

# PHILIPS

Data handbook



Electronic  
components  
and materials

## Components and materials

Book C4

1984

Ferroxcube potcores, square cores & cross cores

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# FERROXCUBE POTCORES, SQUARE CORES AND CROSS CORES

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## DATA HANDBOOK SYSTEM

Our Data Handbook System comprises more than 50 books with specifications on electronic components, subassemblies and materials. It is made up of four series of handbooks:

ELECTRON TUBES	BLUE
SEMICONDUCTORS	RED
INTEGRATED CIRCUITS	PURPLE
COMPONENTS AND MATERIALS	GREEN

The contents of each series are listed on pages iv to viii.

The data handbooks contain all pertinent data available at the time of publication, and each is revised and reissued periodically.

When ratings or specifications differ from those published in the preceding edition they are indicated with arrows in the page margin. Where application information is given it is advisory and does not form part of the product specification.

Condensed data on the preferred products of Philips Electronic Components and Materials Division is given in our Preferred Type Range catalogue (issued annually).

Information on current Data Handbooks and on how to obtain a subscription for future issues is available from any of the Organizations listed on the back cover.

Product specialists are at your service and enquiries will be answered promptly.

## ELECTRON TUBES (BLUE SERIES)

The blue series of data handbooks is comprised of the following parts:

- T1 Tubes for r.f. heating**
- T2a Transmitting tubes for communications, glass types**
- T2b Transmitting tubes for communications, ceramic types**
- T3 Klystrons, travelling-wave tubes, microwave diodes**
- ET3 Special Quality tubes, miscellaneous devices (will not be reprinted)**
- T4 Magnetrons**
- T5 Cathode-ray tubes**  
Instrument tubes, monitor and display tubes, C.R. tubes for special applications
- T6 Geiger-Müller tubes**
- T7 Gas-filled tubes**  
Segment indicator tubes, indicator tubes, dry reed contact units, thyratrons, industrial rectifying tubes, ignitrons, high-voltage rectifying tubes, associated accessories
- T8 Picture tubes and components**  
Colour TV picture tubes, black and white TV picture tubes, colour monitor tubes for data graphic display, monochrome monitor tubes for data graphic display, components for colour television, components for black and white television and monochrome data graphic display
- T9 Photo and electron multipliers**  
Photomultiplier tubes, phototubes, single channel electron multipliers, channel electron multiplier plates
- T10 Camera tubes and accessories**
- T11 Microwave semiconductors and components**
- T12 Vidicons and Newvicons**
- T13 Image intensifiers**
- T14 Infrared detectors**



## SEMICONDUCTORS (RED SERIES)

The red series of data handbooks comprises:

- S1 Diodes**  
Small-signal germanium diodes, small-signal silicon diodes, voltage regulator diodes (< 1,5 W), voltage reference diodes, tuner diodes, rectifier diodes
- S2 Power diodes, thyristors, triacs**  
Rectifier diodes, voltage regulator diodes (> 1,5 W), rectifier stacks, thyristors, triacs
- S3 Small-signal transistors**
- S4a Low-frequency power transistors and hybrid modules**
- S4b High-voltage and switching power transistors**
- S5 Field-effect transistors**
- S6 R.F. power transistors and modules**
- S7 Microminiature semiconductors for hybrid circuits**
- S8 Devices for optoelectronics**  
Photosensitive diodes and transistors, light-emitting diodes, displays, photocouplers, infrared sensitive devices, photoconductive devices.
- S9 Power MOS transistors**
- S10 Wideband transistors and wideband hybrid IC modules**

## INTEGRATED CIRCUITS (PURPLE SERIES)

The purple series of data handbooks comprises:

