BRIMAR

RECEIVING VALVE
6BA6

APPLICATION REPORT VAD/509.2

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Standard Telephones and Cables Limited

FOOTSCRAY, KENT, ENGLAND

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INTRODUCTION: The Brimar 6BA6 is an indirectly-heated variable-mu RF pentode. The heater is intended for operation in parallel with other valves in AC operated equipment. The valve is designed for use as an RF or IF amplifier; suitable shielding and short leads provide a good performance in high frequency circuits. This report contains characteristics of the valve and details of its performance.

DESCRIPTION: The valve consists of a miniature variable-mu RF pentode having a mutual conductance of the order of 4 mA/V and is mounted in a standard T5½ bulb and fitted with a B7G standard base.

CHARACTERISTICS:	Indirectly-heated oxide-coated cathode.	
	Heater Voltage	6·3 volts
	Heater Current	0·3 amperes
	Max. DC Heater-Cathode Potential	250 volts
DIMENSIONS:	Max. Overall Length	2-1/8 ins.
	Max. Diameter	3/4 ins.
	Max. Seated Height (excluding tip)	1-19/32 ins.
BASE:	Type B7G	
BASE CONNECTIONS:	Pin 1 Control Grid	
	Pin 2 Suppressor and Internal Shield	
	Pin 3 Heater	
	Pin 4 Heater	
	Pin 5 Anode	
	Pin 6 Screen	
	Pin 7 Cathode	
MAXIMUM RATINGS:	Max. Anode Voltage	300 volts
	Max. Screen Voltage	125 volts
	Max. Screen Supply Voltage	300 volts
	Max. Anode Dissipation	3·0 watts
	Max. Screen Dissipation	0·6 watts
CAPACITIES (approx.):	Measured with no external shield.	
	Pentode Connected:	
	Input	5·5 pF
	Output	5·0 pF
	Grid-Anode	0·0035 pF max.
	Grounded Grid Operation:	
	Anode-Cathode	0·01 pF
	Input	6·0 pF
	Output	5·6 pF

CHARACTERISTIC CURVES: Attached to this report are curves showing:

a. Anode current (i_a) plotted against control grid voltage for various screen voltages (Curve No. 309·28).

b. Mutual conductance (g_m) and anode impedance (r_a) against control grid voltage for fixed and sliding screen voltage operation (Curve No. 309·29).

c. Anode current plotted against anode voltage for a screen voltage of 125 volts (Curve No. 309·30) and for a screen voltage of 100 volts (Curve No. 309·31).

TYPICAL OPERATING CONDITIONS

Class A Amplifier (suppressor connected to cathode):

Heater Voltage	6·3	6·3	6·3	volts
Anode Voltage	100	250	250	volts
Screen Supply Voltage	—	—	250	volts
Series Screen Resistor	—	—	33000	ohms
Screen Voltage	100	100	—	volts
Grid Voltage	—1	—1	—1	volts
Cathode Bias Resistor	68	68	68	ohms
Anode Current	10·8	11	11	mA
Screen Current	4·4	4·2	4·2	mA
Anode Impedance	0·25	1·5	1·5	megohms
Inner Amplification Factor	22·7	21·0	21·3	
Grid Voltage for g_m=1/100 of its value at grid voltage of —1 volt	—21	—21	—51	volts
Suppressor Voltage for g_m=1/100 of its value at grid voltage of —1 volt and suppressor voltage of zero	—37·5	—73	—70	volts
Equivalent Noise Resistance	3800	3650	3650	ohms
Input Impedance at 45 Mc/s	4500	4500	4500	ohms
Input Impedance at 90 Mc/s	900	900	900	ohms

Operation as an RF or IF Amplifier: The valve is intended primarily for service in the above application. It is recommended that cathode bias always be used rather than fixed bias and that normally the suppressor grid and the internal shield be connected to the cathode at the socket. The valve socket should be so mounted that the grid and anode leads to the remainder of the circuit run in opposite directions to each other and are as short as is practicable in order to ensure high gain with stability. The decoupling components should also be chosen and located with care for similar reasons.

When used in VHF receivers the valve may be employed with normal pentode connections or as a grounded grid amplifier at frequencies of the order of 100 Mc/s. It is also very efficient as an IF amplifier using intermediate frequencies around 10 Mc/s. When so employed a stage gain of 44 times can be expected with a total bandwidth of 200 Kc/s for 3 db down with IF coils of Q 70 and tuning capacity 50 pF.

For those applications where very high frequencies are employed and changes in input capacity and input impedance are undesirable, it is advisable that grid bias be applied to the control grid and suppressor grid simultaneously, the control grid being biased to a value of approximately 2·5% of that applied to the suppressor grid.

Curves are attached to this report showing input capacity and input impedance plotted against control grid voltage for the sliding screen conditions at 50 Mc/s (Curve No. 309·35), and similarly but for auto bias (Curve No. 309·36). Curves Nos. 309·37 and 309·38 are similar to the above but taken at a frequency of 90 Mc/s.

Operation as a Resistance-Capacity Coupled Amplifier: Although the valve has a variable-mu control grid characteristic it may still be used for small inputs as an RC coupled amplifier; curves are attached to this report covering this application. Curve No. 309·32 is plotted with an anode load resistor of 100,000 ohms and shows the relationship between anode current, screen current and control grid voltage for various screen voltages. Curves Nos. 309·33 and 309·34 are similar to the above but plotted for anode load resistors of 220,000 and 470,000 ohms respectively. The method of using these curves to design an RC coupled amplifier is described below.

If, for example, it is desired to use the valve at a supply voltage of 250 volts with an anode load resistor of 220,000 ohms and a succeeding valve grid leak of 470,000 ohms, then an examination of Curve No. 309·33 shows that grid current (I_{g1}) commences at about —0·7 volts, hence a grid bias should be chosen such that the signal never swings the grid to a value of much less than —1 volt. If a value of —1·5 volts is taken then fairly straight portions of the I_a/V_a curves are available for V_{g2} 30 volts. Taking the operating point as V_{g2} 30 volts and V_{g1} —1·5 volts, the plate current will be 0·81 mA and the screen current I_{g2} 0·28 mA, hence the cathode resistor will be:

$$\frac{1{\cdot}5 \times 1000}{0{\cdot}81 + 0{\cdot}28} \text{ or } 1380 \text{ ohms;}$$

in practice 1500 ohms would be used. The screen dropping resistor would be:

