SGS-THOMSON MICROELECTRONICS

APPLICATION NOTE

TV AND MONITORS : CHOICE OF DIODE FOR A HORIZONTAL DEFLECTION

B. Rivet

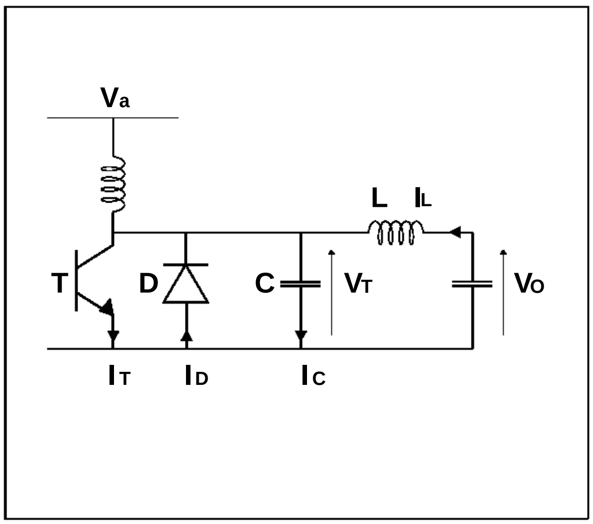
I - INTRODUCTION

The purpose of this note is to review the operation of the basic horizontal deflection circuit, to do an analysis of the different losses in the damper diode, and to suggest criteria for choosing between the DTV32-1500A and DTV32-1500B for a given application.

II - BEHAVIOUR OF THE BASIC HORIZONTAL DEFLECTION CIRCUIT

The basic horizontal deflection circuit is shown in Fig.1

Fig.1 : Basic horizontal deflection circuit



The current and voltage waveforms in the circuit are shown in Fig.2

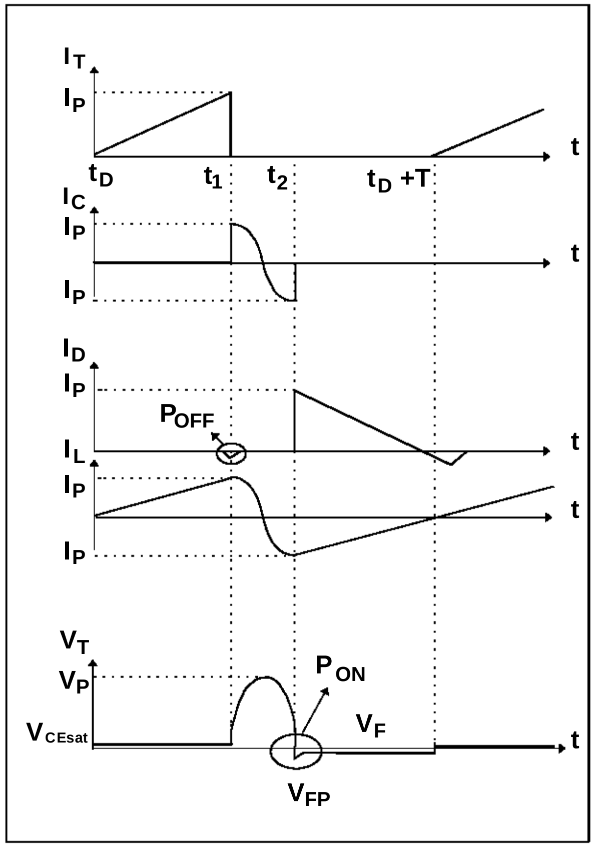
At $t = t_0$ the transistor starts to turn ON. The current in the line yoke and in the transistor is given by

$$I_T(t) = I_L(t) = \frac{Vo.t}{L}$$

The voltage V_T across the diode is equal to the V_{CEsat} of the transistor. The damper diode is blocked.