### EXISTING SERIES

- IC1** Bipolar ICs for radio and audio equipment
- IC2** Bipolar ICs for video equipment
- IC3** ICs for digital systems in radio, audio and video equipment
- IC4** Digital integrated circuits  
CMOS HE4000B family
- IC5** Digital integrated circuits – ECL  
ECL10 000 (GX family), ECL100 000 (HX family), dedicated designs
- IC6** Professional analogue integrated circuits
- IC7** Signetics bipolar memories
- IC8** Signetics analogue circuits
- IC9** Signetics TTL logic
- IC10** Signetics Integrated Fuse Logic (IFL)
- IC11** Microprocessors, microcomputers and peripheral circuitry

## NEW SERIES

- IC01N** Radio, audio and associated systems  
Bipolar, MOS
- IC02N** Video and associated systems  
Bipolar, MOS
- IC03N** Telephony equipment  
Bipolar, MOS
- IC04N** HE4000B logic family  
CMOS
- IC05N** HE4000B logic family uncased integrated circuits  
CMOS (published 1984)
- IC06N** PC54/74HC/HCU/HCT logic families  
HCMOS
- IC07N** PC54/74HC/HCU/HCT uncased integrated circuits  
HCMOS
- IC08N** 10K and 100K logic family  
ECL
- IC09N** 54/74: STD, LS, S, F logic series  
TTL
- IC10N** Memories  
MOS, TTL, ECL
- IC11N** Analogue - industrial
- IC12N** Semi-custom gate arrays & cell libraries  
ISL, ECL, CMOS
- IC13N** Semi-custom integrated fuse logic  
IFL series 20/24/28
- IC14N** Microprocessors, microcontrollers & peripherals  
Bipolar, MOS

### Note

Books available in the new series are shown with their date of publication.

## COMPONENTS AND MATERIALS (GREEN SERIES)

The green series of data handbooks comprises:

- C1 Assemblies for industrial use**  
PLC modules, PC20 modules, HN1L FZ/30 series, NORbits 60-, 61-, 90-series, input devices, hybrid ICs
- C2 Television tuners, video modulators, surface acoustic wave filters**
- C3 Loudspeakers**
- C4 Ferroxcube potcores, square cores and cross cores**
- C5 Ferroxcube for power, audio/video and accelerators**
- C6 Synchronous motors and gearboxes**
- C7 Variable capacitors**
- C8 Variable mains transformers**
- C9 Piezoelectric quartz devices**  
Quartz crystal units, temperature compensated crystal oscillators, compact integrated oscillators, quartz crystal cuts for temperature measurements
- C10 Connectors**
- C11 Non-linear resistors**  
Voltage dependent resistors (VDR), light dependent resistors (LDR), negative temperature coefficient thermistors (NTC), positive temperature coefficient thermistors (PTC)
- C12 Variable resistors and test switches**
- C13 Fixed resistors**
- C14 Electrolytic and solid capacitors**
- C15 Film capacitors, ceramic capacitors**
- C16 Permanent magnet materials**
- C17 Stepping motors and associated electronics**
- C18 D.C. motors**
- C19 Piezoelectric ceramics**
- C20 Wire-wound components**



**GENERAL PROPERTIES OF MANGANESE-ZINC  
AND NICKEL-ZINC FERRITES**



## INTRODUCTION

The Ferroxcube\* range of manganese-zinc and nickel-zinc magnetically soft ferrites are intended for use as core material in coils and transformers operating over a wide range of frequencies. Ferroxcube is a ceramic material, manufactured from high-grade raw materials of controlled composition; the composition defines the electrical and mechanical properties.

Ferroxcube products are made by a sequence of ceramic techniques: mixing, pre-firing, milling, drying, shaping by pressing or extruding, sintering and machining. The finished products have a stable structure and high electrical resistivity. This electrical resistivity allows them to be used at high frequencies without the eddy current losses becoming prohibitively high. Ferroxcube is made in a wide range of permeabilities.

Ferroxcube cores are available in convenient shapes such as potcores, square cores, E and I-cores, EC-cores, X-cores, U-cores, toroids, aerial rods, yoke rings, screw cores, rods, tubes, beads, cores for magnetic recording and special materials for proton accelerators.