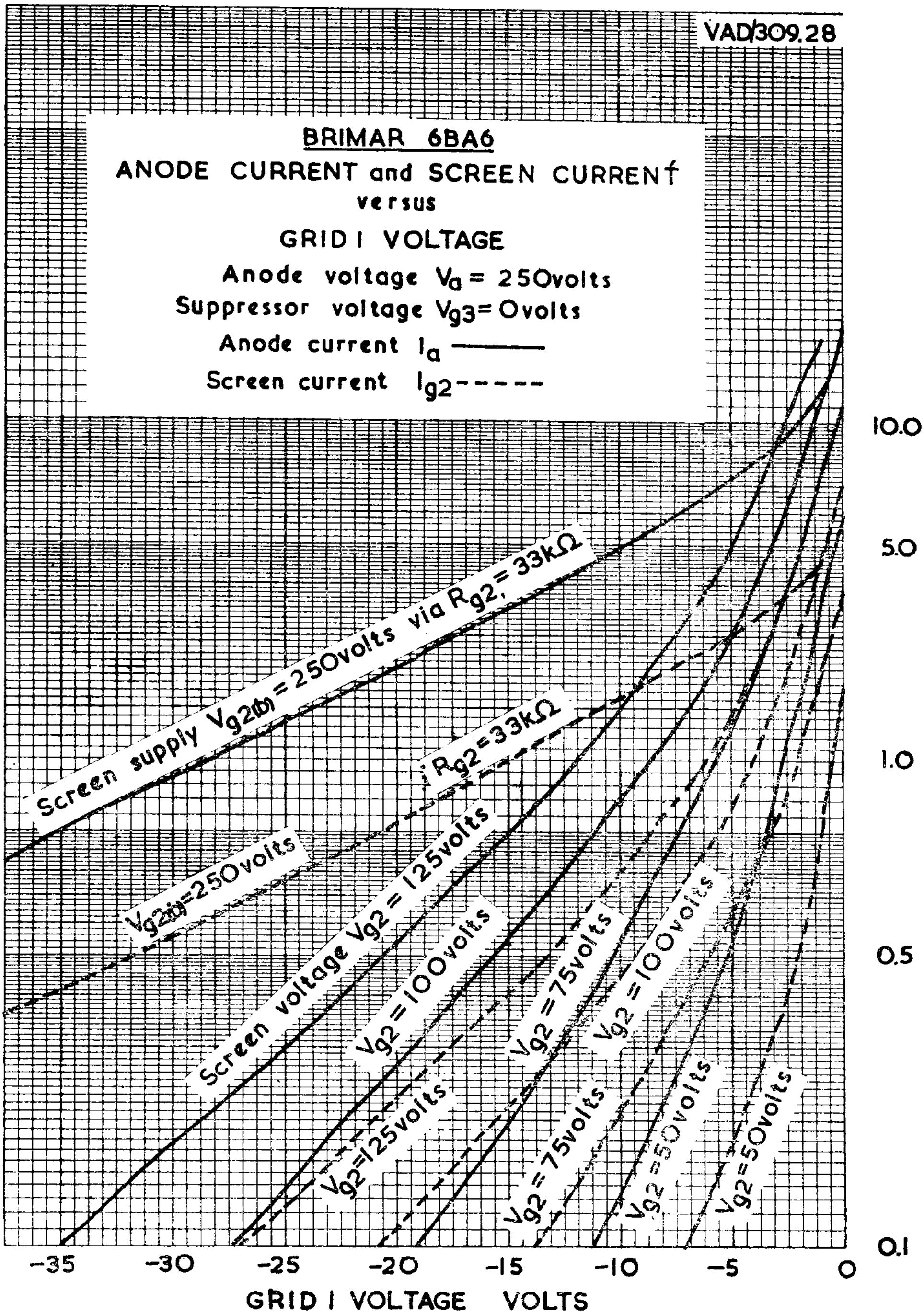
$$\frac{250 - 30}{0{\cdot}28} \times 1000, \text{ or } 785{,}000 \text{ ohms.}$$

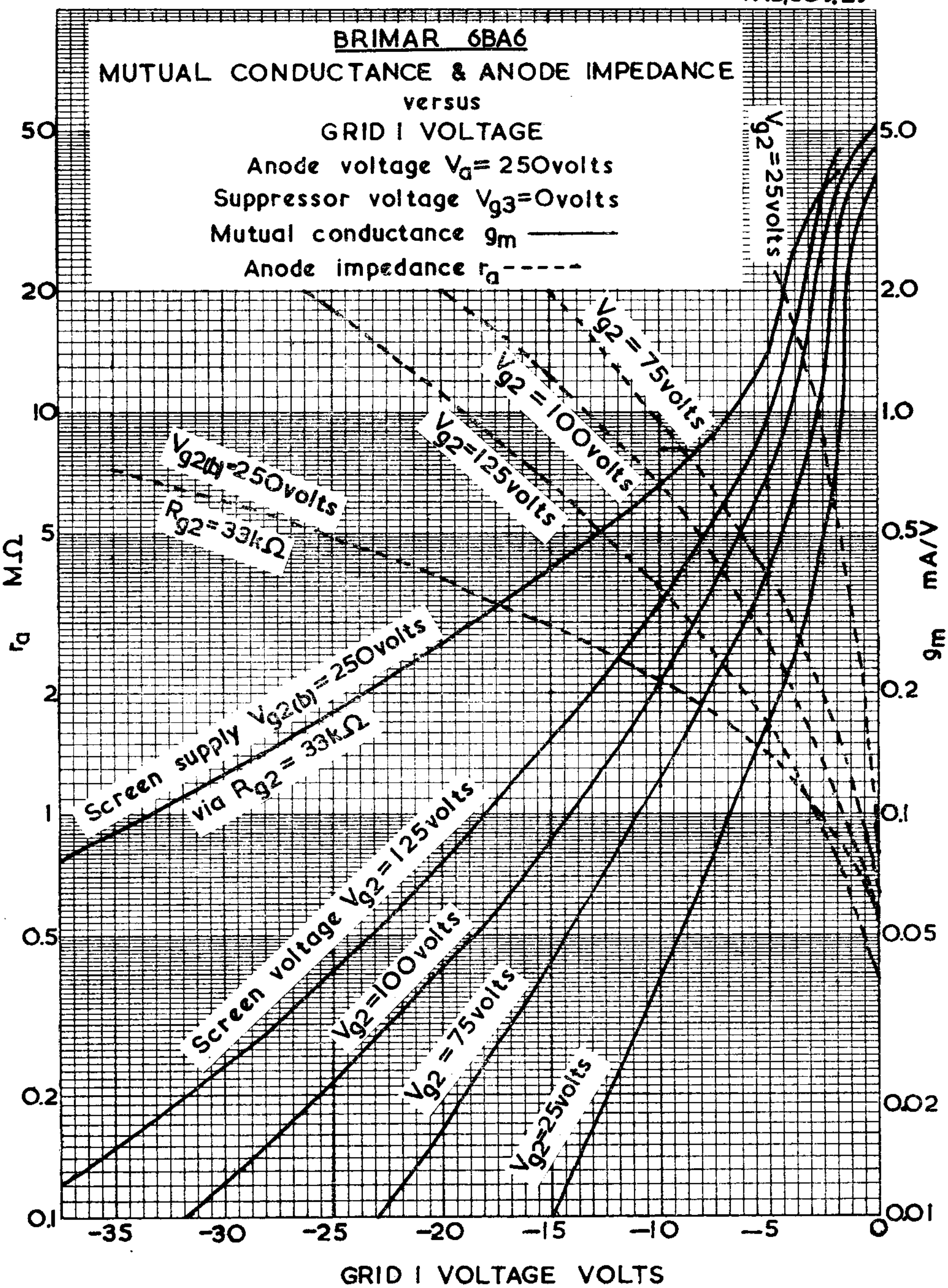
Again the nearest preferred value would be 680,000 ohms. If the grid has a peak AF input of ±0·5 volts as a maximum, the anode current will vary from 0·60 mA at a grid voltage of —2·0 volts to 1·07 mA at —1 volt, hence a change of 0·47 mA in 220,000 is 104 volts peak-peak. This is an output of 52 volts peak and a voltage gain of 104.