At t = t1 the transistor starts to turn OFF, the circuit becomes resonant (V_O . L . C). The current in the line decreases from Ip to -Ip and an overvoltage (V_{FP}) appears across the diode.

Fig.2 : Wavesform in the basic horizontal deflection circuit



At $t = t_2$ the voltage V_T across the diode becomes negative and the damper diode conducts. The current in the diode and in the line Yoke is then :

$$I_D(t) = -I_L(t) = I_P - \frac{Vo.t}{L}$$

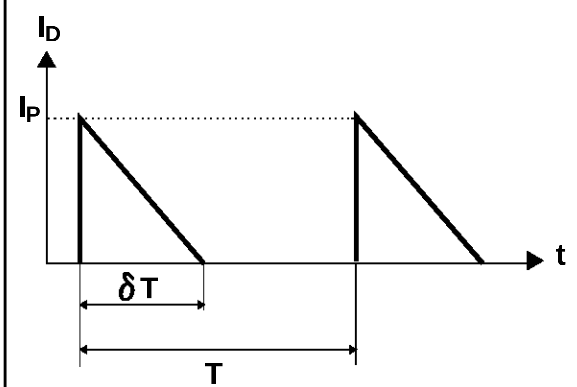
At $t = t_0 + T$ a new cycle starts

III - ANALYSIS OF THE POWER LOSSES IN THE DAMPER DIODE

a) Conduction losses : P_{COND}

The current in the damper diode is triangular Fig.3

Fig.3 : Current in the damper diode



The conduction losses are given by :

$P_{COND} = V_{TO} \cdot I_{F(AV)} + rd\ I_F^2(RMS)$

with

$$I_{F(AV)} = \frac{I_P\,\delta}{2}$$

and

$$I^2_{F(RMS)} = \frac{I_P^2\,\delta}{3}$$

Example : With a DTV32-1500 A

$V_{TO} = 1$ V
rd = 25 mΩ
and
$I_P = 6$ A
δ = 0.45

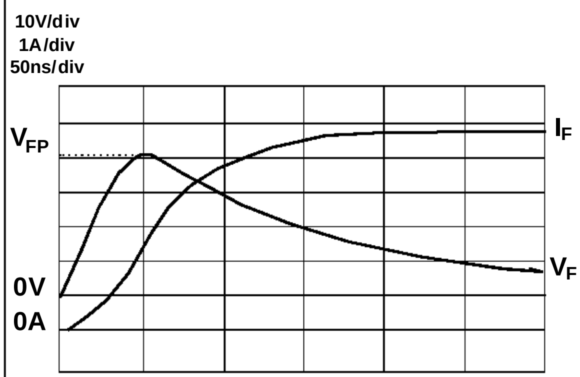
We find **P_{COND} = 1.5 W**

b) Switch ON losses : P_{ON}

When the diode switches ON (t=t2 Fig.2), the current in it increases from 0 to Ip with an high dI_F/dt (80A/µs). This current variation results in an overvoltage across the diode (V_{FP}) and switch ON losses.

Fig.4 shows the oscillogram of the current and the voltage across the damper diode when it is switched ON.

Fig.4 : Current and voltage in the damper diode at switch ON



P_{ON} is calculated with the oscillogram of Fig.4 and the following formula :

$$P_{ON} = \frac{1}{T}\int_0^{t_{fr}} V_F \cdot I_F\, dt$$

t_{fr} is the time during which the voltage accross the diode increases from OV to V_{FP} and then decreases from V_{FP} to V_{FR} = 2V

