード電圧を最小の状態にしておき，高圧印加後にコレクタ電流が規定の値になるよう調整してください。なおコレクタ電流とアノード電圧には次の関係があります。

$Icol+Ia+Ihel=KEa^{\frac{3}{2}} \fallingdotseq Icol$

ここにKはパービアンスと呼ばれる比例定数で1W80のときは$6\sim7\times10^{-6}$であります

(3) この進行波管は負荷の変動に対して安定に動作するよう設計されておりますが，負荷からの反射電力が大きいと，反射電力はほとんど進行波管内で消費されるため特に寿命に影響します。また，周波数特性にも影響を与えますから高周波回路の接続には充分ご注意ください。

(4) 周囲温度に対して充分安定に動作するよう設計されておりますがたとえば夏季と冬季のように温度差が30℃以上ある場合は，電磁石電流を調整した方が寿命に対して良い結果が得られます。

保守，交換

(1) 出力減少

進行波管を使用中に，出力が減少した場合には次の点を調べてください。

(a) 入力信号レベル

まず管の利得が充分であるかどうかを調べるため，入力信号が適正な値であるかどうかためしてください。

(b) 各電極の電圧電流

各電極の電圧電流が規定値であるかどうかを調べてください。一般にヒータ電圧やアノード電圧が低いとコレクタ電流が減って，利得が低下します。ヒータ電圧は規定値に，またアノード電圧は規定値の範囲内（3600V～5400V）で調整してください。

(2) ヘリックス電流の増加

進行波管を使用中にヘリックス電流が規定の値よりも大きくなった場合は次の点を調べてください。

(a) 電磁石電流

特に電磁石電流が減少するとヘリックス電流は増加しますから電磁石電流を調整してください。

(b) ヘリックス電圧

ヘリックス電圧が低いとヘリックス電流は増加する傾向があります。

(c) 高周波回路

負荷からの反射電力が大きいとヘリックス電流が増加します。また，出力電力指示回路までの高周波回路の接続が悪いと管の出力は指示回路の電力よりも大きくなり，ヘリックス電流が増加します

(3) 雑　　音

雑音については電源変動，周囲温度変化などがあっても十分安定に動作するよう製作，調整されておりますが万一雑音が発生した場合は次の点を確認してください。

(a) 各電極の電圧電流が検査成績表の値から大きくはずれていると雑音が発生しますのでお確めください。

(b) 進行波管の入力信号のS/Nはどうかご確認ください。

(c) 長期間放置された進行波管は高圧印加後のS/Nは若干低いことがありますが普通数分間の動作で安定します。

(4) イオンポンプ電流

イオンポンプのイオン電流が50μAを越える場合にはイオンポンプのソケットのリーク，またはイオンポンプ絶縁部表面のリークが考えられますからポンプからソケットをはずしソケットのリーク電流を確認し，またポンプ絶縁部表面に汚れがないかどうか確認してください。

以上の各項の操作，調整後もこれら不具合点がある場合には進行波管を交換してください。なお交換された不具合管を返送される場合には，不具合発生までの運用データおよび上記調整時の記録を添付の上，必らず正規の包装箱を使用されますようお願いします。

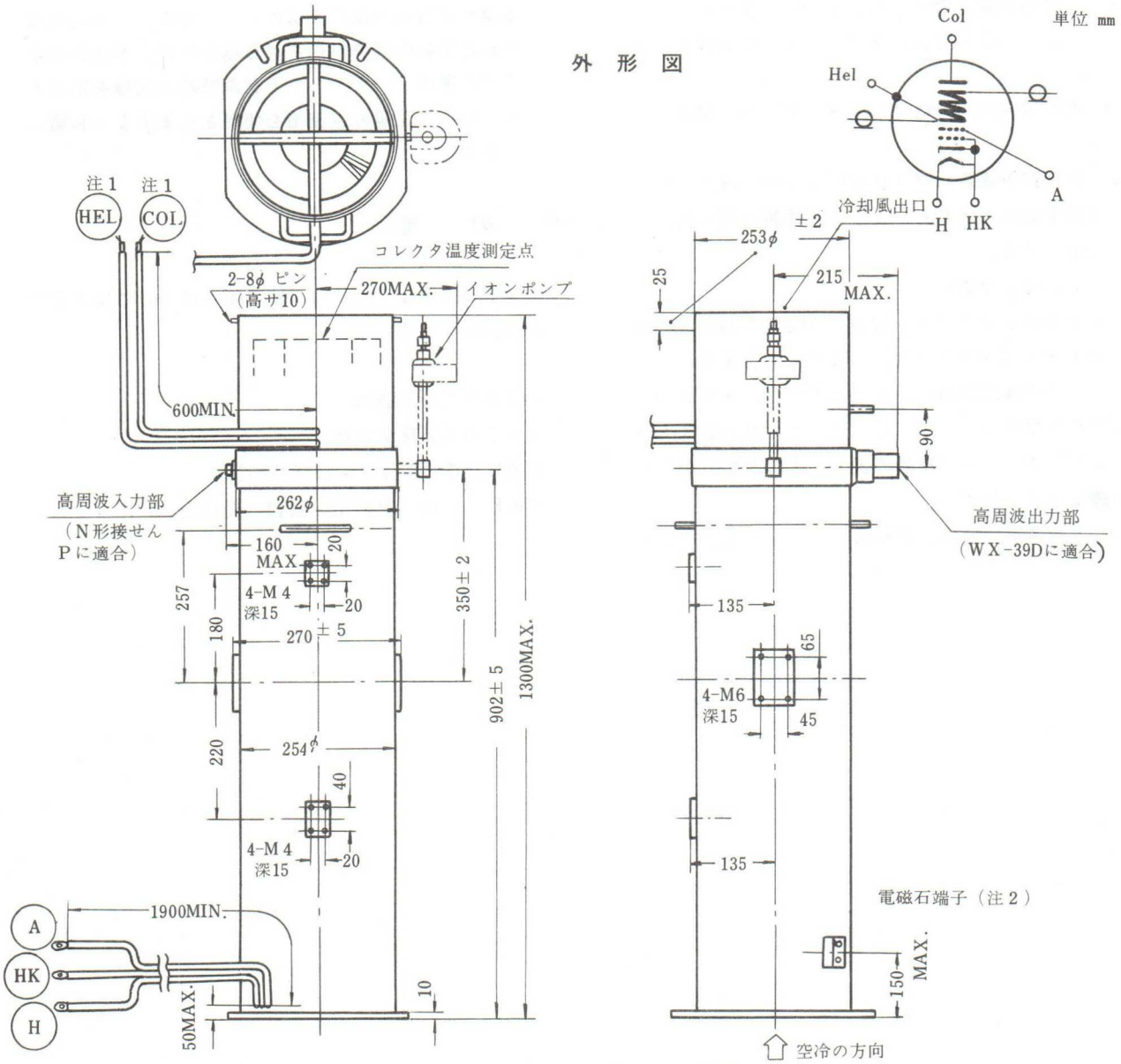
そ　の　他

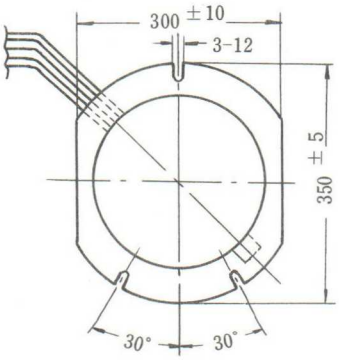
上記中ご不明な点や特殊の使用条件については下記にお問合せください。

川崎市堀川町72番地
東京芝浦電気株式会社
電子管技術部マイクロ波管技術課
ＴＥＬ　川崎（044）52－2111（大代表）

外形図

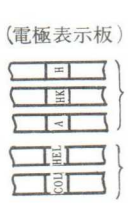
単位 mm

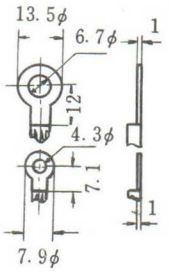




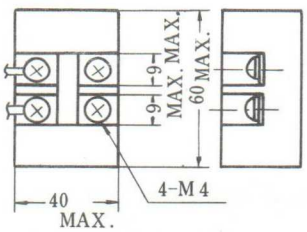
注1. リード詳細

(電極)	(リード線の色)
ヒータ	茶
ヒータ陰極	黄
加速電極	青
ヘリックス	だいだい
コレクタ	赤





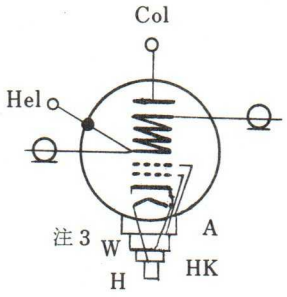
注2. 電磁石端子詳細

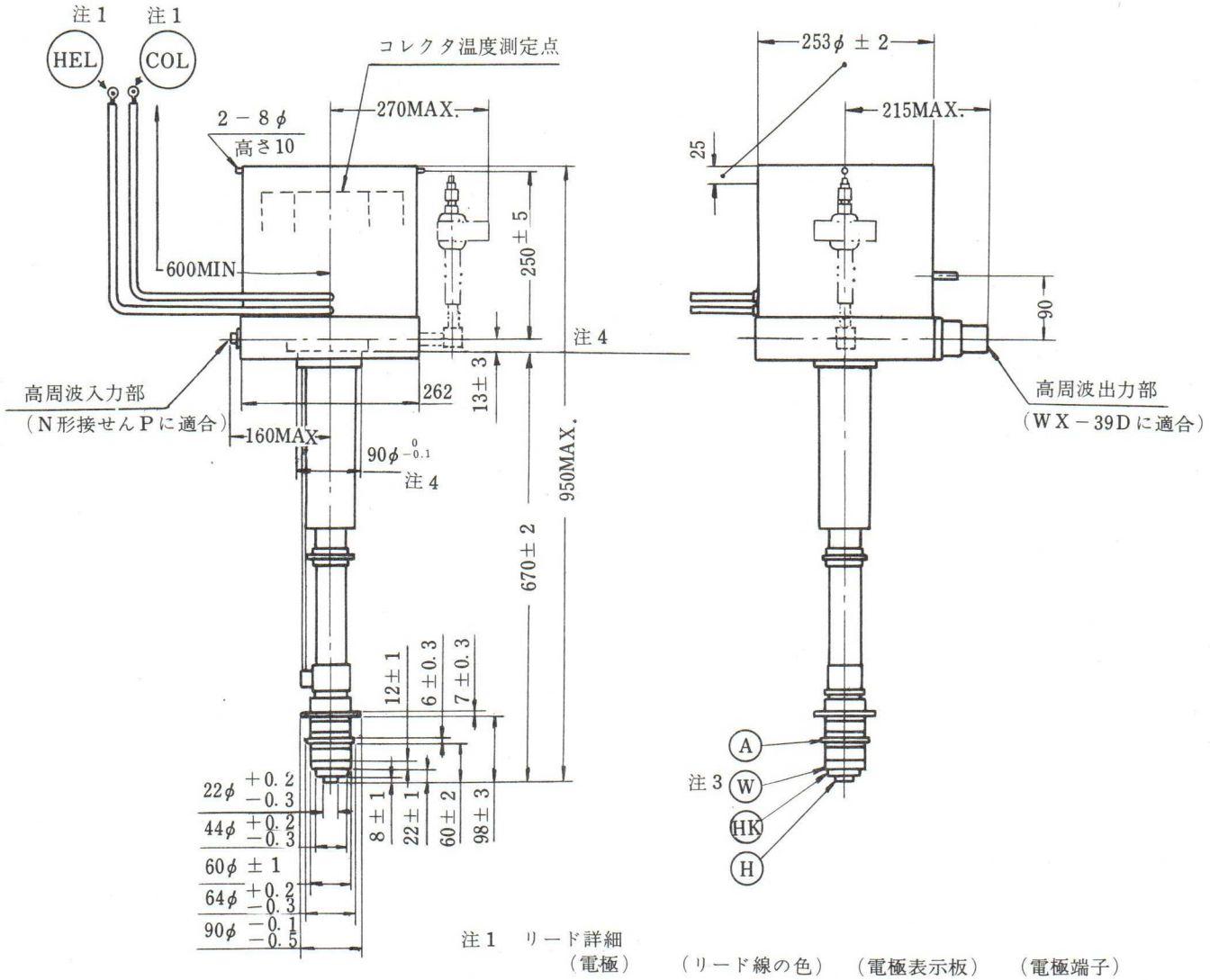


注3. 二点鎖線で示した2種類の外形のものがあります。

外　形　図

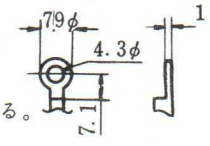
単位 mm





注1　リード詳細

（電極）	（リード線の色）	（電極表示板）	（電極端子）
ヘリックス	だいだい	HEL	
コレクタ	赤	COL	



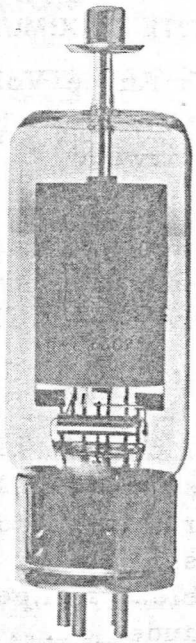
注2　2点鎖線で示したように2種類の外形のものがある。

注3　(W)(HK)　はソケットで接続される。

注4　電磁石との嵌合部分

TOSHIBA HYDROGEN THYRATRON
2G22P/5C22

Toshiba 2G22P is a hydrogen thyratorn for switching service in radar modulators and in other pulse applications.
It is capable of switching a peak power of 2.5 MW at an average power level of 1600 watts.
2G22P is interchangeable with the 5C22.



GENERAL DATA

ELECTRICAL:

Cathode: Oxide-Coated	Minimum	Bogie	Maximum	
Heater Voltage	5.9	6.3	6.7	V
Heater Current (Ef=6.3V)	9.6	10.6	11.6	A
Heating Time	300	-	-	sec
Anode Voltage Drop	-	100	175	V
Anode Delay Time	-	-	0.6	μs
Anode Current Time Jitter	-	0.002	0.005	μs

MECHANICAL:

Dimensions: ..... See Outline Drawing
Overall Length ..... 216 ± 6 mm
Max. Diameter ..... 65 mm
Base Number:
Cap ..... A14S, Medium (JEDEC No. C1-5)
Base.. D25PA-1, Large-Metal-Shell Super-Jumbo 4-pin with Bayonet (JEDEC No. A4-18)
Recommended Socket:
Cap ..... Toshiba VT-29057
Base ..... Toshiba VT-21026
Base Connections ..... See Outline Drawing
Cooling ..... Natural
Mounting Position ..... Any
Net Weight (Approx.) ..... 300 g

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★ The information contained herein may be changed without prior notice. It is therefore advisable to contact TOSHIBA before proceeding with the design of equipment incorporating this product.

No.ED-T100 1982-05-14

RATINGS

ABSOLUTE MAXIMUM:

Peak Anode Voltage:			
Inverse ([1])		16,000	V
Forward ([2])	5% epy ∿	16,000	V
Anode Current:			
Peak Current		325	A
Average Current		0.2	A
Averaging Time		1	cycle
Minimum DC Supply Voltage		4,500	V
Negative Grid Voltage (Before Conduction)		200	V
Rate of Rise of Cathode Current		1,500	A/μs
Pulse Rapetition Rate (prr)		1,000	pps
Operation Factor ([3])		3.2×10^9	
Pulse Duration		6	μs
Ambient Temperature		-50 ∿ +90	°C
Altitude		3,000	m

GRID DRIVE ([4]):

Peak Grid Voltage (Min.)	150	V
Time of Rise (Max.)	0.5	μs
Grid Pulse Duration (Min.)(70.7% Amplitude)	2	μs
Grid Drive Circuit Impedance (Max.)	500	Ω

TYPICAL OPERATION (Pulse Modulator):

DC Anode Supply Voltage	16,000	V
Pulse Repetition Rate (prr)	1,000	pps
Pulse Width	1	μs
Pulse Forming Network Impedance	50	Ω
Grid Drive Voltage	220	V
Peak Power Output	1,280	kW
Average Power Output	1,280	W
DC Anode Current	175	mA
Time Jitter	0.01	μs

Note ([1]) In pulsed operation, the peak inverse anode voltage exclusive of a spike of 0.05 microsecond maximum duration should not exceed 5000 volts during the first 25 microsecond after the pulse.

([2]) Where the anode supply voltage is applied instantaneously, the maximum value of the anode voltage shall not reach 13,500 volts in less than 0.04 microsecond.

([3]) prr(puse repetition rate. pps)$\times_{epy}$ (peak forward anode voltage. V)$\times_{ib}$ (peak anode current. A)

([4]) Measurements are at the tube socket with the thyratron grid disconnected.

GENERAL OPERATIONAL RECOMMENDATION

1. High Voltage

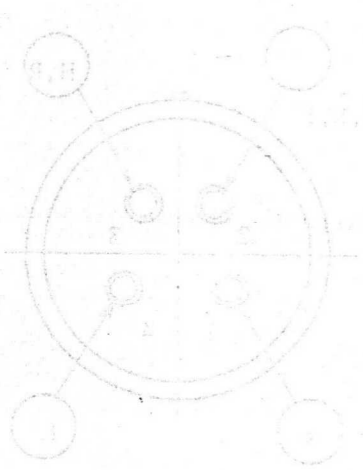
Operating voltages for power tubes range from several hundred volts to higher than 50,000 volts. Since these voltage can be deadly, equipment must be designed so that one can not come in contact with high voltage.

2. X-RAY Radiation

High-vacuum tubes operating at voltage higher than 10 kilovolts produce progressively more dangerous X-ray radiation as the voltage is increased. X-ray shielding must be provided on all sides of tubes which operate above 10 kilovolts, to provide adequate protection through the tube's life. If there is any doubt as to the adequacy of shielding, an expert in this field should be contacted to perform an X-ray survey of the equipment.

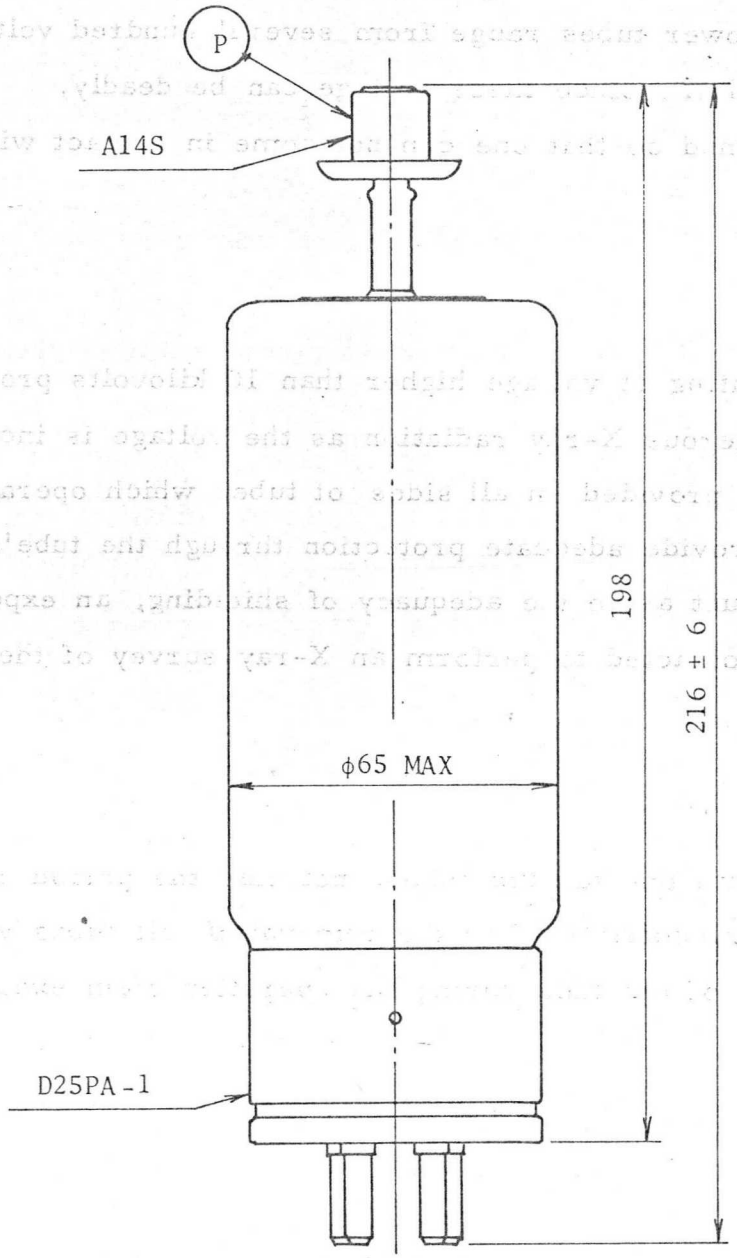
3. High Temperature

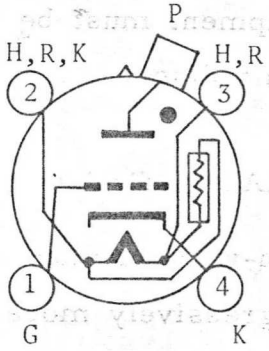
Don't come in contact with the vacuum tubes, not only the period of the operation but also immediately after the removal of all tubes voltages becuase the temperature of the tube during the operation often exceeds 200°C.



DIMENSIONAL OUTLINE
2G22P/5C22

Unit : mm





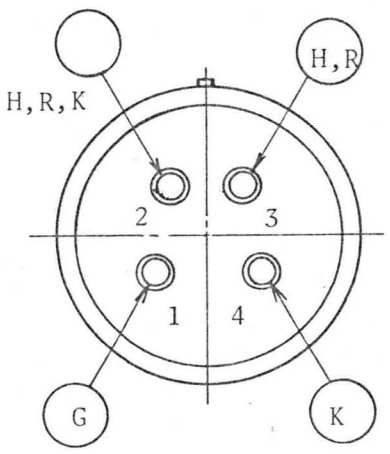
P: Anode

G: Grid

K: Cathode

H: Heater

R: Reservoir



Toshiba TECHNICAL DATA

Toshiba Magnetron
2M21

2M21

The Toshiba 2M21 is a fixed frequency continuous wave magnetron, designed to operate on the commercial alternating wave anode supply, in the 2425 to 2475 megacycle frequency range with an average power output of 950 watts.
The tube is required liquid cooling and an external magnetic field.
The output fitting is designed for coupling to the rectangular waveguide or the heating cavity directly.
The tube is intended for use in microwave heating and cooking application.

GENERAL DATA

Electrical :

Frequency	2450 ± 25 Mc
Heater voltage	9.3 V
Heater current	33 A
Cathode preheating time	240 sec
Cold heater resistance	0.028 Ω

Mechanical :

Physical dimensions	See outline drawing
Base and electrical connection	See outline drawing
Mounting position	Cathode vertical
RF coupling	See attached drawing
Magnetic field	External
Cooling	Liquid
Net weight	1.7 kg approx.
Type of cathode	Oxide unipotential

SE62A

Toshiba TECHNICAL DATA

Toshiba Magnetron

2M21

MAXIMUM RATINGS

	Minimum	Maximum
Heater voltage (preheat)	8.6 V	10.0 V
Cathode preheating time	180 sec	-
Heater voltage (operate)	See attached drawing	
Peak anode voltage	-	6.5 kV
Peak anode current	-	1.6 A
Average anode current	-	295 mAdc
Average anode power input	-	1900 W
Load VSWR	-	4
Anode temperature (see outline drawing measurement point)	-	100 °C
Cathode bushing temperature (see outline drawing measurement point)	-	300 °C

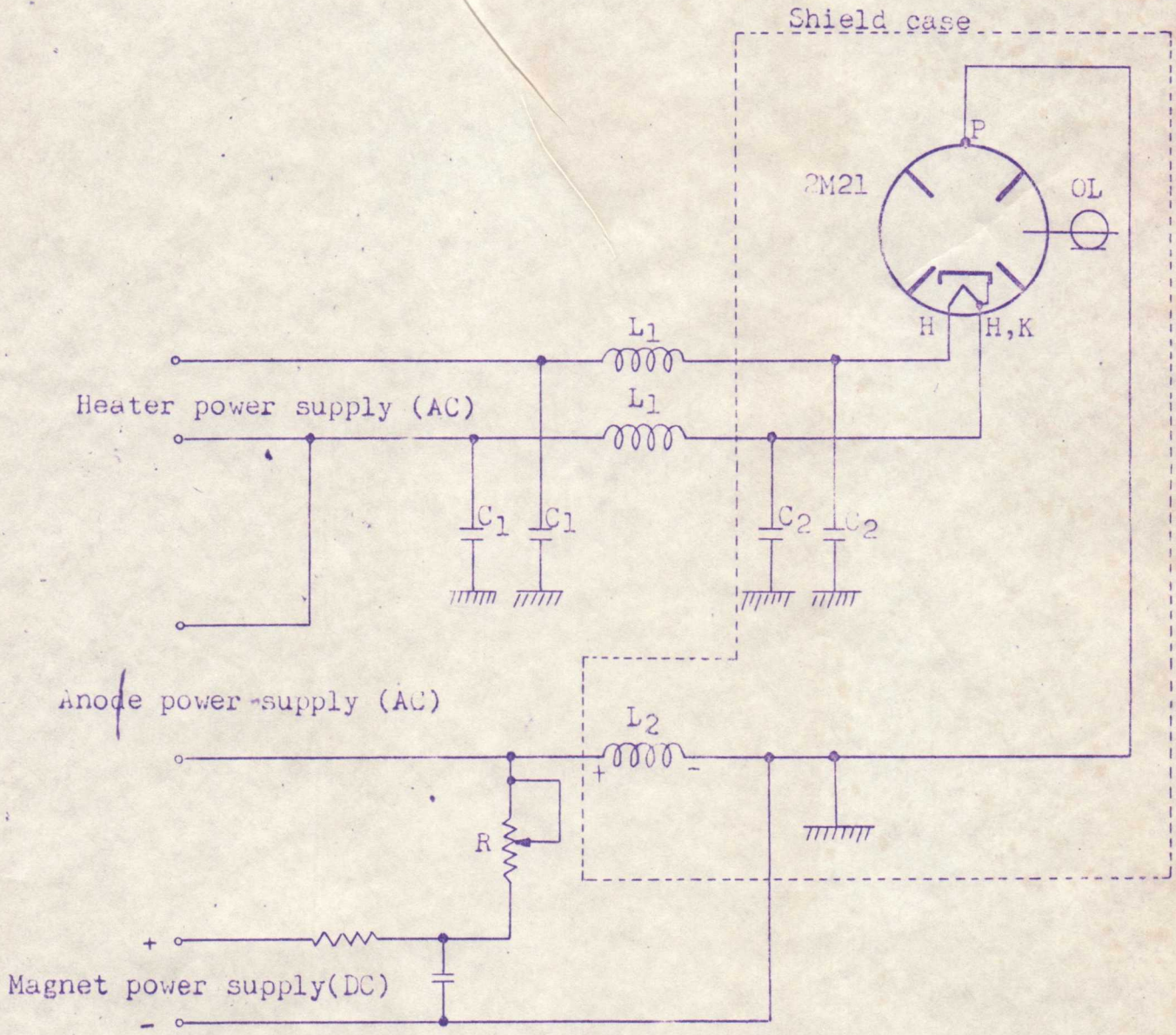
TYPICAL OPERATION

	Commercial AC
Frequency	2450 Mc
Heater voltage (operate)	8.0 V
Peak anode voltage	6.3 kV
Average anode current	275 mAdc
Average power output	950 W
Pulling factor (load VSWR 2)	12 Mc
Magnetic field strength (magnet No. 4514-800)	1450 G
Cooling quantity (water)	1 ℓ/min

Toshiba TECHNICAL DATA

Toshiba Magnetron
2M21

2M21
Operating Circuit



L_1 : 1.64 μH #Z-515

L_2 : Electro magnet #4514-800

C_1 : 500 PF #Z-516A

C_2 : 95 PF

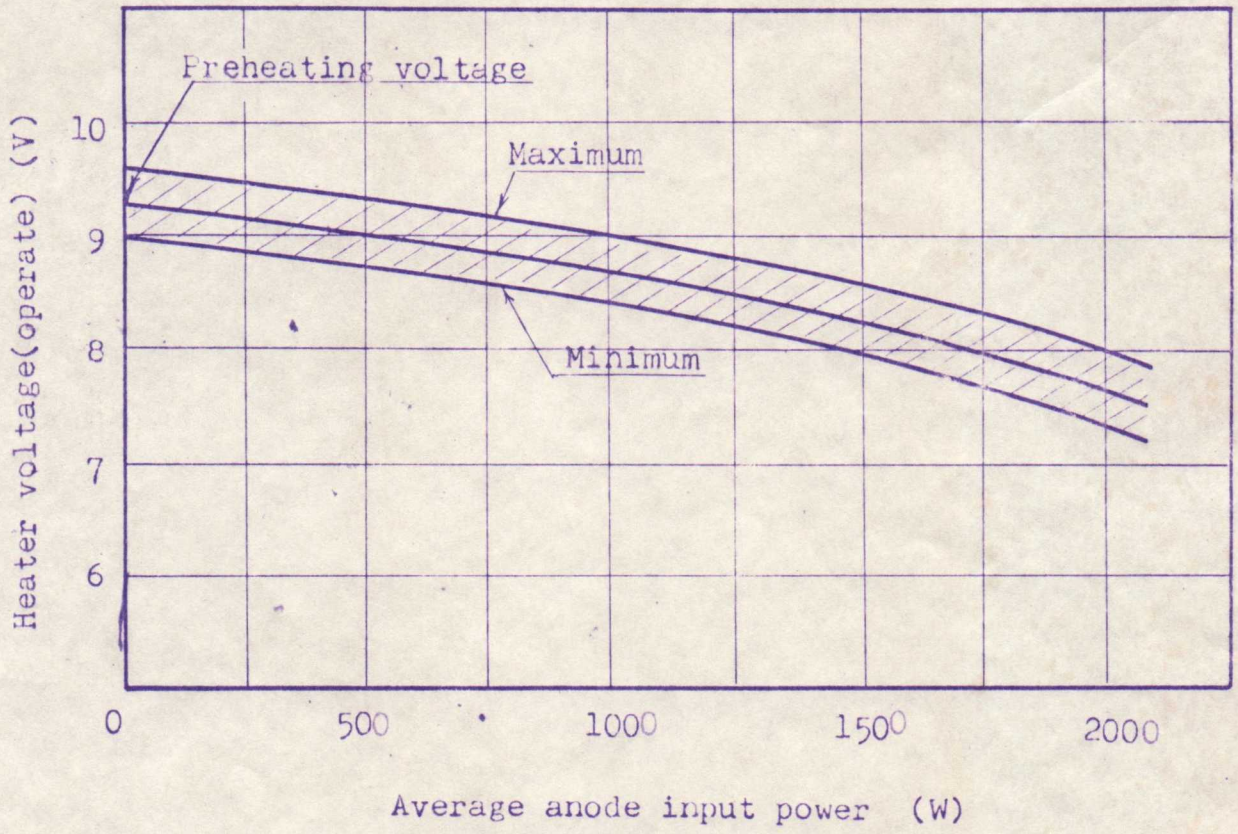
Toshiba TECHNICAL DATA

Toshiba Magnetron

2M21

2M21

Heater voltage vs input power schedule

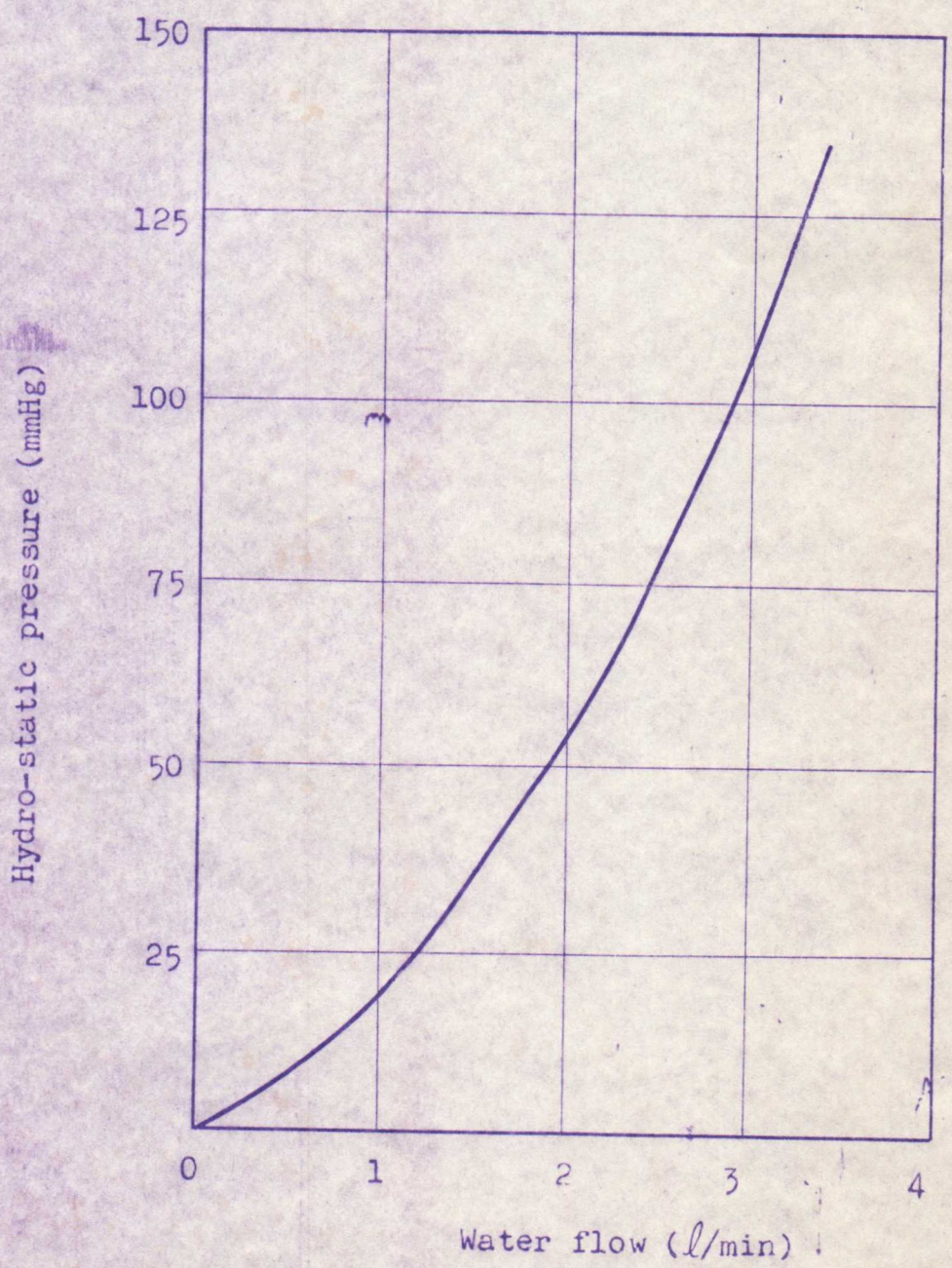


Toshiba TECHNICAL DATA

Toshiba Magnetron
2M21

2M21

Water flow vs Pressure

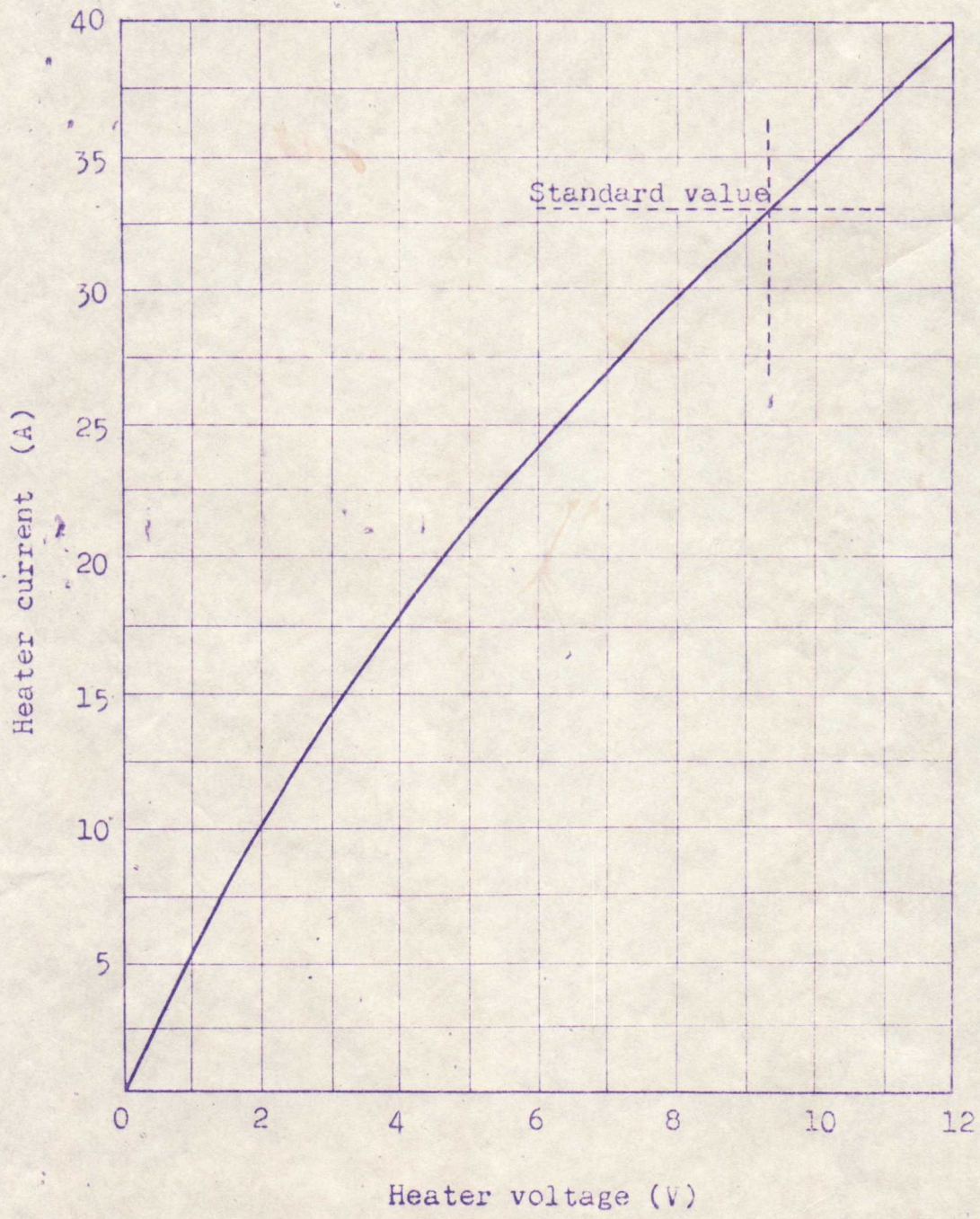


Toshiba TECHNICAL DATA

Toshiba Magnetron
2M21

2M21

Heater Characteristics



Toshiba TECHNICAL DATA

Toshiba Magnetron

2M21

2M21
Operating Characteristics
(Performance chart)