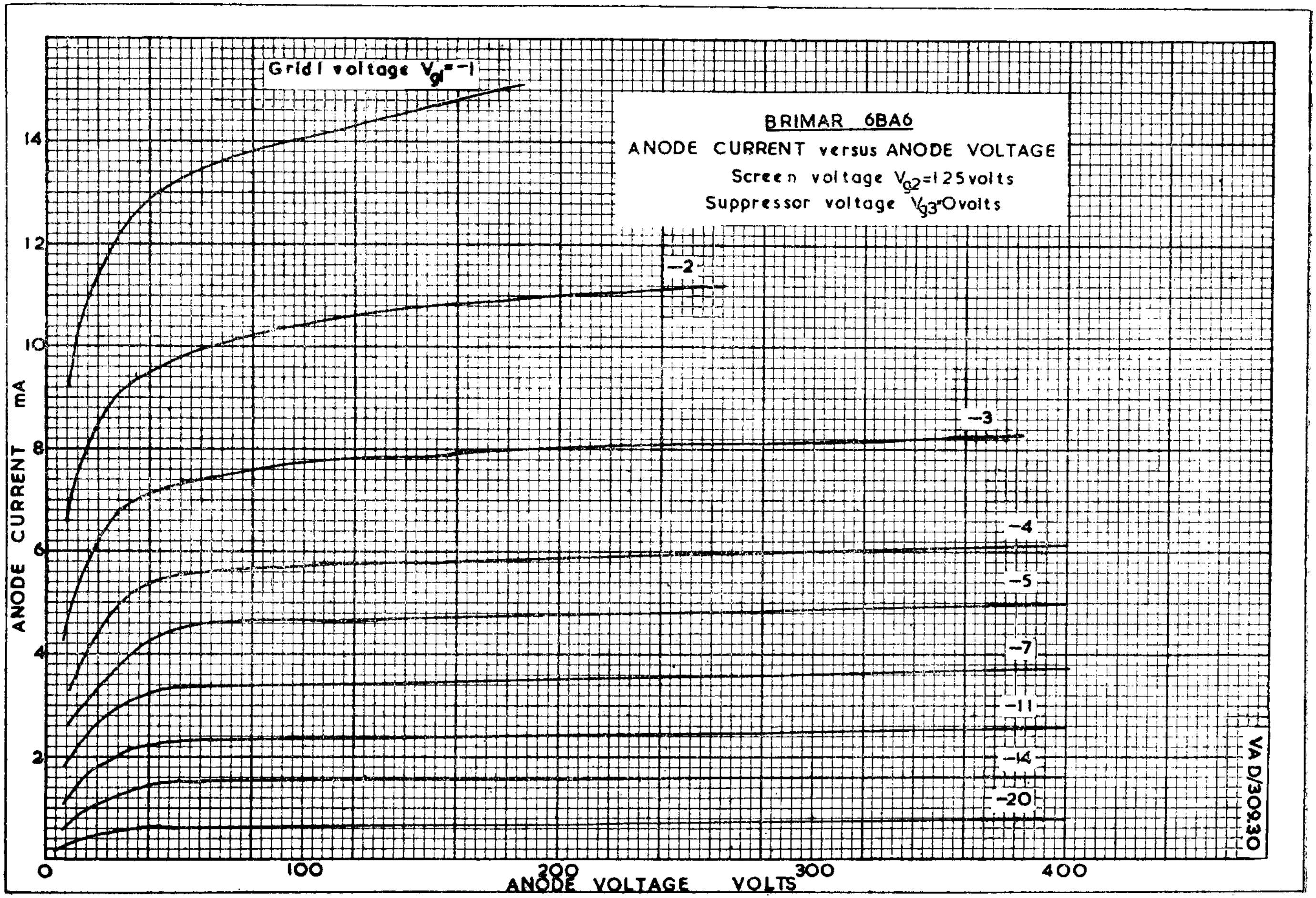
As allowance must be made for the succeeding valve grid leak the above values will be reduced by a factor of:

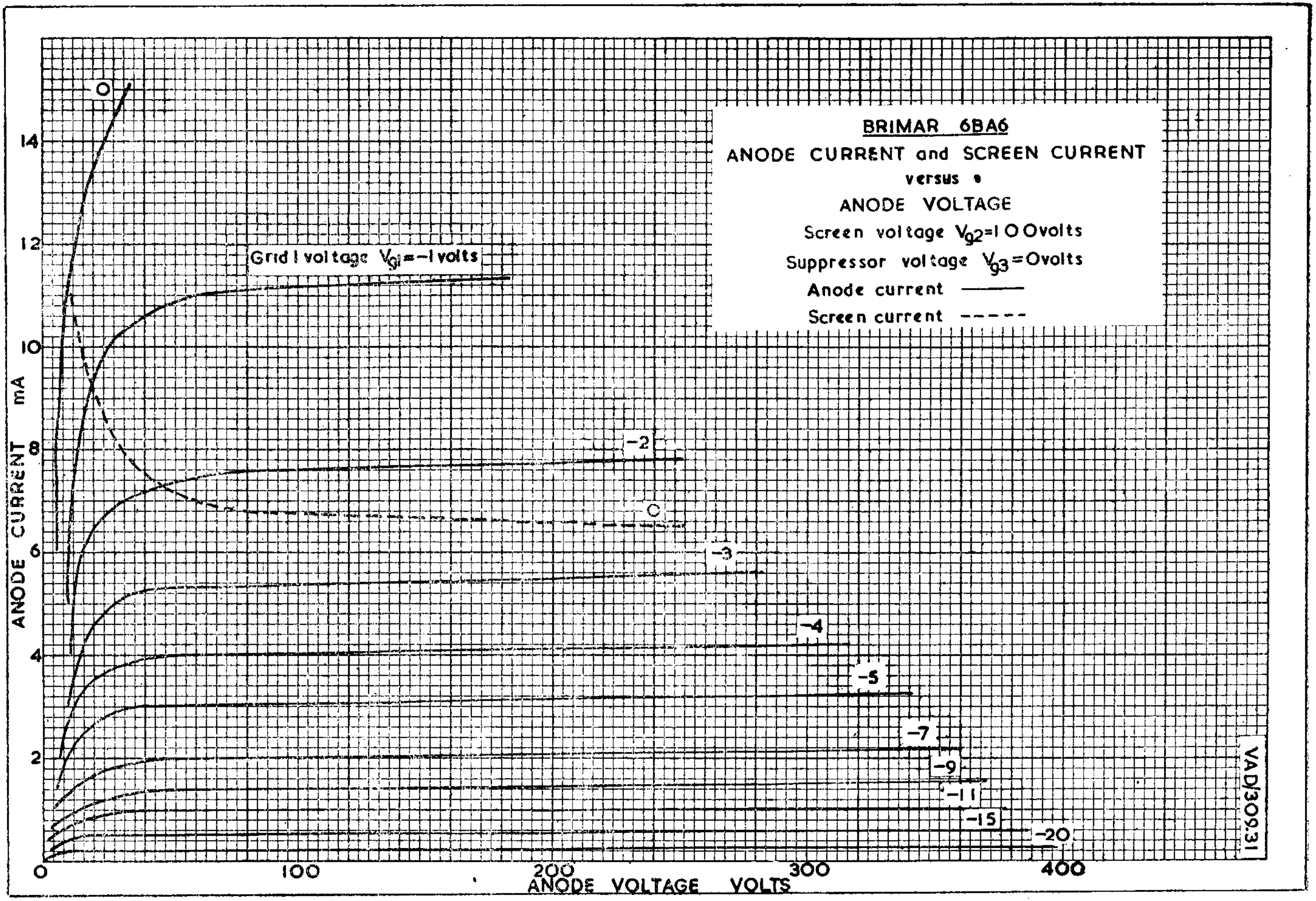
$$\frac{470{,}000}{470{,}000 + 220{,}000} \text{ or } 0{\cdot}68,$$