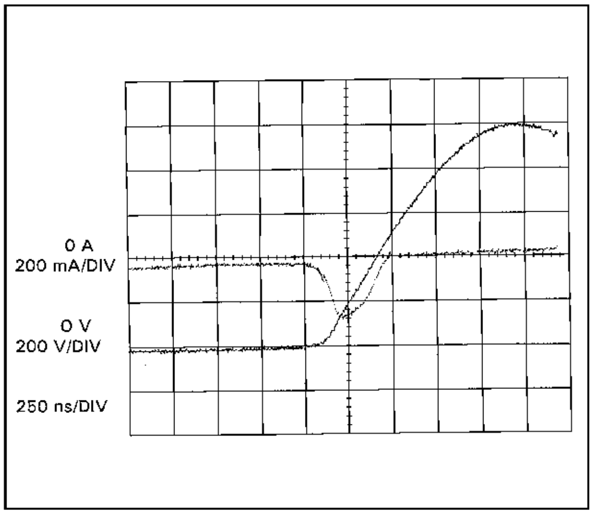
Example : With a DTV32-1500B
and
Tj = 100°C
dIF/dt = 80A/µs
V_{FP} = 42V
f = 32kHz
I_P = 6A

We find : **P_{ON} = 1 W**

c)Switch OFF losses : P_{OFF}

When the switching frequency of the horizontal deflection circuit is low (40 kHz), P_{OFF} is negligible. The diode disposes of all its stored charge with a low voltage across it (V_{CEsat}). At high frequencies there is insufficient time to complete this discharge during the conduction time of the transistor. In this case, when the transistor switches off, a current appears in the diode (at t=t1 Fig.2) and the voltage reaches a high value (600V) resulting in switch-OFF losses (Fig.5)

Fig.5 : Current and voltage in the damper diode at switch OFF (f = 70kHz)



Example : With a DTV32-1500A
and P = 6A
f = 70 kHz
Tj = 80°C
trr = 210 ns
(Tj = 25C IF = 1A VR = 30V dIF/dt = -50A/s)
P_{OFF} is estimated at P_{OFF} **= 0.9 W**

This estimate has been made by measurements on the board whose circuit diagram is given in appendix A.

IV - CHOICE BETWEEN THE DTV32-1500A AND THE DTV32-1500B FOR A GIVEN APPLICATION

SGS THOMSON offers two high voltage damper diodes : the DTV32- 1500A and the DTV32-1500B. The principal characteristics of these two diodes are given in the following table :