Operating conditions

Heater voltage : 8.0 V

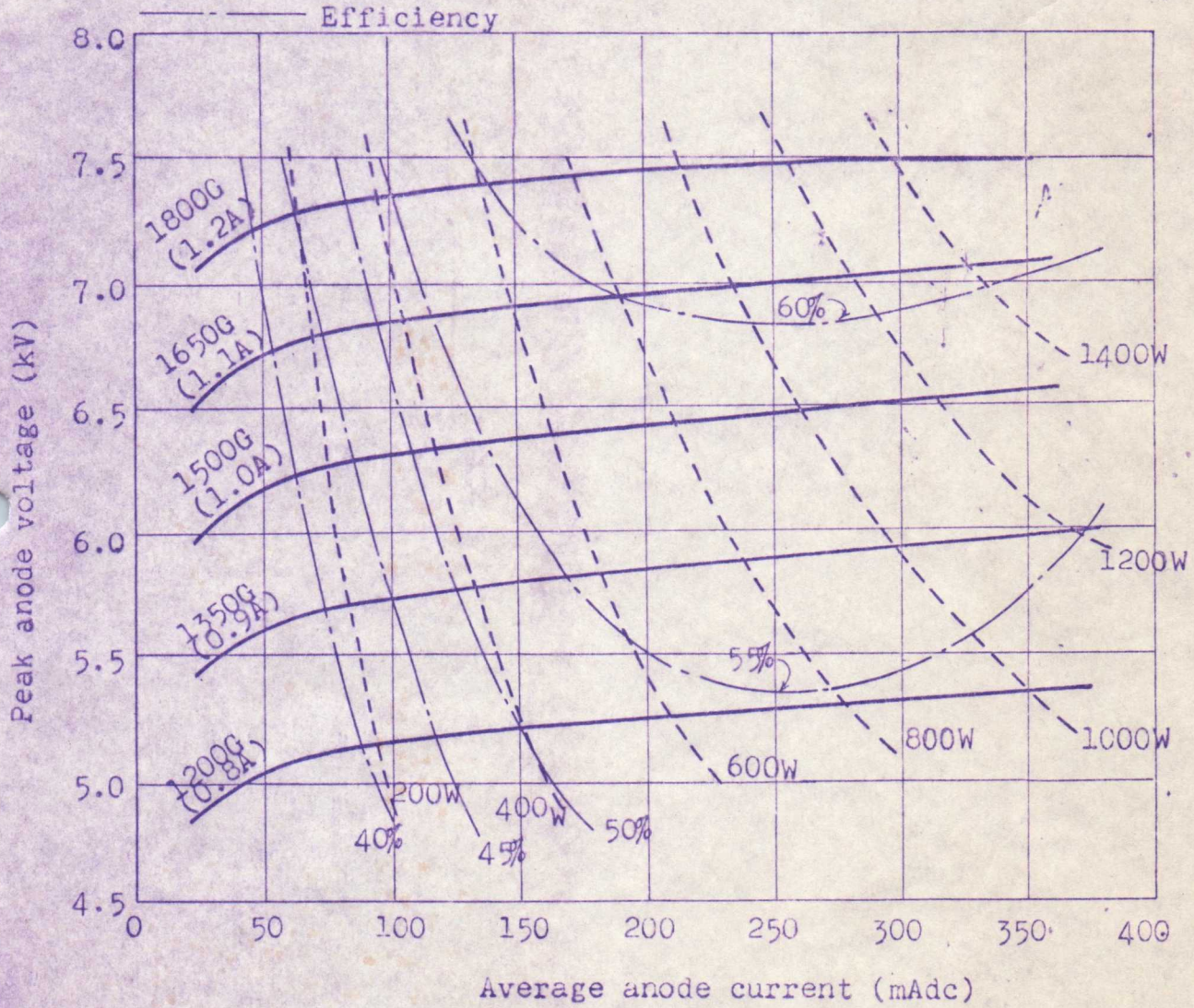
Anode supply : commercial AC

Load VSWR : less than 1.1

------- Average power output

——— Magnetic flux density: In parenthesis, there is shown value of current through electro-magnet #4514-800.

——·——·—— Efficiency



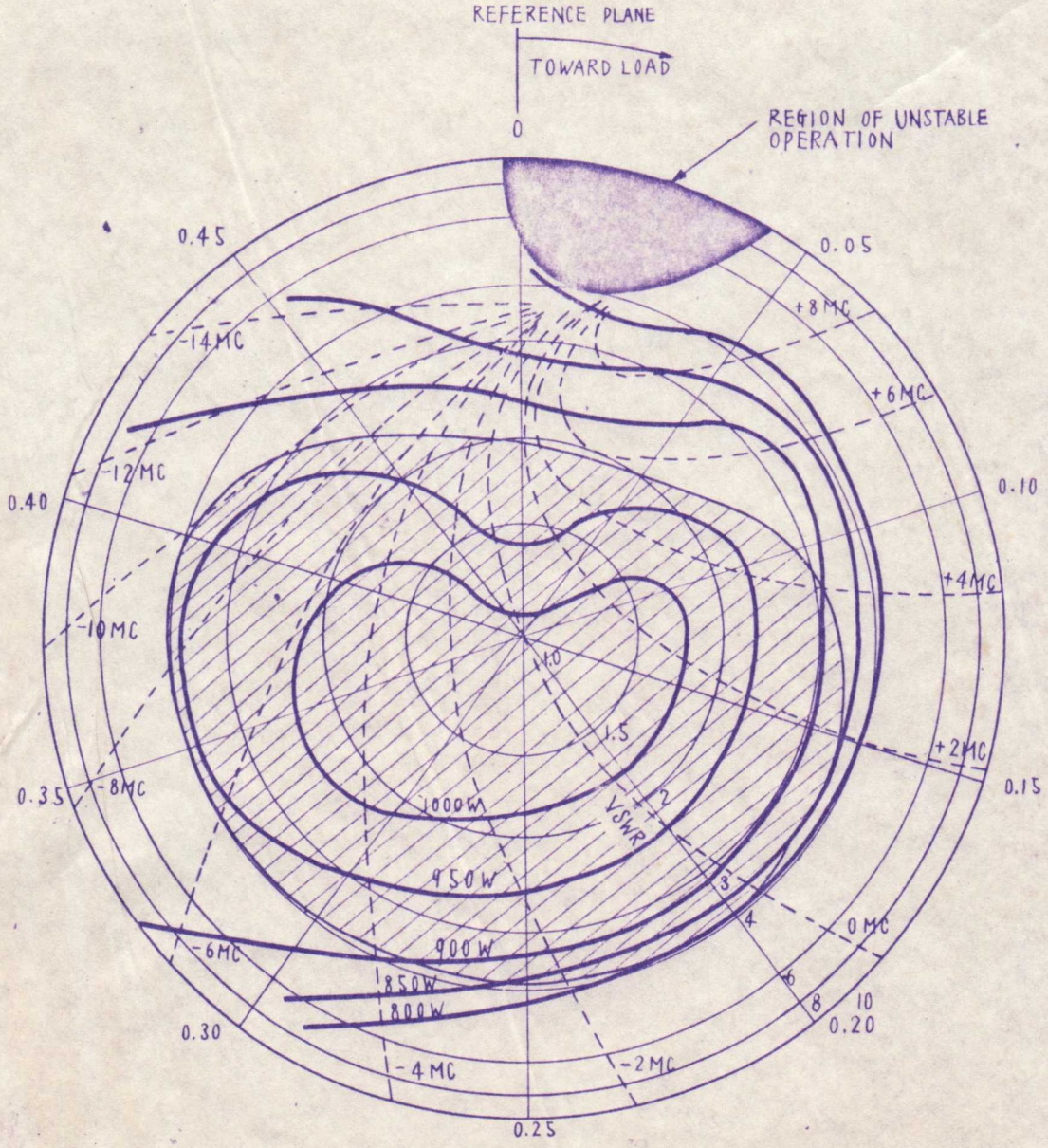
Toshiba TECHNICAL DATA

Toshiba Magnetron
2M21

2M21 Rieke Diagram

Operating conditions

Anode supply : Commercial AC
Heater voltage : 8.0 V
Average anode current : 275 mAdc
At matched load
Peak anode voltage : 6.3 kV
Frequency : 2450 Mc
Phase reference plane : axis of output antena



AVERAGE POWER
FREQUENCY

Toshiba

TECHNICAL DATA

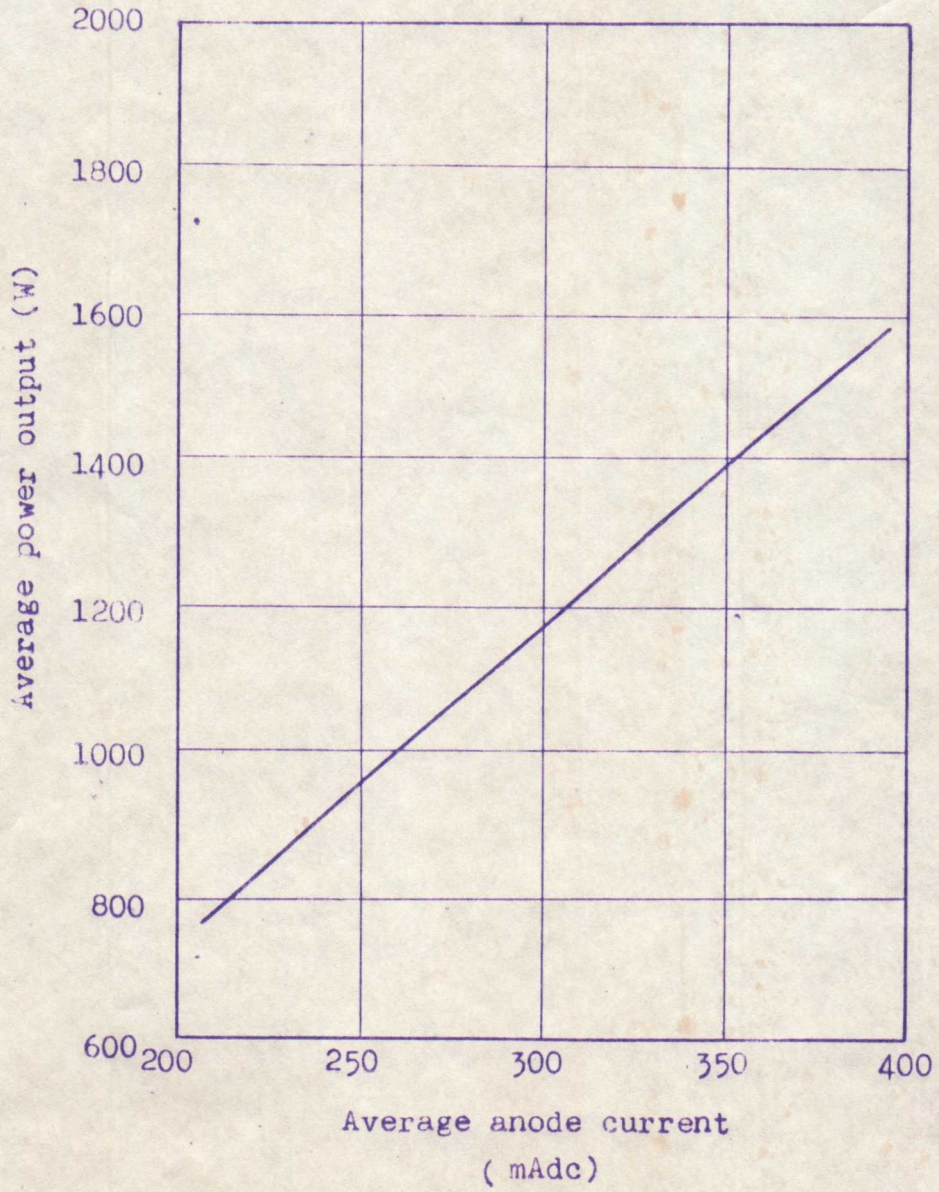
Toshiba Magnetron

2M21

2M21 Constant voltage characteristics

Operating conditions

Heater voltage : 8.0 V
Anode supply : Commercial AC
Peak anode voltage : 6.3 kV
Load VSWR : Less than 1.1



SE62A

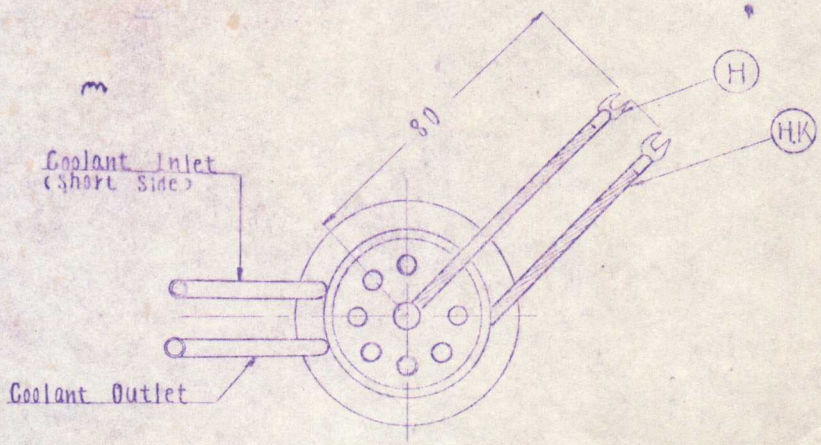
Toshiba TECHNICAL DATA

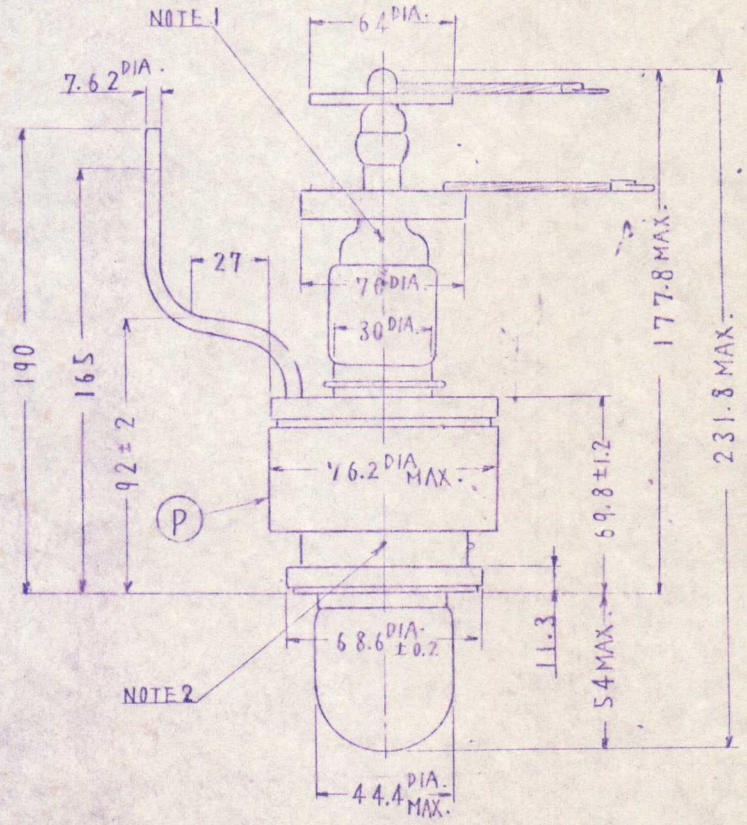
Toshiba Magnetron

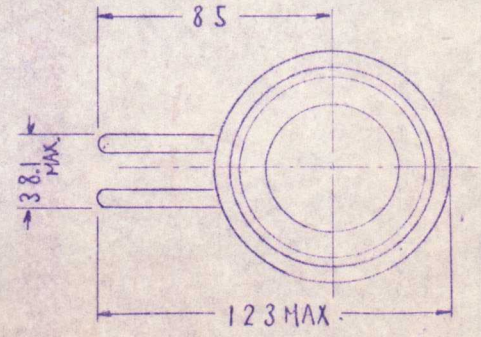
2M21

2M21 OUTLINE DRAWING.

Unit m m







NOTE 1. Cathode Bushing Temperature Measuring Point.

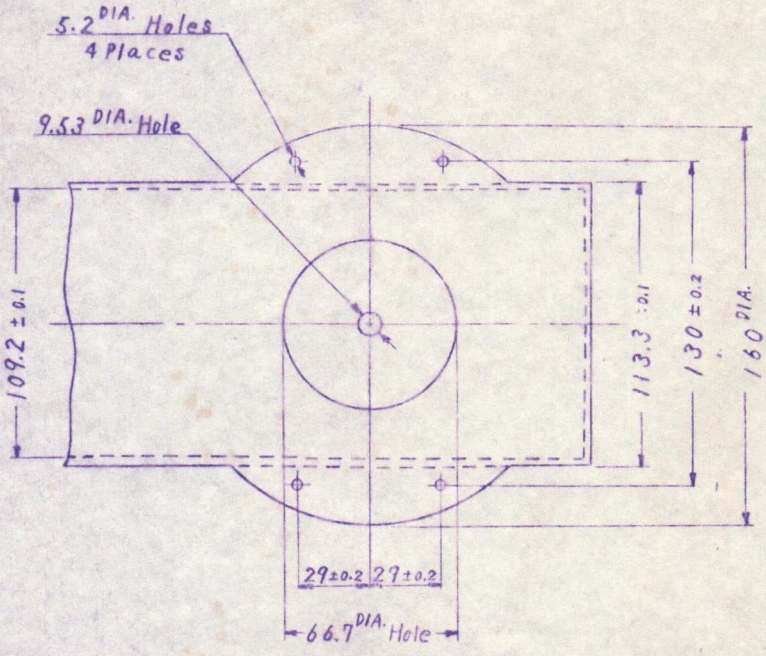
2. Anode Temperature Measuring Point.

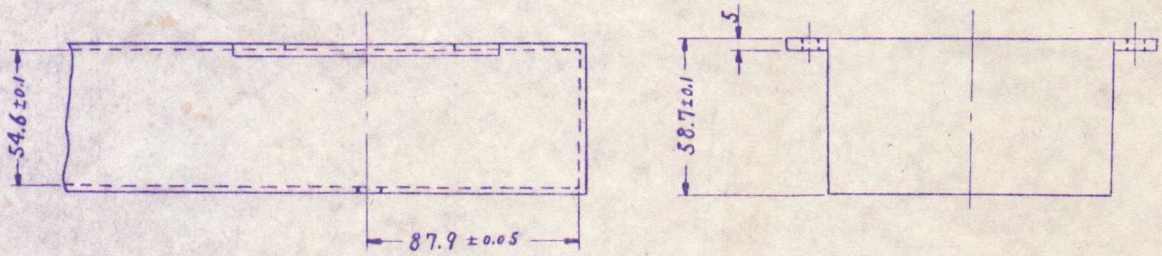
Toshiba TECHNICAL DATA

Toshiba Magnetron
2M21

2M21 RF. OUTPUT COUPLER

Unit mm





NOTE. The Waveguide System is WR 430

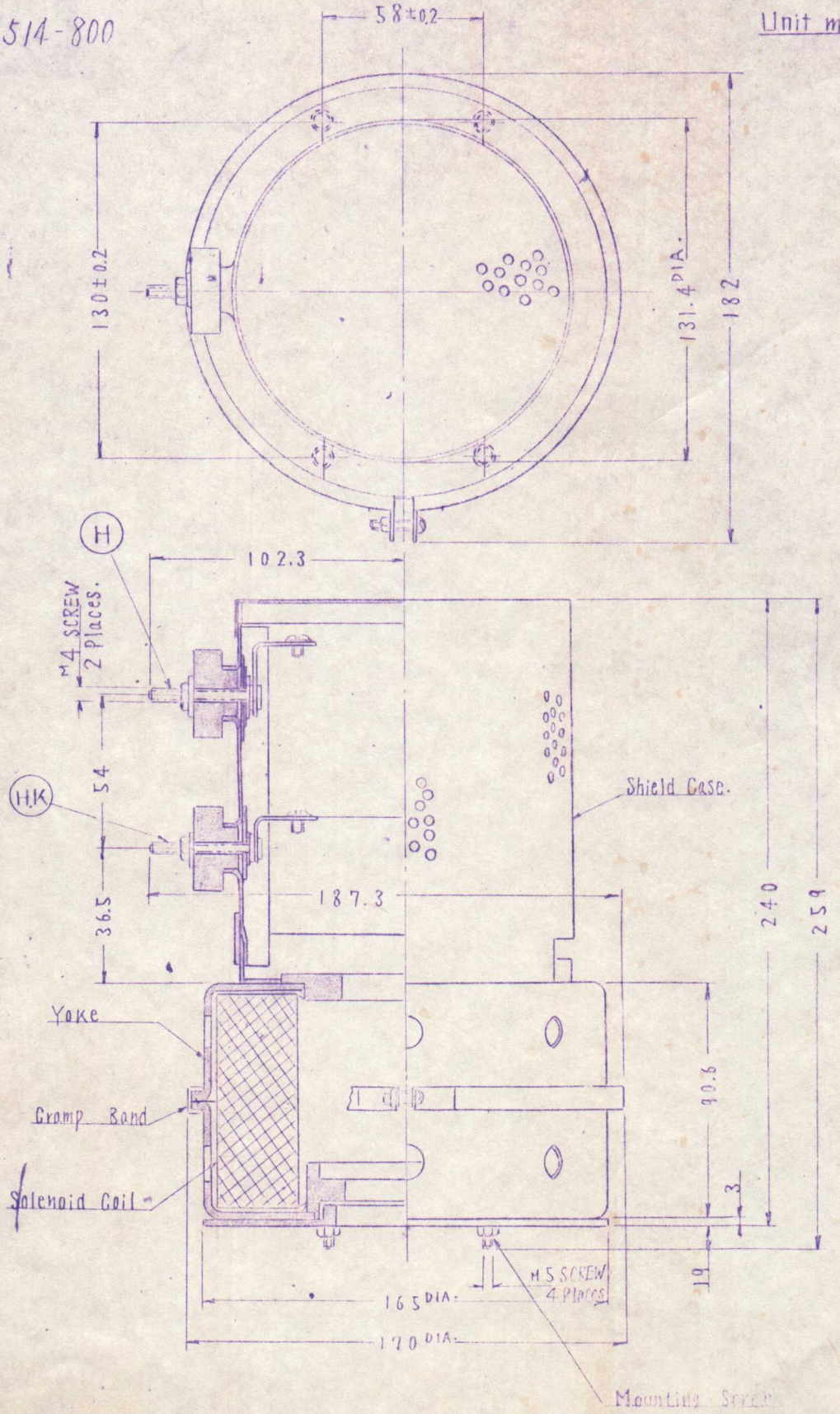
Toshiba TECHNICAL DATA

Toshiba Magnetron
2M21

2M21 RECOMMENDED ELECTRO MAGNET.

Type No. 4514-800

Unit mm



SE63+-00

Toshiba TECHNICAL DATA

Toshiba Magnetron

2M51

The Toshiba 2M51 is a fixed frequency continuous wave magnetron, designed to operate on an commercial alternating wave anode supply, in the 2425 to 2475MHz frequency range with an average power output of 200 watts.

The tube is integral magnet type and required forced air cooling, able to be heat conduction colling when the tube is used under low power operating condition.

The ontput fitting is designed for connecting with coaxial line.

The tube is intended for use in medical applications.

GENERAL DATA

Electrical:

Frequency	2450 ± 25 MHz
Filament voltage	4 V
Filament current	10 A
Cathode preheating time	10 sec

Mechanical:

Physical dimensions	See outline drawing
Base and electrical connection	See outline drawing
Mounting position	Any
RF coupling	See attached drawing
Magnetic field	Integral
Cooling	Heat conduction or forced air.
Net weight	2.4 kg approx.
Type of cathode	Thoriated tungsten direct heating

Toshiba TECHNICAL DATA

Toshiba Magnetron

2M51

MAXIMUM RATINGS

	Minimum	Maximum	
Filament voltage	3.7	4.3	V
Cathode preheating time	8	-	sec
Peak anode voltage	-	1900	V
Peak anode current	-	1400	mA
Average anode current	-	230	mAdc
Average anode power input	-	400	W
Load VSWR	-	2	
Anode temperature (See outline drawing measuring point)	-	125	°C
Cathode bushing temperature (See outline drawing measuring point)	-	250	°C

TYPICAL OPERATION

Frequency	2450	2450	MHz
Filament voltage (Operation)	4	4	V
Peak anode voltage	1800	1600	V
Peak anode current	1.2	0.5	A
Average anode current	200	100	mAdc
Average power output	200	80	W
Pulling factor (load VSWR)	10	10	MHz
Cooling system	Forced air, (800 ℓ/m)	Heat conduction	

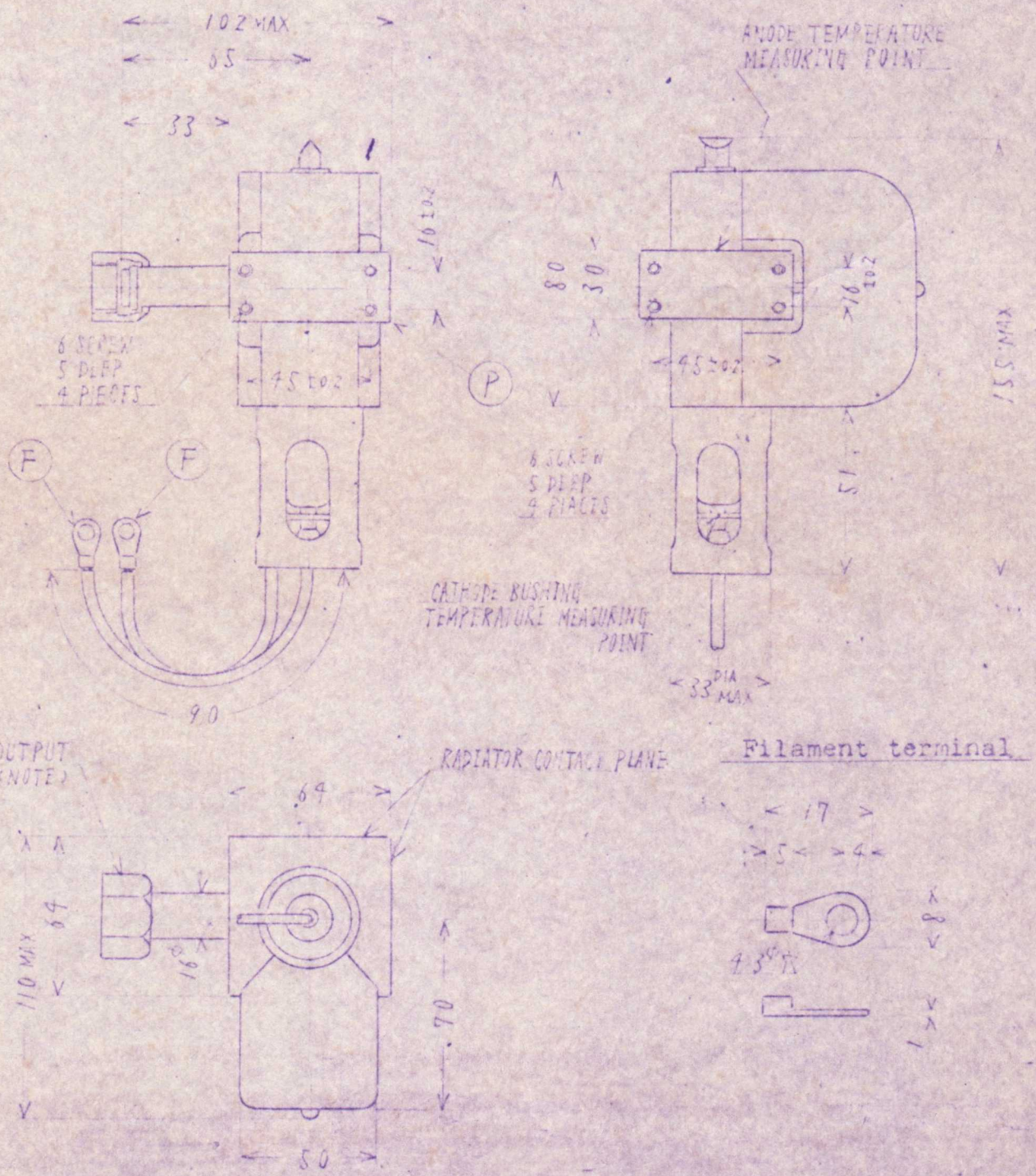
Toshiba TECHNICAL DATA

Toshiba Magnetron

2M51

OUTLINE DRAWING

Unit mm

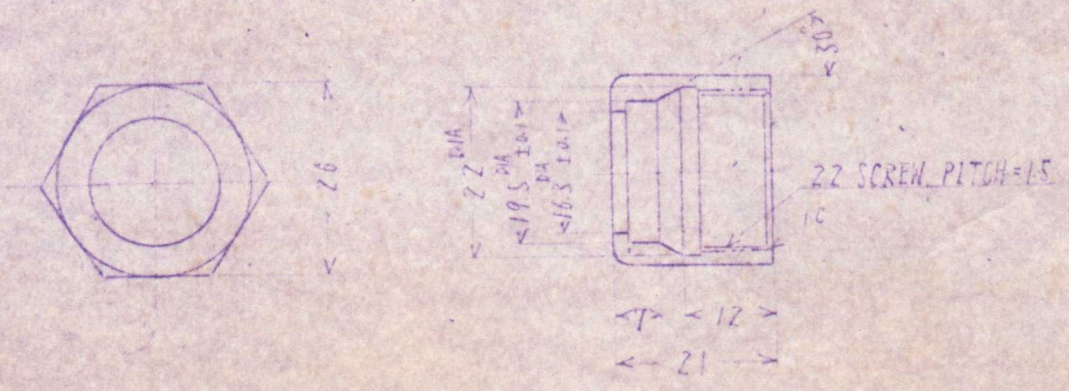


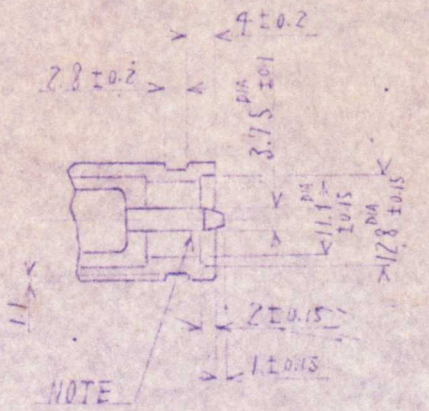
Note : See Enlarged View.

TOKYO SHIBAURA ELECTRIC CO., LTD.

ENLARGED VIEW OF OUTPUT

Unit mm





Note: Output Inner Conductor to be Concentric with Inside Dia of Outer Conductor within 0.813mm.

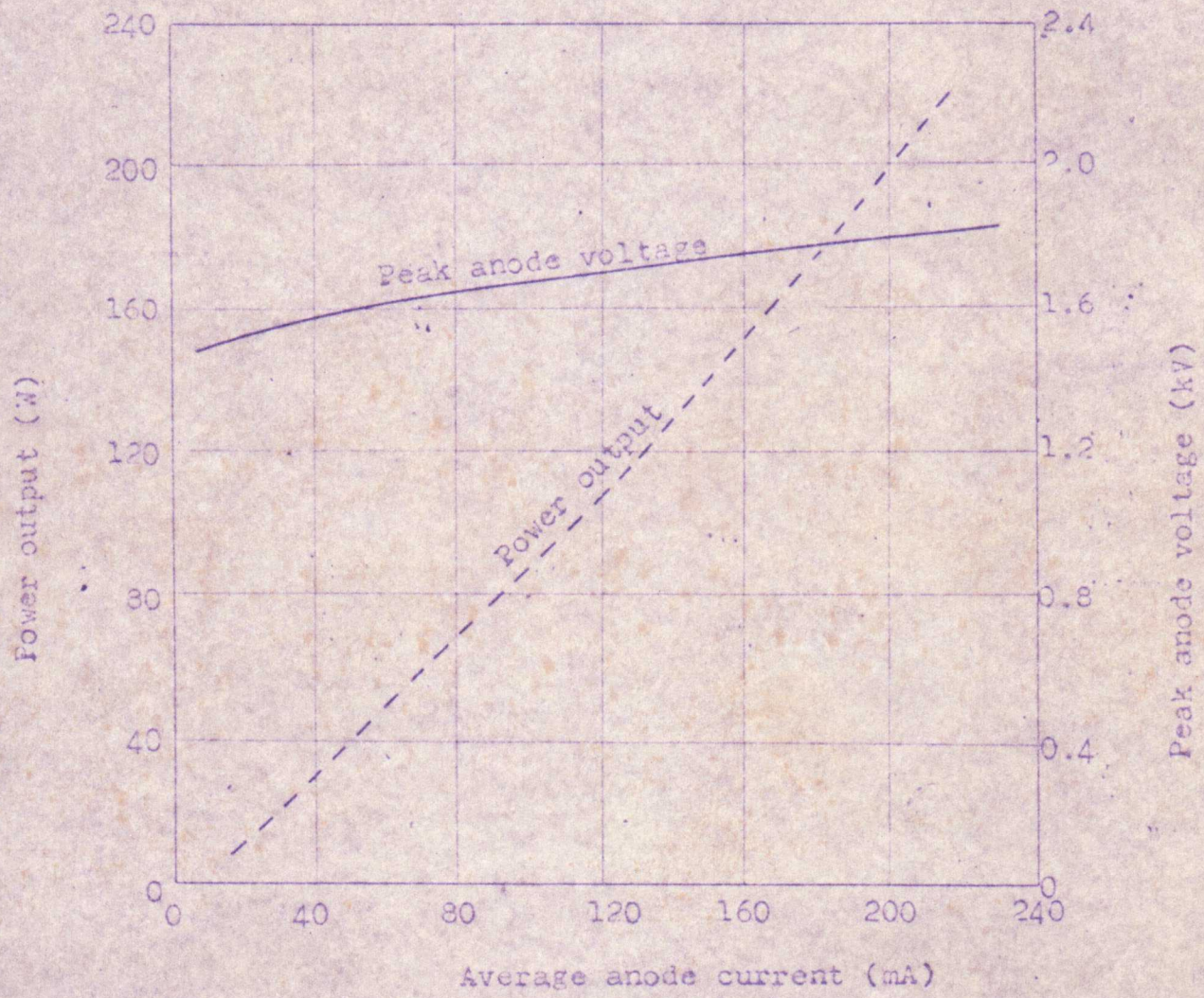
OPERETING CHARACTERICTICS

Operating Condition

Filament voltage: 4V

Commereial alternating wave

Load VSWR: 1.1Max.