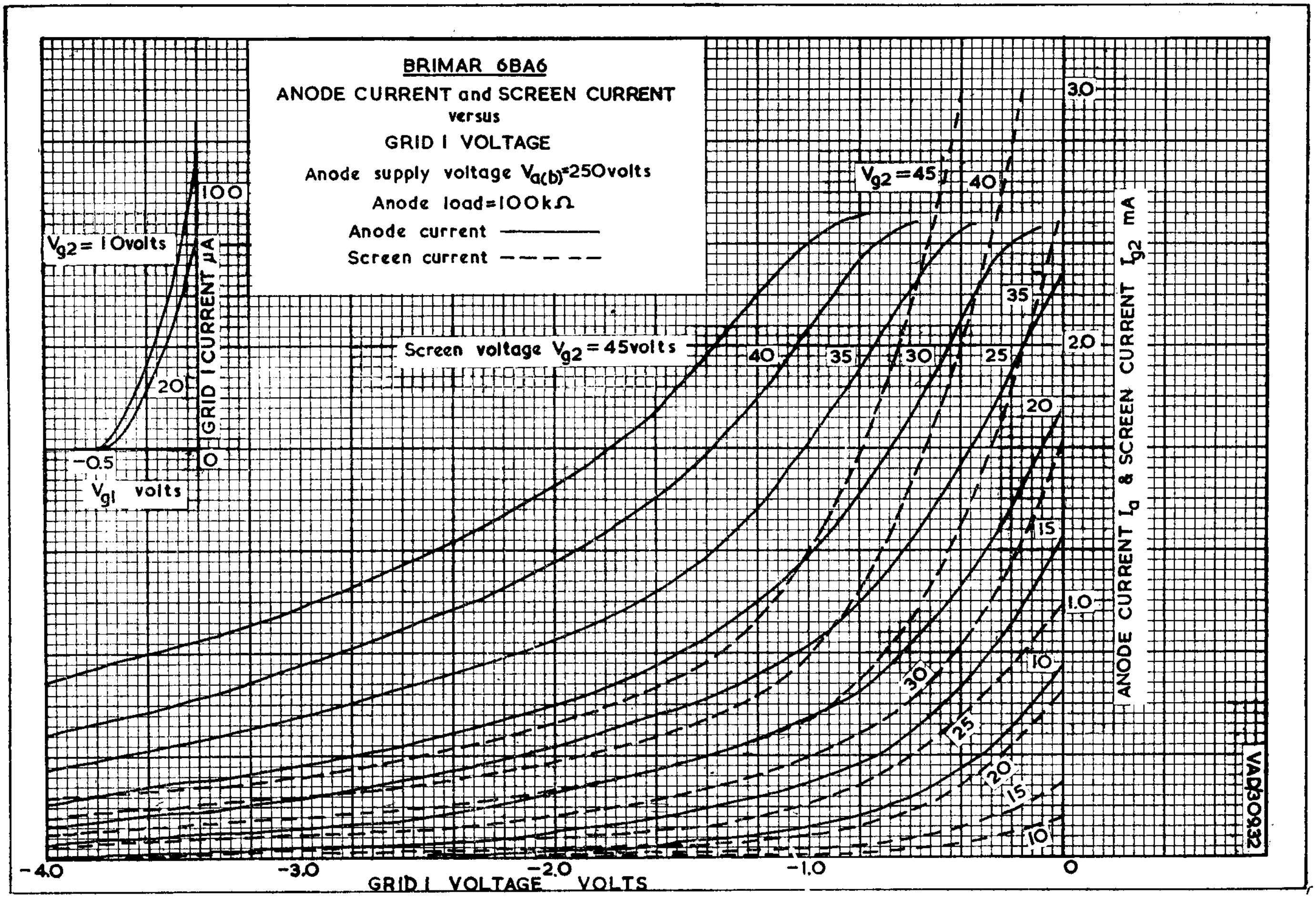
hence the actual operating gain will be 70 and the output voltage 50 volts peak for an input of 0·7 volts peak. An estimate of the distortion can be obtained by calculating in a similar manner the voltage gain for the positive swing (—1·5 to —1·0 volts) and the negative swing (—1·5 to —2·0 volts) separately, the resultant figures indicating the amount by which one peak is amplified more than the other.


VAD/309.28
BRIMAR 6BA6
ANODE CURRENT and SCREEN CURRENT†
versus
GRID I VOLTAGE
Anode voltage Va = 250volts
Suppressor voltage Vg3 = 0volts
Anode current Ia
Screen current Ig2
Screen supply Vg2(b) = 250volts via Rg2 = 33kΩ
Rg2 = 33kΩ
Vg2(b) = 250volts
Screen voltage Vg2 = 125volts
Vg2 = 100volts
Vg2 = 125volts
Vg2 = 75volts
Vg2 = 75volts
Vg2 = 100volts
Vg2 = 50volts
Vg2 = 50volts
10.0
5.0
1.0
0.5
0.1
ANODE & SCREEN CURRENT mA
-35
-30
-25
-20
-15
-10
-5
0
GRID I VOLTAGE VOLTS