Potcores, square cores, E and I-cores and X-cores enable well-defined air gaps to be used without introducing appreciable stray fields. In this way the permeability of the material may be reduced to an effective value at which core and copper losses are matched. The dependence of the permeability on temperature and time is furthermore reduced to values that guarantee correct operation of the equipment.

This section contains comprehensive data on manganese-zinc and nickel-zinc ferrites and their various grades.

When ordering cores, please quote the 12-digit catalogue number for the core in question given in the data sheet. ←

\* Our trade name for magnetically soft ferrites.

## APPLICATIONS

The various grades of Ferroxcube, the forms in which they are available and their principal applications are listed in the table below.

grade	core shapes and some preferred applications
● 2A2	yoke rings
● 3B	rods and tubes
3B7	potcores and square cores
● 3B8	potcores, square cores and cross cores (power applications)
● 3C2	yoke rings
3C6	rods and tubes
● 3C8	E, EC, ETD, U and I cores, square cores (power applications)
● 3D3	potcores, square cores, screw cores
3E1	E and I cores, toroids, potcores, square cores
● 3E2	H cores and toroids
● 3E4	potcores and square cores
3E5	square cores
● 3H1	potcores, square cores, cross cores
3H2	tubes, rods, toroids
● 3H3	potcores, square cores
4A4	frames for i.f. transformers, rods and tubes
● 4B1	frames for i.f. transformers, rods and tubes
● 4C6	potcores, square cores, toroids, frames for i.f. transformers, rods and tubes
4D1, 4D2	frames for i.f. transformers, screw cores, rods and tubes
4E1	rods and tubes
3H22, 3F1, 4E2, 4L2, 4M2, 8C11, 8C12	} special-purpose NiZn ferrites developed for resonant cavities for particle accelerators. A technical discussion is usually necessary to determine the correct material for this type of application.
8A5, 8C1, 8E1, 8E2, 8E21, 8X1	} cores and structural material for magnetic recording heads.

### Note

When ordering cores, please quote the 12-digit catalogue number for the core in question given in the data sheet.

● Preferred material.



## SYMBOLS, TERMS, DEFINITIONS AND BASIC FORMULAE

This list of symbols is based on the recommendations of IEC Publications 50, 125 and 401. Where symbols or formulae are used in connection with one application, material or core only, they are explained in the relevant section or data sheet.

symbol	units	definition
$A_{CP \min}$	$\text{mm}^2$	minimum cross-sectional area of centre pole.
$A_e$	$\text{mm}^2$	effective cross-sectional area.
$A_{e \min}$	$\text{mm}^2$	minimum effective cross-sectional area.
$A_L$	nH	inductance factor = $L/N^2$ . Note: unless otherwise stated in this Handbook, $A_L$ is the inductance factor in nH.
AT	A	ampere-turns.
B	T	flux density.
$B_s$	T	saturation flux density.
$B_r$	T	remanence: flux density remaining after magnetization to saturation and removal of the external field.
$\hat{B}$	T	peak flux density.
$C_1$	$\text{mm}^{-1}$	core constant: $C_1 = \Sigma(\ell/A)$ .
D	—	disaccommodation: the fractional change of permeability of a magnetic material measured at a constant temperature over a period of time after cessation of a disturbance $D = \frac{\mu_1 - \mu_2}{\mu_1}$
$D_F$	—	disaccommodation factor: obtained by dividing D by the first measured relative permeability (at $t_1$ ) and the logarithm of the ratio of the measuring times $D_F = \frac{\mu_1 - \mu_2}{\mu_1^2 \log(t_2/t_1)}$ Times $t_1$ and $t_2$ are given in the core data.
$E_1$	V	voltage at fundamental frequency.
$E_3$	V	voltage at third harmonic.
$f_{Cu}$	—	space (copper) factor: proportion of the winding cross section occupied by conductor.
f	Hz	frequency.
H	A/m	magnetic field strength.
$H_c$	A/m	coercivity: the value of the external field strength for which the flux density is zero after the material has been magnetized to saturation.