Fig.3 : Principal characteristics of the DTVV32-1500A and the DTV32-1500B

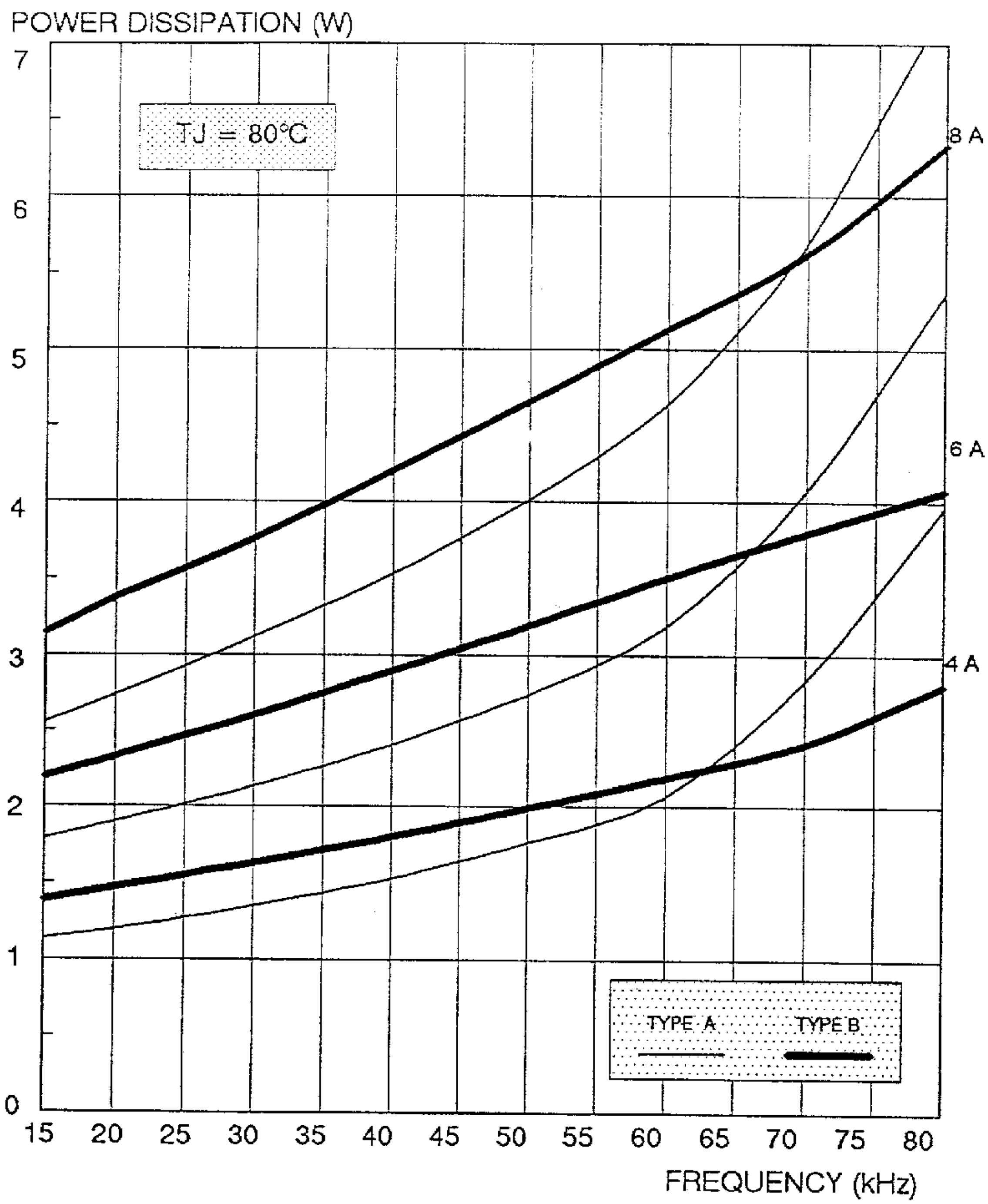
Parameters		DTV32-1500A	DTV32-1500B
V_{TO}	max	1 V	1.2 V
rd	max	25 mΩ	34 mΩ
V_{FP} typ	80 A/µs V_{FR} = 2 V	30 V	39 V
t_{fr}	typ	500 ns	600 ns
t_{rr}	25°C I_F = 1A V_R = 30 V -50 A/µs typ	250 ns	130 ns

Figs:7 - 9 show the total loss ($P_T = P_{COND} + P_{ON} + P_{OFF}$) in the damper diodes A and B versus frequency, for different currents I_P and different junction temperatures.

These curves have the same forms for the different junction temperatures (80°C - 100°C - 120°C)