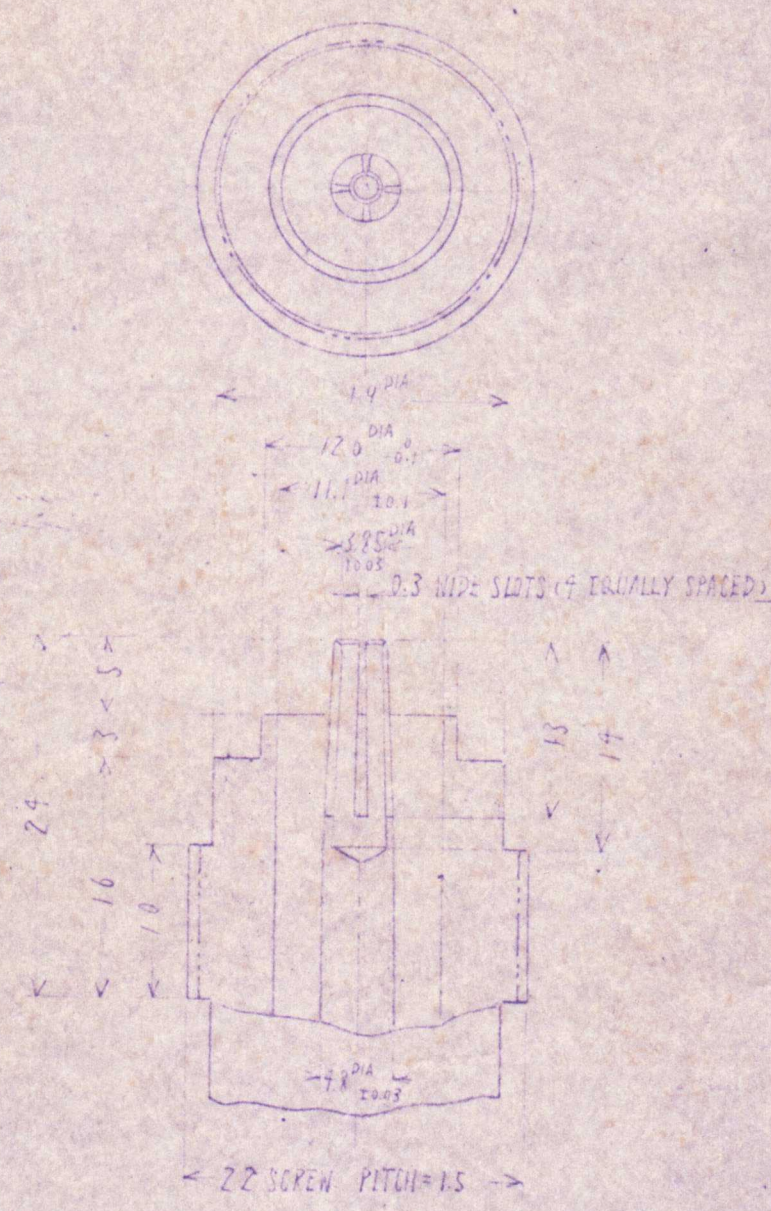
Toshiba TECHNICAL DATA

Toshiba Magnetron

2M51

R.F. COUPLER

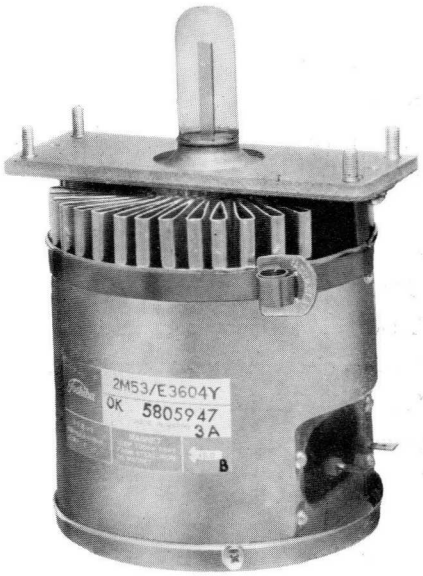
Unit mm



TOSHIBA MAGNETRON

2M53

The Toshiba 2M53 is a fixed frequency continuous wave magnetron intended for use in microwave heating and cooking appliances. The average power output is 800 watts in the frequency range from 2420 MHz to 2480 MHz. This tube is an integral magnet type and requires forced air cooling. The output is fed either into a rectangular wave guide or into a heating oven directly.
In order to minimize the unwanted radiation and to avoid the high voltage danger, the input part of the tube is covered with a metal shield case.



Features

Short Preheating Time

An improved thoriated tungsten direct heating filament requires only a few seconds of preheating.

No Filament Voltage Reduction Necessary

Power supply can be made simple, no relay is necessary to reduce filament voltage when operating.

Low Spurious Noise Radiation

As an integrated filter suppresses spurious noise radiation through filament leads, no external filter circuit is necessary for oven.

Stable under the most severe load conditions

Within acceptable VSWR up to 4 at any phase, high power output with good heating uniformity is ensured.

Long Life Expectancy

Selected materials with Toshiba's long experience in vacuum tube production ensures long life expectancy of more than 3000 hours.

12-1970

TOKYO SHIBAURA ELECTRIC CO., LTD.

TOSHIBA MAGNETRON

2M53

GENERAL DATA

Electrical :		
Frequency	2450 ± 30	MHz
Filament voltage	3.15	V
Filament current	13	A
Cathode preheating time	8	sec.
Cold heater resistance	0.03	Ω
Mechanical :		
Physical dimensions	See outline drawing	
Base and electrical connection	See outline drawing	
Mounting position	Any	
RF coupling	See attached drawing	
Magnetic field	Integral	
Cooling	Forced air	
Net weight	2.0 kg approx.	
Type of cathode	Thoriated tungsten direct heating	

MAXIMUM RATINGS

	Minimum	Maximnm	
Filament voltage (preheat)	3.0	3.3	V
Cathode preheating time	5	—	sec.
Peak anode voltage	—	4.5	kV
Average anode current	—	350	mAdc
Anode power input	—	1400	W
Load VSWR	—	4	
Anode remperature (See outline drawing measuring point)	—	150	°C

TYPICAL OPERATION

Unsmoothed fullwave rectified current

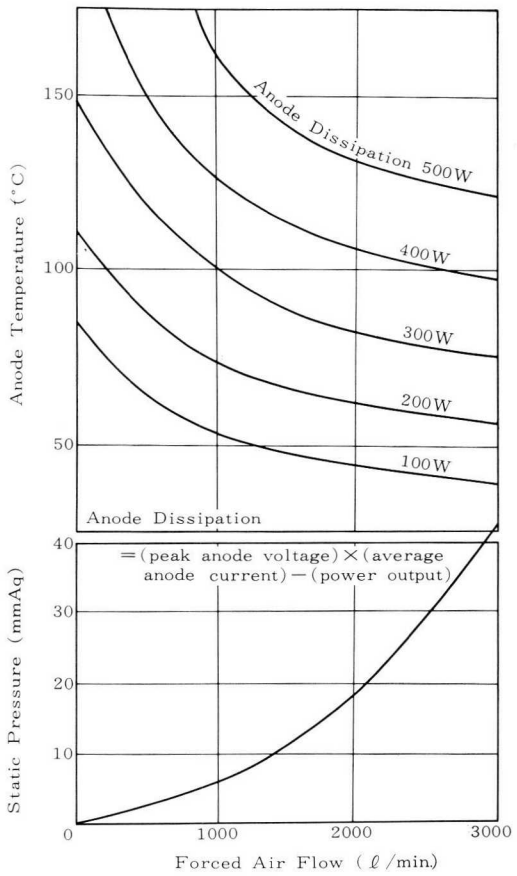
Frequency	2450	MHz
Filament voltage (operation)	3.15	V
Peak anode voltage (Note 1)	4	kV
Average anode current	300	mA
Power output (matched load) (Note 2)	800	W
Magnetic field intensity	PKG	
Cooling quantity anode (forced air)	1500	l/min.

Note 1 Anode power supply is single phase full wave rectified without filter.
Note 2 Power output for typical microwave oven is expected about 85 percent of the power output at matched load.

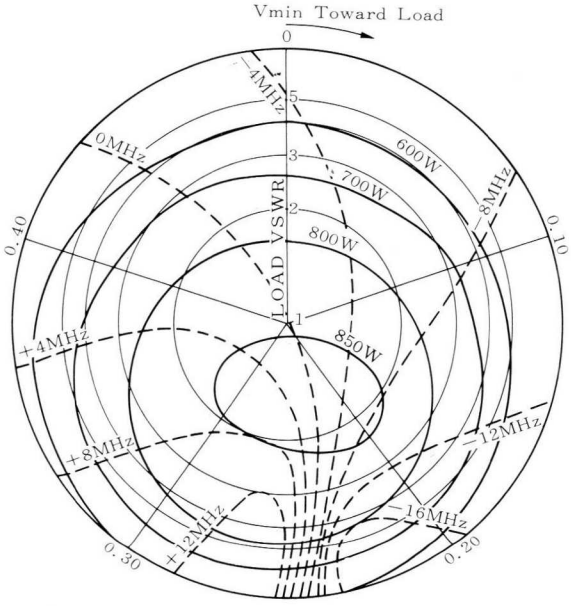
TOSHIBA MAGNETRON

2M53

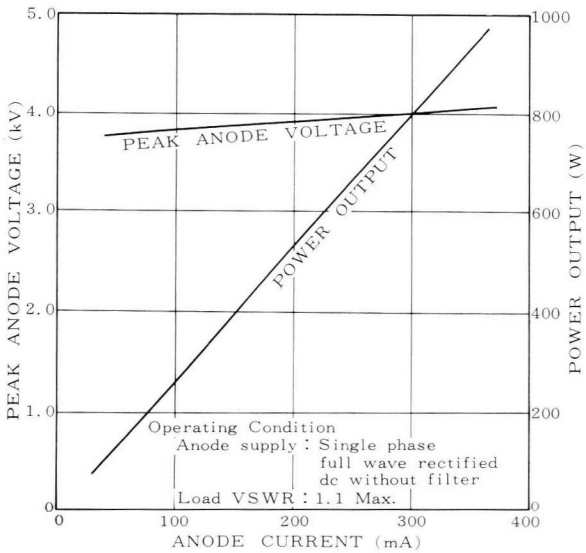
COOLING CHARACTERISTICS



RLEKE DIAGRAM



PERFORMANCE CHART



Operating Conditions
Anode Supply : Unsmoothed Fullwave Rectified
Average Anode Current : 300mAdc
Phase Reference Plane : Antenna

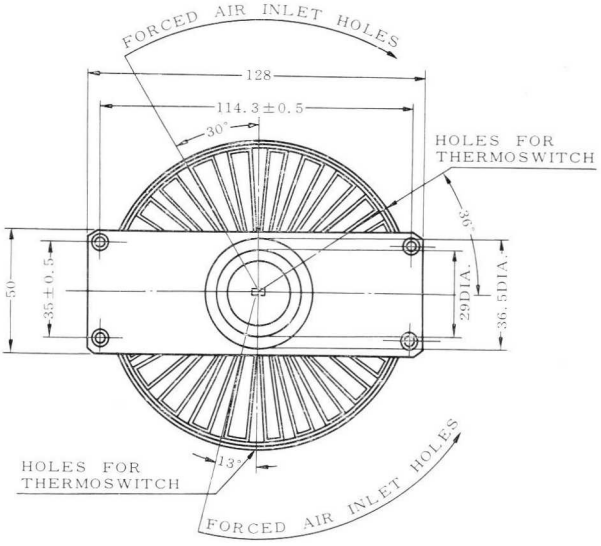
TOSHIBA MAGNETRON

2M53

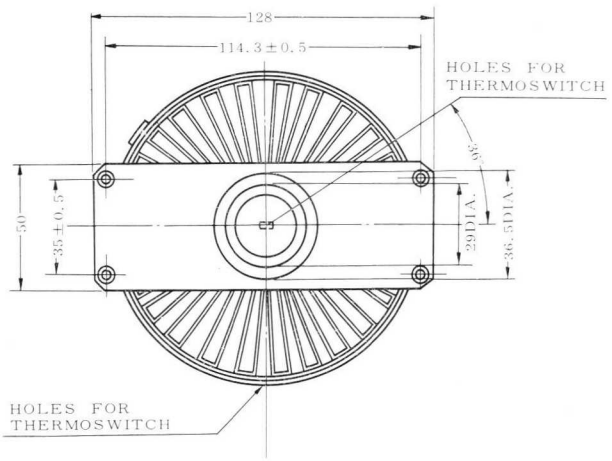
OUTLINE DIMENTIONS

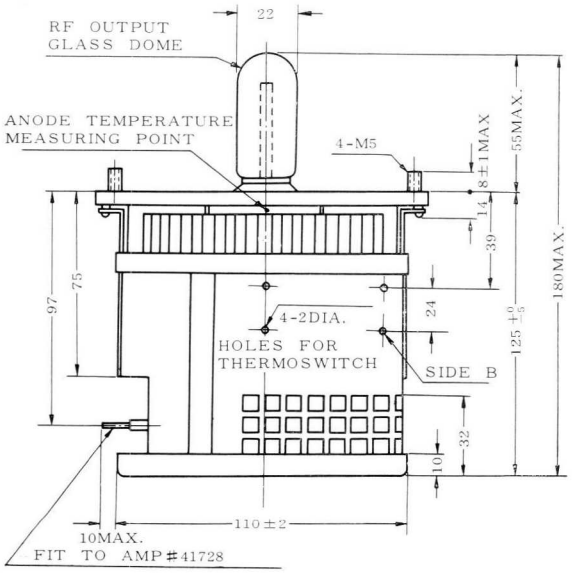
Unit mm

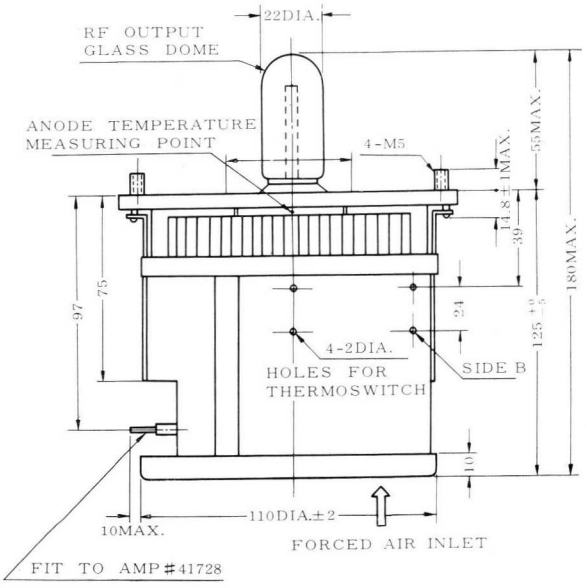
2M53/E3604Y



2M53/E3604







TOKYO SHIBAURA ELECTRIC CO., LTD.

Printed in Japan

Consumer Products Export Division 2-1, 5 chome, Ginza, Chuo-ku, Tokyo

Toshiba TECHNICAL DATA

Toshiba Magnetron

2M66(C)

The Toshiba 2M66 is a ceramic sealed fixed frequency continuous wave magnetron, designed to operate on an unsmoothed D.C. anode supply, in the 2420 to 2480MHz frequency range with an average power output of 800 watts.
The tube is required forced air cooling and an external magnetic field.
The output fitting is designed for coupling to the rectangular waveguide or cavity directly.
The tube is intended for use in microwave heating and cooking application.

GENERAL DATA

Electrical:		
Frequency	2450 ± 30	MHz
Filament voltage	3	V
Filament current	13	A
Cathode preheating time	8	sec
Cold heater resistance	0.03	Ω
Mechanical:		
Physical dimensions	See outline drawing	
Base and electrical connection	See outline drawing	
Mounting position	Any	
RF coupling	See attached drawing	
Magnetic field	External	
Cooling	Forced air	
Net weight	1.3 kg approx.	
Type of cathode	Thoriated tungsten direct heating	

Toshiba TECHNICAL DATA

Toshiba Magnetron

2M66 (C)

MAXIMUM RATINGS

	Minimum	Maximum	
Filament voltage (preheat)	2.85	3.15	V
Cathode preheating time	5	-	sec
Peak anode voltage	-	4.5	kV
Average anode current	-	350	mAdc
Anode power input	-	1400	W
Load VSWR	-	4	
Anode temperature (See outline drawing measuring point)	-	120	°C
Filament lead temperature (See outline drawing measuring point)	-	250	°C

TYPICAL OPERATION

	Unsmoothed fullwave rectified	
Frequency	2450	MHz
Filament voltage (Operation)	3	V
Peak anode voltage	4	kV
Average anode current	300	mAdc
Power output (Standard oven)	600	W
Power output (Matched lead)	800	W
Magnetic field intensity	1500	Gauss
Cooling quantity anode (Forced air)	700	l/min.

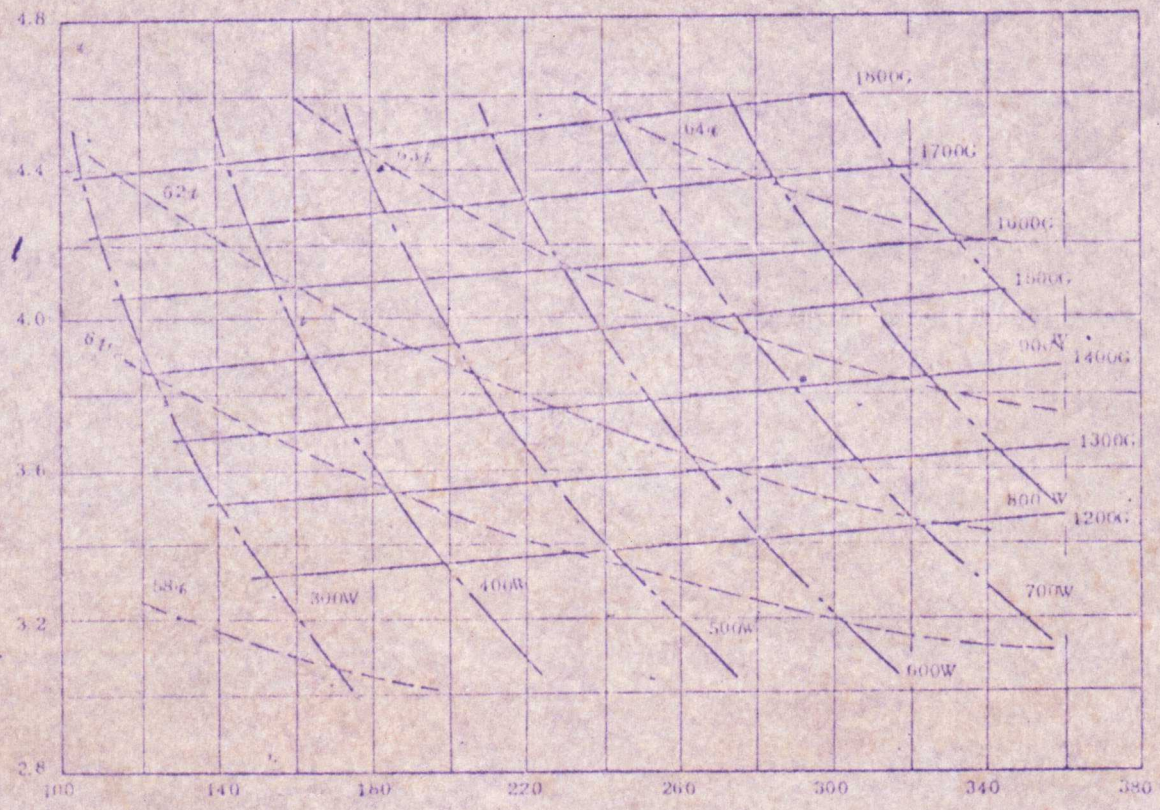
Toshiba

TECHNICAL DATA

Toshiba
Magnetron Tube
2M66(T)

Performance Chart

Operating Conditions
Filament Voltage : 3V
Anode Supply : Unsmoothed DC

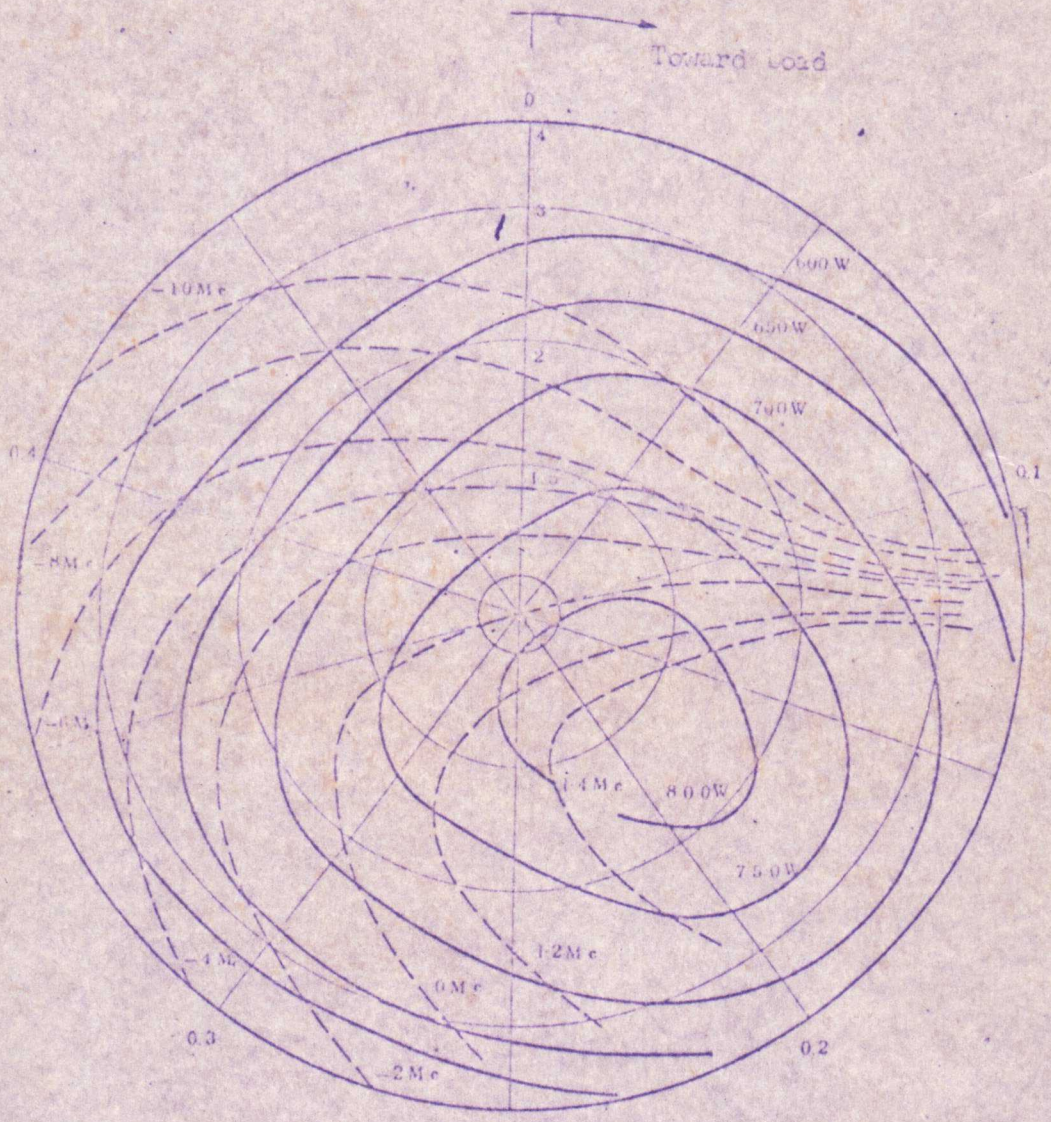


——— Magnetic Flux Density
——·——·—— Output Power
– – – – – – Efficiency

Polar Diagram

Operating Conditions
Filament Voltage : 3 V
Anode Supply : Unsmoothed DC
Average Anode Current : 300 mAdc
Peak Anode Voltage : 4 kV (Matched Load)
Frequency : 2450 MHz
Phase Reference Plane : Axis of Output Antenna

Reference Plane



——— Output Power

– – – – – Efficiency

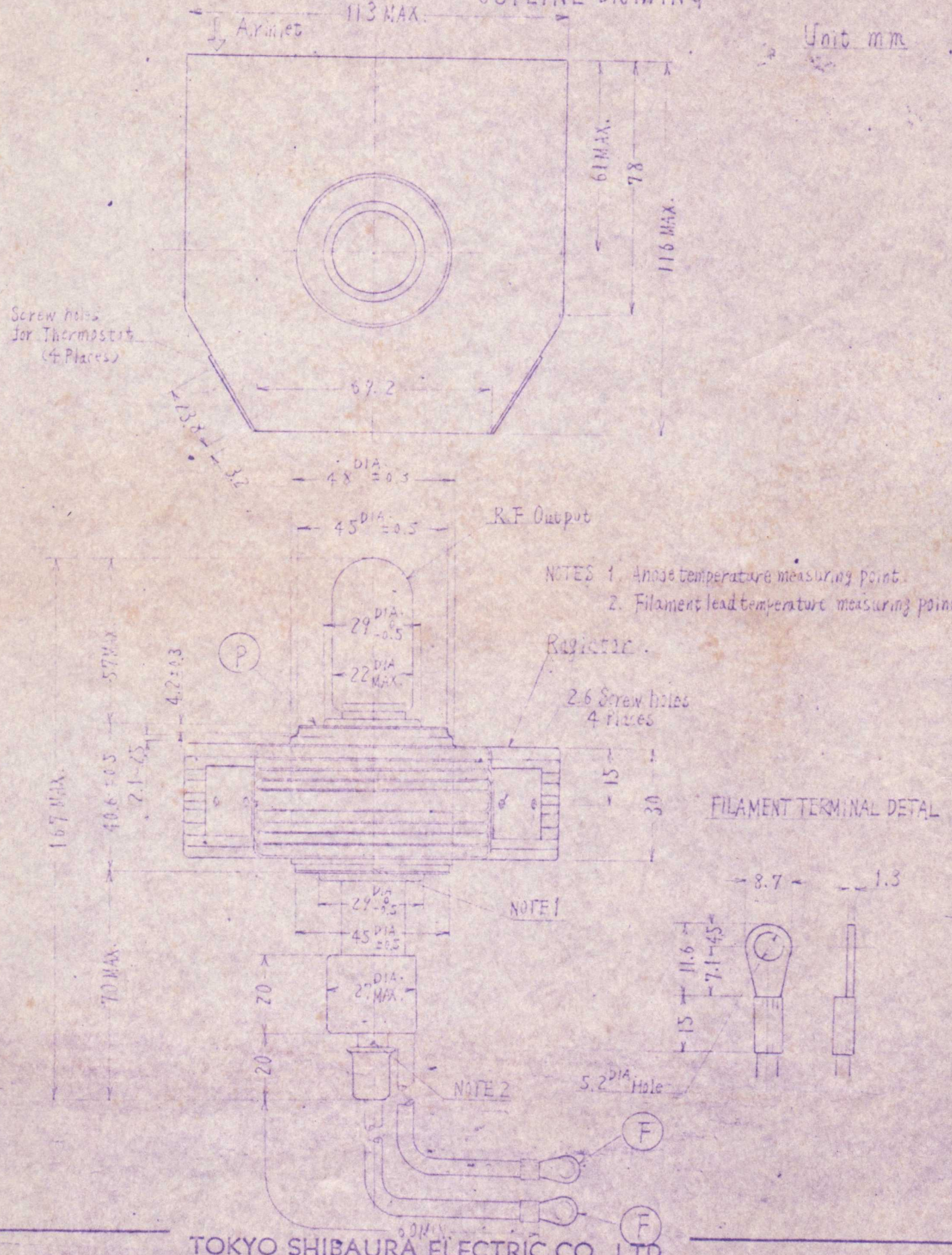
Toshiba TECHNICAL DATA

Toshiba Magnetron

2M66 (C)

OUTLINE DRAWING

Unit mm



TOKYO SHIBAURA ELECTRIC CO., LTD.

Toshiba TECHNICAL DATA

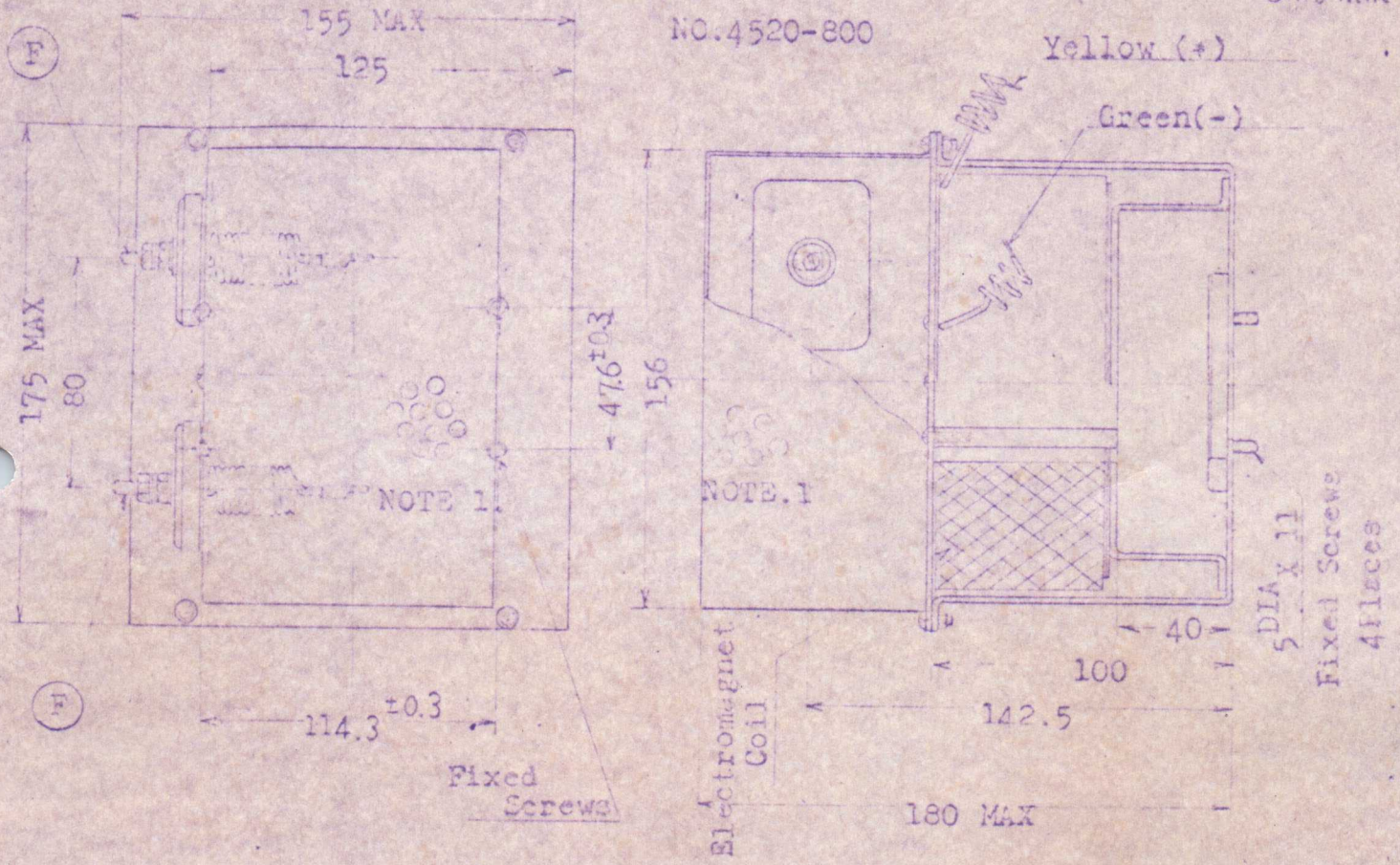
Toshiba Magnetron

2M66 (C)

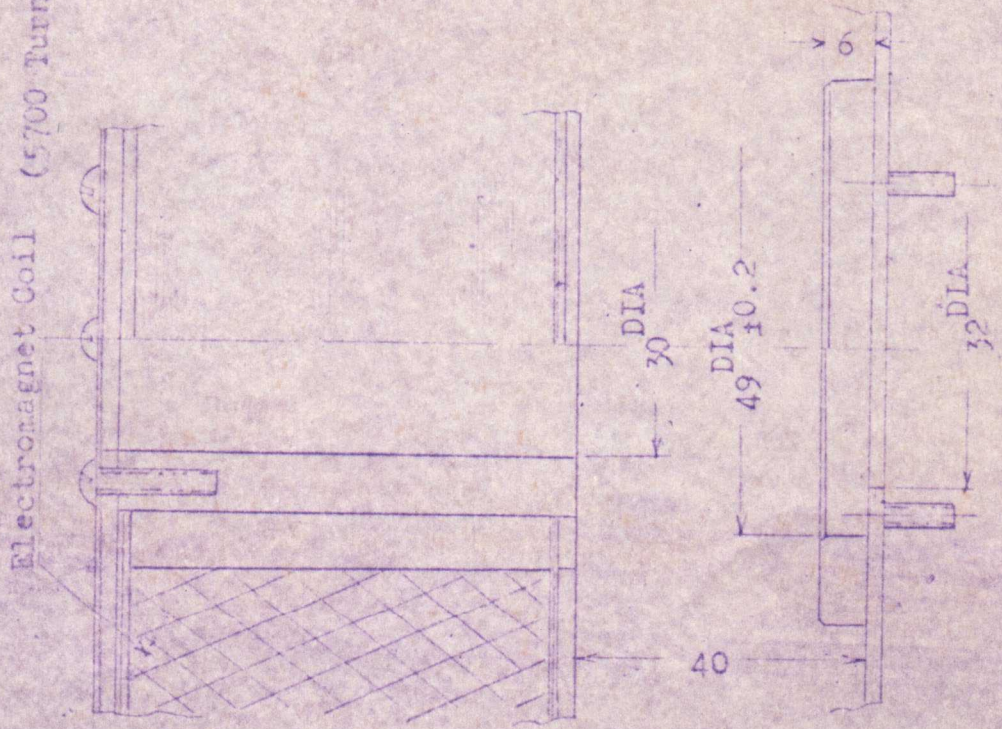
ELECTROMAGNET FOR 2M66

Unit mm

NO.4520-800



NOTE.1 Air Holes for Cooling



TOSHIBA MAGNETRON

2M69

The Toshiba 2M69 is a compact sized low voltage CW magnetron especially intended for use in microwave heating and cooking applications. It provides 1.5 kW of power at the frequency of 2450 MHz. The tube has permanent magnet and is cooled with forced air. Its cathode is a directly heated filament which enables short warm up time. The input side of the tube is covered with a metal shield in order to minimize unwanted radiation and to avoid high voltage hazard. The output is of the probe type in a glass dome and capable of directly driving a rectanglar waveguide or a heating oven.



Features

Short Preheating Time

An improved thoriated tungsten direct heating filament requires only a few seconds of preheating.

No Filament Voltage Reduction Necessary

Power supply can be made simple, no relay is necessary to reduce filament voltage when operating.

Low Anode Voltage

The lowest anode voltage (2.5 kVpeak for 1.5 kW magnetron) enables to use economical transformer and rectifier.

Low Spurious Noise Radiation

As an integrated filter suppresses spurious noise radiation through filament leads, no external filter circuit is necessary for oven.

Stable under the most severe load conditions

Within acceptable VSWR up to 4 at any phase, high power output with good heating uniformity is ensured.

Long Life Expectancy

Selected materials with Toshiba's long experience in vacuum tube production ensures long life expectancy of more than 3000 hours.

12-1970

TOKYO SHIBAURA ELECTRIC CO., LTD.