$\hat{H}$	A/m	peak magnetic field strength.
$I_0$	A	direct current.
$\ell_e$	mm	effective magnetic path length.
$L$	H	inductance.
$N$	—	number of turns.
$P$	kW/m <sup>3</sup>	specific power loss in core material.
$Q$	—	inductance quality factor.
$R_h$	$\Omega$	effective series resistance of an inductor due to hysteresis losses in the core.
$T_c$	$^{\circ}\text{C}$	Curie temperature: the temperature at which a ferromagnetic material becomes paramagnetic.
$V_e$	mm <sup>3</sup>	effective volume of a core: the volume of an ideal toroid of the same material and having the same magnetic properties: $V_e = \frac{\sum(\ell/A)^3}{\sum(\ell/A^2)^2}.$
$\alpha$	—	turns factor: number of turns for an inductance of 1 mH.
$\rightarrow \alpha_F$	$\text{K}^{-1}$	temperature factor of a core without air gap. The original definition in IEC 133

$$\alpha_F = \frac{\mu_{\theta} - \mu_{\text{ref}}}{\mu_{\text{ref}}^2 (\theta - \theta_{\text{ref}})}$$

$$= \frac{0,4\pi(A_L \theta - A_L \text{ref})}{A^2 L_{\text{ref}} C_1 (\theta - \theta_{\text{ref}})}$$

where  $\theta$  is the applied temperature, was superseded in 1976 by the definition in IEC 367-1:

$$\alpha_F = \frac{\mu_{\theta} - \mu_{\text{ref}}}{\mu_{\theta} \mu_{\text{ref}} (\theta - \theta_{\text{ref}})}$$

$$= \frac{0,4\pi(A_L \theta - A_L \text{ref})}{A_L \theta A_L \text{ref} C_1 (\theta - \theta_{\text{ref}})}$$

The second definition is required for new, close-tolerance products, and for products whose properties are guaranteed over a wide temperature range.

$\alpha_{\mu}$	$\text{K}^{-1}$	temperature coefficient of a core with an (ground) air gap. Where $\mu_e$ is the effective permeability of the core,
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$$\alpha_{\mu} \approx \alpha_F \mu_e.$$

Alternatively,

$$\alpha_{\mu} \approx \alpha_F C_1 A_L / \mu_0.$$

These approximations hold for fairly small changes in  $\mu_e$  or  $A_L$  over the temperature range considered.

$\beta_F$	—	d.c. sensitivity constant for a core: $\beta_F = \frac{\mu_e - \mu_e \Delta}{\mu_e \mu_e \Delta}$ where $\mu_e \Delta$ is the relative incremental permeability of the core.
$\frac{\tan \delta}{\mu_i}$		eddy-current and residual loss constant at a given frequency, measured at $\widehat{B} \leq 0,1$ mT. The corresponding R/L value is given by $R/L = \frac{2\pi f \mu \tan \delta}{\mu_i}$
$\Delta$	mm	air-gap length.
$\eta_B$	T <sup>-1</sup>	hysteresis constant: $\eta_B = \frac{\Delta R_h}{\Delta \mu_e 2\pi f L}$ where $\Delta \widehat{B} = \widehat{B}_2 - \widehat{B}_1$ and $\Delta R_h = R_{\widehat{B}_2} - R_{\widehat{B}_1}$ . (That is, series resistance $R_{\widehat{B}_1}$ is measured at $\widehat{B}_1$ and then $R_{\widehat{B}_2}$ at $\widehat{B}_2$ .)
$\theta$	°C	temperature.
$\mu_a$	—	relative amplitude permeability for a signal of amplitude greater than that for $\mu_\Delta$ so that the value is dependent on flux density B: $\mu_a = \frac{1}{\mu_0} \cdot \frac{B}{H}$
$\mu_e$	—	relative effective permeability: the permeability of a core with an air gap $\mu_e = \frac{C_1}{\Sigma \ell / A} \text{ or } \frac{1}{\mu_e} \cdot \frac{L}{N^2} C_1$
$\mu_i$	—	relative initial permeability: measured on a core without air gap for a small field change $\Delta H \rightarrow 0$ . $\mu_i = \lim_{(H \rightarrow 0)} \mu_a$
$\mu_{rem}$	—	relative incremental permeability about remanence.
$\mu_\Delta$	—	relative incremental permeability of a polarized core: at a given d.c. applied field, the permeability observed when a small alternating field is superimposed. $\mu_\Delta = \frac{\Delta B}{\mu_0 \Delta H}$ Here, $\Delta B \leq 0,2$ mT and $f = 4$ kHz.
$\mu_\theta$	—	relative permeability at a given temperature.
$\rho$	$\Omega m$	specific resistance for direct current.