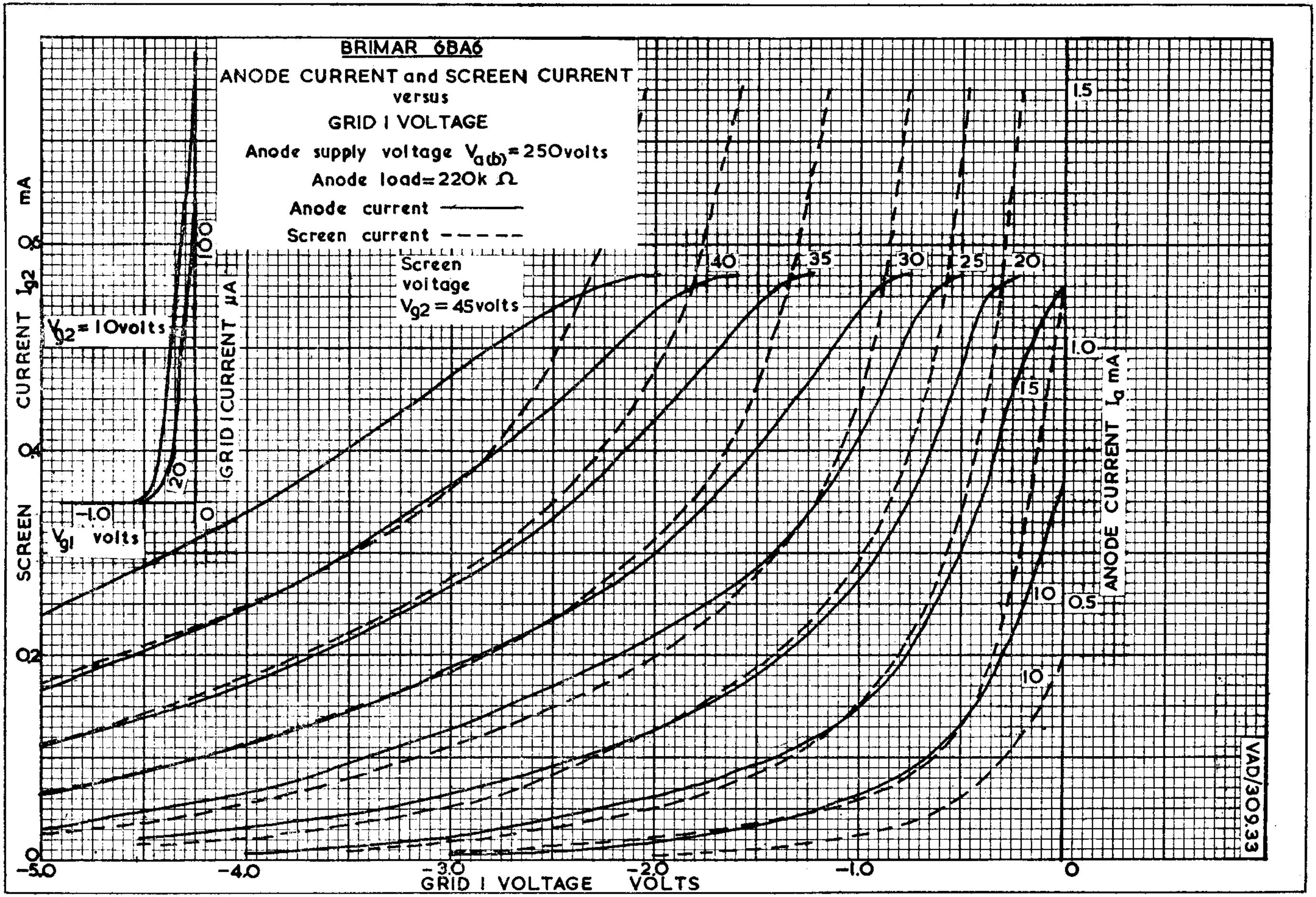

BRIMAR 6BA6
MUTUAL CONDUCTANCE & ANODE IMPEDANCE
versus
GRID I VOLTAGE
Anode voltage Va=250volts
Suppressor voltage Vg3=0volts
Mutual conductance gm ———
Anode impedance ra-----
Vg2=25volts
Vg2=75volts
Vg2=100volts
Vg2=125volts
Vg2(b)=250volts
Rg2=33kΩ
Screen supply Vg2(b)=250volts
via Rg2=33kΩ
Screen voltage Vg2=125volts
Vg2=100volts
Vg2=75volts
Vg2=25volts
ra MΩ
50
20
10
5
2
1
0.5
0.2
0.1
gm mA/V
5.0
2.0
1.0
0.5
0.2
0.1
0.05
0.02
0.01
-35
-30
-25
-20
-15
-10
-5
0
GRID I VOLTAGE VOLTS

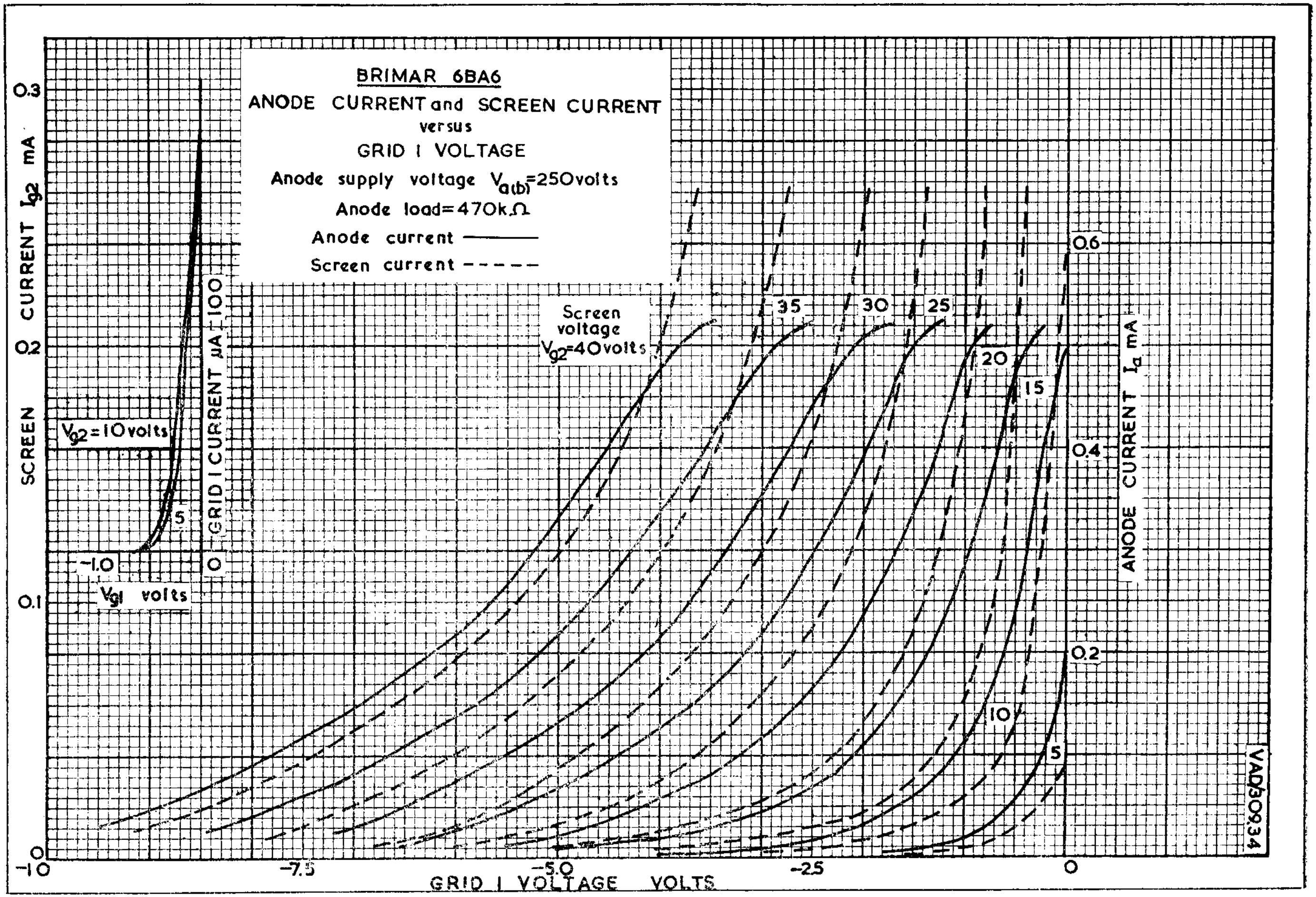

BRIMAR 6BA6
ANODE CURRENT versus ANODE VOLTAGE
Screen voltage V_{g2}=125 volts
Suppressor voltage V_{g3}=0 volts
Grid I voltage V_{g1}=−1
−2
−3
−4
−5
−7
−11
−14
−20
ANODE CURRENT mA
14
12
10
8
6
4
2
0
100
200
300
400
ANODE VOLTAGE VOLTS
VA D/309.30