TOSHIBA MAGNETRON

2M69

GENERAL DATA

Electrical :		
Frequency	2450 ± 30	MHz
Filament voltage	5	V
Filament current	20	A
Cathode preheating time	5	sec.
Mechanical :		
Physical dimensions	See outline drawing	
Base and electrical connection	See outline drawing	
Mounting position	Vertical	
RF coupling	Probe	
Magnetic field	Integral	
Cooling	Forced air cooling	
Net weight	2.7 kg approx.	
Type of cathode	Thoriated tungsten direct heating	

MAXIMUM RATINGS

	Minimum	Maximum	
Filament voltage (preheat)	4.7	5.3	V
Cathode preheating time	5	—	sec.
Peak anode voltage	—	2.75	kV
Average anode current	—	1100	mAdc
Peak anode current	—	3	A
Anode power input	—	2.8	kW
Load VSWR	—	4	
Anode temperature (See outline drawing measuring point)	—	150	°C

TYPICAL OPERATION

Unsmoothed fullwave rectified current

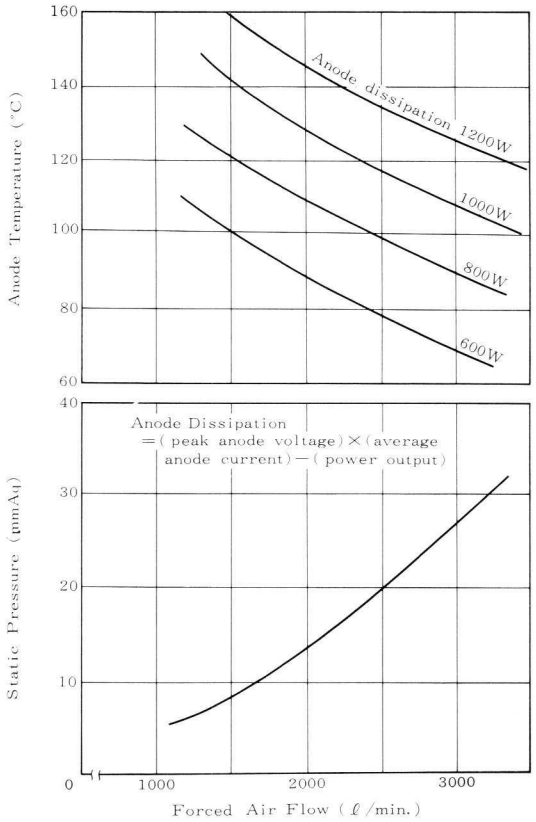
Frequency	2450	MHz
Filament voltage (operation)	5	V
Peak anode voltage (Note 1)	2.5	kV
Average anode current	1000	mAdc
Power output (matched load) (Note 2)	1500	W
Cooling quantity anode (forced air)	2500	l/min.

Note 1 Anode power supply is single phase full wave rectified D.C. without filter.
Note 2 Power output for typical microwave oven is expected about 85 percent of the power output at matched load.

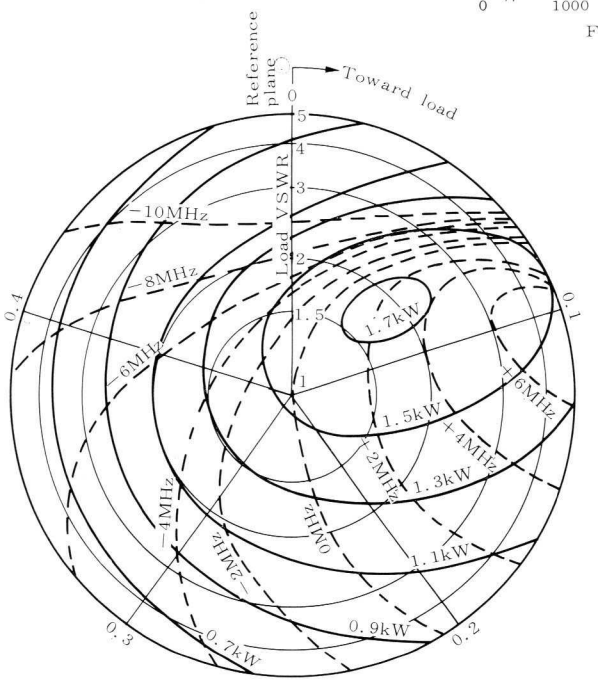
TOSHIBA MAGNETRON

2M69

COOLING CHARACTERISTICS

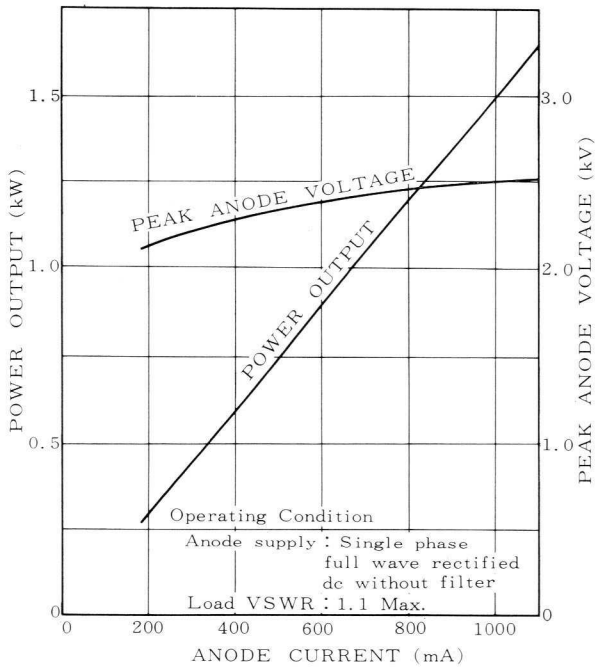


RIEKE DIAGRAM



Operating Condition
Anode supply : Single phase unsmoothed full wave rectified
Average anode current : 1.0A
Phase reference plane : Antenna

PERFORMANCE CHART

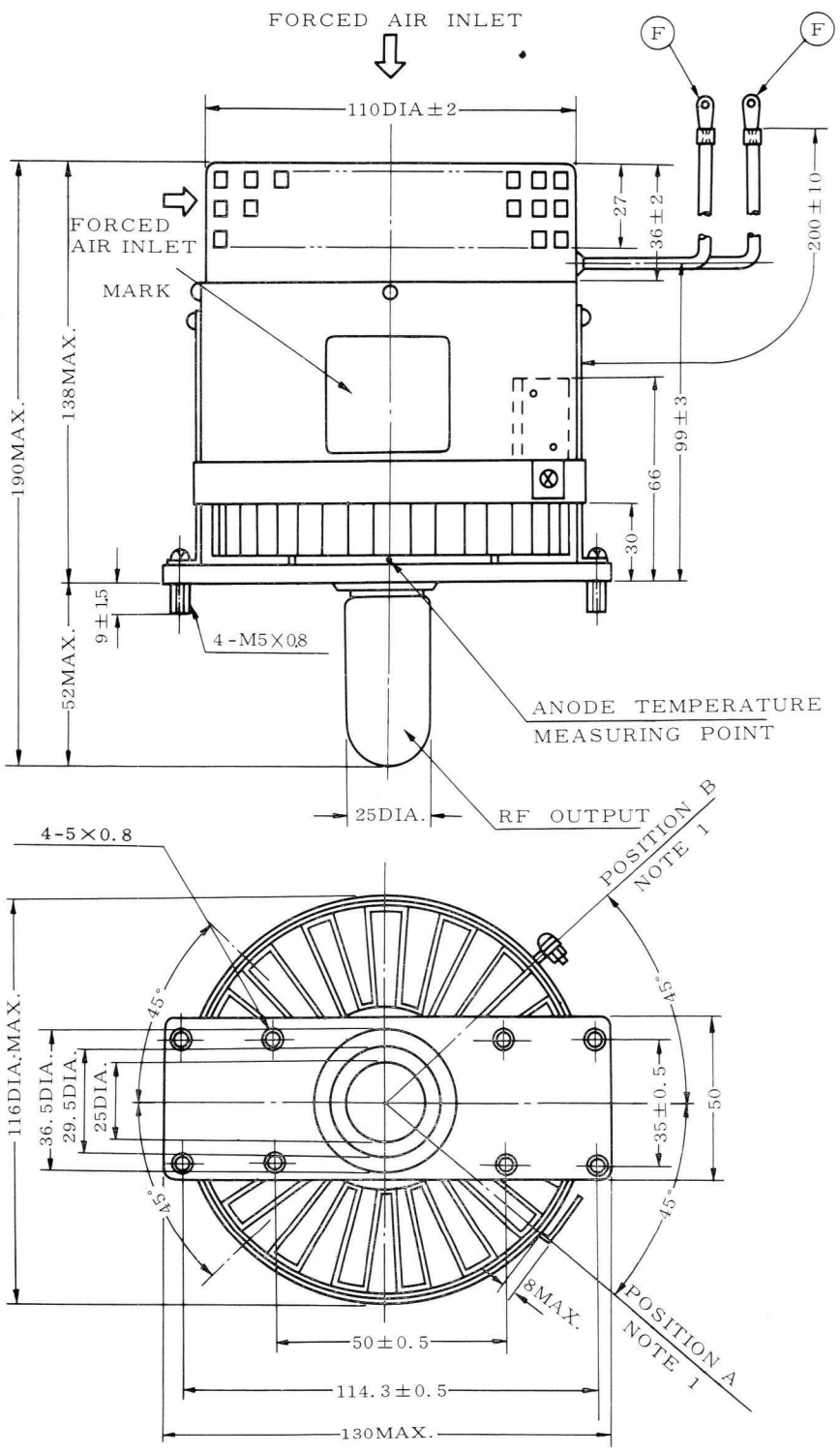


TOSHIBA MAGNETRON

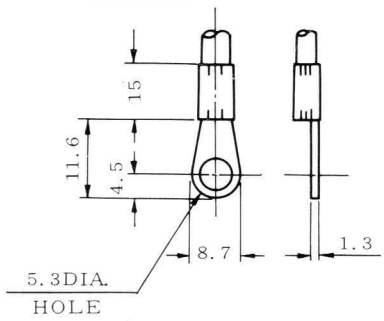
2M69

OUTLINE DIMENTIONS

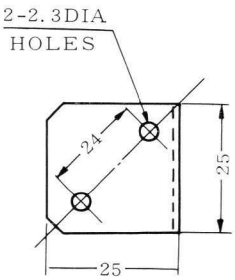
Unit mm



FILAMENT TERMINAL DETAIL



THERMOSWITCH MOUNTING TAB



Note 1. Specify thermoswitch mounting position "A" or "B" as 2M69(A) or 2M69(B) respectively.

TOKYO SHIBAURA ELECTRIC CO., LTD.

Printed in Japan

Consumer Products Export Division 2-1, 5 chome, Ginza, Chuo-ku, Tokyo

Toshiba **TECHNICAL DATA**

2M89

The Toshiba 2M89 is a fixed frequency continuous wave magnetron, designed to operate on the commercial alternating wave anode supply, in the 2400 to 2500 Mc frequency range with an average power output of 1400 watts.
The tube is required liquid cooling and an external magnetic field.
The output fitting is designed for coupling to the rectangular waveguide or cavity directly.
The tube is intended for use in microwave heating and cooking application.

GENERAL DATA

Electrical :	
Frequency	2450 ± 50 Mc
Filament voltage	5 V
Filament current	16 A
Cathode preheating time	10 sec
Mechanical :	
Physical dimensions	See outline drawing
Base and electrical connection	See outline drawing
Mounting position	Cathode vertical
RF coupling	See attached drawing
Magnetic field	External
Cooling	Liquid
Net weight	550 g approx.
Type of cathode	Thoriated tungsten, direct heating

Toshiba TECHNICAL DATA

Toshiba Magnetron
2M89

MAXIMUM RATINGS

	Minimum	Maximum
Filament voltage	4.8 V	5.2 V
Cathode preheating time	8 sec	-
Peak anode voltage	-	7.7 KV
Peak anode current	-	1.5 A
Average anode current	-	350 mAdc
Load VSWR	-	4
Anode temperature (see outline drawing measurement point)		100 °C
Cathode bushing temperature (see outline drawing measurement point)		250 °C

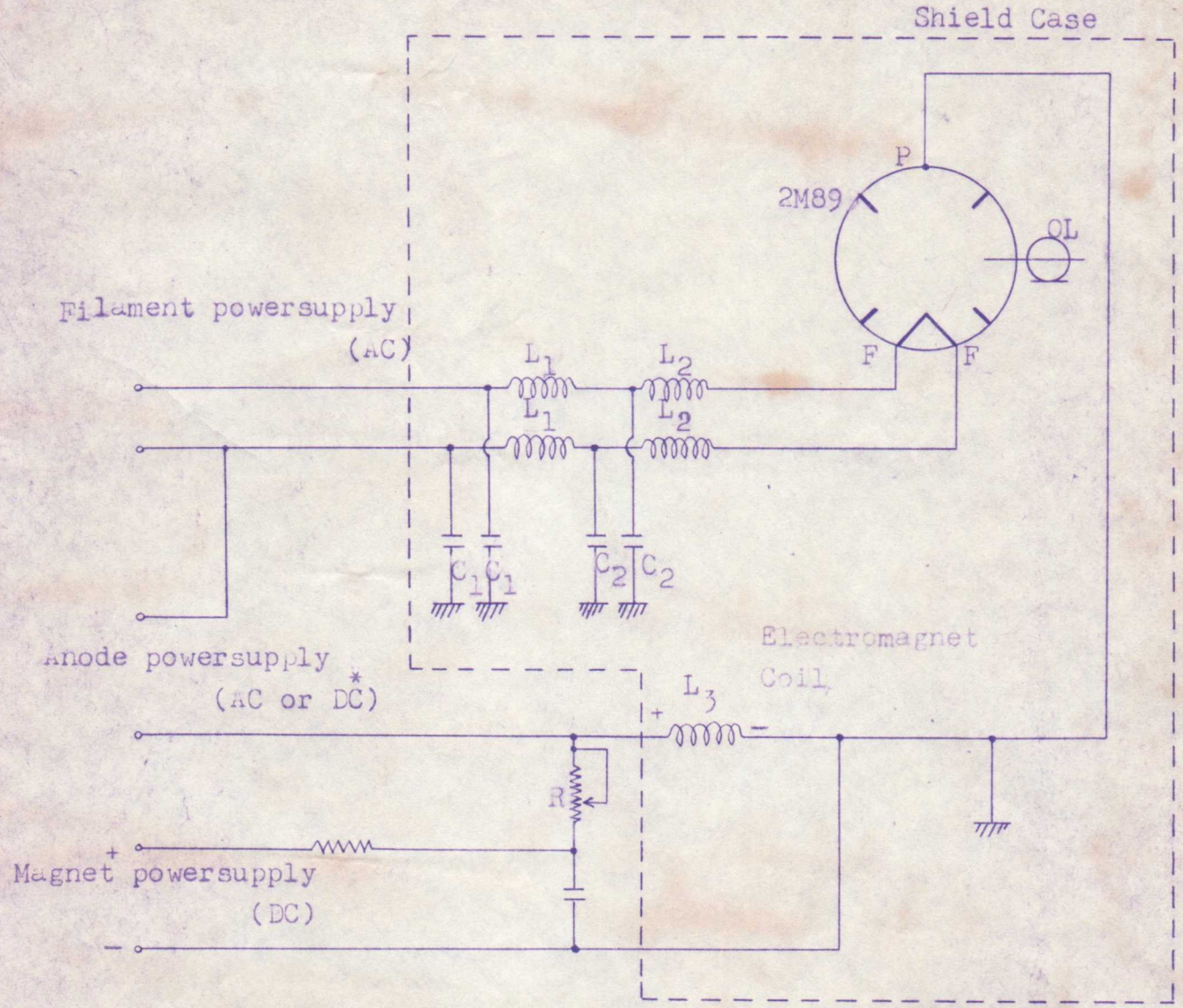
TYPICAL OPERATION

	Commercial AC	Unsmoothed fullwave rectified
Frequency	2450 Mc	2450 Mc
Filament voltage (operating)	5 V	5 V
Peak anode voltage	6.5 KV	7.0 KV
Average anode current	300 mAdc	300 mAdc
Average power output	1200 W	1400 W
Magnetic field intensity	1650 G	1800 G
Cooling quantity (water)	1.7 ℓ/min	1.7 ℓ/min

Toshiba TECHNICAL DATA

Toshiba Magnetron
2M89

OPERATING CIRCUIT



L_1 ..... 1.0 μH C_1 ..... 50 PF

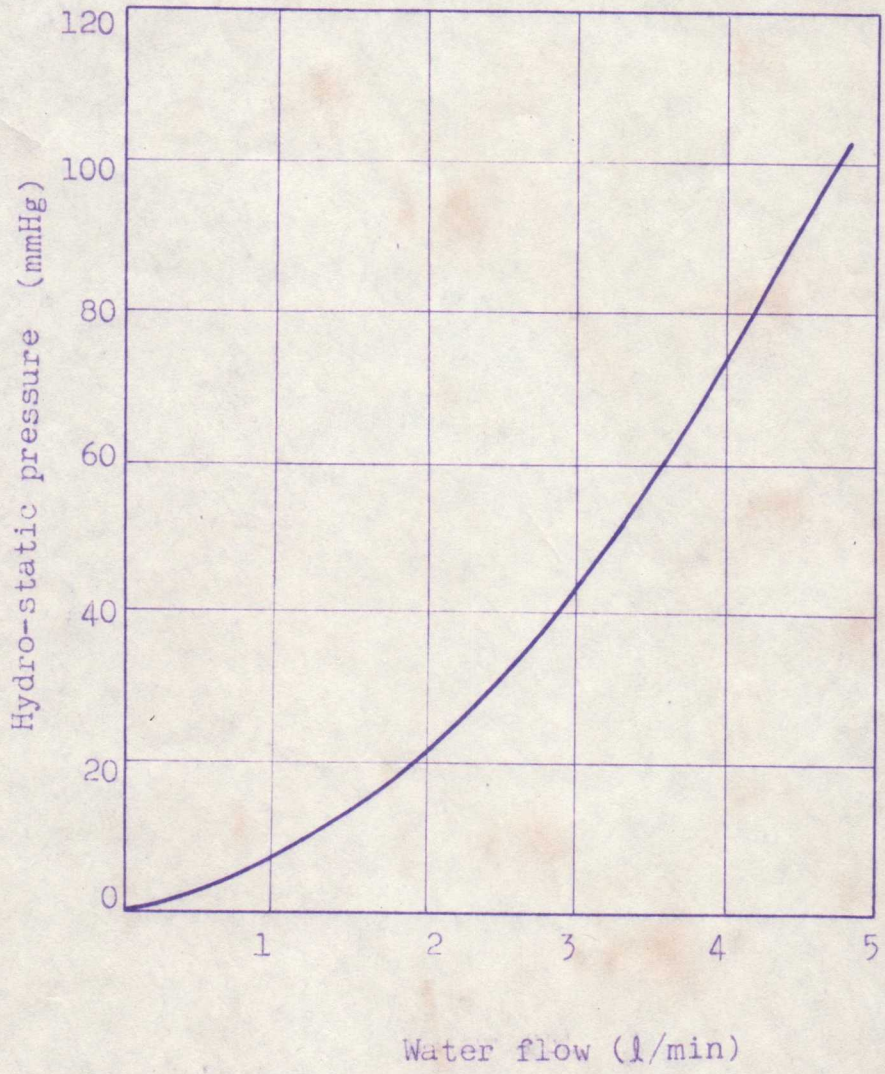
L_2 ..... 1.0 μH C_2 .....500 PF

* Unsmoothed fullwave rectified Anode supply

Toshiba TECHNICAL DATA

2M89

Water flow vs. Pressure

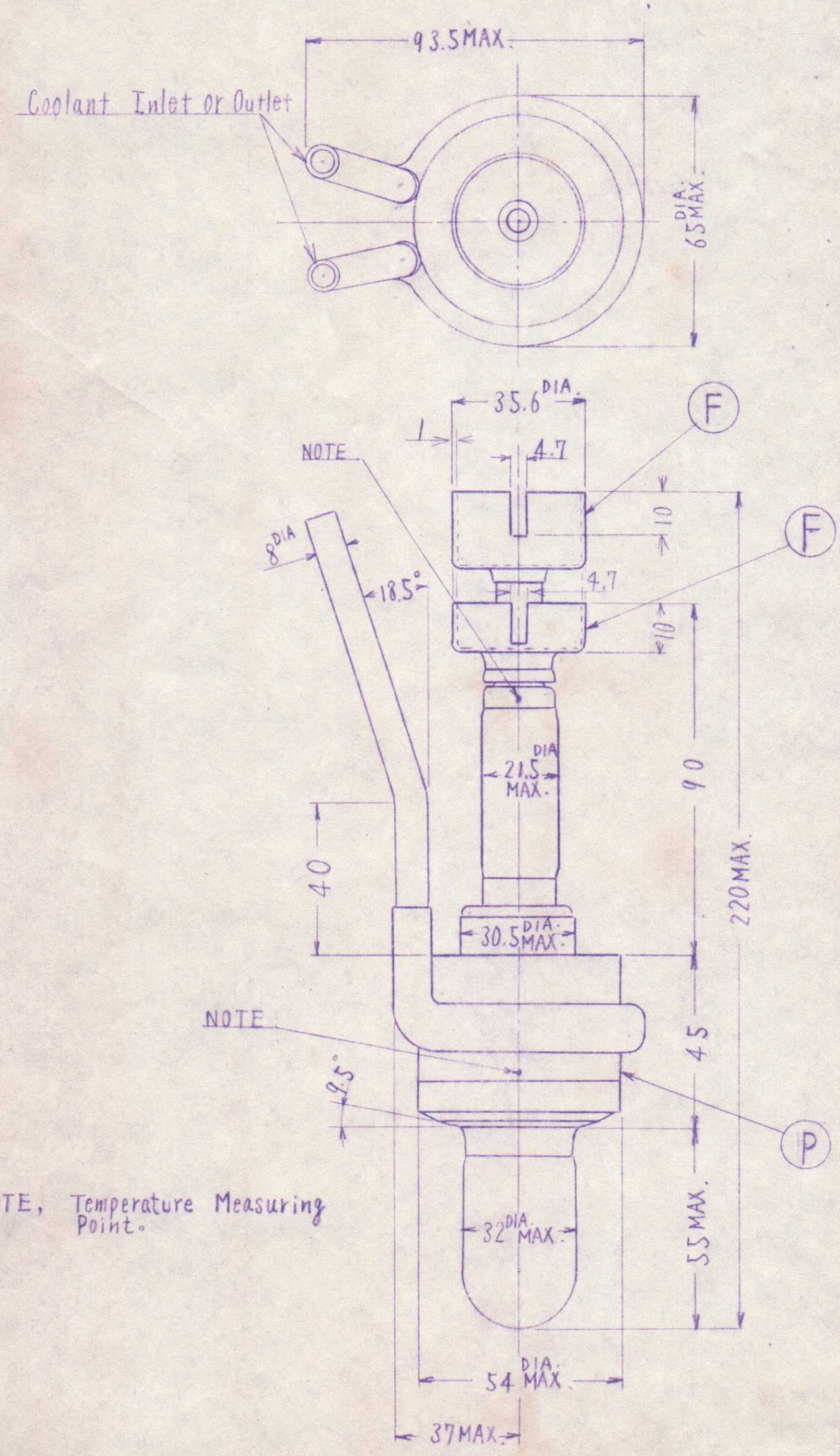


Toshiba **TECHNICAL DATA**

Toshiba Magnetron
2M89

2M89 OUTLINE DRAWING.

Unit mm



NOTE, Temperature Measuring Point.

6-24-1965

2-26-1966

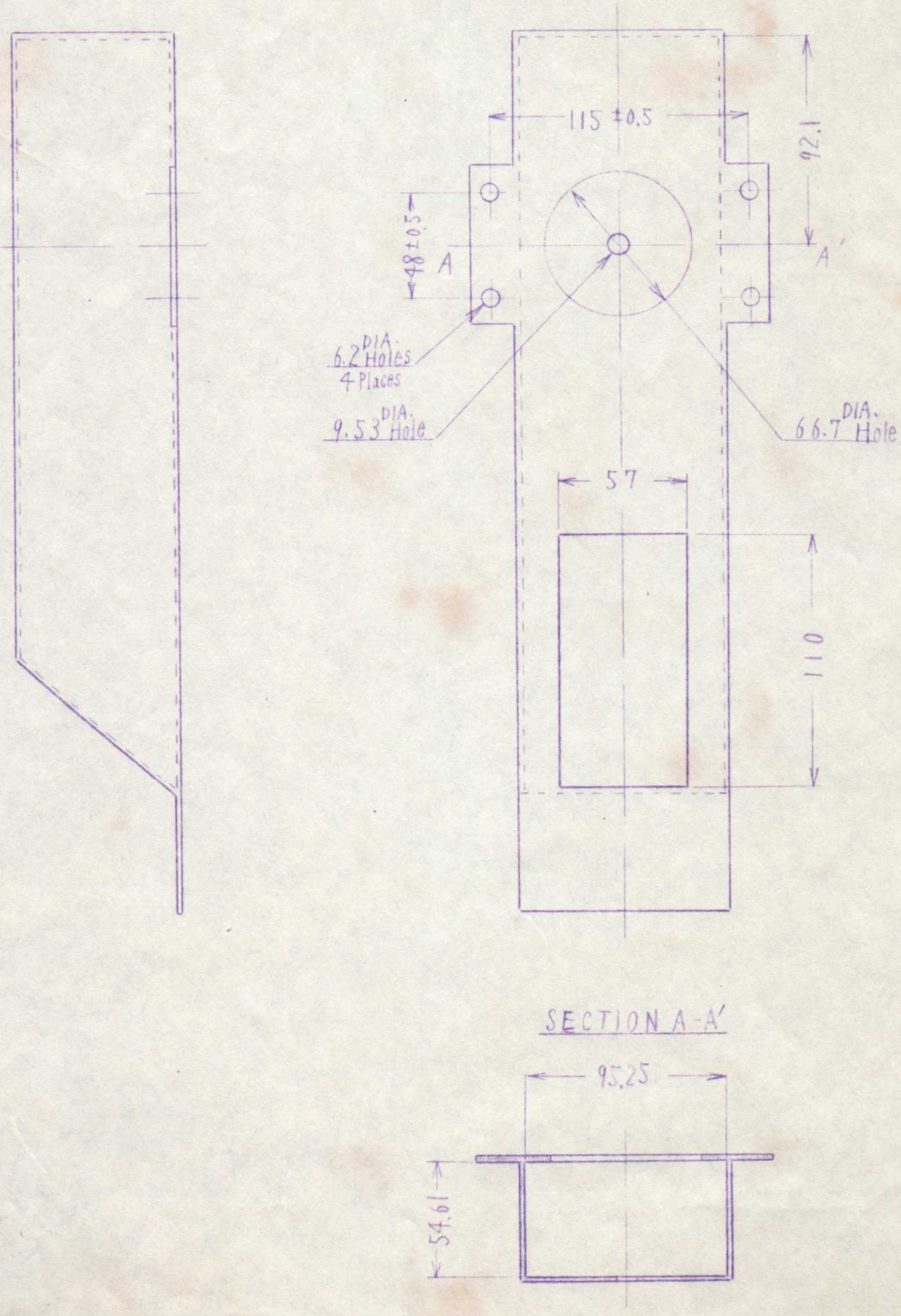
Toshiba TECHNICAL DATA

Toshiba Magnetron

2M89

2M89 R.F. OUTPUT COUPLER.

Unit mm



SECTION A-A'

6-24-1965

2-26-1966 TOKYO SHIBAURA ELECTRIC CO., LTD.

EM-2M89-3b

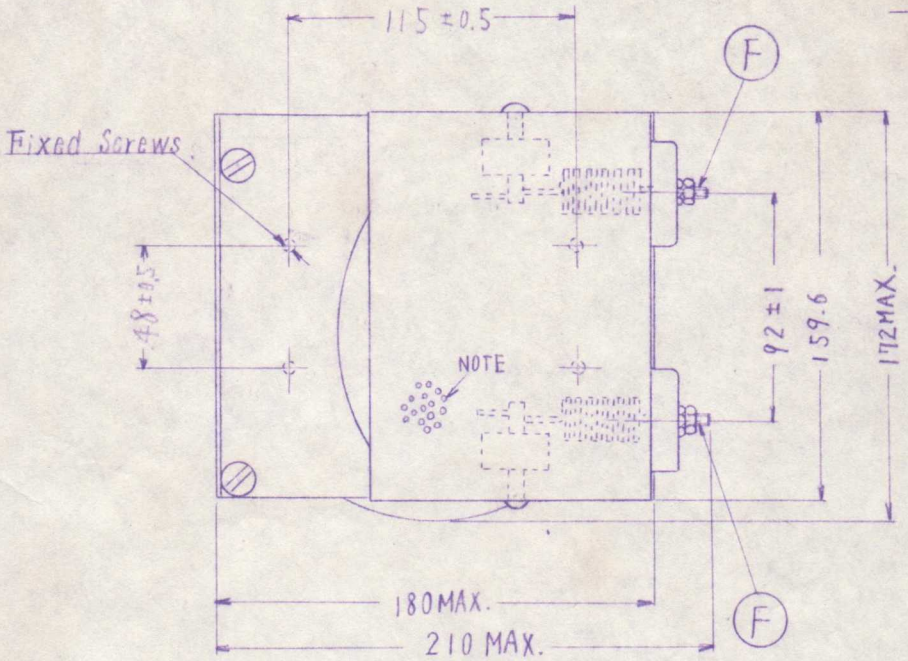
Toshiba **TECHNICAL DATA**

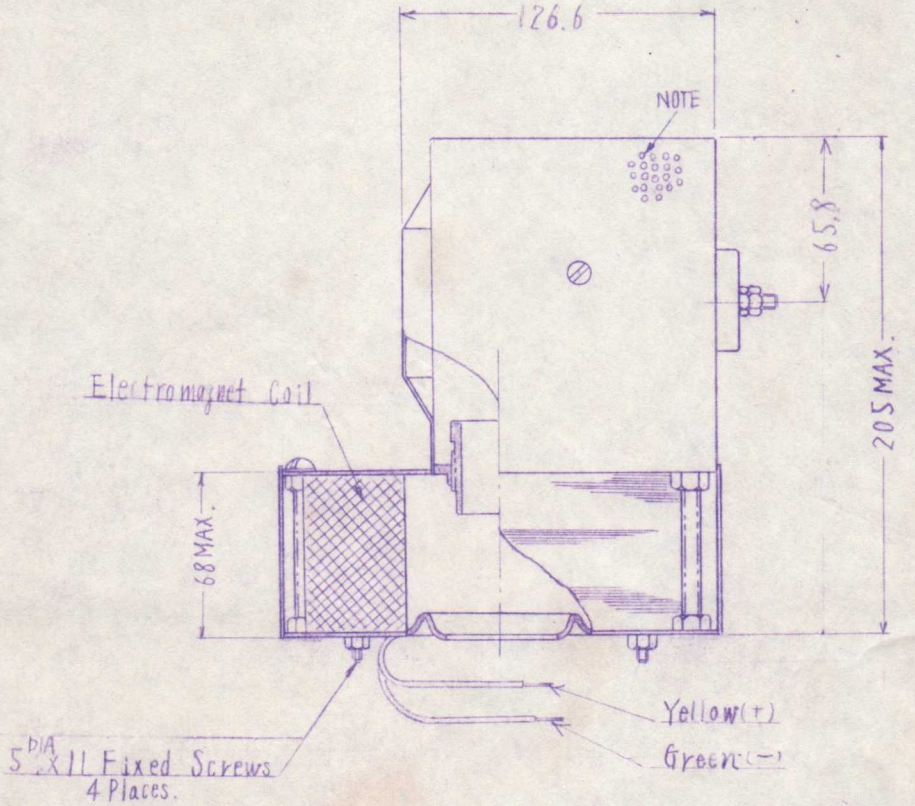
Toshiba Magnetron
2M89

ELECTROMAGNET FOR 2M89

NO. 4519-800D

Unit mm





NOTE. Air Holes for Cooling.

6-24-1965

2-26-1966

TOKYO SHIBAURA ELECTRIC CO., LTD.

KAWASAKI JPAAN

Toshiba

EIA REGISTRATION DATA

Type 3BHP-

Date issued May 30 1960



Toshiba 3BHP- is a 3-inch, flat face, single gun, electrostatic and focus cathode-ray tube.

This tube features helical post acceleration, very high deflection sensitivities and half-heater-power.

This tube is particularly suitable for miniaturized (transistorized) oscilloscope in the low voltage operation and also hiph speed & high precision observation in the high voltage operation.

General :

Heater, for Unipotential Cathode :

Voltage (AC or DC)	*6.3 volts*
Current	*0.3 amp*

Direct Interelectrode Capacitances ; Approximate

Cathode to all other electrodes	*4 μμf*
Grid No. 1 to all other electrodes	*6 μμf*
D1 to D2	*1.7 μμf*
D3 to D4	*1.2 μμf*

Printed in Japan

from JEDEC release #2962, Sept. 19, 1960

D1 to all other electrodes	4.1 μμf
D2 to all other electrodes	4.1 μμf
D3 to all other electrodes	3.1 μμf
D4 to all other electrodes	3.1 μμf
Helical-Post-Accelerator Resistance	min. 30 megohms

Phosphor

Phosphor Number	P1	P2	P4	P7	P11
Fluorescent Color	Green	Greenish-yellow	White	Blue-white	Blue
Phosphorescent Color	Green	Greenish-yellow	White	Yellow	Blue
Persistence	Medium	Long	Medium	Long	Short

Focusing Method	Electrostatic
Deflection Method	Electrostatic
Overall Length	$13\frac{3}{16}'' \pm \frac{3}{8}''$
Greatest Diameter of Bulb	$3'' \pm \frac{1}{16}''$
Minimum Useful Screen Diameter	$2\frac{5}{8}''$
Bulb Contact	JI-21
Base	JEDEC No. B12-37
Basing	14 AQ

Bulb Contact Adjustment

JI-21 contact aligns with trace of D1-D2 ± 10 degrees.

JI-21 contact on same side as pin No. 4.

Base Alignment

D3-D4 trace aligns with pin No. 1 and tube axis ± 10 degrees.

Positive voltage on D1 deflects beam approximately toward pin No. 4.

Positive voltage on D3 deflects beam approximately toward pin No. 1.

Angle between D1-D2 and D3-D4 traces ..... 90 ± 2 degrees

Maximum Ratings (Design-center Values):

Post-Accelerator Voltage	7000 max. volts DC
Accelerator Voltage	2000 max. volts DC
Isolation Shield Voltage	2100 max. volts DC
Ratio Post-Accelerator voltage to Accelerator Voltage	6 max.
Grid No. 3 (Focusing Electrode) Voltage	800 max. volts DC
Grid No. 1 Value	
Negative-Bias Value	200 max. volts DC

Positive-Bias ..... 0 max. volts DC

Positive-Peak Value ..... 2 max. volts

Peak-Heater-Cathode Voltage

Heater negative with respect to cathode

During warm-up period not exceed 15 seconds ..... 180 max. volts

After equipment warm-up period ..... 125 max. volts

Heater positive with respect to cathode ..... 125 max. volts

Peak Voltage between Accelerator and any Deflection Electrode ..... 500 max. volts

Accelerator Input ..... 6 max. watts

Characteristics Range Values for Equipment Design :

For any post-accelerator voltage (E_{C5}) (Note 1) between 1000 and 7000 volts and accelerator voltage (E_{C4}) (Note 1) 500 and 2000 volts.

