IS 2597-2 (1967): Code of practice for the use of electron tubes, Part 2: Special quality receiving tubes [LITD 4: Electron Tubes and Display Devices]

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Indian Standard

CODE OF PRACTICE FOR THE USE OF ELECTRON TUBES

PART II SPECIAL QUALITY RECEIVING TUBES

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NEW DELHI 110002

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Indian Standard

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PART II SPECIAL QUALITY RECEIVING TUBES

Electron Tubes and Valves Sectional Committee, ETDC 39

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CODE OF PRACTICE FOR THE USE OF ELECTRON TUBES

PART II SPECIAL QUALITY RECEIVING TUBES

0. FOREWORD

0.1 This Indian Standard (Part II) was adopted by the Indian Standards Institution on 18 May 1967, after the draft finalized by the Electron Tubes Sectional Committee had been approved by the Electrotechnical Division Council.

0.2 This code is intended to give general guidance to the designers of electronic equipment to be supplemented by data sheets from the tube manufacturers, so that optimum efficiency, performance, life and the intended special requirements can be obtained.

0.2.1 This part of the code covers recommendation applicable to special quality receiving tubes and is intended to be used in conjunction with IS : 2597 (Part I)-1964*.

0.3 The term 'Special Quality Tubes' refers to types with one or more attributes such as resistance to damage from mechanical vibration and shock, stability of characteristics, close tolerances or long life. These attributes are necessary to an exceptional degree because these tubes are used in conditions different from or more rigorous than those normally experienced in domestic radio and television receivers. Special quality receiving tubes are primarily intended for service in mobile communication, civil aircraft, industrial electronics, repeaters, computers, equipment for the armed services and space communications.

0.3.1 In repeaters and computers, tubes are expected to have particularly long life but are not subjected to appreciable mechanical shock. Under the same conditions certain types of dc amplifiers require tubes of high electrical stability during normal life. In equipment for the armed services, civil aircraft, mobile telecommunications and industrial electronics, tubes are required to withstand moderate conditions of vibration and shock over a moderate length of life. On the other hand in projectiles and guided missiles, tubes must withstand particularly severe

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conditions of vibration and shock over the comparatively short operational life required. For space communications, however, long operational life may be necessary.

0.4 This code is based to a large extent, on B.S. Cp (1005) : 1962 ' The use of electronic valves ' issued by the British Standards Institution.

0.5 Explanatory paragraphs given under some of the clauses have been indicated in *italics*.

0.6 For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS : 2-1960*. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

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1. SCOPE

1.1 This standard (Part II) covers recommendations for the use of special quality receiving tubes.

2. TERMINOLOGY

2.1 For the purpose of this standard (Part II), the definitions of terms as given in IS : 1885 (Part IV/Section I)-1973† and those given in **2** of IS : 2597 (Part I)-1964‡ shall apply.

3. CHOICE OF TYPES

3.1 Manufacturer's published data will indicate the special features which have been introduced and the benefits of these special features will best be realized by paying careful attention to treatment and operating environments of the tube.

3.2 Examination of the published data will indicate the particular type of application for which the tube was designed but it could not be assumed without consultation with the tube manufacturer that those characteristics for which no specific claims are made are necessarily better than those of normal tubes. For example, types for which no reduction in

*Rules for rounding off numerical values (*revised*).

†Electrotechnical vocabulary : Part IV Electron tubes, Section 1 Common terms.

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microphony is claimed will not necessarily be better in this respect than normal tubes and tubes stated to have high stability of characteristics with respect to time may be subject to a normal spread from tube to tube.

4. RATING

4.1 Ratings are the set of limiting values defining the operating conditions within which the tube can be expected to give satisfactory performance. These are so chosen that failure rate, life and performance are sufficiently satisfactory. The expectation of life generally decreases continuously as the ratings are approached. Exceeding the rating accelerates the decline. Barring a few exceptions the more conservative the use of the tube with respect to ratings the greater is the life expectancy and reliability.

4.2 The first maximum or minimum rating reached should be the limiting factor. All ratings are not mutually compensating, for example, it is not safe to assume that one rating (say, maximum anode voltage) may be exceeded provided a corresponding reduction is made in some other rating (for example, anode current), although this may be permissible in some instances. Further, a rating variation authorized for a particular tube type is not necessarily applicable to another similar type. Use of tubes in applications where the absolute maximum ratings are exceeded should be done only in consultation with the tube manufacturer.

5. HEATERS

5.1 Improved life and reliability will be obtained by working to closer heater tolerance than those suggested in **3.4.2.2** and **3.4.2.3** of IS : 2597 (Part I)-1964*. The order of improvement in life and reliability which may be obtained in any particular instance depends on a number of factors such as the design features of the tube and the nature of the application. It is, therefore, recommended that the circuit designer should consult the tube manufacturer in each particular case (*see* **5.1.1** and **5.1.2**).