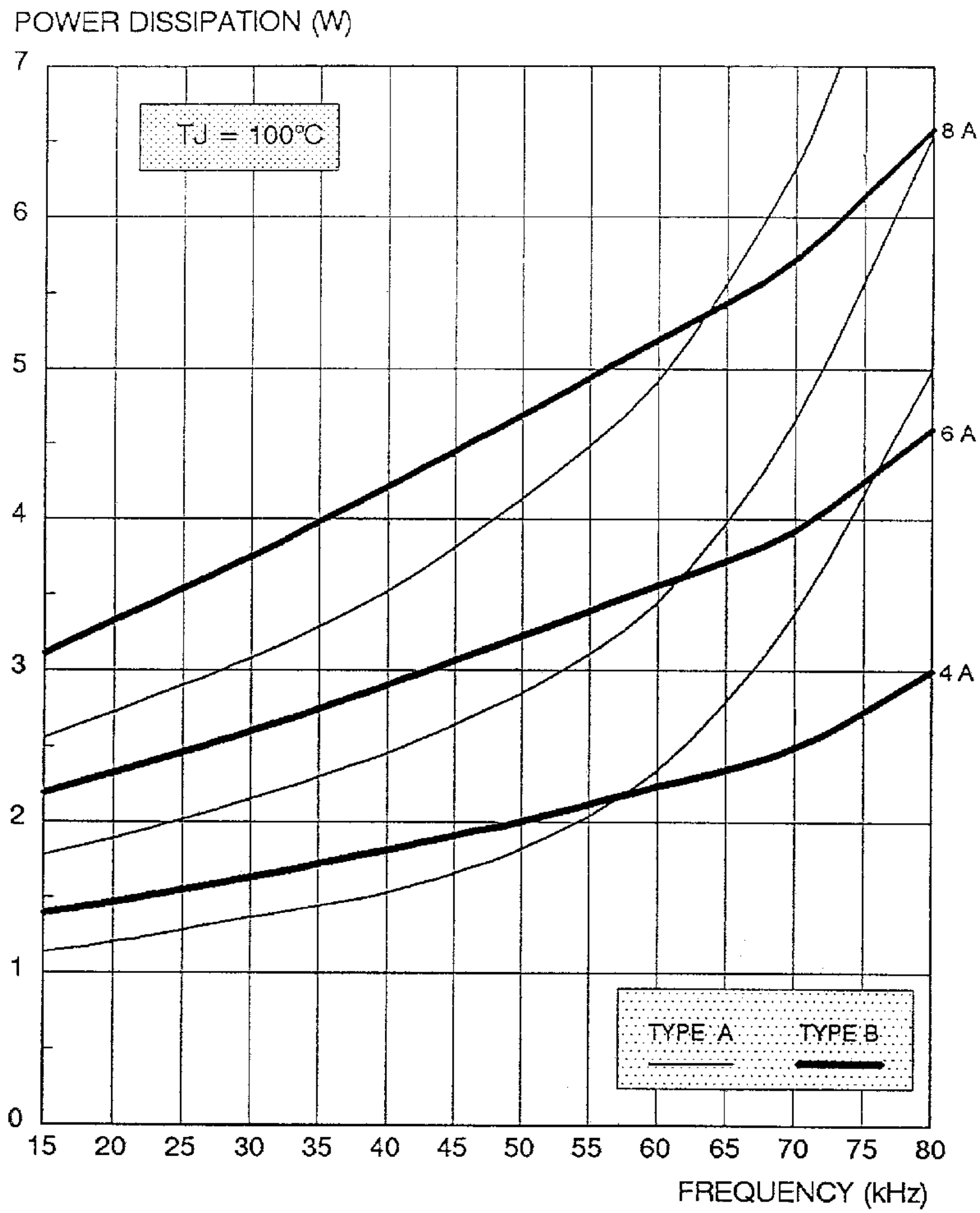
For the lower frequencies (< 55 kHz) total losses are greater in the DTV32-1500B. In this area conduction and switch ON losses are predominant. For the high frequencies (> 65 kHz) total losses become greater in the DTV32-1500A (switch OFF losses are more significant in this diode). This difference in high- frequency losses between the two devices also increases with temperature.