Isolation Shield Voltage (Note 2) ..... 95% to 105% of E_{C4} volts

Focusing Electrode Voltage ..... 14% to 26% of E_{C4} volts

Grid No. 1 Voltage for visual extinction

of undeflected focused spot ..... −3.0% to −5.5% of E_{C4} volts

Focusing Electrode current for any operating condition ..... −15 to +10 μamp

Deflection Factors (Note 5)

Post-accelerator voltage = Accelerator voltage

D1 and D2 ..... 30.2 to 46.3 volts DC/inch/kilo volt of E_{C4}

D3 and D4 ..... 12.7 to 22.9 volts DC/inch/kilo volt of E_{C4}

Post-accelerator voltage = 6 Accelerator voltage

D1 and D2 ..... 65.2 to 85.6 volts DC/inch/kilo volt of E_{C4}

D3 and D4 ..... 23.8 to 34.3 volts DC/inch/kilo volt of E_{C4}

Useful Scan (Note 5)

Post-accelerator voltage = Accelerator voltage

D1-D2 ..... full screen diameter

D3-D2 ..... 2 3/8"

Post-accelerator voltage = 6 Accelerator voltage

D1-D2 ..... 2 1/4"

D3-D4 ..... 1 5/8"

Spot position (undeflected) (Note 4) ..... 10 max. millimeters

Examples of Use of Design Ranges:

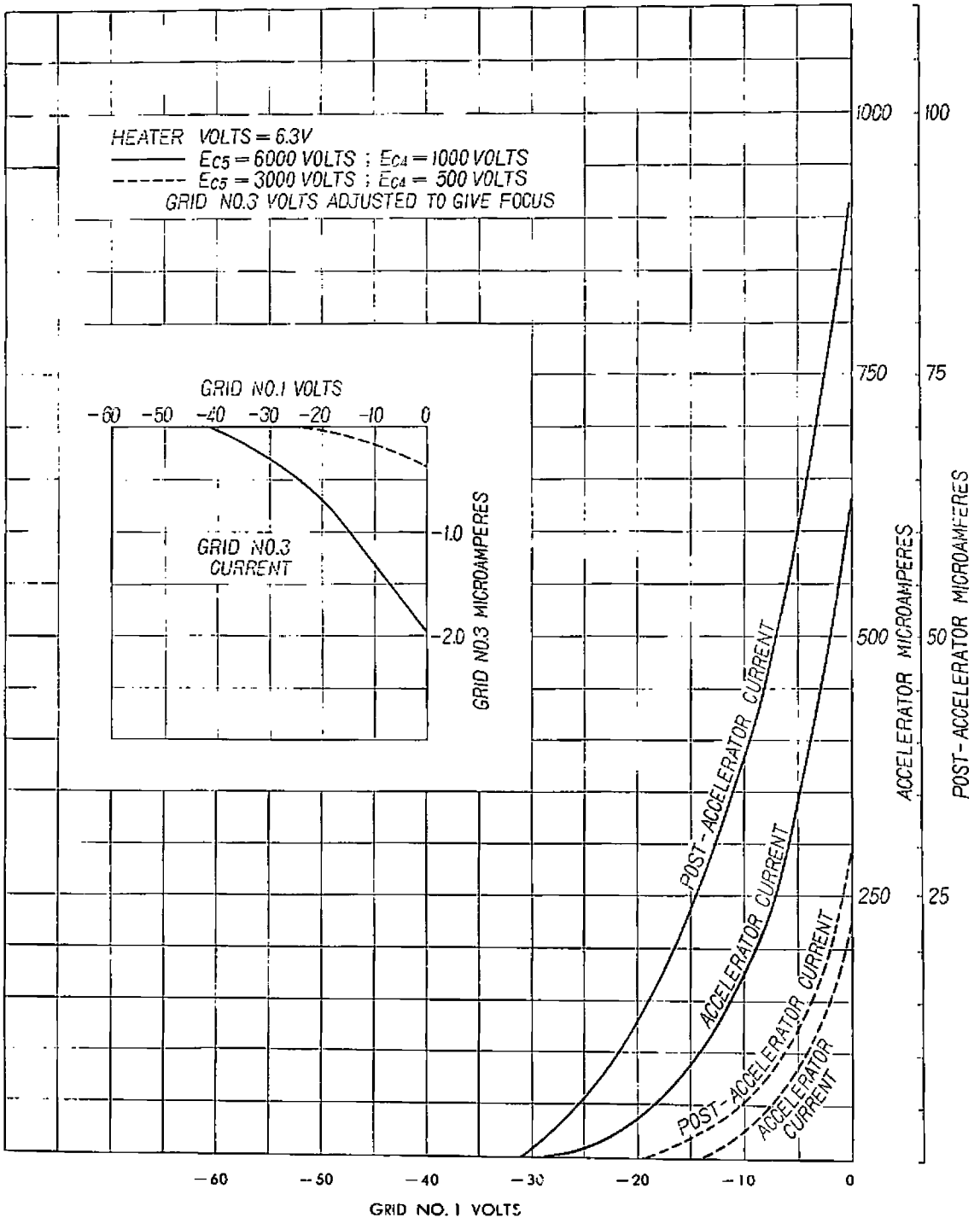
Post-Accelerator Voltage (Note 1)	*3000*	*6000*	*volts*
Isolation Shield Voltage	*475 to 525*	*950 to 1050*	*volts*
Accelerator voltage (Note 3)	*500*	*1000*	*volts*
Grid No. 3 Voltage (Focusing Electrode)	*70 to 130*	*140 to 250*	*volts*
Grid No. 1 Voltage	*−15 to −27.5*	*−30 to −55*	*volts*
Deflection Factors			
D1 and D2	*32.6 to 42.8*	*65.2 to 85.6 volts*	*DC/inch*
D3 and D4	*11.9 to 17.2*	*23.8 to 34.3 volts*	*DC/inch*
Useful Scan D1-D2	*2¼″*	*2¼″*	
Useful Scan D3-D4	*1 9/32″*	*1 9/32″*	
Pattern Distortion (Note 6)	*2*	*2*	*% max.*

Maximum Circuit Values:

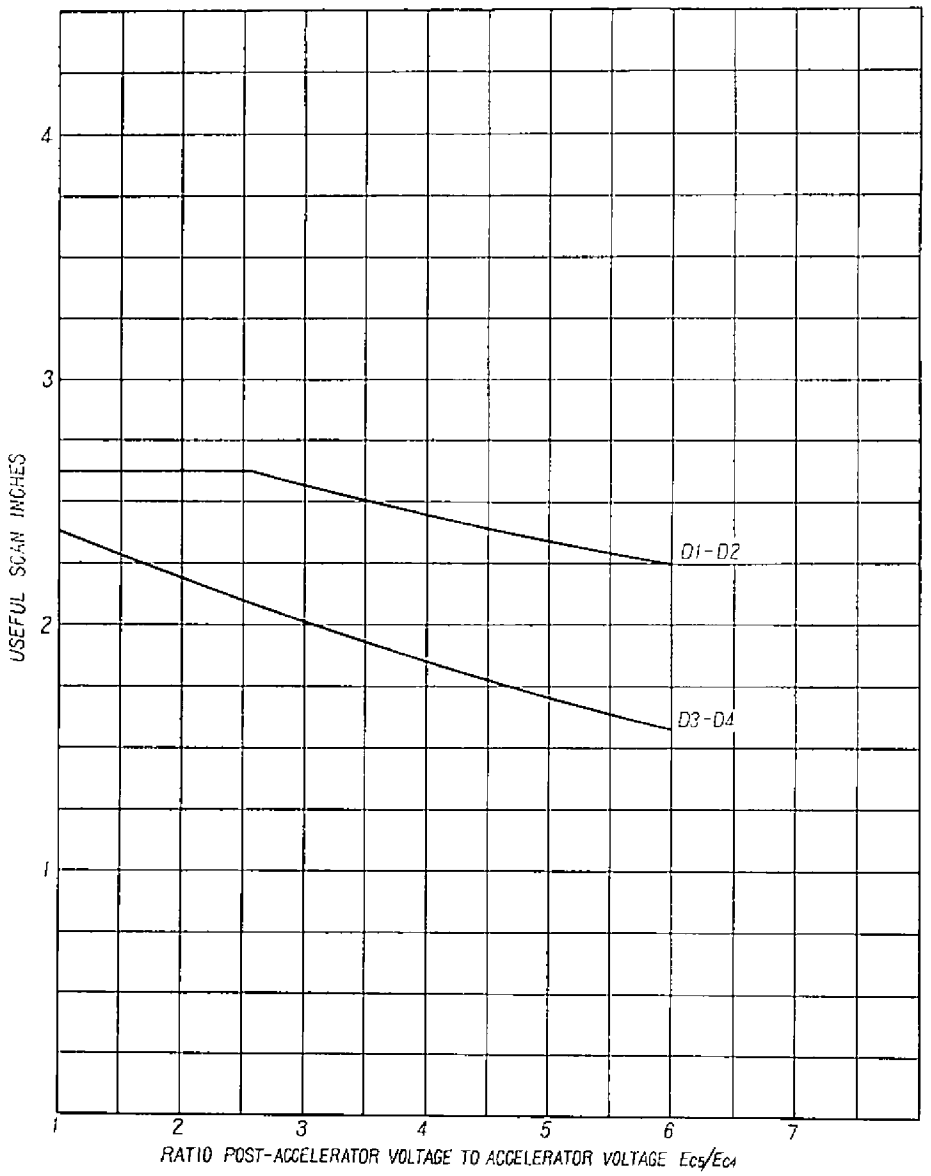
Grid No. 1 Circuit Registance	*1.5 max. megohms*
Resistance in any Deflection-Electrode Circuit (Note 4)	*5 max. megohms*

NOTES:
1. For P1 and P11 Screens, it is recommended that the post-accelerator voltage be not less than 1000 volts and the accelerator voltage be not less than 500 volts. For P2, P4 and P7 screens, it is recommended that the post-accelerator voltage be not less than 2000 volts.
2. The isolution shield and the lower end of the helical-post-accelerator are connected together within the tube.
   With the proper potential on this electrode combination, barrel and pin-cushion distortions are minimized.
3. Connect free deflecting electrode to anode.
4. It is recommended that the deflecting-electrode-circuit resistances be approximately equal.
5. In cases of the operation E_{C5}/E_{C4} ratio of 1 to 6, Deflection factors characteristics and Useful scan characteristics of following pages are available.
6. All portions of a raster pattern, adjusted so its widest points just touch the sides of a 1.772″ × 1.181″ rectangle, will fall within the area bounded by the 1.772″ × 1.181″ rectangle and an inscribed 1.700″ × 1.134″ rectangle.

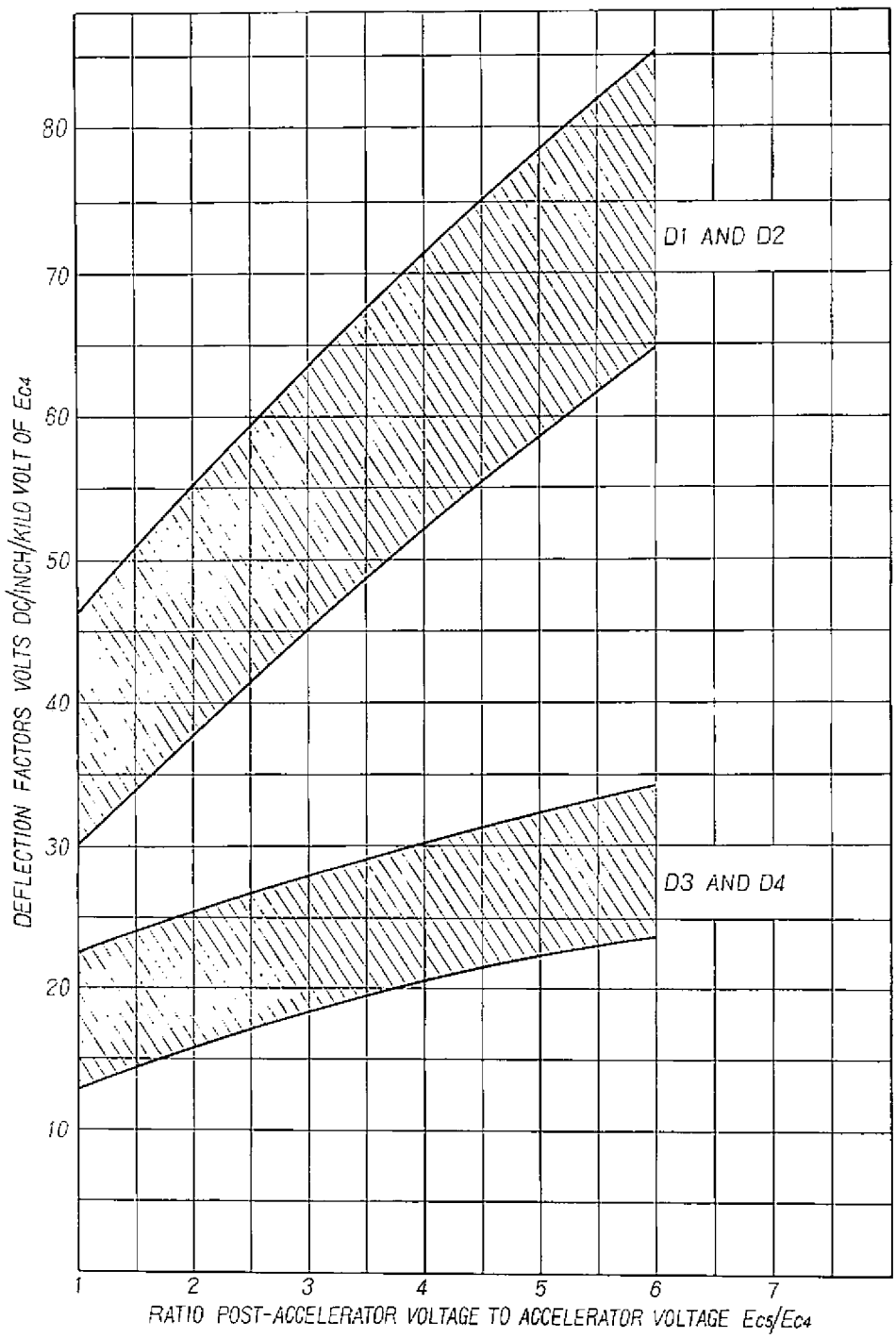
3BHP- AVERAGE CHARACTERISTICS



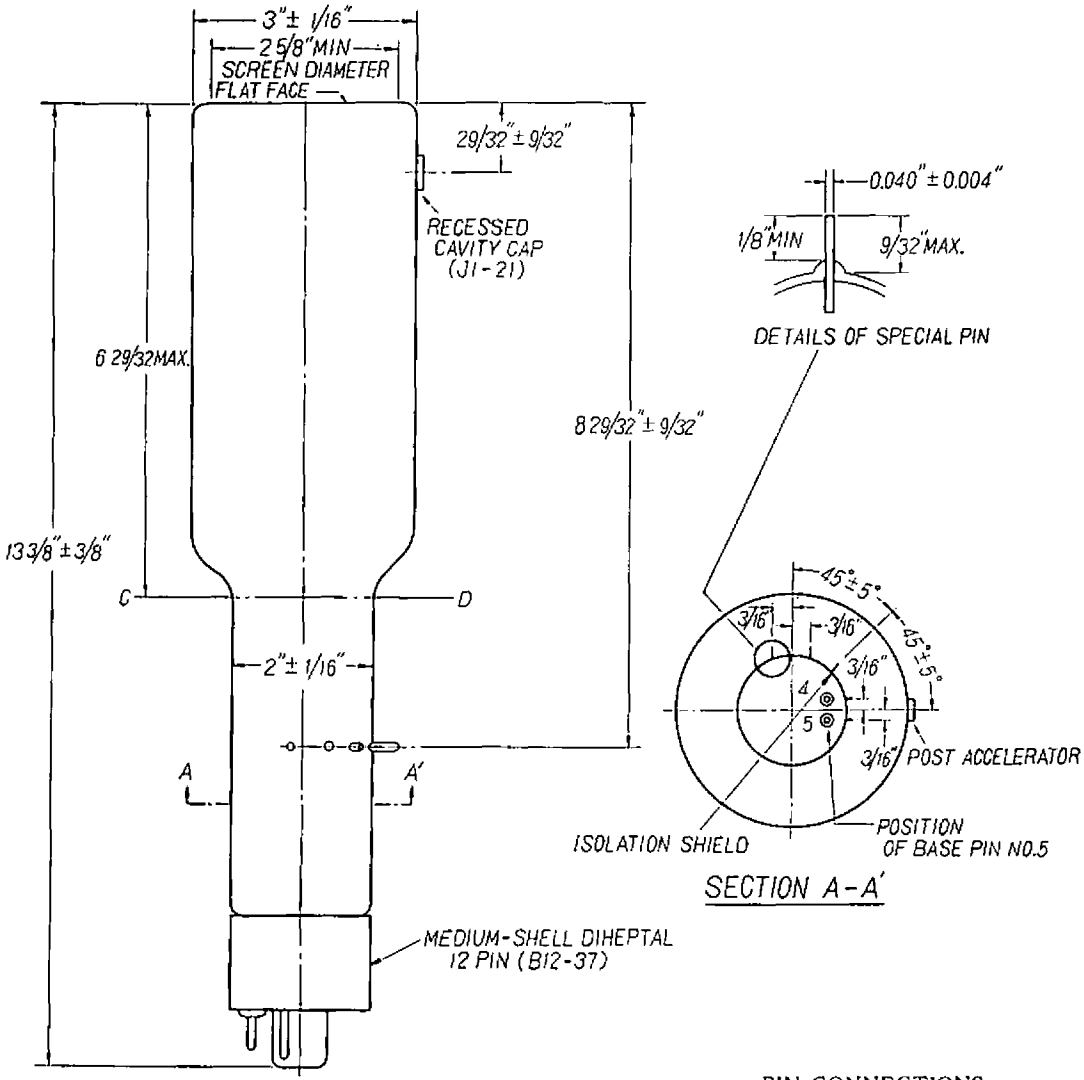
3BHP- USEFUL SCAN CHARACTERISTICS

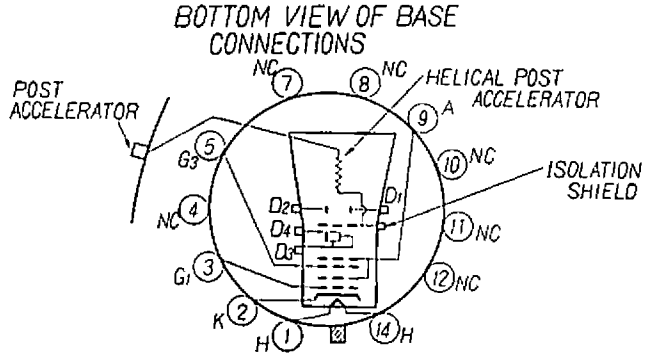


3BHP- DEFLECTION FACTORS CHARACTERISTICS



DIMENSIONAL OUTLINE OF 3BHP-





PIN CONNECTIONS

PIN 1—Heater
PIN 2—Cathode
PIN 3—Grid No. 1
PIN 4—NC
PIN 5—Grid No. 3 (Focusing Electrode)
PIN 7—NC
PIN 8—NC
PIN 9—Accelerator (Grid No. 2, Grid No 4)
PIN 10—NC
PIN 11—NC
PIN 12—NC
PIN 14—Heater

Toshiba

All inquiries as to the data shoud be addressed to Tokyo Shibaura Electric Co., Ltd., Lamp and Tube Manufacturing and Sales Division, 72 Horikawacho, Kawasaki, Kanagawa-ken, Japan.

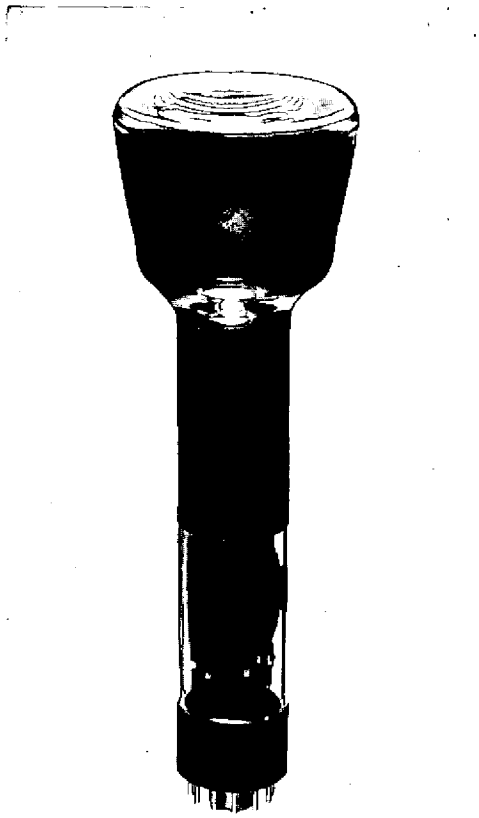
TOKYO SHIBAURA ELECTRIC CO., LTD.
KAWASAKI JPAAN

Toshiba

EIA REGISTRATION DATA

Type **3BJP4**

Date issued May 30 1960



Toshiba 3BJP4 is a 3 inch, round face, non-aluminized, electrostatic focus and magnetic deflection view-finder cathode-ray tube, especially suitable for transistorized camera use.

This tube features half-heater-power, high light out put, high resolution and adaptable with conventional 70 degrees deflection yoke.

General:

Heater for Unipotential Cathode:

Voltage (AC or DC)	*6.3 volts*
Current	*0.3 amp*

Direct Interelectrode Capacitances; Approximate

Grid No. 1 to all other electrodes	*6 μμf*
Cathode to all other electrodes	*5 μμf*

Printed in Japan

from JEDEC release #2962, Sept. 19, 1960

Phosphor	P 4
Fluorescent color	white
Persistence	medium
Focusing Method	Electrostatic
Deflection Method	Electromagnetic
Deflection Angle (Approximate)	40 degrees
Electron Gun	Requires external single-field iontrap magnet
Overall Length	9¼" ± ¼"
Greatest Diameter	3" ± 1/16"
Minimum Useful Screen Diameter	2¾"
Basing	12 BD
Base	JEDEC No. B 12-43

Maximum Ratings (Design-center Values):

Ultor Voltage	3000 max. volts DC
Ultor Input	6 max. watts
Grid No. 4 (Focusing electrode) Voltage	1500 max. volts DC
Grid No. 2 Voltage	410 max. volts DC
Grid No. 1 Voltage	
Negative-bias value	125 max. volts DC
Positive-bias value	0 max. volts DC
Positive-peak value	2 max. volts
Heater to Cathode Voltage	
Heater positive with respect to cathode	125 max. volts
Heater negative with respect to cathode	125 max. volts
Peak value during a warm-up period not exceed 15 second; heater negative	410 max. volts

Characteristics Range Values for Equipment Design:

For any ultor voltage (E_{C5}) between 2500 and 3000 volts	
Grid No. 4 voltage for focus with ultor current of 200 μA	30 to 48% of E_{C5} volts
Grid No. 1 voltage for visual extinction	
of undeflected focused spot when circuit design utilizes	
grid No. 2 voltage (E_{C2}) at fixed value	11 to 26% of E_{C2} volts
Grid No. 4 current for any operating conditing	15 to 10 μ amp

Examples of Use of Design Ranges:

Ultor voltage	*2500*	*3000*	*volts DC*
Grid No. 4 voltage (Focusing electrode) (Note 1)	*750～1200*	*900～1500*	*volts DC*
Grid No. 2 voltage	*200*	*300*	*volts DC*
Grid No. 1 voltage (Note 2)	*−22～−51*	*−33～−77*	*volts*
Field strength of iontrap magnet	*12*	*14*	*gausses*

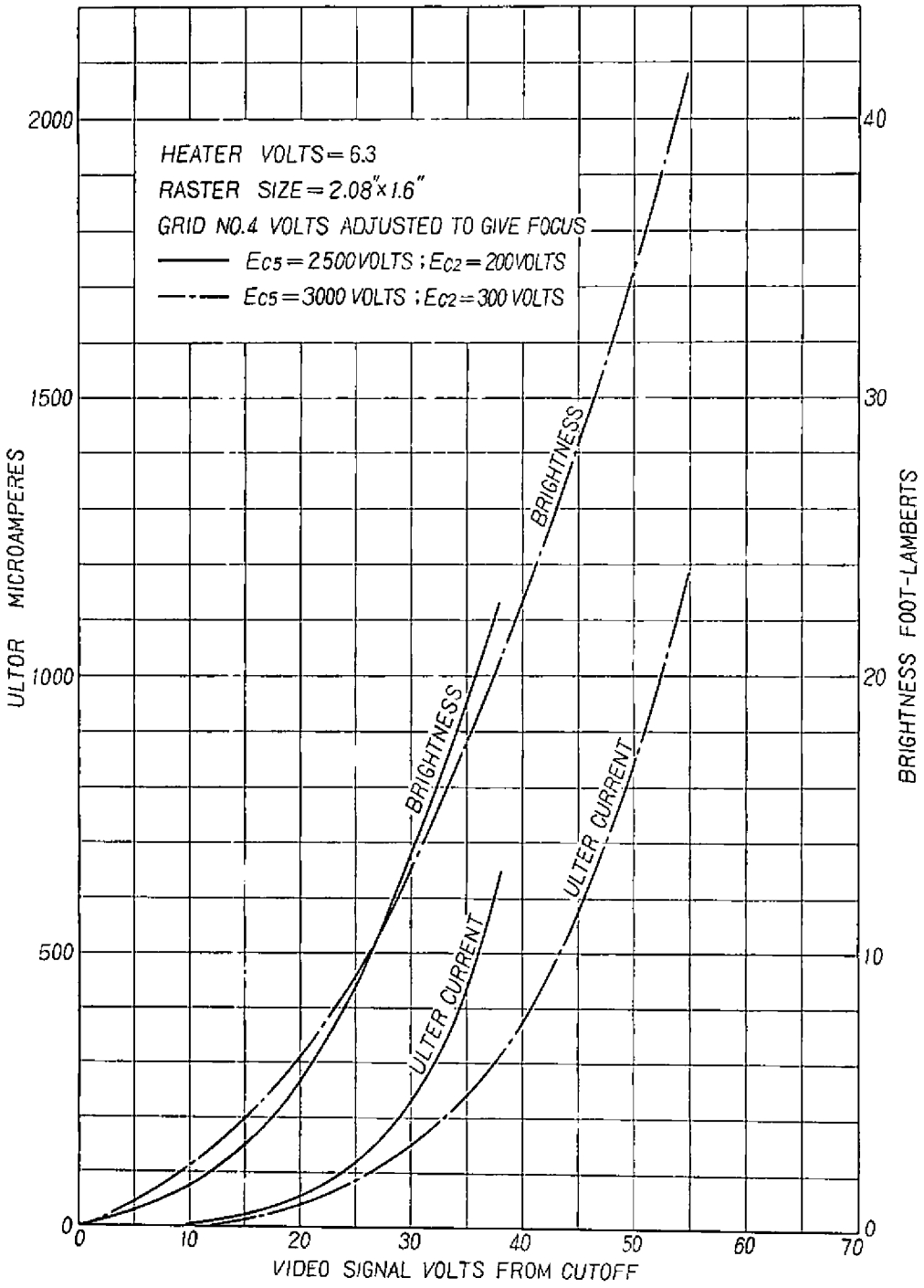
Maximum Circuit Values:

Grid No. 1 circuit resistance ..... *1.5 max. megohm*

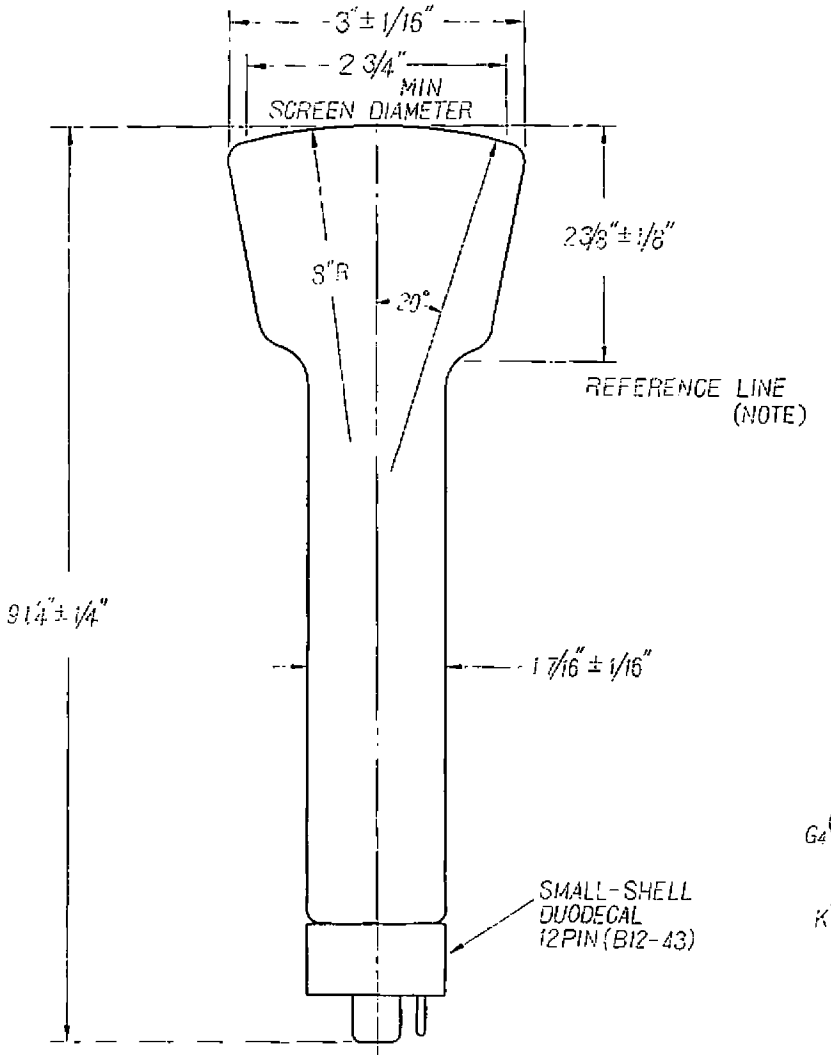
NOTES: 1. With the combined grid No. 1 bias and signal voltage adjusted to give an anode current of 200 μA in 2.08″ × 1.6″ picture size.

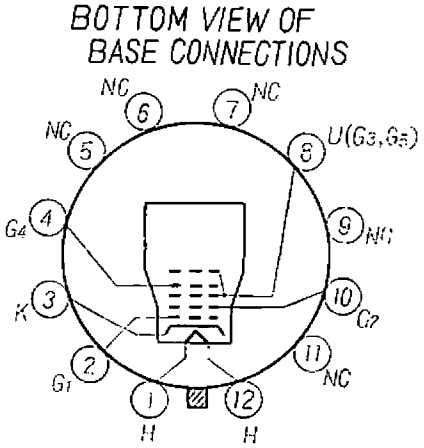
2. Visual extinction of undeflected focused spot.

3BJP4 AVERAGE CHARACTERISTICS



DIMENSIONAL OUTLINE





Note: Reference line is determined by position where hinged gauge 1.500"+0.03"−000" and 2" long will rest on bulb cone.

PIN CONNECTIONS

PIN 1- Heater
PIN 2--Grid No. 1
PIN 3 -Cathode
PIN 4—Grid No. 4
PIN 5—NC
PIN 6—NC
PIN 7—NC
PIN 8—Ultor (Grid No. 3, Grid No. 5 Collector)
PIN 9- NC
PIN 10- Grid No. 2
PIN 11—NC
PIN 12- Heater

Toshiba

All inquiries as to the data shoud be addressed to Tokyo Shibaura Electric Co., Ltd., Lamp and Tube Manufacturing and Sales Division, 72 Horikawacho, Kawasaki, Kanagawa-ken, Japan.

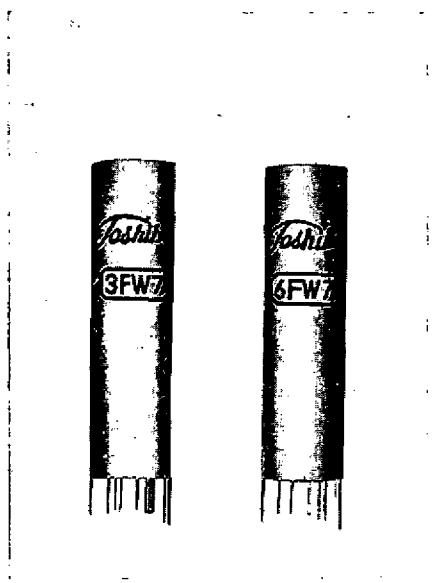
TOKYO SHIBAURA ELECTRIC CO., LTD.
KAWASAKI JAPAN

Toshiba **E I A**

REGISTRATION DATA

Type **3FW7, 6FW7**

Date issued **SEP. 1 1962**



Toshiba 3FW7, 6FW7 are 8 pin subminiature medium Mu dual triode with shield can having indexing legs.

They are designed especially for use as mixer oscillator in VHF TV and FM tuners.

The section 1 is intended to service as an oscillator and the section 2 as an mixer.

The 3FW7 is like the 6FW7 except that it has 3.5-volt/600-Milliampere heater for use in series string circuit.