5.1.1 When tubes are to be used in civil aircraft, advice should be sought from the tube manufacturers and from the approving authority about the special operating conditions to its service. For example, where three tubes having 6·3 volt heaters (of the same current rating) not specifically approved for series operation are run in series, a regulated power supply of 19 ± 1 V should be used.

5.1.2 Where a number of tubes are required to be operated in civil aircraft in series from supplies other than a regulated 19 ± 1 V supply

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each particular arrangement should be the subject of special consideration during the consultations referred to in **5.1.1**.

6. VIBRATION AND SHOCK FATIGUE

6.1 Certain tubes are rated for use in various conditions of vibration and shock which will be specified by the manufacturer. The maximum shock for which the tubes are rated is stated in terms of '*g*' (the value of acceleration due to gravity). The maximum vibration conditions are defined similarly but the frequency range may also be specified. In both cases the direction and manner in which it is permissible to apply shock and vibration may be defined in the ratings. The application of shock and vibration sets up stresses in the tube structure which these tubes have been specially designed to withstand. Nevertheless it is essential that vibration and shock should never be exceeded or these stresses will result in such distortion of the tube structure that performance, life and reliability will be impaired.

7. CIRCUIT DESIGN

7.1 The failure rate of the tube will depend to a large extent upon the conditions of its use and the adoption of the recommendations specified in **7.1.1** to **7.1.3** will contribute to equipment reliability.

7.1.1 *Reliance on Characteristics* — It is generally a good practice to so design circuits that the minimum of reliance is placed upon the values or stability with time of individual characteristics (for example, conductance or the point at which grid current starts). Nevertheless if such design unduly increases the number of components or tubes this shall be taken into account when estimating the overall reliability.

7.1.2 *Choice of Valve Operating Point* — The operating conditions should be such that those minor changes in tube characteristics which may occur during life will not greatly affect the electrode dissipation of the tube itself [*see also* **3.10.2** of IS : 2597 (Part I)-1964*]. The expected direction of change in electrical characteristics shall also be taken note of. Based on the analysis of life test data, the tube manufacturers may supply this information.

For example, operating conditions close to the specified life conditions; the amount of change to be expected in such characteristics as mutual conductance; leakage current and leakage between sections of dual types are usually indicated.

7.1.3 *Heater or Filament Characteristics* — Particular attention is drawn to **5**.

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8. HEATER SURGES

8.1 Parallel Operation — It is desirable that surges be avoided as far as possible, preferably by either gradual application of voltage or by the use of a surge limiting device.

8.2 Series Operation — Particular attention is drawn to **3.4.2.3** of IS : 2597 (Part I)-1964*. When tubes are run with series connected heaters, heater current switching surges can be reduced to very small proportions by the use of a thermistor in series with the heater chain. It should be remembered that such an arrangement will limit the current-surge effectively only when starting from cold so that at least 5 minutes should elapse after the heater supply has been switched off before it is switched on again.

8.3 Switching — If possible, HT voltage should be applied after the cathode is hot, particularly in the case of tubes such as rectifiers operating at a high value of cathode current and peak inverse voltage. This applies particularly when the frequency of the supply is appreciably above 50 c/s.

The random failure rate of certain tubes may be increased by an increase in the frequency of heater switching; nevertheless the actual total possible emission life of the cathode will be increased if heaters are switched off during standby periods since prolonged standby operation with heaters energized increases the rate at which the cathode interface impedance builds up (*see* **9**).

8.4 Component Variation — The use of components which may vary significantly in value or in characteristics during life or from batch to batch should be avoided.

8.5 Parallel Systems — The use of discrete systems or stages in parallel which are arranged to come automatically into operation in the event of failure of one system is common engineering practice and leads to a considerable increase in reliability. When the use of tubes in parallel is being considered, the effect of possible inter-electrode short circuits in one tube on the operation of tubes in parallel, on the power supplies, and on the circuit as a whole should be considered.

9. EFFECTS OF INTERFACE IMPEDANCE GROWTH

9.1 Particular attention is drawn to the recommendation given in **3.14.1** of IS : 2597 (Part I)-1964*. There is danger of loss of performance when tubes are run with a very low cathode current or with no cathode current at all, particularly when they are required to give high pulse current after a period of low current operation.

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9.2 Unless the manufacturer's data specifically permit for this type of operation it should not be assumed that the tubes concerned are suitable for this type of operation; the manufacturer should be consulted and adequate tests carried out on a sufficient number of tubes to ascertain whether the tubes are suitable or not.

Formation of interface resistance may be minimized by avoiding standby operations wherever possible or at least restricted to short periods of time.