Fig.6 : Comparison type "A" and type "B" at Tj = 80°C



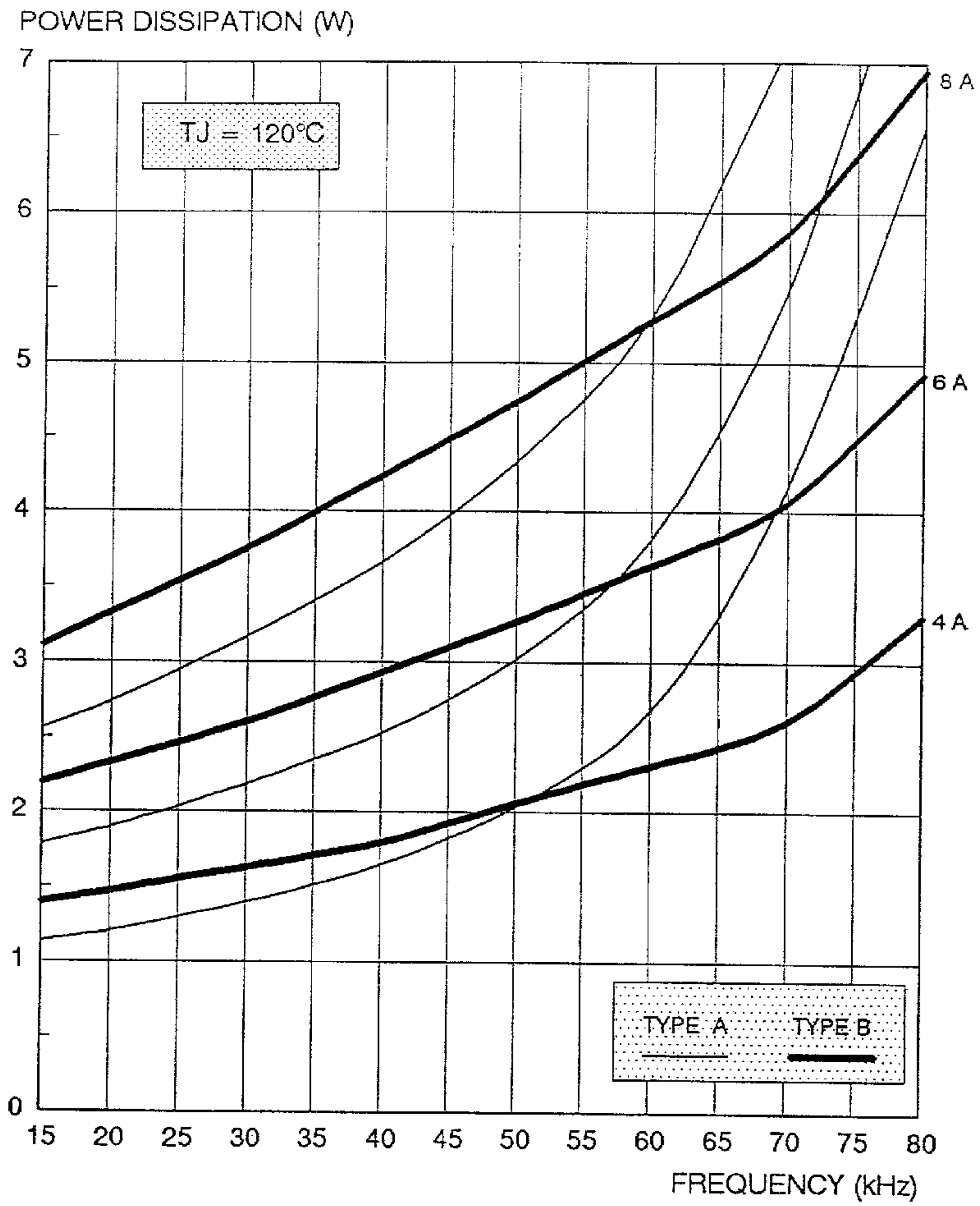
Total power dissipation versus operationg frequency for different peak currents

Fig.7 : Comparison type "A" and type "B" at Tj = 100°C



Total power dissipation versus operationg frequency for different peak currents

Fig.8 : Comparison type ”A” and type ”B” at Tj = 120°C



Total power dissipation versus operationg frequency for different peak currents

V - CONCLUSION

SGS-THOMSON offers two Damper diodes to cover the need in horizontal deflection circuit for televisions and monitors. The operating frequency determines the choice of damper diode. For frequencies below 55 kHz the DTV32-1500A is preferable while above 65 kHz the DTV32-1500B is the better choice.

APPENDIX A