GENERAL DATA

Electrical :

	3FW7	6FW7	
Heater, for unipotential cathode :			
Voltage (AC or DC)	3.5	6.3	volts
Current	600	300	ma
Heater warm up time	Approx. 11	—	sec
Direct interelectrode capacitance (with shield can) :	Unit 1	Unit 2	
Grid to plate : (g to p)	1.6	1.5	$\mu\mu f$
Input : g to (h+k+sd)	2.6	3.0	$\mu\mu f$
Output : p to (h+k+sd)	1.8	1.4	$\mu\mu f$

Mechanical :

Operating position	*Any*
Maximum overall length	*1.969″*
Maximum diameter	*0.512″*
Bulb	*T 3*
Base	*E8-9*

Printed in Japan

from JEDEC release #3940, Oct. 22, 1962

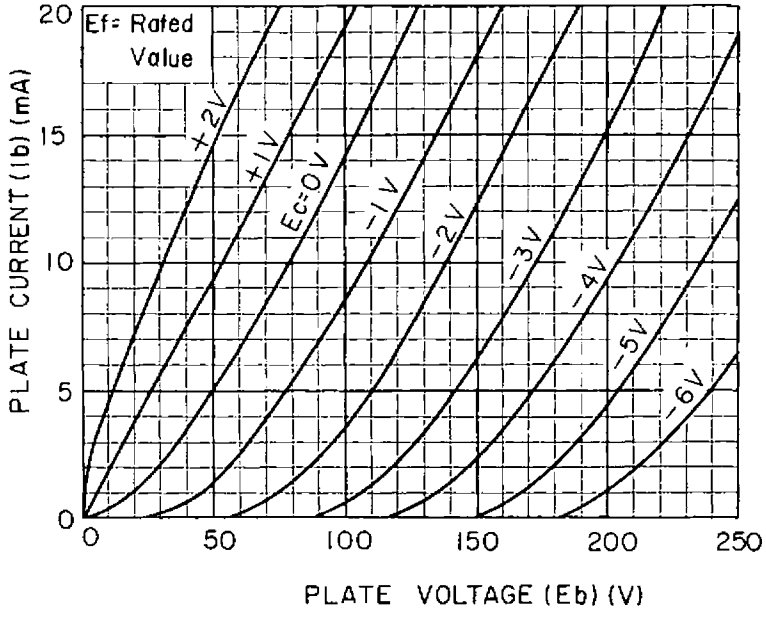
Maximum Ratings (Design Maximum Values): (*Each Section*)

Plate voltage (with cutoff bias)	300	*volts*
Plate voltage	150	*volts*
Cathode current	20	*ma*
Circuit Values: Grid circuit resistance (each section)	0.5	*megohms*
Heater-cathode voltage		
Heater negative with respect to cathode, DC	200	*volts*
Total, DC and peak	200	*volts*
Heater positive with respect to cathode, DC	100	*volts*
Total, DC and peak	200	*volts*

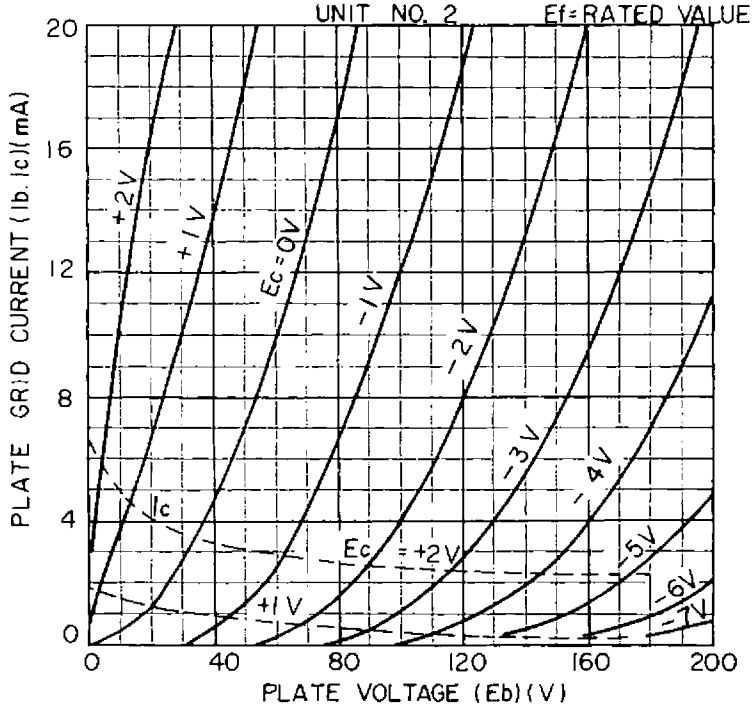
Typical Operating Conditions and Characteristics:

Class A1 Amplifier	*Unit 1*	*Unit 2*	
Plate voltage	90	90	*volts*
Grid voltage	−1	−1	*volts*
Amplification factor	36	36	
Plate resistance	6,000	3,800	*ohms*
Transconductance	6,000	9,500	*μmho*
Plate current	7.0	9.0	*ma*

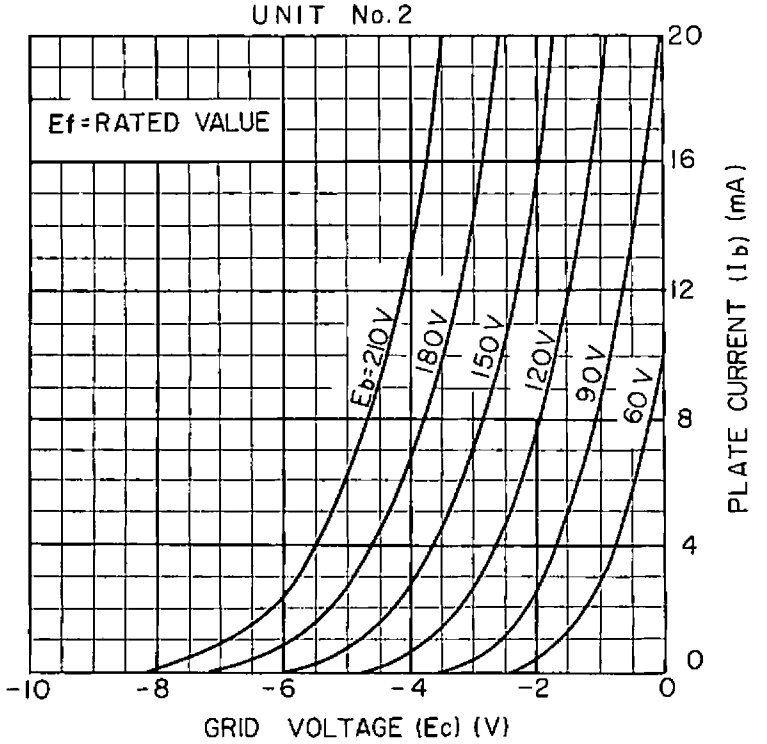
3FW7 , 6FW7
AVERAGE CHARACTERISTICS
UNIT No. 1



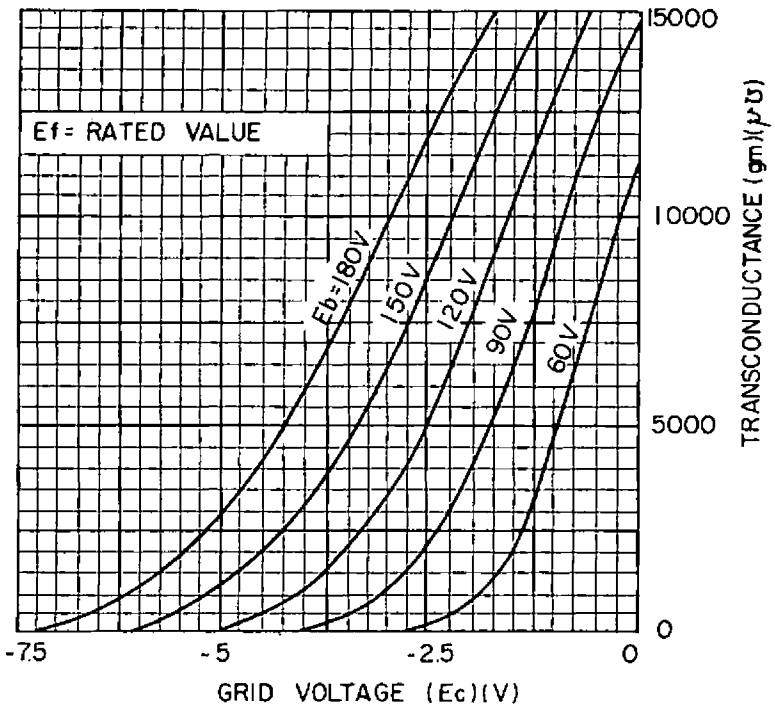
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AVERAGE PLATE CHARACTERISTICS
UNIT NO. 2 Ef=RATED VALUE



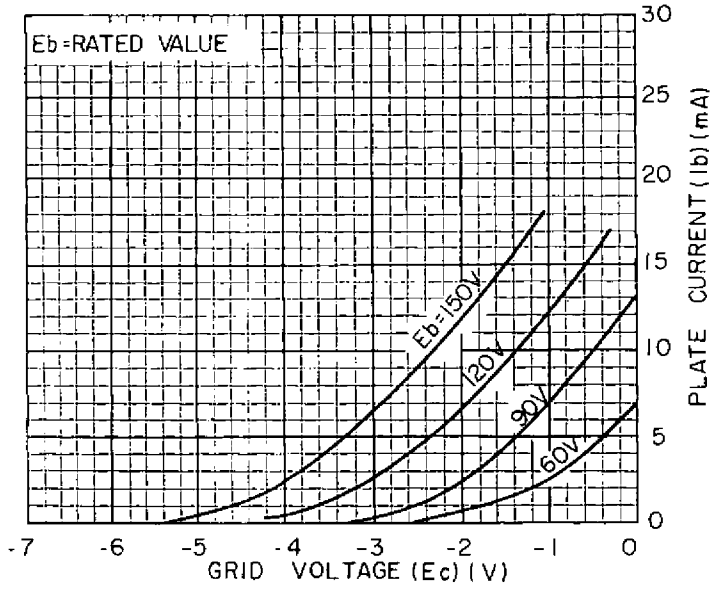
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AVERAGE PLATE CHARACTERISTICS
UNIT No.2



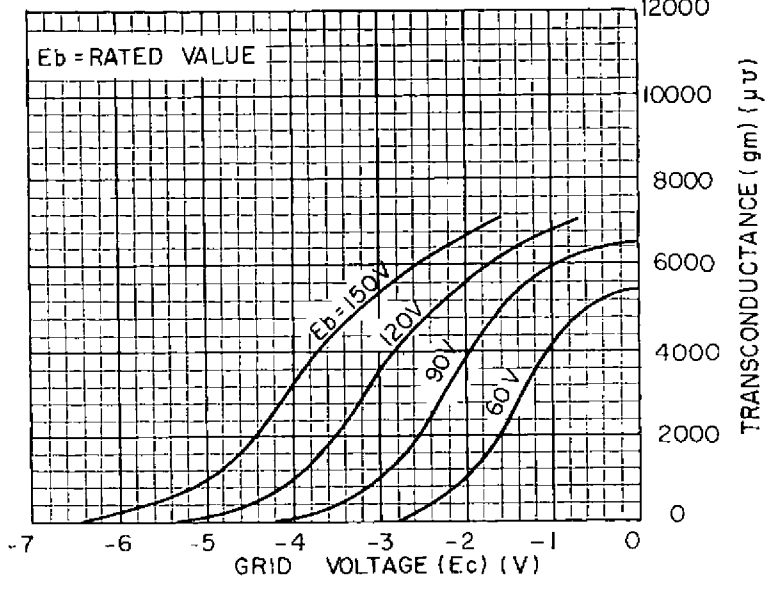
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AVERAGE CHARACTERISTICS
UNIT NO. 2



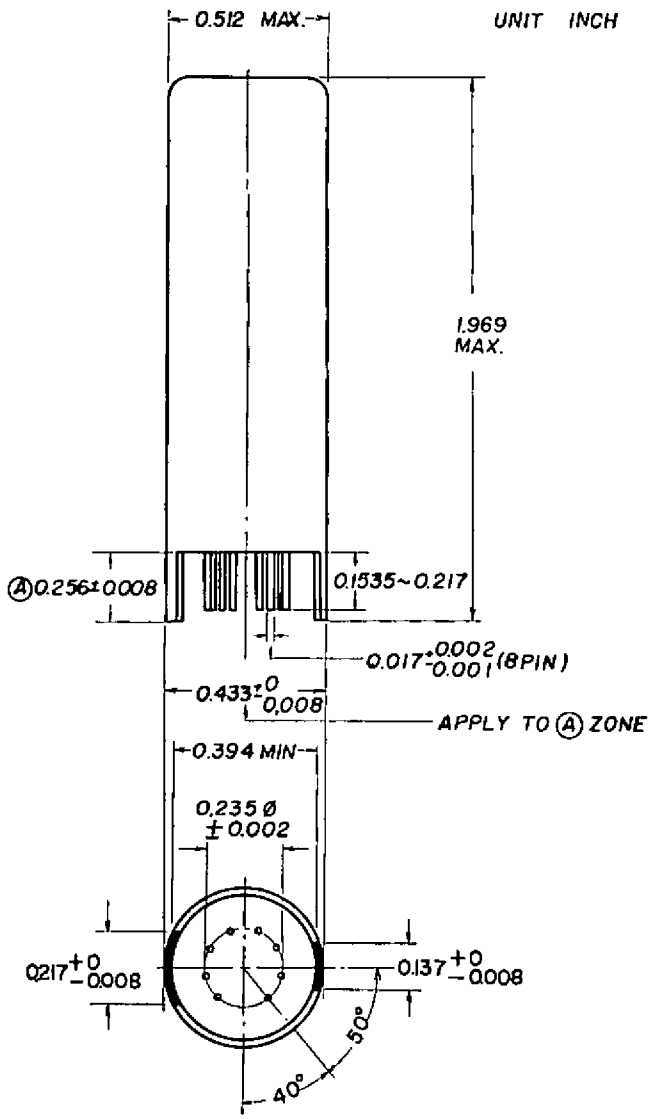
3FW7, 6FW7
AVERAGE CHARACTERISTICS
UNIT NO. 1



3FW7, 6FW7
AVERAGE CHARACTERISTICS
UNIT NO. 1

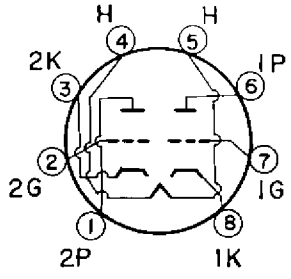


3FW7 6FW7
DIMENSIONAL OUTLINE



3FW7 6FW7
SOCKET CONNECTIONS
BOTTOM VIEW

PIN 1 Unit 2 Plate
PIN 2 Unit 2 Grid
PIN 3 Unit 2 Cathode
PIN 4 Heater
PIN 5 Heater



PIN 6 Unit 1 Plate
PIN 7 Unit 1 Grid
PIN 8 Unit 1 Cathode

8LM

Toshiba

All inquiries as to the data should be addressed to Tokyo Shibaura Electric Co., Ltd., Lamp and Tube Manufacturing and Sales Division, 72 Horikawacho, Kawasaki, Kanagawa-ken, Japan.

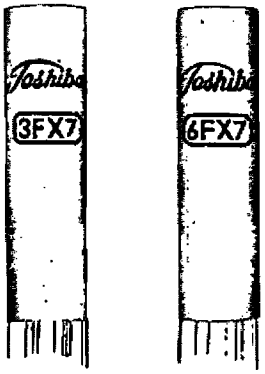
TOKYO SHIBAURA ELECTRIC CO., LTD.
KAWASAKI JAPAN

Toshiba

EIA REGISTRATION DATA

Type 3FX7, 6FX7

Date issued Mar. 31 1962



Toshiba 3FX7, 6FX7 are 8 pin subminiature, with shield can having indexing lugs, medium Mu twin triode, with high transconductance, low noise and low interelectrode capacitance, designed for use as a cascode amplifier in high gain tuners for television receivers.

Toshiba 3FX7 is like Toshiba 6FX7 except that it has a 3.5-volt/600-milliampere heater for use in series string circuit.

GENERAL DATA

Electrical:

	6FX7	3FX7	
Heater, for unipotential cathode:			
Voltage (AC and DC)	6.3	3.5	Volts
Current	300	600	ma
Heater warm up time	—	Approx. 11	sec.
Direct Interelectrode capacitances (with shield can)	Unit 1	Unit 2	
Grid to plate: (g to p)	2.05	1.45	μμf
Input: g to (h+k+is+sd)	—	3.1	μμf
Input: 1K to (h+lg+is+sd) Grounded Grid	5.5	—	μμf
Output: p to (h+k+is+sd)	—	1.05	μμf
Output: 1P to (h+lg+is+sd) Grounded Grid	2.95	—	μμf
Plate to Cathode: p to k	0.16	—	μμf
Heater to Cathode: h to k	2.3	2.5	μμf

Printed in Japan

from JEDEC release #3801, July 23, 1962

Mechanical:

Operating position	Any
Maximum overall length	1.772"
Maximum Diameter	0.512"
Bulb	T 3
Base	E 8—9

Maximum Ratings (Design Maximum Values):

Plate Supply Voltage with Cut off Bias	300 Volts
Plate Voltage (each section)	100 Volts
Plate Dissipation (each section)	1.7 Watts
Plate Dissipation (unit 1, Unit 2)	3.2 Watts
Cathode Current	20 ma
Circuit Values: Grid Circuit Resistance (each section)	0.5 Megohms
Heater Cathode Voltage	
Heater Negative with Respect to Cathode, DC	200 Volts
Total, DC and peak	200 Volts
Heater Positive with Respect to Cathode, DC	100 Volts
Total, DC and peak	200 Volts

Typical Operating Conditions and Characteristics:

Class A1 Amplifier (each section)

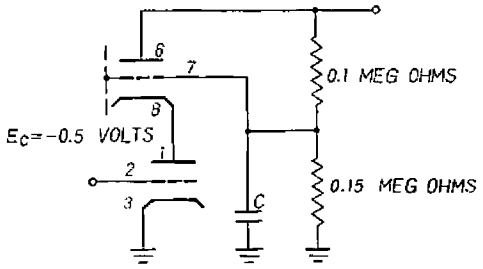
Plate Voltage	90 Volts
Grid Voltage	—1 Volts
Amplification Factor	36
Plate Resistance	3800 Ohms
Transconductance	9500 μmhos
Plate Current	9.0 ma
Grid Voltage, Approximate for Ib=10 μa	—4 Volts

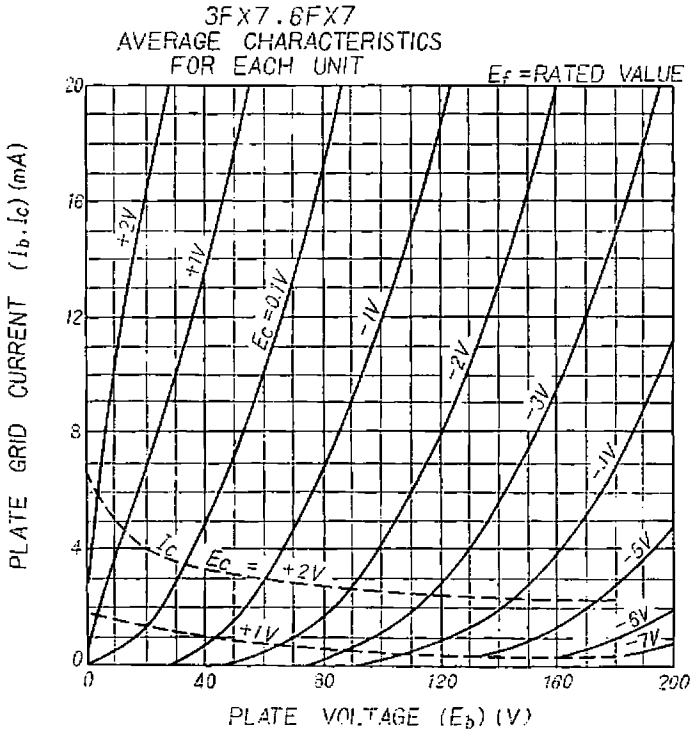
Cascode Amplifier (see typical operating circuit):

Plate Voltage	165 Volts
Grid Voltage	—0.5 Volts

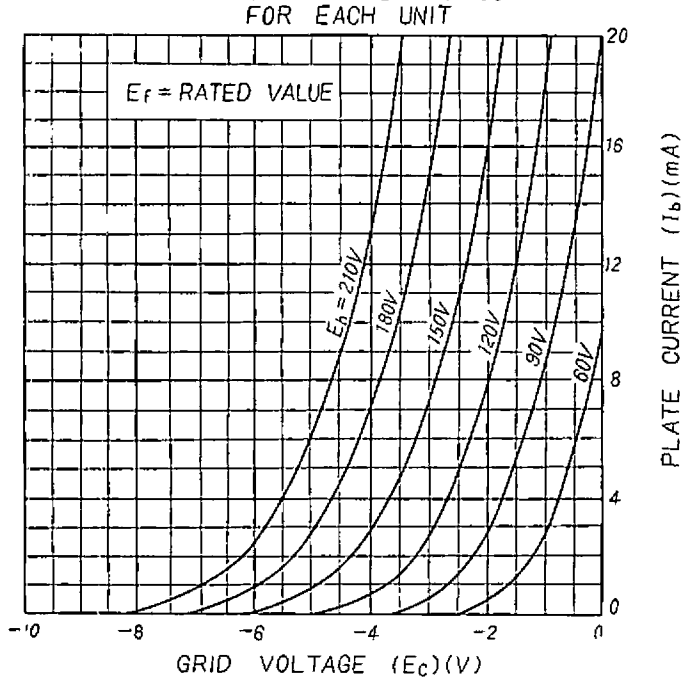
Transconductance	*13000 μ mhos*
Plate Current	*16.5 ma*
Grid Voltage, Approximate for gm = 50 μ mhos	*−5 Volts*

TYPICAL OPERATING CIRCUIT

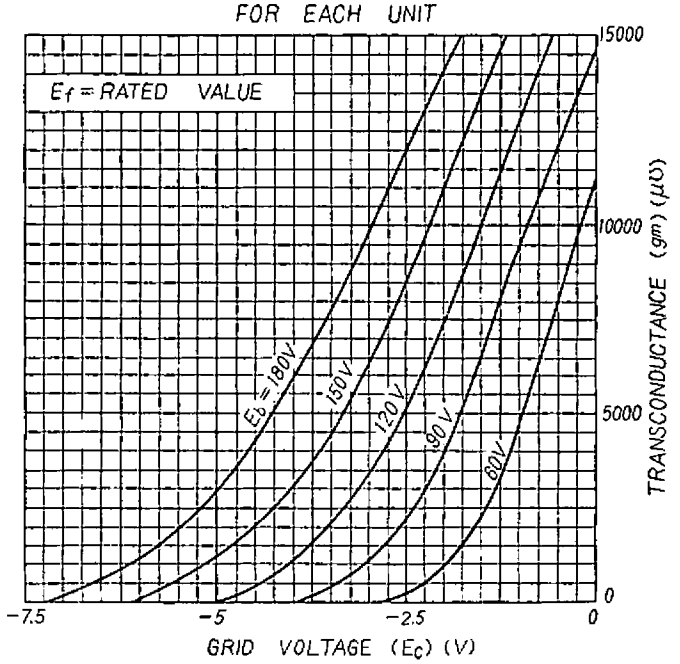




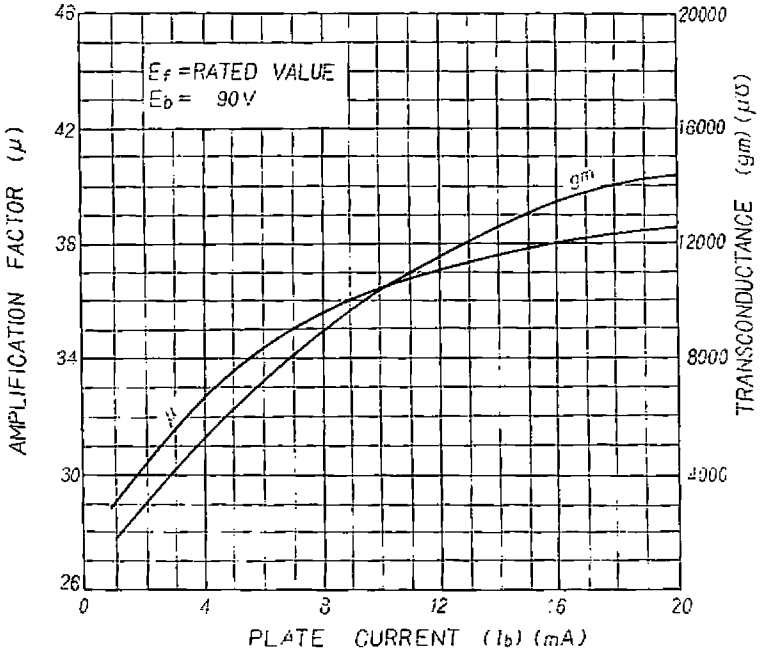
3FX7 . 6FX7
AVERAGE CHARACTERISTICS
FOR EACH UNIT



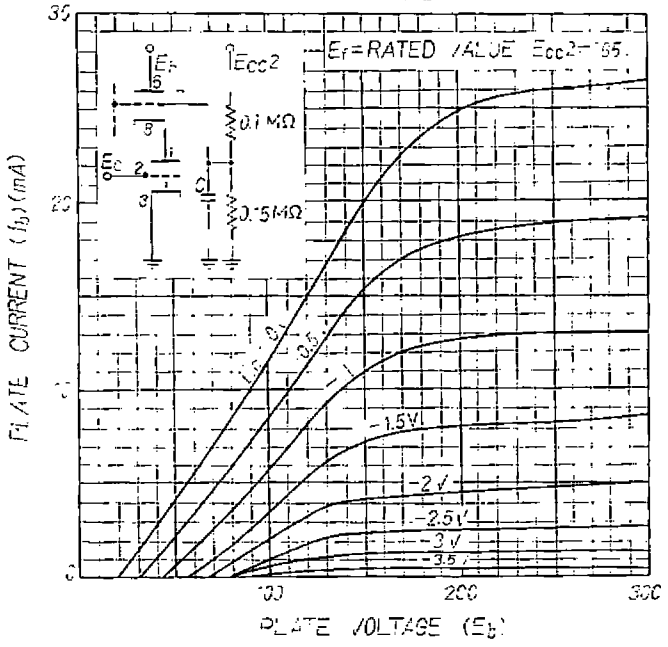
3FX7 . 6FX7
AVERAGE CHARACTERISTICS
FOR EACH UNIT



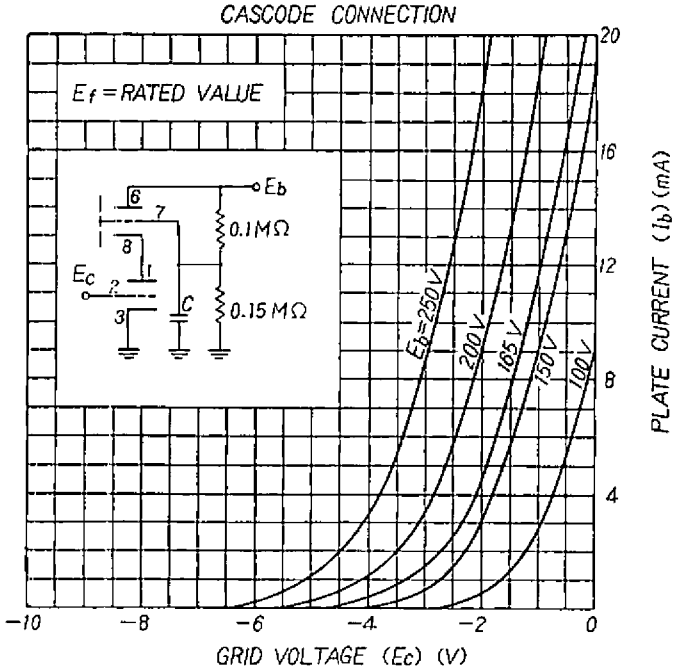
3FX7 . 6FX7
AVERAGE CHARACTERISTICS
FOR EACH UNIT



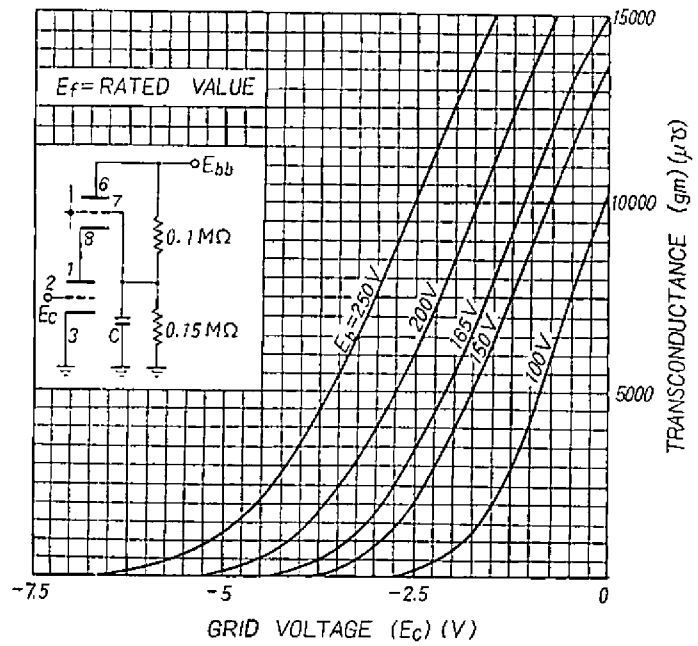
3FX7 . 6FX7
AVERAGE PLATE CHARACTERISTICS
CASCODE CONNECTION



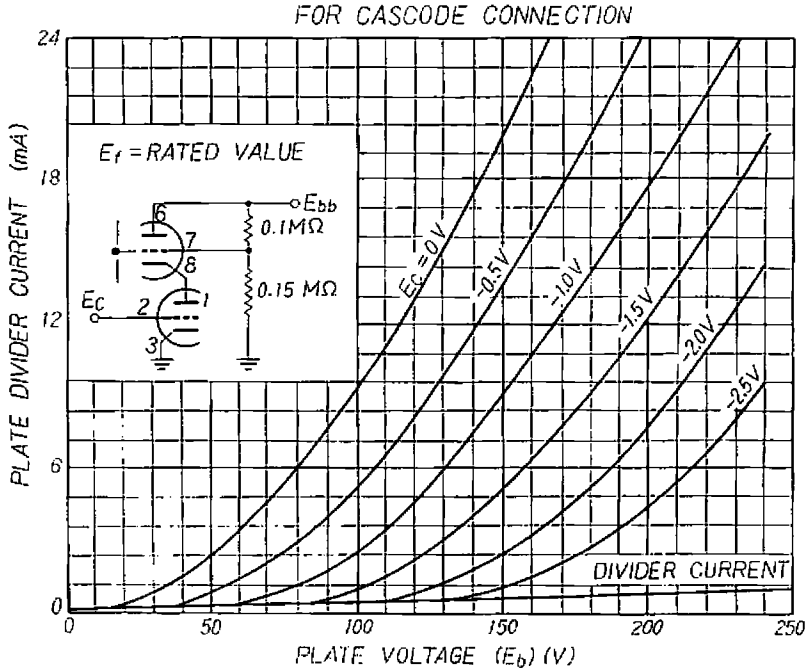
3FX7 . 6FX7
AVERAGE PLATE CHARACTERISTICS
CASCODE CONNECTION



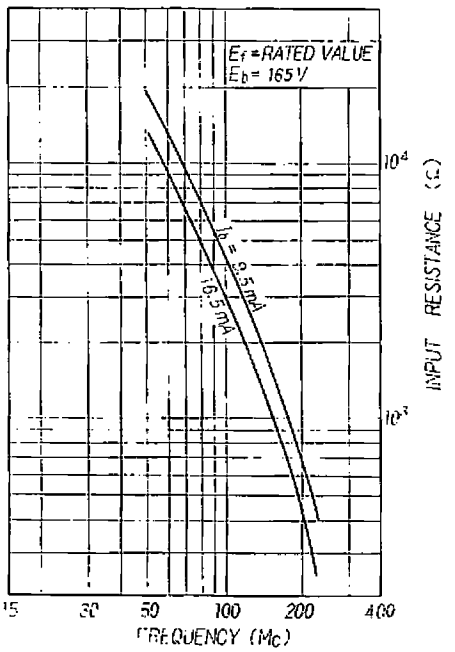
3FX7 . 6FX7
AVERAGE CHARACTERISTICS
FOR CASCODE CONNECTION



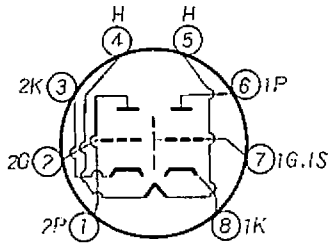
3FX7 . 6FX7
AVERAGE CHARACTERISTICS
FOR CASCODE CONNECTION



3FX7 . 6FX7
AVERAGE CHARACTERISTICS
INPUT RESISTANCE CASCODE CONNECTION



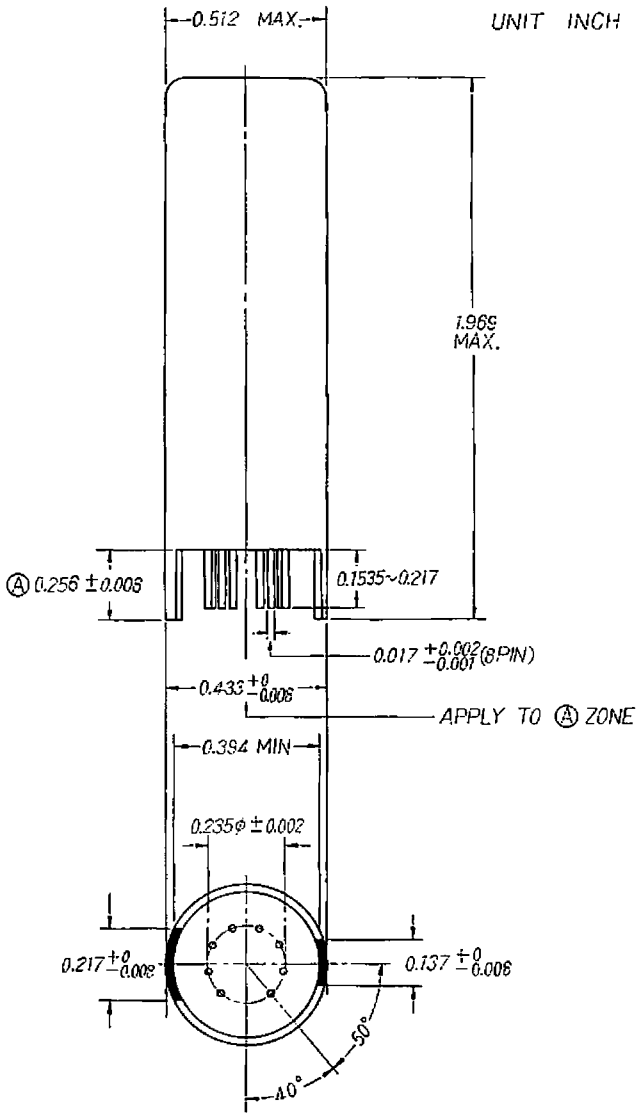
3FX7. 6FX7
SOCKET CONNECTIONS
BOTTOM VIEW



PIN 1: Unit 2 Plate
PIN 2: Unit 2 Grid
PIN 3: Unit 2 Cathode
} Grounded Cathod Input Section
PIN 4: Heater
PIN 5: Heater
PIN 6: Unit 1 Plate
PIN 7: Unit 1 Grid
Internal Shield
PIN 8: Unit 1 Cathode
} Grounded Grid Output Section

8LK

3FX7 . 6FX7
DIMENSIONAL OUTLINE



Toshiba

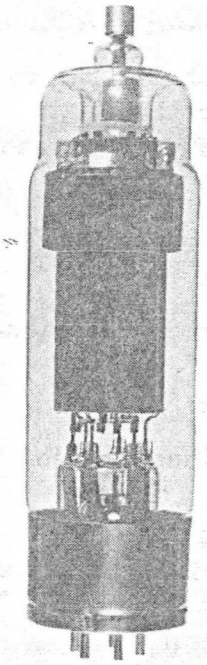
All inquiries as to the data should be addressed to Tokyo Shibaura Electric Co., Ltd., Lamp and Tube Manufacturing and Sales Division, 72 Horikawacho, Kawasaki, Kanagawa-ken, Japan.

TOSHIBA

Electron Tube, Device & Equipment

TECHNICAL DATA

TOSHIBA HYDROGEN THYRATRON 3G49P/5949



Toshiba 3G49P/5949 is a hydrogen thyratron for switching service in rader modulator and other pulse applications. It is capable of switching a peak power of 6 MW at an average power of 6 kW.

3G49P/5949 has a hydrogen reservoir which assures freedom from failure due to gas clean-up. The reservoir compensates for the gas consumed during operation and permits the user to adjust the pressure within the tube to the most suitable volume for the particular application.

GENERAL DATA

ELECTRICAL:

	Minimum	Bogie	Maximum	
Cathode ; Indirectly Heated Tied to the Heater Midpoint				
Heater Voltage	6.0	6.3	6.6	V
Heater Current (Ef=6.3V)	15	18.5	22	A
Reservoir Heater Voltage ([1])	3.0	-	5.5	V
Reservoir Heater Current (Eres=4.5V)..	2	-	5	A
Cathode and Reservoir Heating Time	900	-	-	
Anode Voltage Drop	-	150	250	V
Anode Delay Time	-	-	1.0	μs
Anode Current Time Jitter	-	0.005	0.01	μs

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* The information contained herein may be changed without prior notice. It is therefore advisable to contact TOSHIBA before proceeding with the design of equipment incorporating this product.

No.ED-T100 1982-05-14

MECHANICAL:

Dimensions:	See Outline Drawing
Overall Length	305±13 mm
Maximum Diameter	84 mm
Base Number:	
Cap	A14S (JEDEC No. C1-5)
Base	E32S-1 (Equivalent JEDEC No.A5-97)
Recommended Socket:	
Cap	Toshiba VT-29061
Base	Toshiba VT-21031
Base Connections	See Outline Drawing
Colling (2)	Convection
Mounting Position	Any
Net Weight (Approx.)	860 g

RATINGS

ABSOLUTE MAXIMUM:

Maximum Peak Anode Voltage (3);			
Inverse		25,000	V
Forward	5% epy	∿ 25,000	V
Minimum Supply Voltage		5,000	V
Negative Grid Voltage (Before Conduction)		450	V
Maximum Anode Current:			
Peak		500	A
Average		0.5	A
RMS (4)		15	A
Averaging Time		1	cycle
Maximum Rate of Rise of Anode Current		2,500	A/ s
Pulse Repetiting Rate (prr)(5)		2,000	pps
Operation Factor (6)		6.25×10^{9}	
Pulse Duration		6	μs
Ambient Temperature Limits		-55 ∿ +75	°C
Altitude		3,000	m

GRID DRIVE (7):

Grid Trigger Voltage (Peak)	550 ∿ 1,000	V
Maximum Rise Time	0.25	μs
Minimum Grid Pulse Duration	2	μs
Grid Drive Circuit Impedance	50 ∿ 200	Ω

Notes (1) The optimum reservoir voltage for operation at maximum tube voltage, maximum peak and average tube currents, and at a repetition corresponding to the rated operation factor is inscribed on the base of the tube, and must be held within ±5 percent. Applications involving operation at other conditions will necessitate the redetermination of the optimum reservoir voltage.

(2) Cooling of anode lead by forced convection permissible, but there shall be no air blast directly on the bulb.

(3) Instantaneous starting is not recommended. However, in case where it is necessary to apply anode voltage instantaneously, the maximum permissible forward starting voltage is 18,000 volts peak. The power-supply filter should be designed to limit the rate of application of this voltage to 450,000 volts per second.

The minimum inverse anode voltage permissible is 5 percent of the peak forward voltage and the maximum is 5000 volts during the first 25 microseconds following the anode pulse exclusive of a spike of 0.05 microsecond maximum duration.

(4) The root mean square anode current shall be computed as the square root of the product of peak current (ib) and the average current (Ib), i.e.

$$Irms = \sqrt{ib \times Ib}$$

(5) prr (pusle repetiting rate) depends on both peak forward anode voltage epy (V) and peak anode current ib (A). The figure given above is an example of epy and ib against maximum ratings. Actually, the design should be made within the limit of epy (V) × prr (pps) × ib (A) ≦ Operation Factor

Notes (6) Operation factor = epy (peak forward anode voltage) × ib (peak anode current) × prr (pulse repetition rate).

(7) Driver pulse measured at tube socket with the thyratron grid disconnected.

GENERAL OPERATIONAL RECOMMENDATION

1. High Voltage

Operating voltages for power tubes range from several hundred volts to higher than 50,000 volts. Since these voltage can be deadly, equipment must be designed so that one can not come in contact with high voltage.

2. X-RAY Radiation

High-vacuum tubes operating at voltage higher than 10 kilovolts produce progressively more dangerous X-ray radiation as the voltage is increased. X-ray shielding must be provided on all sides of tubes which operate above 10 kilovolts, to provide adequate protection through the tube's life. If there is any doubt as to the adequacy of shielding, an expert in this field should be contacted to perform an X-ray survey of the equipment.