BRIMAR 6BA6
ANODE CURRENT and SCREEN CURRENT
versus
ANODE VOLTAGE
Screen voltage Vg2=100volts
Suppressor voltage Vg3=0volts
Anode current
Screen current
Grid I voltage Vg1=-1volts
0
-2
0
-3
-4
-5
-7
-9
-11
-15
-20
ANODE CURRENT mA
14
12
10
8
6
4
2
0
100
200
300
400
ANODE VOLTAGE VOLTS
VAD/309.31

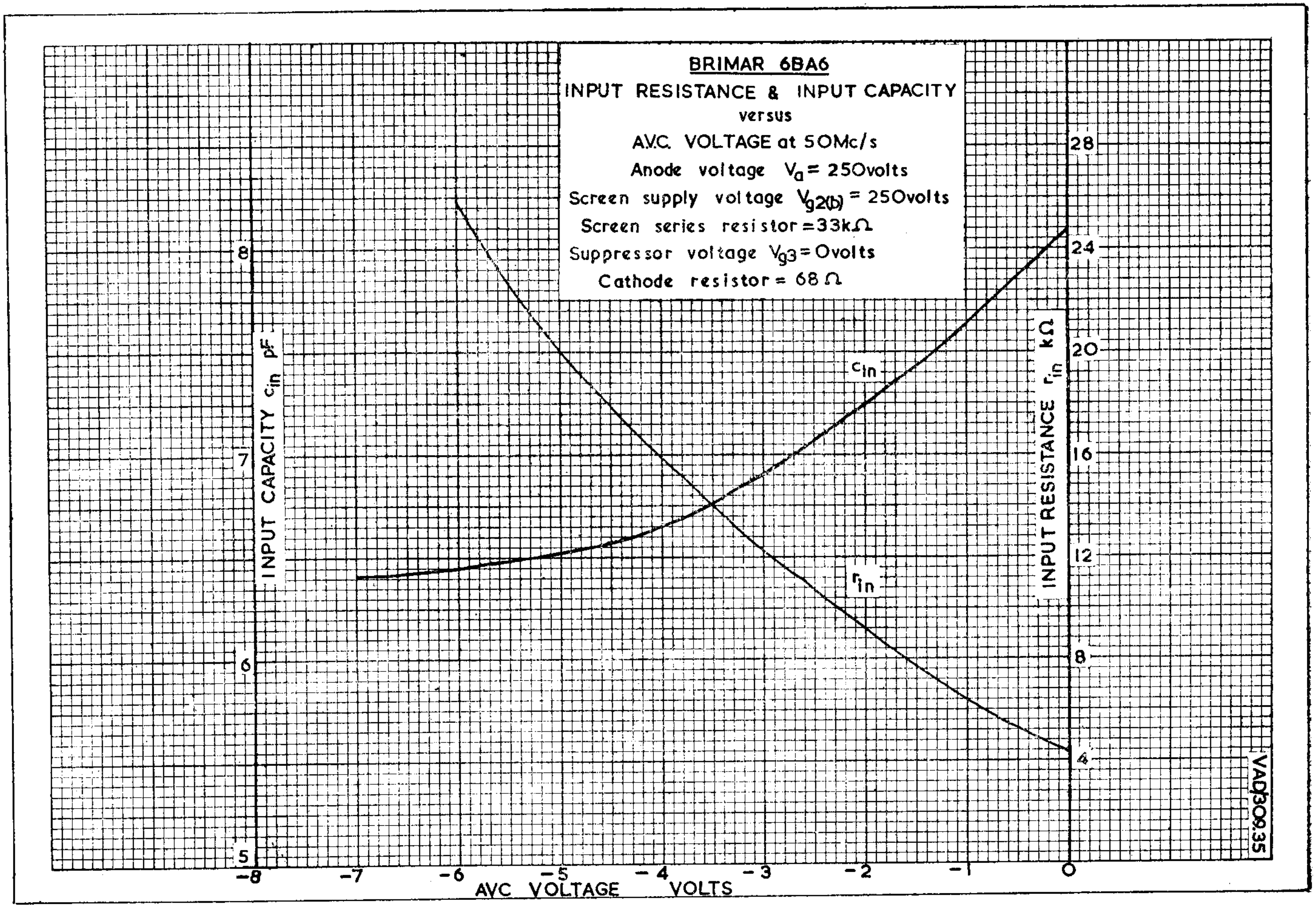


BRIMAR 6BA6
ANODE CURRENT and SCREEN CURRENT
versus
GRID I VOLTAGE
Anode supply voltage $V_{a(b)}$=250volts
Anode load=100kΩ
Anode current
Screen current
Screen voltage V_{g2}=45volts
V_{g2}=45
V_{g2}=10volts
GRID I CURRENT μA
V_{g1} volts
ANODE CURRENT I_a & SCREEN CURRENT I_{g2} mA
GRID I VOLTAGE VOLTS
VAD/30932