10. MOUNTING

10.1 The method of mounting of a special quality tube should be such as to reduce to a minimum the vibration or shock transmitted to the tube by way of the base cap or other connections. An anchor point should be provided sufficiently close to the base in the case of tubes having flexible leads to prevent resonances from building up and causing a fatigue fracture of the lead.

The use of a tube holder or screening can, of which any part is resonant at a vibration frequency present in the equipment may significantly increase the amplitude of the vibration transmitted from the chassis to the tubes to vibration exceeding its maximum rating.

11. TEMPERATURE CONSIDERATIONS

11.1 Envelope Temperature

11.1.1 High envelope temperature may cause early life failure in tubes. The majority of high envelope temperatures, particularly of the miniature types, is caused by the use of screening cans which trap a layer or air round the tube and so prevent convection cooling. They also reflect heat back to the tube.

11.1.2 Where a screening can has to be used it should be a close fitting one, firmly connected to the chassis and its inside surface should be black. It should have as many points of contact as possible with the tube envelope and should be capable of giving good contact when used with limit sizes of envelopes.

11.1.3 Where there is no metal chassis to act as a heat sink, as in the case of printed circuits, an alternative method of cooling the screening can such as radiating fins or forced air cooling should be employed.

11.1.4 In all cases of doubts the internal dissipation of the tube should be reduced in consultation with the tube manufacturer.

11.1.5 Attention is also drawn to the atmospheric pressure limitations outlined in **3.3.3** of IS : 2597 (Part I)-1964*. If a tube is used at high

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altitude the total internal dissipation may have to be reduced by about 50 percent as there is insufficient air to provide the necessary cooling.

12. HANDLING

12.1 It is of great importance that special quality receiving tubes should undergo the minimum of handling before being placed in service and this requirement should be brought to the notice of all responsible supervisory and operating personnel.

12.2 Excessive handling, particularly unnecessary insertion into and withdrawal from tube holders may create stresses in the base of all-glass tubes with semi-rigid pins and will result in premature failure. It is, therefore, strongly recommended that if special quality receiving tubes are subjected to extensive acceptance testing before being placed in service, this should be carried out on a sampling basis only. The tube should not be placed in the equipment until this has been tested and found to be satisfactory with a set of tubes kept for this purpose. In this connection particular attention is drawn to recommendations in **3.5.1** to **3.5.6** of IS : 2597 (Part I)-1964*.

13. PREVENTIVE MAINTENANCE

13.1 For some types of tubes the failure rate tends to decrease after a relatively short period of operation and to remain thereafter at a substantially stable level. There is considerable evidence that tubes become stabilized in the particular circuit in which they are operating. Arbitrary replacement of tubes which have reached this stage is obviously undesirable.

13.2 However, where sufficient life data have been established by the tube manufacturer or other competent authority, it may be possible to indicate an approximate time at which the rate of failure is subsequently liable to increase seriously and thus to suggest a time at which replacement of the tubes will result in more reliable operation of the equipment.

13.3 Preventive maintenance to remove potential failures may be instituted in consultation with the equipment designer and the tube manufacturers at certain specified times during the life of the equipment. An increase for a short period, in heater voltage to slightly beyond the upper limit likely to be reached during the subsequent period of equipment operation will indicate potential failures due to increase of grid current or inter-electrode leakage current in those circuits where

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these characteristics are likely to be critical. It is desirable that such test should be made with the equipment operating at the maximum ambient temperature reached in normal operation. Similarly a decrease, for a short period, of heater voltage to slightly below the lower limit likely to be reached during the subsequent period of equipment operation will indicate potential failures due to falling cathode emission and growth of cathode interface impedance (resistance) in those circuits where those characteristics are of importance.

13.3.1 This procedure may enable tubes approaching the state of inadequate performance for the particular application to be detected and replaced.

INTERNATIONAL SYSTEM OF UNITS (SI UNITS)

Base Units

QUANTITY	UNIT	SYMBOL
Length	metre	m
Mass	kilogram	kg
Time	second	s
Electric current	ampere	A
Thermodynamic temperature	kelvin	K
Luminous intensity	candela	cd
Amount of substance	mole	mol

Supplementary Units

QUANTITY	UNIT	SYMBOL
Plane angle	radian	rad
Solid angle	steradian	sr

Derived Units

QUANTITY	UNIT	SYMBOL	DEFINITION
Force	newton	N	1 N = 1 $kg.m/s^2$
Energy	joule	J	1 J = 1 N.m
Power	watt	W	1 W = 1 J/s
Flux	weber	Wb	1 Wb = 1 V.s
Flux density	tesla	T	1 T = 1 Wb/m^2
Frequency	hertz	Hz	1 Hz = 1 c/s (s^{-1})
Electric conductance	siemens	S	1 S = 1 A/V
Electromotive force	volt	V	1 V = 1 W/A
Pressure, stress	pascal	Pa	1 Pa = 1 N/m^2

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