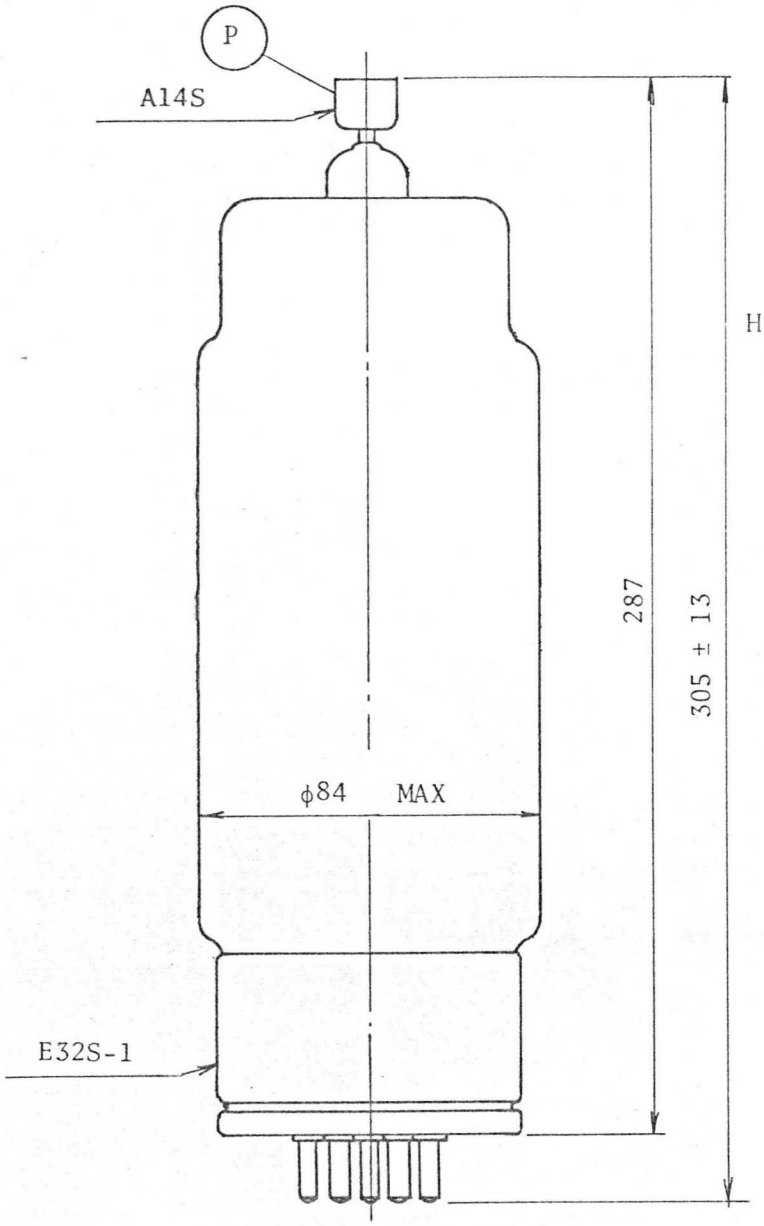
3. High Temperature

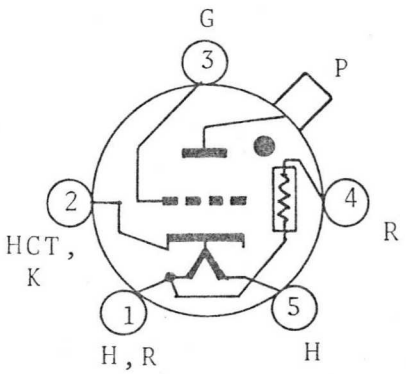
Don't come in contact with the vacuum tubes, not only the period of the operation but also immediately after the removal of all tubes voltages becuase the temperature of the tube during the operation often exceeds 200°C.

DIMENSIONAL OUTLINE

3G49P/5949

Unit : mm





P: Anode

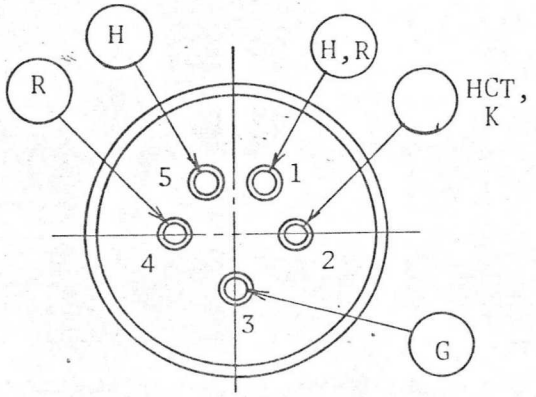
G: Grid

K: Cathode

H: Heater

HCT: Center of Heater

R: Reservoir

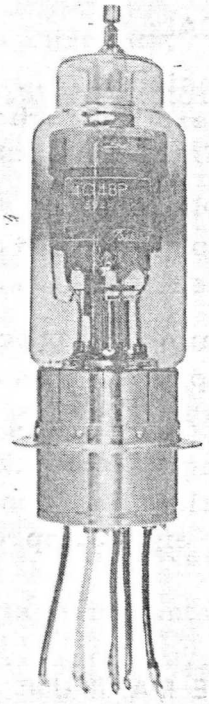


TOSHIBA

Electron Tube, Device & Equipment

TECHNICAL DATA

TOSHIBA HYDROGEN THYRATRON
4G48P/5948



Toshiba 4G48P/5948 is a hydrogen thyratron for switching service in rader modulator and other pulse applications. It is capable of switching a peak power of 12 MW at an average power of 12 kW.

4G48P/5948 has a hydrogen reservoir which assures freedom from failure due to gas clean-up. The reservoir compensates for the gas consumed during operation and permits the user to adjust the pressure within the tube to the most suitable value for the perticular application.

GENERAL DATA

ELECTRICAL:

	Minimum	Bogie	Maximum	
Cathode ; Indirectly Heated Tied to the Heater Midpoint				
Heater Voltage	6.0	6.3	6.6	V
Heater Current (Ef=6.3V)	25	29	33	A
Reservoir Heater Voltage ([1])	2.5	-	5.5	V
Reservoir Heater Current ..... (Eres=4.5V)	3	-	6	A
Cathode and Reservoir Heating Time ..	900	-	-	
Anode Voltage Drop	-	250	400	V
Anode Delay Time	-	-	1.0	μs
Anode Current Time Jitter	-	0.005	0.01	μs

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* The information contained herein may be changed without prior notice. It is therefore advisable to contact TOSHIBA before proceeding with the design of equipment incorporating this product.

No.ED-T100 1982-05-14

MECHANICAL:

Dimensions:	See Outline Drawing
Overall Length	400 ± 13 mm
Maximum Diameter	154 mm
Base Number:	
Cap	A14S (JEDEC No. C1-5)
Base	See Outline Drawing
Recommended Socket:	
Cap	Toshiba VT-29061
Base Connections	See Outline Drawing
Colling (2)	Convection
Mounting Position	Vertical, Base down
Net Weight (Approx.)	2000 g

RATINGS

ABSOLUTE MAXIMUM:

Maximum Peak Anode Voltage (3);			
Inverse		25,000	V
Forward	5% epy ∿	25,000	V
Minimum Supply Voltage		5,000	V
Negative Grid Voltage (Before Conduction)		650	V
Maximum Anode Current:			
Peak		1,000	A
Average		1	A
RMS (4)		30	A
Averaging Time		1	cycle
Maximum Rate of Rise of Anode Current		5,000	A/μs
Pulse Repetiting Rate (prr)(5)		1,500	pps
Operation Factor (6)		9×10^9	
Pulse Duration		6	μs
Ambient Temperature Limits	-90 ∿	+75	°C
Altitude		3,000	m

GRID DRIVE (7):

Grid Trigger Voltage (Peak)	-700 ∿	1,000	V
Maximum Rise Time		0.35	μs
Minimum Grid Pulse Duration		2	μs
Grid Drive Circuit Impedance	50 ∿	200	Ω

Notes (1) The optimum reservoir voltage for operation at maximum tube voltage, maximum peak and average tube currents, and at a repetition corresponding to the rated operation factor is inscribed on the base of the tube and must be held within ±5 percent. Applications involving operation at other conditions will necessitate the redetermination of the optimum reservoir voltage.

(2) Cooling anode lead by forced convection permissible, but there shall be no air blast directly on the bulb.

(3) Instantaneous starting is not recommended. However, in case where it is necessary to apply anode voltage instantaneously, the maximum permissible forward starting voltage is 18,000 volts peak. The power-supply filter should be designed to limit the rate of application of this voltage to 450,000 volts per second.

The minimum inverse anode voltage permissible is 5 percent of the peak forward voltage and the maximum is 5000 volts during the first 25 microseconds following the anode pulse exclusive of a spike of 0.05 microsecond maximum duration.

(4) The root mean square anode current shall be computed as the square root of the product of peak current (ib) and the average current (Ib), i.e.

$$Irms = \sqrt{ib \times Ib}$$

(5) prr (pulse repetiting rate) depends on both peak forward anode voltage epy (V) and peak anode current ib (A). The figure given above in an example of epy and ib against maximum ratings.

Actually, the design should be made within the limit of epy (V) × prr(pps) × ib(A) ≦ Operation Factor.

(6) Operation factor = epy (peak forward anode voltage) × ib (peak anode current) × prr (pulse repetition rate).

(7) Driver pulse measured at tube socket with the thyratron grid disconnected.

GENERAL OPERATIONAL RECOMMENDATION

1. High Voltage

Operating voltages for power tubes range from several hundred volts to higher than 50,000 volts. Since these voltage can be deadly, equipment must be designed so that one can not come in contact with high voltage.

2. X-RAY Radiation

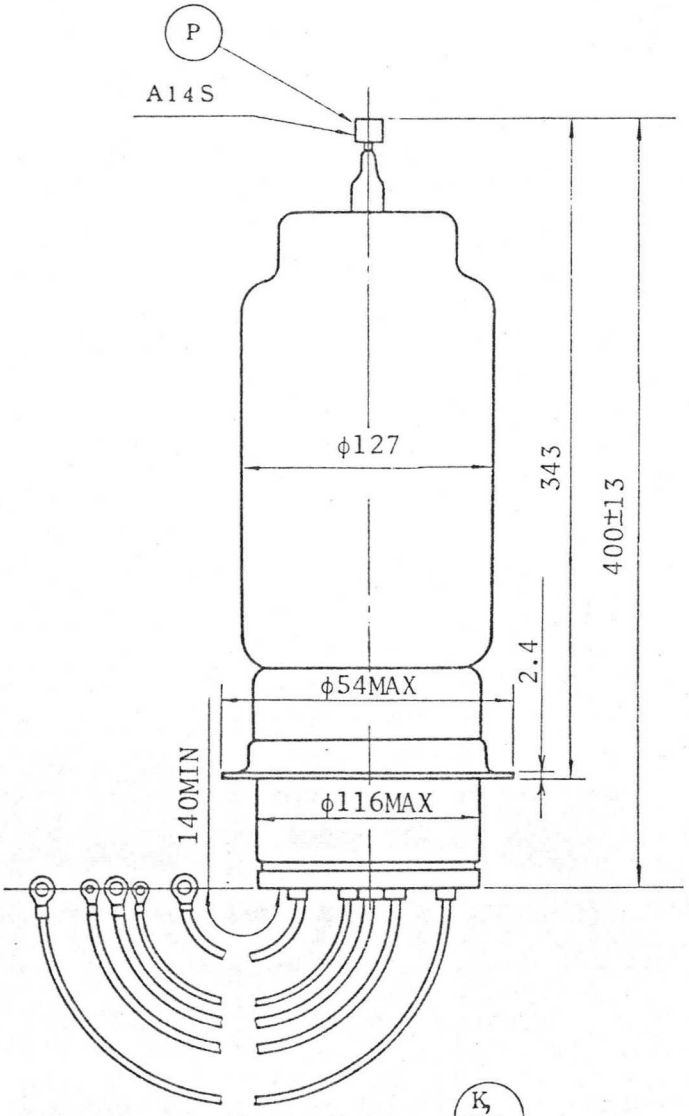
High-vacuum tubes operating at voltage higher than 10 kilovolts produce progressively more dangerous X-ray radiation as the voltage is increased. X-ray shielding must be provided on all sides of tubes which operate above 10 kilovolts, to provide adequate protection through the tube's life. If there is any doubt as to the adequacy of shielding, an expert in this field should be contacted to perform an X-ray survey of the equipment.

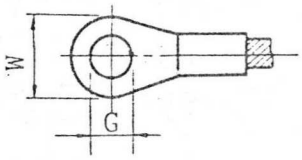
3. High Temperature

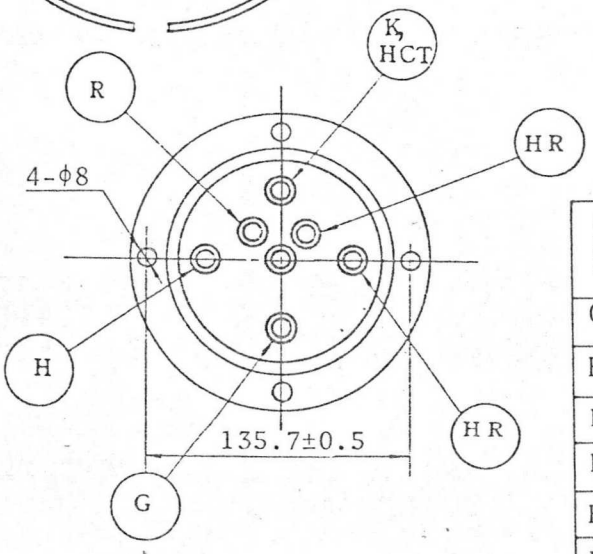
Don't come in contact with the vacuum tubes, not only the period of the operation but also immediately after the removal of all tubes voltages becuase the temperature of the tube during the operation often exceeds 200°C.

DIMENSIONAL OUTLINE Unit : mm

4G48P /5948







LEAD	Color	DIMENSIONS	
		G	W
G	Green	5±0.25	10MAX
H	Yellow	7.3±0.6	15.3MAX
K	Black	7.3±0.6	15.3MAX
R	Red	5±0.25	10MAX
HR	Red with Black sleeve	7.3±0.6	15.3MAX
HR	Red with Yellow sleeve	5±0.25	10MAX

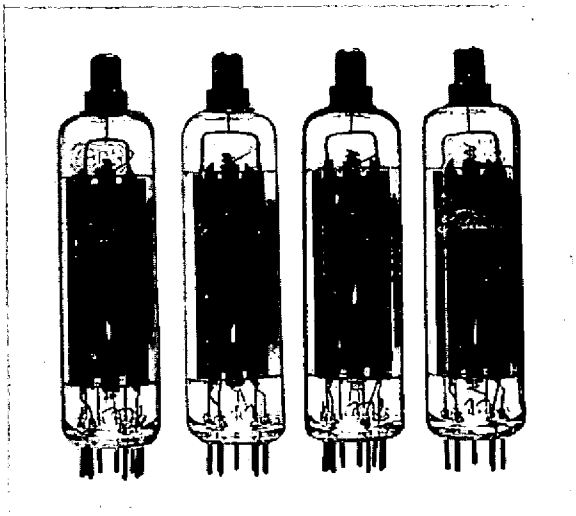
TOKYO SHIBAURA ELECTRIC CO., LTD.
KAWASAKI JAPAN

Toshiba

EIA REGISTRATION DATA

Type 6BR3 12BR3 17BR3 25BR3

Date issued Aug. 31 1962



Toshiba 6BR3, 12BR3, 17BR3, and 25BR3 are 9 pin miniature heater cathode type diode designed for use as damping diode in horizontal deflection circuit of television receivers.

As the cathode is connected to top cap and is capable high output current, they are especially convenient for design of television receivers.

They also withstand high pulse voltage between the heater and cathode and high inverse pulse voltage between the plate and cathode.

These characteristics make the tube especially suitable horizontal circuit in large deflection type television receivers.

Except for heater ratings, the 12BR3, 17BR3 and 25BR3 are identical to the 6BR3.

The 12BR3, 17BR3 and 25BR3 are controlled heater warm-up characteristic which makes them suited for use in television receivers that employ series connected heater.

GENERAL DATA

Electrical :

Heater, for unipotential cathode :	*6BR3*	*12BR3*	*17BR3*	*25BR3*	
Voltage (AC and DC)	*6.3*	*12.6*	*16.8*	*25.0*	*volts*
Current	*1.2*	*0.60*	*0.45*	*0.30*	*Amperes*
Heater warm up time	*Approx. —*	*11*	*11*	*11*	*Seconds*

Direct Interelectrode Capacitances (without external shield) :		
Heater to Cathode	*3.0*	*μμf*
Cathode to Plate and Heater	*10.5*	*μμf*
Plate to Cathode and Heater	*8.5*	*μμf*

Printed in Japan

from JEDEC release #3940, Oct. 22, 1962

Mechanical :

Operating Position	Any
Maximum Overall Length	3½"
Maximum Seated Height	3¼"
Maximum Diameter	⅞"
Bulb	T-6½
Base	E9-1
Top Base	C1-3

Maximum Ratings (Design Maximum Values) :

TV Damper service for operating in a 525 line, 30 frame system.

Peak Inverse Plate Voltage*	5500	volts Max.
Peak Plate Current	1200	ma Max.
DC Plate Current	200	ma Max.
Plate Dissipation	6.5	Watts Max.
Peak Heater to Cathode Voltage		
Heater Negative with Respect to Cathode**	5500	volts Max.
Heater Positive with Respect to Cathode***	300	volts Max.
Bulb Temperature (at Hottest Point)	180	°C Max.

* The duration of the voltage pulse should not exceed 15% of one horizontal scanning cycle. In 525-Line, 30-Frame system, 15% of one horizontal scanning cycle is 10 microseconds.

** The DC component must not exceed 900 volts.

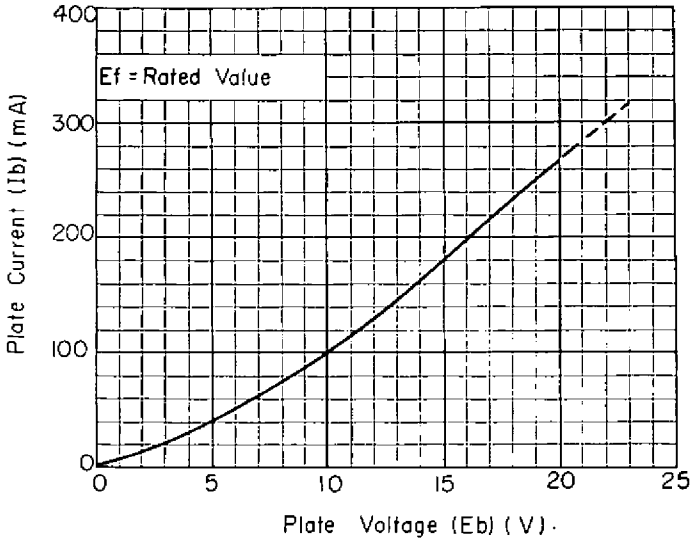
*** The DC component must not exceed 100 volts.

Average Characteristics :

Tube Voltage Drop Ib=250 mA DC	19	volts

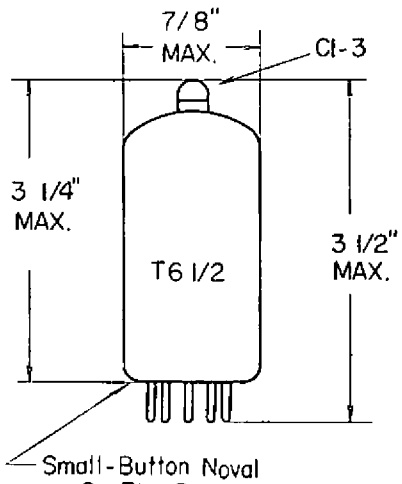
6BR3 12BR3 17BR3 25BR3

Average Plate Characterstics



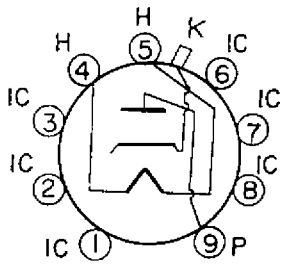
Toshiba TOKYO SHIBAURA ELECTRIC CO., LTD.
KAWASAKI JAPAN

6BR3 12BR3 17BR3 25BR3
DIMENSIONAL OUTLINE



6BR3 12BR3 17BR3 25BR3
SOCKET CONNECTIONS
Bottom View

Pin 1 : Internal Connection
Pin 2 : Same as Pin 1
Pin 3 : Same as Pin 1
Pin 4 : Heater
Pin 5 : Heater



Pin 6 : Same as Pin 1
Pin 7 : Same as Pin 1
Pin 8 : Same as Pin 1
Pin 9 : Plate
Cap : Cathode

9CB

All inquiries as to the data should be addressed to Tokyo Shibaura Electric Co., Ltd., Lamp and Tube Manufacturing and Sales Division, 72 Horikawacho, Kawasaki, Kanagawa-ken, Japan.

CTPI T.P.D. (4)

Received March 1961

TOSHIBA IMAGE ORTHICON CAMERA TUBE

TYPE 5820

Toshiba

TOKYO SHIBAURA ELECTRIC CO., LTD.

2, Ginza Nishi 5-chome, Chuo-ku, Tokyo, Japan Cable : TOSHIBA TOKYO

TOSHIBA IMAGE ORTHICON CAMERA TUBE
TYPE 5820

The Toshiba tube type 5820 is a television camera tube suitable for both studio and outdoor pickups. It is interchangeable with the RCA tube type 5820.

The Toshiba 5820 has several merits as follows:

(1) Toshiba 5820 can be used at higher temperatures, because it has special target glass made by Toshiba.

(2) Less tendency for "Burning" contributes to longer service hours.

(3) Higher resolution capability

INTRODUCTION

The Toshiba 5820 is a television camera tube suitable both for outdoor pickups at low level of illumination as well as for studio pickups because of its exceptionally high sensitivity and particular storage capacity.
A light flux of only 0.25 milli-lumen to the photocathode is sufficient to make full use of the transfer characteristic of the tube. In spite of this high sensitivity the 5820 shows no sign of instability.

The spectral sensitivity of the photocathode used in the 5820 is high for blue and green, very good for yellow and good for red; in the infrared region there is practically no sensitivity, thus preventing a colour-masking by this part of this spectrum.

The secondary electron multiplier incorporated in the 5820 has an average gain of 500 to 1000, giving signal currents of several micro-amperes; these high output currents eliminate the need for a special low noise amplifier in the camera and allow the use of a relatively low number of stages.

Under proper operating conditions, the 5820 has light transfer characteristics which do not require the use of gamma-correction circuits to provide normal tone rendition in black-and-white pictures on the picture tube screen.

OPERATING PRINCIPLES

The 5820 has three sections — an image section, a scanning section, and a multiplier section

1. Image Section

The image section contains a semitransparent photocathodes on the inside of faceplate, a grid to provide an electrostatic accelerating field, and a target which contains of a thin glass disc with a fine mesh screen very closely spaced to it on the photocathode side. Focusing is accomplished by means of a magnetic field produced by an external coil, and by varying the photocathode voltage.

Light from the scene to be televised is focused by an optical lens system onto the photocathode from which photo-electrons are emitted proportionally to the intensity of the optical image at any particular point. These photo-

electrons are focused onto the target by the compined action of the electrostatic and longitudinal magnetic field, the latter being produced by an external coil. Secondary electrons produced by the incident photo-electrons are collected by the fine mesh screen which is held at a definite small positive potential with respect to the target. The potential excursion of the target is thus limited, ensuring complete stability at all light levels. The secondary emission at the target produces a pattern of positive charges corresponding point to point with the light distribution of the original scene. The thinness of the target allows this charge pattern to be reproduced on its reverse side, i.e. the scanned side.

2. Scanning Section

The reverse side of the target is scanned by an electron beam emanating from the electron gun in the scanning section. This gun comprises a thermionic cathode, a control grid (Grid #1) and an accelerating grid (Grid #2). The beam is focused at the target by magnetic field of the external focusing coil and the electrostatic field of Grid #4.

The beam is aligned with the focusing magnetic field by means of a small transverse magnetic field produced by an external coil located at the gun and of the focusing coil.

Deflection of the beam is accomplished by transverse magnetic fields produced by external deflection coils.

The relative potential of the gun and associated electrodes are such that the beam approaches the target with substantially zero velocity. In areas of the target corresponding to the dark areas of the image, the beam is unable to land and the beam is reflected towards the gun. In areas corresponding to the illuminated regions of the image, the target will be positively charged and electrons will be deposited until the traget potential is restored to its original value. That fraction of the beam not required for neutralisation of the target charge pattern will return towards the gun. The return beam is thus amplitude modulated, its intensity being inversely proportional to the brightness of the original image.

3. Multiplier Section

The electrons which fail to land on the target constitute the return beam and are directed to the first dynode of a five stage electrostatically focused multiplier. This utilizes the phenomenon of the secondary emission to amplify signals composed of electron beam. The electrons in the beam impinging on the first dynode surface produce many other electrons, the number depending on the energy of the impinging electrons. These secondary electrons are then directed to the second dynode and knock out more new electrons. Grid # 3 facilitates a more complete correction by dynode #2 of the secondaries from dynode #1. The multiplier process is repeated in each successive stage, with an ever-increasing stream of electrons until those emitted from dynode #5 are corrected by the anode and constitute the current utilized in the output circuit.

The multiplier section amplifies the modulated beam about 500 to 1000 times. The gain of the multiplier is sufficiently high so that the random noise of the electron beam is brought above that of the input stage of the video amplifier. It thus becomes the limiting noise in the use of the tube. The presence of the multiplier also permits the use of an amplifier of fewer stages.

It can be seen that when the beam moves from a less positive portion on the target to a more positive portion, the signal output voltage across the load resistor changes in the positive direction. Hence for highlight in the scene, the grid of the first video amplifier stages swings in the positive direction.

DATA

1. General Ratings

Heater, for Unipotential Cathode:	
Voltage (AC or DC)	6.3 volts ± 10 %
Current	0.6 ampere
Direct Interelectrode Capacitance:	
Anode to all other electrodes	12 pF
Photocathode, Semitransparent:	
Response	See Fig. 2
Rectangular Image (4x3 aspect ratio):	
Useful size of	1.8" max. diagonal
Note: The size of the optical image focused on the photocathode should be adjusted so that its maximum diagonal does not exceed the specified value. The corresponding electron image on the target should have a size such that the corners of the rectangle just touch the target ring.	
Orientation of	Proper orientation is obtained when the vertical scan is essentially parallel to the plane passing through center of faceplate and pin #7 of the shoulder base.
Focusing Method	Magnetic
Deflection Method	Magnetic
Overall length	15.20" ± 0.25
Greatest Diameter of Bulb	3.00" ±0.06
Shoulder Base	Keyed Jumbo Annular 7-pin
End Base	Small-Shell Diheptal 14-pin (JETEC #B14-45)
Operating Position	Undermentioned
Weight (approx.)	1lb 6oz
Minimum Deflecting-Coil Inside Diameter	2-3/8"
Deflection-Coil Length	5"
Focusing-Coil Length	10"
Alignment-Coil Length	15/16"
Photocathode Distance Inside End of Focusing Coil	1/2"

2. Maximum Ratings (Absolute values)

Photocathode:	
Voltage	-550 max. volts
Illumination	50 max. ft-c
Operating Temperature:	
Of any part of bulb	55 max. °C
Of bulb at large end of tube (Target section)	40 min. °C
Temperature Difference:	
Between target section and any part of bulb hotter than target section.	5 max. °C
Grid-No.6 Voltage	-550 max. volts
Traget Voltage:	
Positive value	10 max. volts
Negative value	10 max. volts
Grid-No.5 Voltage	150 max. volts
Grid-No.4 Voltage	300 max. volts

sup.6

Grid No. 3 Voltage	400 max. volts
Grid-No. 2 & Dynode-No. 1 Voltage	350 max. volts
Grid-No. 1 Voltage:	
Negative bias value	125 max. volts
Positive bias value	0 max. volts
Peak Heater-Cathode Voltage:	
Heater negative with respect to cathode	125 max. volts
Heater positive with respect to cathode	10 max. volts
Anode-Supply Voltage	1350 max. volts
Voltage Per Multiplier Stage	350 max. volts

3. Typical Operation and Characteristics

Image Focus (Photocathode) Voltage	-400 to -540 volts
Accelerator (Grid-No. 6) Voltage Approx. 75% of photocathode voltage	-300 to -405 volts
Target-Cutoff Voltage	-3 to +1 volts
Decelerator (Grid-No. 5) Voltage	0 to 125 volts
Beam Focus (Grid-No. 4) Voltage	140 to 180 volts
Multiplier Focus (Grid-No. 3) Voltage	225 to 330 volts
Grid-No. 2 & Dynode-No. 1 Voltage	300 volts
Grid-No. 1 Voltage for Picture Cutoff	-45 to -115 volts
Dynode-No. 2 Voltage	600 volts
Dynode-No. 3 Voltage	800 volts
Dynode-No. 4 Voltage	1000 volts
Dynode-No. 5 Voltage	1200 volts
Anode Voltage	1250 volts
Anode Current (DC)	30 vamp
Signal-Output Current (Peak to peak)	3 to 24 vamp
Target Temperature Range (See Text)	40 to 50 °C
Ratio of Peak-to-Peak Highlight Video-Signal Current to RMS Noise Current (Approx.)	35
Minimum Peak-to-Peak Blanking Voltage	5 volts
Field Strength at Center of Focusing Coil	75 gausses
Field Strength of Alignment Coil (Approx.)	0 to 3 gausses

OPERATION

Sequence of Adjustment

1. Insert tube camera and apply voltages as indicated under Typical Operation. Uncap the lens momentarily while adjusting the Grid #1 voltage to give a small amount of beam current. This procedure will prevent the mesh from being electrostatically pulled into contact with the glass disc. Make certain that the deflection circuits are functioning properly to cause the electron beams to scan the target.
2. Set scan amplitude control at maximum.
3. Leave to warm up for 1/4 to 1/2 hour with the camera lens capped.
4. With the lens still capped and the target voltage set at approximately 2 volts negative, adjust the Grid #1 voltage until noise or a rough-textured picture of Dynode #1 appears on the monitor. Then adjust the alignment coil current so that the small white dynode spot does not move when the beam-focus control (Grid #4) is varied, but simply goes in and out of focus.
5. Uncap camera lens.

6. Increase target voltage until information appears. Set voltage of target approximately 2 volts above cutoff and adjust beam current to the lowest value consistent with a satisfactory picture.
7. Decrease the scanning amplitude until the edge of the target ring just disappear at the corner of the picture.
8. Adjust the lens to produce the best optical-focus, and the voltage on the photocathode as well as the voltage on Grid # 4 to produce the sharpest picture.
9. Adjust the Grid #5 voltage control to produce the picture that has the most uniform shading from center to edge.
10. Adjust the Grid #3 voltage control to produce the maximum signal output.
11. Adjust image accelerator (Grid #6) for minimum S distortion.
12. Adjust gain for signal of correct amplitude.
13. Readjust beam, beam focus and image focus for the best picture.

SPECTRAL RESPONSE

The spectral response of the 5820 is not subject to appreciable variation from tube to tube.

The spectral response of the 5820 without correcting filter is shown by curve A in Fig. 2. Curve B in the same figure, shows the spectral response when a Wratten #6 filter is used with the 5820. This curve very closely approaches that of the eye shown by the dotted curve C.

TRANSFER CHARACTERISTICS

The basic light transfer characteristic of the 5820 is shown in Fig. 3. This curve is representative only for small area highlights. For larger area highlights, the bend or "knee" is not quite as abrupt as shown in Fig. 3.

The knee of the curve is explained by the fact that the charge accumulated by the target can not exceed the charge which raises the voltage of the target to the collector-mesh potential. As the result, when the 5820 is operated with highlights above the knee, not all of the secondary electrons emitted by the target glass disc are collected by the adjacent mesh, because it no longer maintains a positive accelerating field between itself and the charged areas. These secondary electrons not collected fall back on their original location or are randomly distributed over adjacent picture areas. Since they land on these areas at a low velocity, they tend to discharge the positive areas and limit their charge buildup.

Operation with the highlights above the knee allows the image orthicon to develop an electrial signal that, in conjunction with the light-output characteristics of the TV receiver kinescope, presents a picture having normal tone rendition.

In general, when operated with the camera lens stop opened one position beyond point where the highlights of the scene reach the knee of the curve, the 5820 will produce a picture having very normal and pleasing tone rendition, especially for studio pickup where light levels and contrast range can be controlled.

For outdoor pickup where extreme scene brightness ranges are encountered, it will be necessary to operate the 5820 with the lens stop opened so that highlights fall further than one stop above the knee. This setting is necessary in order that the extreme scene contrast can be compressed into

the rather narrow contrast range reproducing capabilities of a television system without loosing the informations contained in the low light areas of the scene. Operating the lens stop two positions above the point where the highlights of the scene reach the knee will normally suffice in outdoor pickup operation. If the lens stop is opened further, excessive black flare around bright object will occur and random distribution effects will produce a distorted picture.

OPERATING POSITION

The operating position of the 5820 should preferably be such that any loose particles in the neck of the tube will not fall down and strike or become lodged on the target. Therefore, it is recommended that the tube never be operated in a vertical position with the diheptal-base end up nor in any other position where the axis of the tube with base up makes an angle of less than 20° with the vertical.

OPERATING TEMPERATURE

Aiming at higher resolution, the Toshiba 5820 has special target glass made by Toshiba. therefore this range is 5°C higher than conventional tube types

The operating temperature of any part of the glass bulb should never exceed 55°C, and no part of the bulb at the large end of the tube (target section) should ever fall below 40°C during operation.

The temperature of the target is essentially the same that of the adjacent glass bulb and can, therefore be determined by measuring the temperature of the glass bulb adjacent to the target.

For best results, it is recommended that the temperature of the entire bulb be held between 40°C and 50°C.

Operation at too low temperature will be characterized by the appearance of a rapidly disappearing "sticking picture" of opposite polarity from the original when the picture is moved.

Operation at too high temperature will cause loss of resolution and possibly permanent damage to the tube. Resolution is regained by waiting for the temperature to drop below 50°C.

No part of the bulb should run more than 5°C hotter than the target section to prevent cesium migration to the target. Such migration will result in loss of resolution and in probable parmanent damage to the tube.

Like other photosensitive devices employing cesium, the 5820 may show fluctuation in performance from time to time. Strict observance of the above recommendations with respect to operation temperature will not completely eliminate these variations but will greatly improve the stability of the characteristics during the life of the tube.

RESOLUTION

The resolution of the 5820 is primarily limited by magnetic stray fields from the scanning coils reaching as far as the image section of the tube; under the influence of these fields the points of impact of the photo-electrons on the glass membrane perform minute scanning motions. This effect,

mostly referred to as "cross talk", can be minimized by an efficient magnetic shielding of the scanning coils.

A Second factor limiting the resolution is excessive conductivity of the glass membrane: here one has to distinguish between a surface conductivity and the volume conductivity of the glass. A surface conductivity may be caused by condensation of cesium on the glass membrane whenever the tube is operated under conditions where parts of the glass envelope become more than 5°C hotter than the bulb in the vicinity of the target. The volume conductivity of the glass membrane depends very strongly on the temperature, increasing by about 6% for every degree rise in temperature, thus leading to a lateral charge spread at excessive temperatures.

RECOMMENDATIONS AND WARNINGS

1. Recommendations
   1. Allow the 5820 to warm up prior to operating.
   2. Hold temperatures within the operating range.
   3. Cap lens during standby operation.
   4. Keep beam current as low as possible to secure higher signal-to-noise ratio.
   5. Make sure the beam is properly aligned.
   6. Adjust target voltage exactly 2 volts above cutoff.
   7. Adjust illumination correctly.
   8. Condition spare tubes by operating several hours once a month.
2. Warnings
   1. Do not force the tube into the shoulder socket.
   2. Do not operate the tube without scanning.
   3. Do not underscan the target.
   4. Do not focus the tube on a stationary bright scene.
   5. Do not carry a tube with the image section downwards.
   6. Do not leave camera unattended without capping lens.