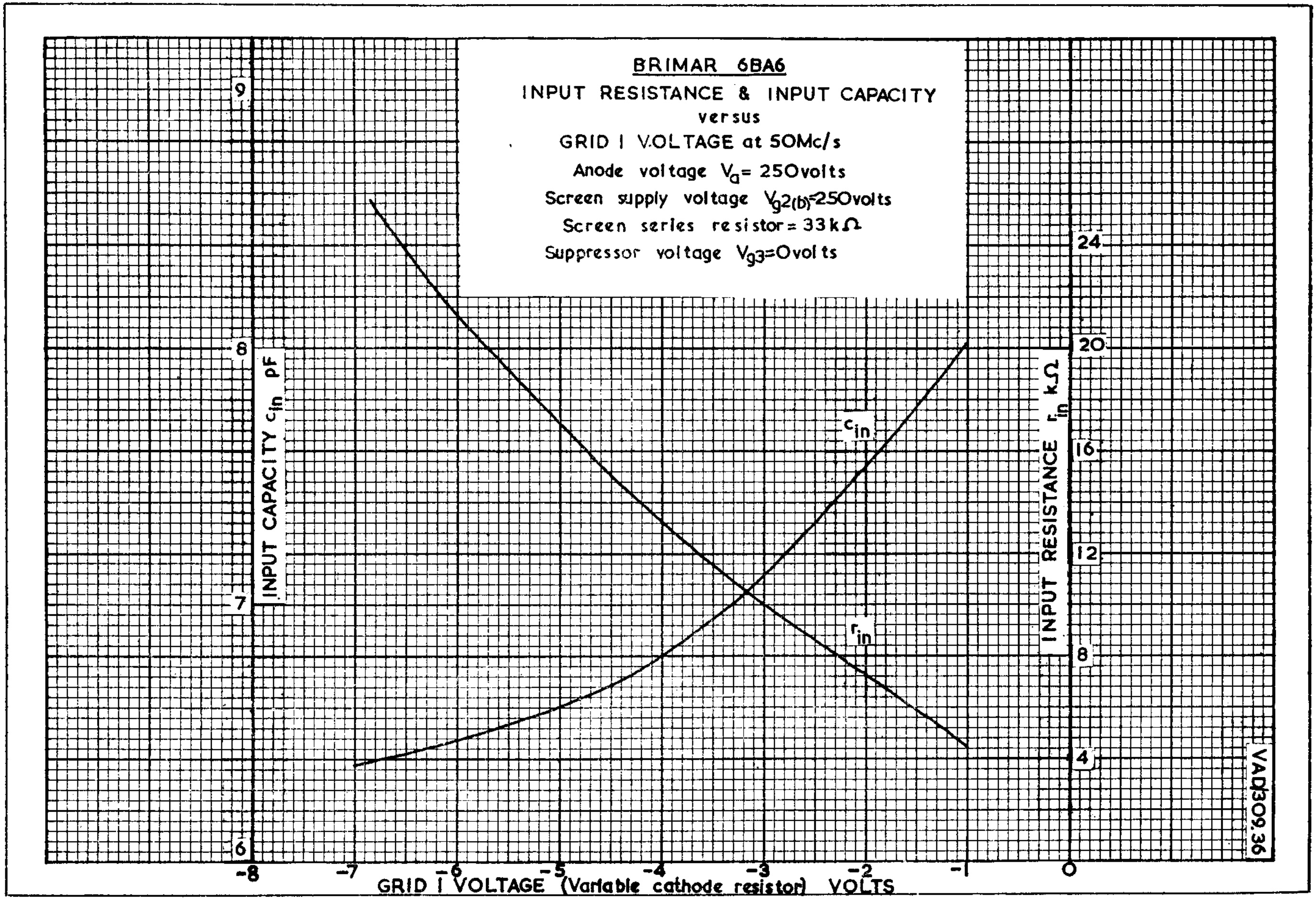

BRIMAR 6BA6
ANODE CURRENT and SCREEN CURRENT
versus
GRID I VOLTAGE
Anode supply voltage $V_{a(b)}$ = 250volts
Anode load = 220k Ω
Anode current ———
Screen current - - - - -
Screen voltage V_{g2} = 45volts
V_{g2} = 10volts
V_{g1} volts
GRID I CURRENT μA
SCREEN CURRENT I_{g2} mA
ANODE CURRENT I_a mA
GRID I VOLTAGE VOLTS
VAD/309.33
-5.0
-4.0
-3.0
-2.0
-1.0
0
0.2
0.4
0.6
0.5
1.0
1.5
-1.0
20
100
10
15
20
25
30
35
40



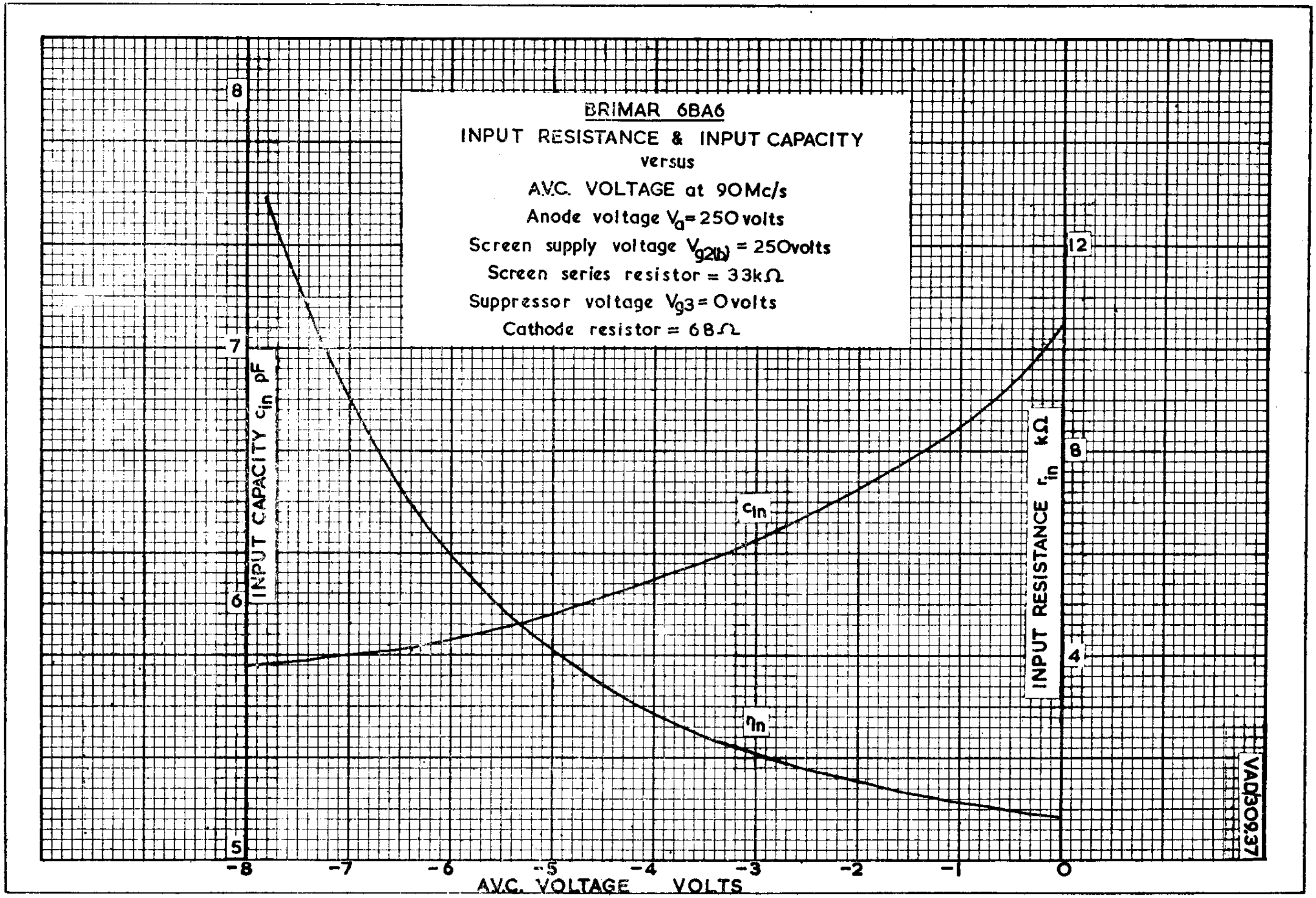
BRIMAR 6BA6
ANODE CURRENT and SCREEN CURRENT
versus
GRID 1 VOLTAGE
Anode supply voltage $V_{a(b)}$=250 volts
Anode load=470k.Ω
Anode current ———
Screen current - - - - -
Screen voltage V_{g2}=40 volts
35
30
25
20
15
10
5
V_{g2}=10 volts
5
-1.0
V_{g1} volts
0 GRID 1 CURRENT μA 100
SCREEN CURRENT I_{g2} mA
0.3
0.2
0.1
0
ANODE CURRENT I_a mA
0.6
0.4
0.2
-10
-7.5
-5.0
-2.5
0
GRID 1 VOLTAGE VOLTS
VAD/309.34