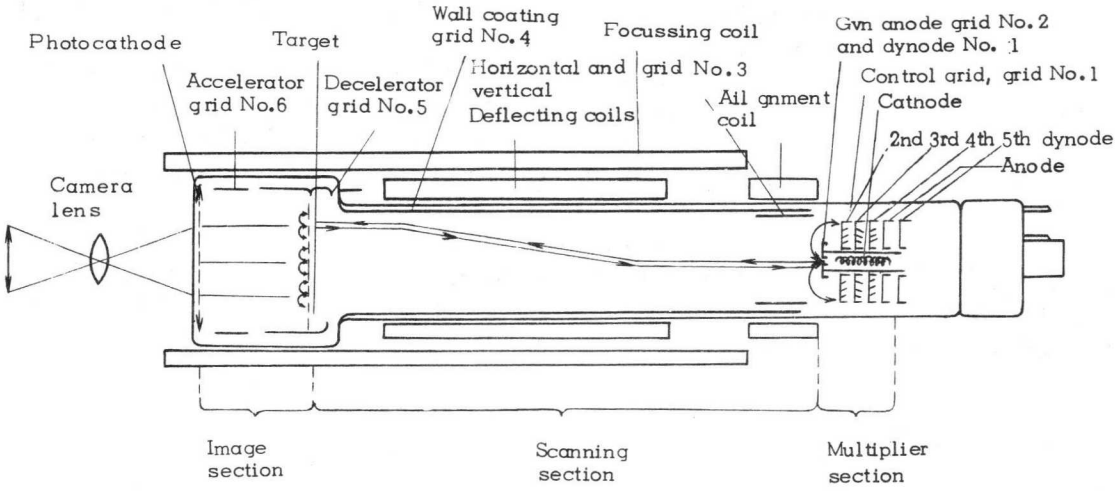


Fig. 1 Construction

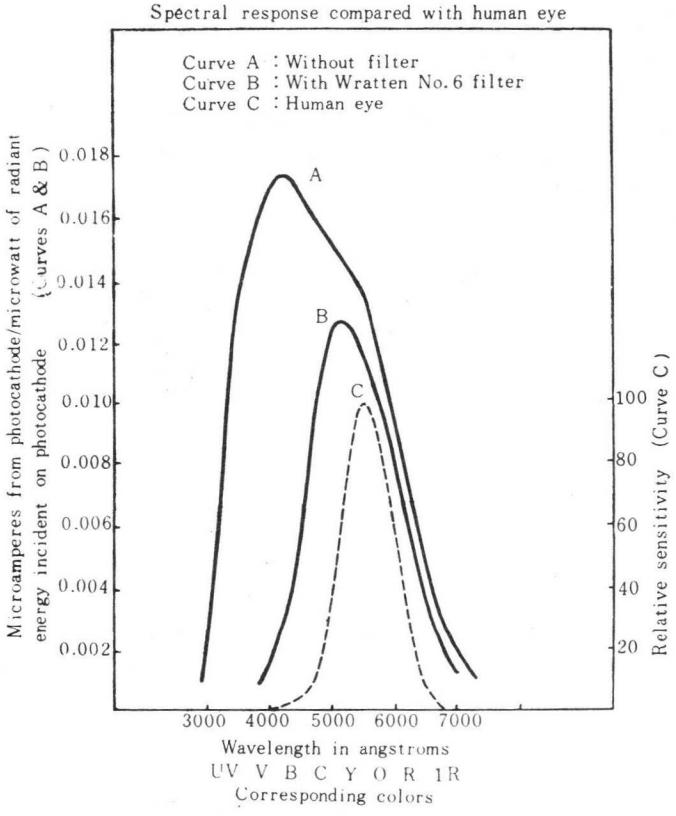


Fig. 2 Spectral response compared with human eye

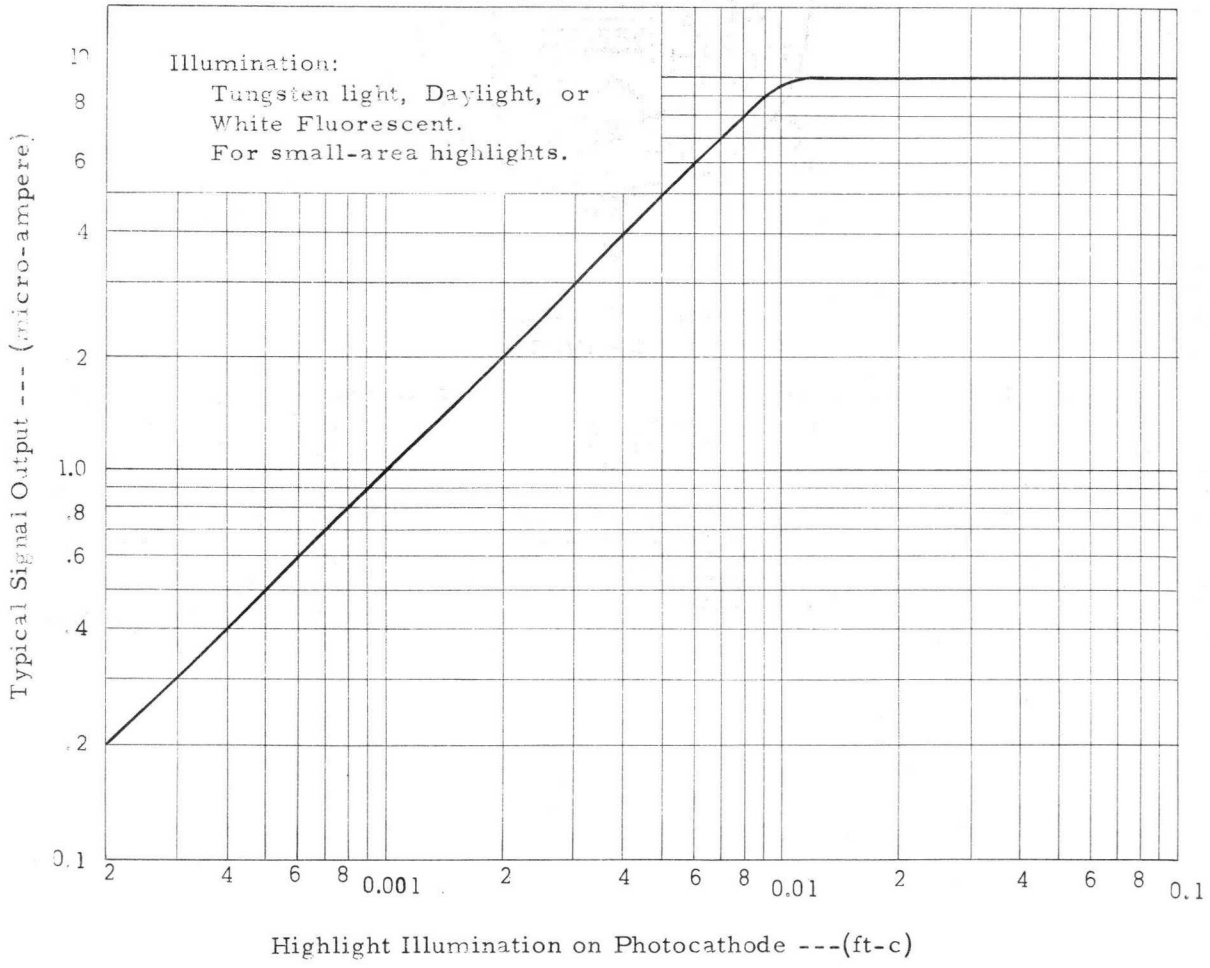
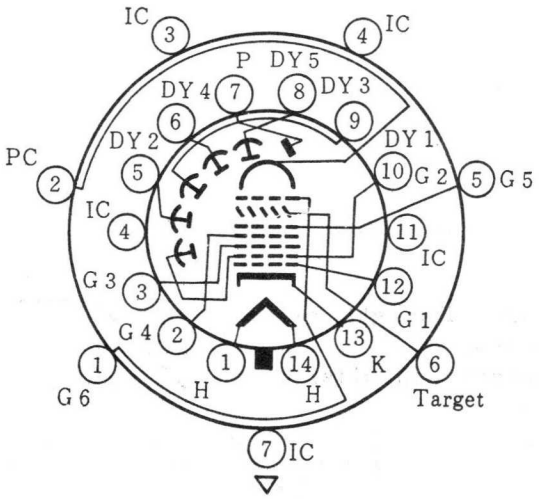


Fig. 3 Basic light transfer characteristics

SOCKET CONNECTIONS
Bottom View



WHITE INDEX LINE
ON FACE

SMALL-SHELL DIHEPTAL 14-PIN BASE

PIN 1: HEATER
PIN 2: GRID NO. 4
PIN 3: GRID NO. 3

PIN 4: INTERNAL CONNEC-
TION--DO NOT USE
PIN 5: DYNODE NO. 2
PIN 6: DYNODE NO. 4
PIN 7: ANODE
PIN 8: DYNODE NO. 5

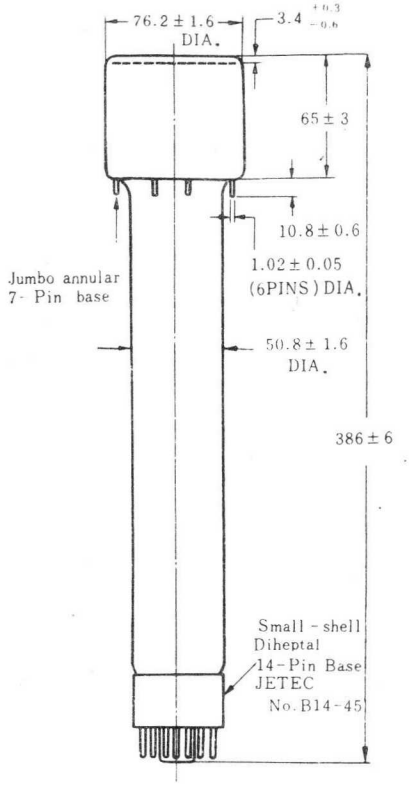
PIN 9: DYNODE NO. 3
PIN 10: DYNODE NO. 1
GRID NO. 2

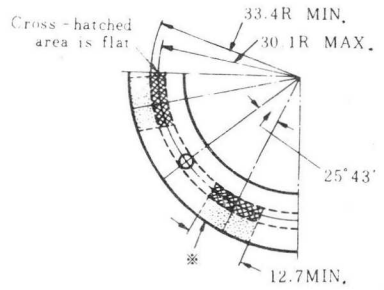
PIN 11: INTERNAL CONNEC-
TION--DO NOT USE
PIN 12: GRID NO. 1
PIN 13: CATHODE
PIN 14: HEATER

KEYED JUMBO ANNULAR 7-PIN BASE

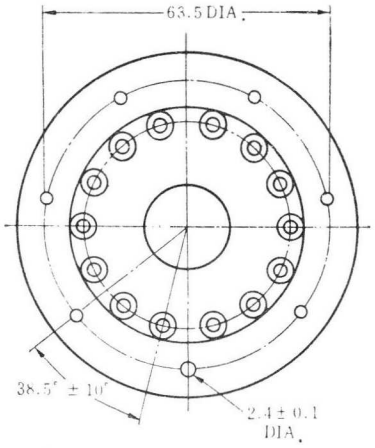
PIN 1: GRID NO. 8
PIN 2: PHOTOCATHODE
PIN 3: INTERNAL CONNEC-
TION--DO NOT USE
PIN 4: INTERNAL CONNEC-
TION DO NOT USE
PIN 5: GRID NO. 5
PIN 6: TARGET
PIN 7: INTERNAL CONNEC
TION--DO NOT USE

DIMENSIONAL OUTLINE
(ALL DIMENSIONS, IN mm)





※ : Dotted area is flat or extends toward Diheptal - base end of tube by 1.5 mm MAX.



T.P.D.

(5)

See p. 5 for reference to "Experimental anti-black-border 5820"

Recd March 1961

TOSHIBA IMAGE ORTHICON 5820
for
TV CAMERA

TOKYO SHIBAURA ELECTRIC CO., LTD.

TOSHIBA Image Orthicon 5820 For TV Camera

By Yoshiaki NAKAYAMA, Shoichi MIYASHIRO and Kaichiro ODAGAWA

Matsuda Research Laboratory,

Tokyo Shibaura Electric Co., Ltd.

TOSHIBA has conducted various studies and investigations into tubes for photo devices that translate light energy into electrical energy, and produced television pickup tubes (iconoscopes, tecoscopes, etc.) and is now manufacturing photo tubes, photomultipliers, image-converter tubes and image intensifiers. Backed by these studies, researches have been conducted with success on image orthicon 5820 which is the best television pickup tube at present.

Structure

The structure of the image orthicon consists of three sections, i.e., the image, scanning and multiplier sections as shown in Fig. 1.

The image section comprises the semitransparent photocathode, accelerating electrode and target assembly. The photocathode is made of Ag-Bi-O-Cs and its spectral characteristic nearly equals that of the human eye as shown in Fig. 2. The accelerating electrode provides an accelerating electrostatic field and focuses a distortionless image on the target. The target assembly consists of a fine mesh of 750 lines per inch and an extremely thin glass plate. This target assembly makes the whole system a highly sensitive pickup tube through its charge-multiplying and storage action. The rise of an after image in the target glass is at present generally considered to be the terminating factor of the life of the image orthicon. In other countries, the life of the image orthicon is said to be 1,000 hr., whereas in Japan it has been considered to be about 500 hr. This is due largely to the temperament of the people who are very critical about picture quality—not only the spurious signal but also the after image.

As a result of various researches on the material of the target glass, a material, having a proper resistance value twice as high as any known heretofore, has been successfully developed. Used at 40 to 50°C, it is free from sticking. Its resolving power is high, and its life has been increased by as much as 30 to 80%. It is believed that the after image, as a whole, occupies less than a few per cent of all factors considered to cause the termination of the life. The main factors are believed to be the excess of the target cut-off voltage over the limit of the image orthicon camera control circuit as well as the black suppression of the tone.

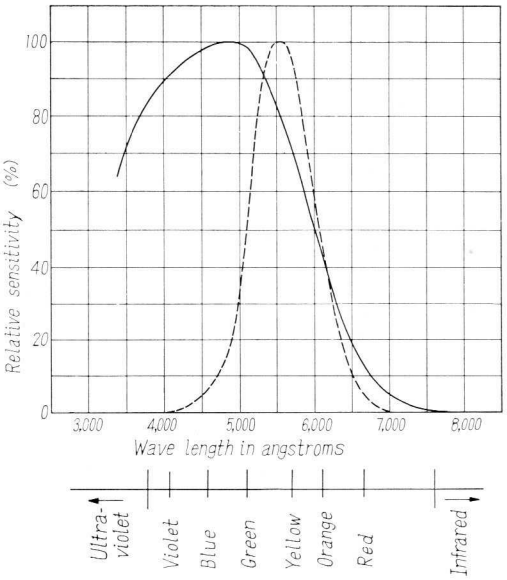


Fig. 2 Spectral sensitivity characteristics of TOSHIBA image orthicon 5820 for equal values of radiant flux at all wave lengths
Dashed curve shows spectral characteristic of average human eye.

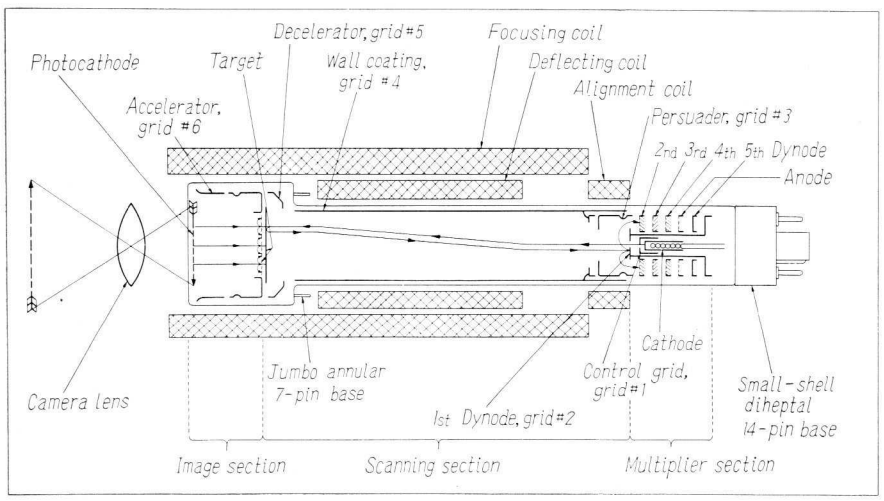


Fig. 1 Schematic arrangement of TOSHIBA image orthicon 5820

In the scanning section, an electron beam is focused and deflected by the magnetic field, slowed down to a low velocity by the decelerating electrode, and scans the whole surface of the target. This scanning beam neutralizes the positive signal charges on the target, is modulated and driven back to the multiplier. In order to improve the signal-to-noise ratio, researches have been made on the landing of the beam onto the target, the velocity distribution of the electron beam, etc.

The multiplier section amplifies the modulated return beam by about 1,000 times. Since the image is likely to be marred by the crude texture of the first dynode surface, a super dynode of fine structure is adopted to improve the image quality. As to a dynode of pinwheel type, researches on the modes of potential-giving and the surface condition of the Ag-Mg secondary emitter have been conducted with satisfactory results.

The formation of ghosts or halos has also been studied. To minimize the black border, the investigation of an image orthicon of anti-black-border type was attempted, and it has been clarified that it can reduce to a great extent the black border which is very unpleasant to the eye.

Since all parts and their materials such as the face plate, target glass, Ag-Mg alloy, etc. have been made and assembled by Toshiba itself under careful control Toshiba image orthicon is assured of high and uniform quality.

Resolution and Sticking Picture[1]

The resolution of the image orthicon is mainly determined by the lateral electric leakage of the target glass. To reduce the lateral leakage, it is necessary to reduce the thickness of the target glass and increase the specific electric resistance within permissible limits. The thickness of the target glass is reduced as much as the mechanical strength can withstand, namely, no more than a few microns.

If the electric resistance of the target glass becomes too high, the electric charges at both sides of the glass plate do not neutralize in a short time. Under this condition, focusing on a stationary bright figure brings a gradual decrease in the output signal current, and the panning of the image orthicon camera brings forth a rapidly disappearing "sticking picture" of opposite polarity. This picture appears when the target glass of the image orthicon is used while it is still cold, and can be prevented by increasing the temperature. This sticking picture differs from the after image which appears and stays for a considerable length of time upon the termination of the life of the tube.

Therefore, it is advisable to keep the electric resistance as high as possible within permissible limits.

The ratio of the sticking signal current of opposite polarity (I_{st}) to the initial value of the image signal current (I_{in}) can be expressed approximately by the following equation (see Fig. 3):

$$I_{st}/I_{in} = \frac{\frac{C_m}{C_g} e^{-T/\tau_g}}{1+\frac{C_m}{C_g}-e^{-T/\tau_g}}$$

where

C_m = the capacitance between the target glass and the mesh of one picture element

C_g = the capacitance between both sides of the target glass of one picture element

T = the time of one frame

$$\tau_g = R_g C_g = \frac{1.1}{4\pi}\rho K \times 10^{-12}\text{sec}$$

ρ indicates the specific electric resistance, K, the dielectric constant of the target glass.

And the number of frames n_0, which pass before the sticking image becomes $1/e$, can be represented approximately as

$$n_0 = \frac{1}{\frac{T}{\tau_g} + \log\left(1+\frac{C_m}{C_g}\right)} + 1$$

From the above equations we can learn the relation between the magnitude of sticking and the electric resistance as well as that between the decrement and the electric resistance. These relations are given in Fig. 4. Based on these calculations, Toshiba 5820 employs a target glass of high resistivity whose value is about ten times larger than that calculated by H. B. De Vore. It has excellent resolution characteristics as shown in Figs. 5 and 6.

The photograph given in Fig. 6 was taken by using the master monitor ST-1763B which employs 10SP4A and also the Toshiba image orthicon camera DO-1330C. And for the coil assembly, the Toshiba stock number FF-45884 was used.

Toshiba image orthicon 5820 enjoys not only excellent resolution as stated above, but also a superb characteristic regarding to the after image that appears at the end of the life, thus making the life longer.

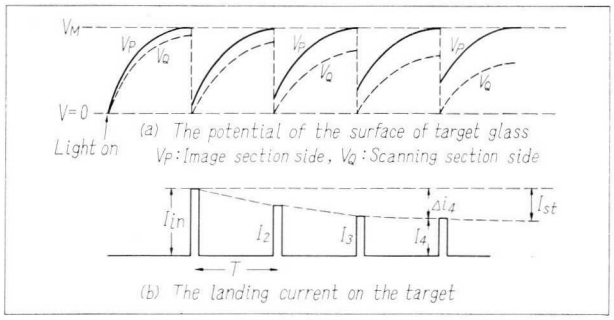


Fig. 3 The potential transition and the landing current on the target glass

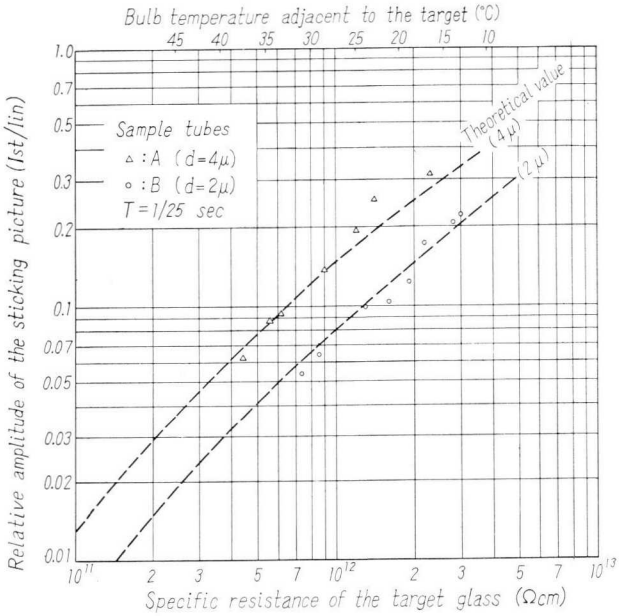


Fig. 4 Relation between the magnitude of sticking pictures and the specific resistance of the target glass

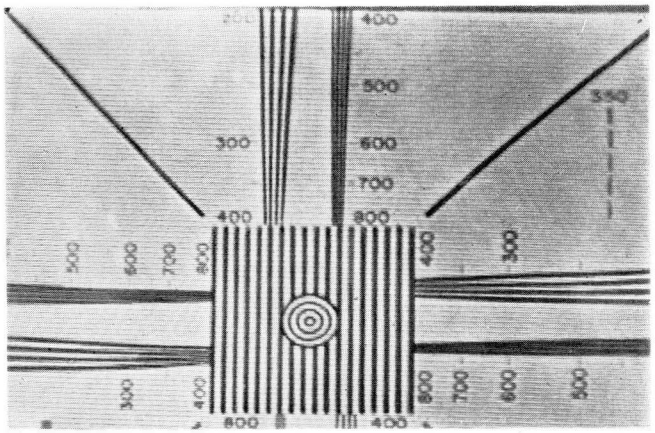


Fig. 5 The picture of the center of the master monitor—
The resolving power of 700 TV lines is observed at 45°C of the target glass temperature.
(Test pattern : RETMA resolution test chart)

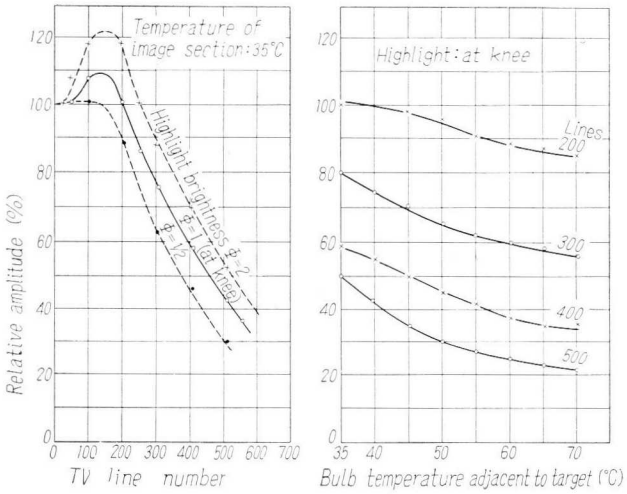


Fig. 6 Amplitude response and effect of temperature of the TOSHIBA 5820 (Test pattern : RETMA resolution test chart)

Signal-to-Noise Ratio[2]

Since the image orthicon contains a high-gain multiplier in itself, it is capable of supplying larger output signal current than the pre-amplifier noise of the camera. Therefore, it is necessary for the image orthicon itself to have a better signal-to-noise ratio. This noise is due mainly to the shot noise in the beam, and so to improve the signal-to-noise ratio, it is of utmost importance to increase the modulation of the signal in the return beam. Consequently, the scanning beam should be so adjusted as to give just enough current to discharge the target positive charge corresponding to the highlight of the picture.

Calculations have made it clear that the reflection coefficient of the scanning beam on the target glass surface and the velocity distribution of the beam largely affect the beam modulation. When the low velocity electrons of the scanning beam impinge on the scanning side of the target glass, a relatively large number of electrons undergo elastic reflection. This reflection can be reduced to a great extent by the evaporation coating of some metal on the scanning side of the target. The reflection coefficient was measured by the use of the image orthicon. If, by feeding sufficient light, the scanning beam current is reduced to 1/30 of the ordinary current (i.e. approximately 1×10^{-9}A), it is possible to keep the surface potential almost constant even at the time the electrons land on the target. Under this condition, the relation between the reflection coefficient and the velocity of landing electrons can be determined by measuring the ratio of the beam current to the magnitude of the landing beam current on the target by varying the potential of the target mesh. Fig. 7 gives the results of measurements taken when metal (i.e. Ag, Au, Pt, Cu, Ge, etc.) was deposited on the scanning side of the target glass. The reflection coefficient stands at 0.7 to 0.9 with the glass alone, while it is reduced to 0.3 to 0.5 when a metal is deposited on the glass. And the figure clearly shows that among other metals Ag is most suitable to reduce the reflection coefficient without loss of resolution.

Fig. 8 shows the velocity distribution of the electrons in the scanning beam along the axis of the tube. Here the measurement was made by the use of a metal plate instead of the glass target. The result coincides approximately with Maxwell's theoretical value calculated from the cathode temperature. It stands at about 0.1eV. It shows clearly that the characteristic of the electron gun is good enough for the beam landing.

The return beam produces impact on the first dynode of fine and uniform texture forming a rectangular raster whose diagonal measures approximately 8 mm. The secondary electrons produced there are directed to the second dynode by the persuader electrode G_3. The observation of the electron trajectories, which have been rendered visible by coating phosphor on

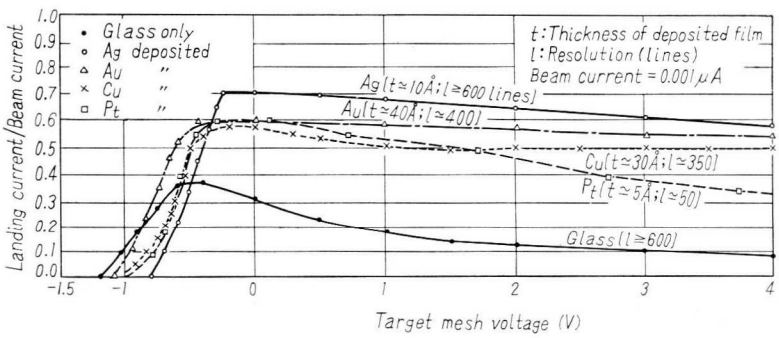


Fig. 7 Reflection of slow electrons on the glasses on which various metals are deposited

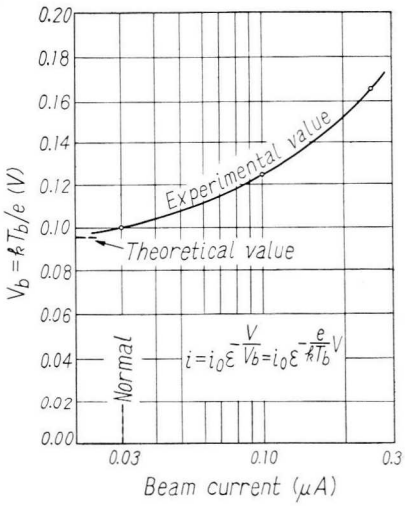


Fig. 8 Velocity distribution of scanning beam electrons

each dynode, is shown in Fig. 9. When the potential of G_3 is about 280 volts, the electrons reach the final dynode without much lateral deflection, resulting in the maximum gain and the minimum multiplier shading.

The multiplier dynode is made of an alloy of Ag-Mg, which, before being placed into the tube, is treated by heat in rarefied oxygen or water vapor to form an MgO film of several hundred A over the surface. It has been found that, during this activation process, the selective oxidization proceeds according to the parabolic rate law in the low pressure atmosphere of oxidizing agent, and that the diffusion rate of Mg through the oxide layer is determined.

Also concerning the characteristic of the Ag-Mg emitter, various basic research data have been obtained on the problem of the gain decay due to carbon contamination induced by the electron bombardment[3] as well as on the effects of cesium vapor, various gases, heat treatment, light exposure, etc. on the gain.

Spurious Signals

Although the spurious signals of the image orthicon include the problems of defects and shading, these will not be discussed in this article since various detailed reports have already been made on them. The writers will report here on newly-obtained information concerning such spurious signals as ghosts, haloes, black-border effects, etc.

Part of the secondary electrons emitted from the target cause spurious signals which are unique to the image orthicon. Although a brief explanation has been made about these phenomena, the writers have learnt that this explanation would not be sufficient. Fig. 10 shows the televised picture of a sheet of black paper with small holes illuminated from the back. A strong contrast ghost image of the hole appears by the side of each real image, being distributed in a counterclockwise direction. These are the same ghost images as those found in an ordinary broadcast picture. By varying the photocathode potential, the ghost image can be made to move toward the true image as seen in Fig. 11. Finally it unites with the real image and disappears. It has also been found that by varying the voltage of the photocathode or the accelerator, the ghost image can be made to fade into a faint round halo. We may call these ghosts and haloes "primary." Furthermore, at the outskirt of the photograph, faint ghosts of a different type can be observed. These "secondary" ghosts almost never change their positions even when the electrode voltage is varied. In Fig. 10, the region other than the black-border appears whitish because of a fogging effect, although the region is dark in the original scene. This kind of halo is called "secondary." On the basis of these factors, it may be reasonable to conclude that the high-velocity electron group gives rise to the relatively inconspicuous "secondary" ghost, whereas, of the medium-velocity electron group those electrons with a velocity that just satisfies the focus condition causes the "primary" ghost as well as the "primary" or round haloes, and the "secondary" halo is caused by the remaining part of the medium-velocity electron group.

The black-border effect is caused by part of the low-velocity secondary electrons emitted from the target, and renders the image scene unpleasant to the eye as illustrated in Figs. 10 and 12. Shown in Fig. 13 is the black-border width as it varies according to the brightness ϕs of the bright spot and the brightness

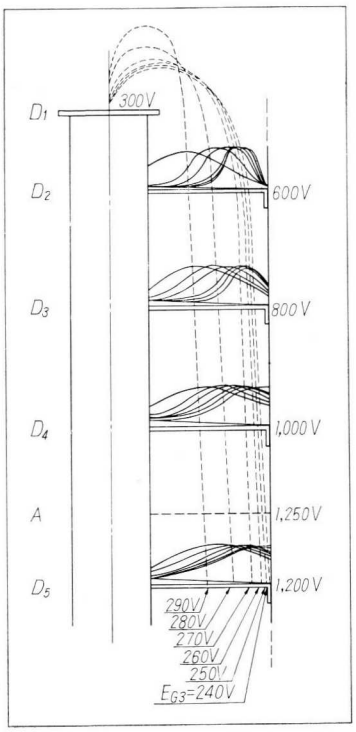


Fig. 9 Electron trajectory in the multiplier

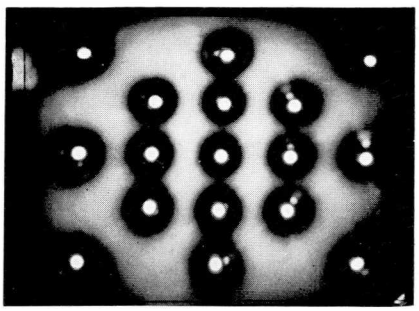


Fig. 10 An image picked up by 5820 image orthicon in spurious signal experiment

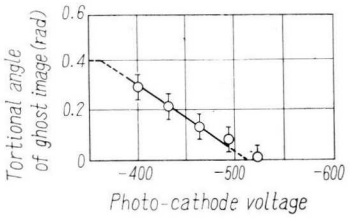


Fig. 11 Tortional angle of ghost image in 5820—
The angle with which the center of picture subtends the arc between ghost and real image

ϕ_B of the background. It is to be noted that at $\phi_B < 1/4$, the black-border is extraordinarily enlarged by the halo effect. It has also been learned that the black-border width is quickly saturated when the size of the bright body is increased.

In order to minimize the black-border, the writers have made experimental tubes[4], whose underlying principle consists in the prevention of the electron redistribution on the target glass by inserting into the photocathode side of the target screen another mesh screen with positive potential to collect the excess secondary electrons. It has been found that there exist optimum points of the potential and position of the collector mesh as a result of theoretical considerations supported by numerous experiments. Fig. 14 and the chain line in Fig. 13 represent the remarkable results obtained with one of the experimental tubes. Such improvement in image quality is highly desirable for picking up a scene of a wide contrast range and for the color TV camera.

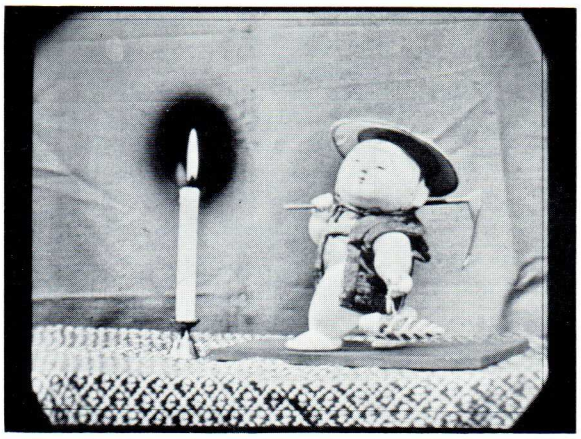


Fig. 12 Example of black-border effect in 5820 image orthicon

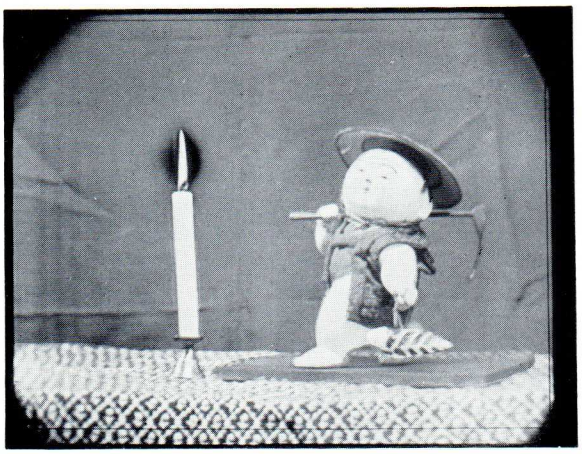


Fig. 14 An example of picture taken by the experimental anti-black-border image orthicon 5820

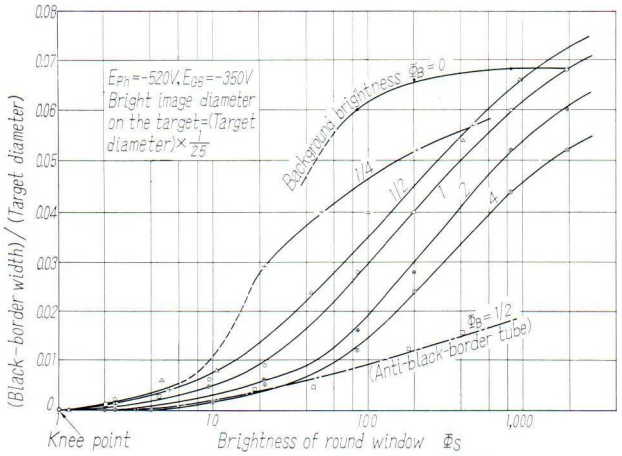


Fig. 13 Magnitude of black border in the image orthicon 5820

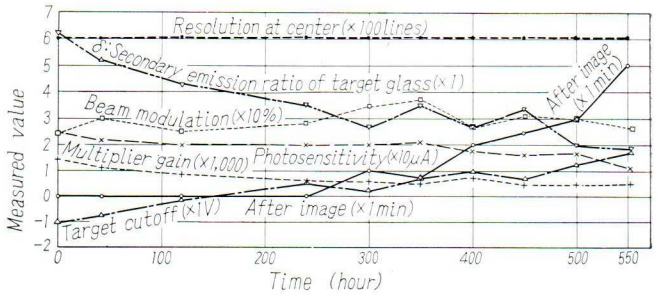


Fig. 15 Results of life tests of TOSHIBA image orthicon 5820

Summary

The characteristics of the tube are very satisfactory, and may be summed up as follows:

(1) The electric resistance of the target glass in use is twice as high as that of a conventional one, and the tube is superior in resolution, sticking and longevity. These are supported by serious theoretical and experimental studies. Fig. 15 shows one of the results of life tests.

(2) The signal-to-noise ratio is high. The beam landing and the velocity distribution of the scanning beam were measured by special methods.

(3) Regarding to the multiplier, various researches were made into the process of forming an MgO film of some hundred Å on the Ag-Mg alloy surface. The electron path was also visually observed to ascertain the potential on the dynode.

(4) Research was done into spurious signals caused by the "secondary" electrons emitted from the target. They were closely observed and carefully studied. Experimental anti-black-border image orthicons have been devised, and the black-border effect considerably reduced, though with some loss of sensitivity.

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