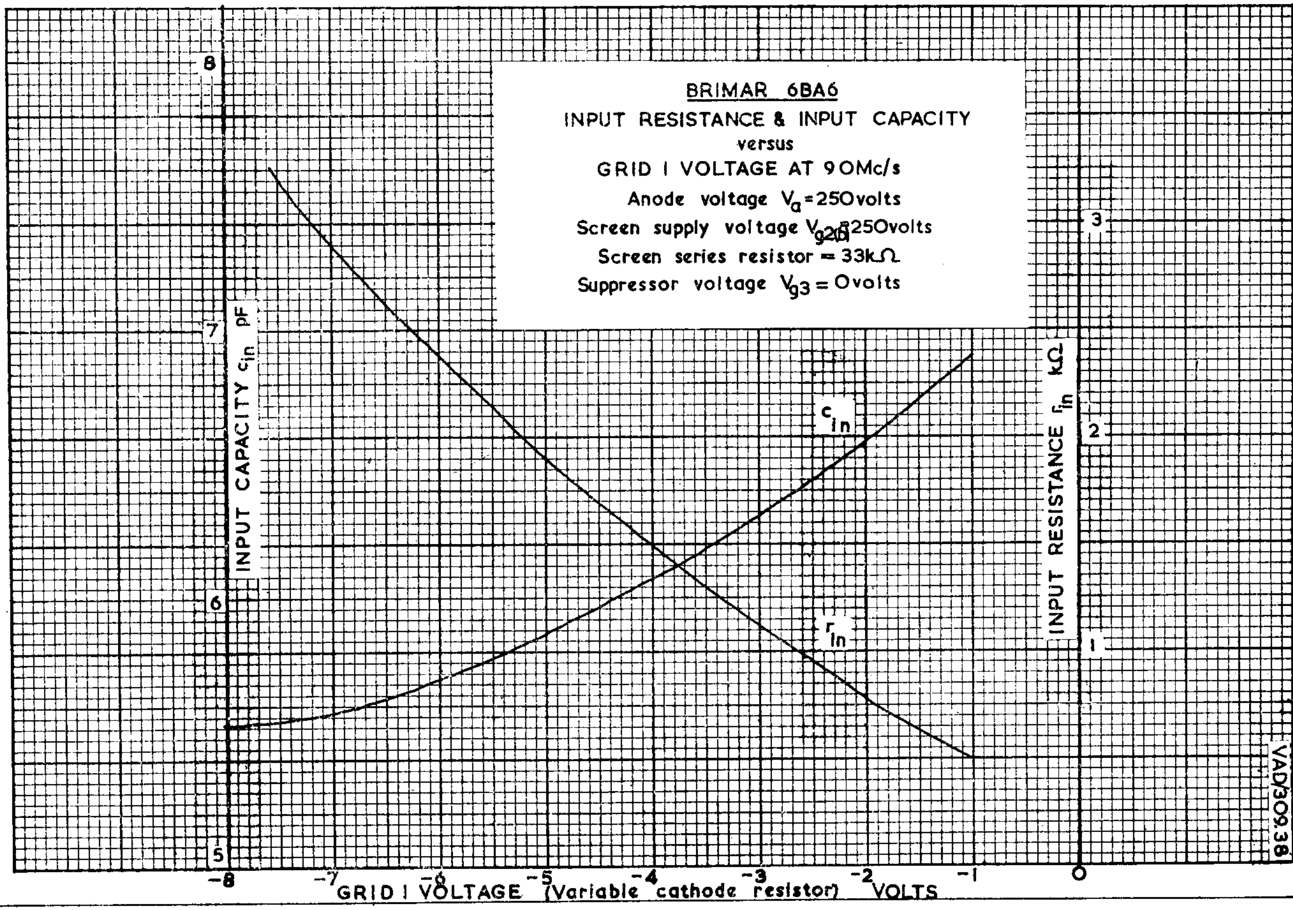
BRIMAR 6BA6
INPUT RESISTANCE & INPUT CAPACITY
versus
A.V.C. VOLTAGE at 50Mc/s
Anode voltage V_a = 250volts
Screen supply voltage $V_{g2(b)}$ = 250volts
Screen series resistor = 33kΩ
Suppressor voltage V_{g3} = 0volts
Cathode resistor = 68 Ω
INPUT CAPACITY c_{in} pF
INPUT RESISTANCE r_{in} kΩ
c_{in}
r_{in}
AVC VOLTAGE VOLTS
−8
−7
−6
−5
−4
−3
−2
−1
0
5
6
7
8
4
8
12
16
20
24
28
VAD/309.35



BRIMAR 6BA6
INPUT RESISTANCE & INPUT CAPACITY
versus
GRID I VOLTAGE at 50Mc/s
Anode voltage V_a = 250volts
Screen supply voltage $V_{g2(b)}$=250volts
Screen series resistor = 33kΩ
Suppressor voltage V_{g3}=0volts
INPUT CAPACITY c_{in} pF
INPUT RESISTANCE r_{in} kΩ
c_{in}
r_{in}
9
8
7
6
24
20
16
12
8
4
-8
-7
-6
-5
-4
-3
-2
-1
0
GRID I VOLTAGE (Variable cathode resistor) VOLTS
VAD/309.36



BRIMAR 6BA6
INPUT RESISTANCE & INPUT CAPACITY
versus
A.V.C. VOLTAGE at 90Mc/s
Anode voltage V_a = 250 volts
Screen supply voltage $V_{g2(b)}$ = 250volts
Screen series resistor = 33kΩ
Suppressor voltage V_{g3} = 0 volts
Cathode resistor = 68Ω
INPUT CAPACITY c_{in} pF
INPUT RESISTANCE r_{in} kΩ
c_{in}
r_{in}
8
7
6
5
12
8
4
-8
-7
-6
-5
-4
-3
-2
-1
0
A.V.C. VOLTAGE VOLTS
VAD/309.37



BRIMAR 6BA6
INPUT RESISTANCE & INPUT CAPACITY
versus
GRID I VOLTAGE AT 90Mc/s
Anode voltage V_a=250volts
Screen supply voltage $V_{g2(b)}$=250volts
Screen series resistor = 33kΩ
Suppressor voltage V_{g3} = 0volts
INPUT CAPACITY c_{in} pF
INPUT RESISTANCE r_{in} kΩ
c_{in}
r_{in}
GRID I VOLTAGE (Variable cathode resistor) VOLTS
8
7
6
5
3
2
1
−8
−7
−6
−5
−4
−3
−2
−1
0
VAD/309.38