# MnZn and NiZn ferrites

## FORMULAE

$$L = \frac{\mu_0 \mu_e N^2 \times 10^{-3}}{C_1}$$

$$A_L = 10^6 \mu_e \mu_0 / C_1$$

$$B = E / (4,44 f N A_e) \times 10^{-6}$$

$$E_3 / E_1 = 0,6 \tan \delta_h$$

$$N = \sqrt{(10^9 L / A_L)} = \alpha \sqrt{(10^3 L)}$$

$$Q = 1 / \tan \delta_{tot}$$

$$\tan \delta_h = \mu B \eta_B$$

$$1 \text{ mT} = 10 \text{ Gauss}$$

$$1 \text{ Oe} = 79,6 \text{ A/m}$$

H	inductance.
(nH)	initial induction factor.
(T)	peak flux density.
	3rd harmonic distortion.
(turns)	number of turns.
	quality factor.
	hysteresis loss factor



## TECHNICAL DATA

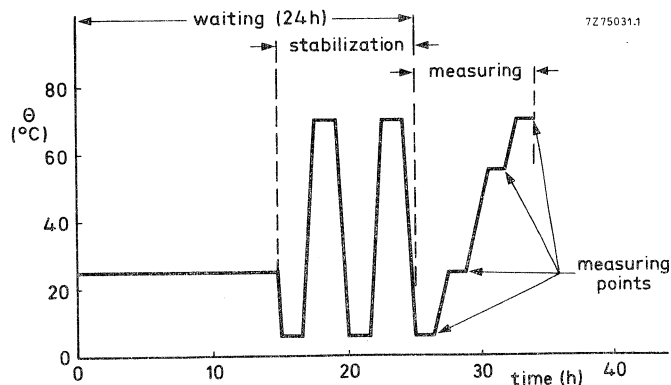
Ferrocube data are given in the tables on the following pages in accordance with the recommendations of IEC 401, and using symbols defined in the previous section.

### GENERAL PROPERTIES

Specific heat at 25 °C	
MnZn ferrites (FXC 3--)	1100 J/(kgK)
NiZn ferrites (FXC 4--)	750 J/(kgK)
Thermal conductivity from 25 °C to 85 °C	3,5 to 4,3 W/(mK)
Coefficient of linear expansion	10 to 12 × 10 <sup>-6</sup> /K
Modulus of elasticity	15 × 10 <sup>4</sup> N/mm <sup>2</sup>
Ultimate tensile strength	18 N/mm <sup>2</sup>
Crushing strength	73 N/mm <sup>2</sup>

### NOTES TO THE DATA TABLES

- The data given apply to medium-sized toroids and should be taken as a guide. Cores that are small or have other shapes will have slightly different properties that cannot readily be predicted on the basis of toroid properties. For this reason, product characteristics are guaranteed for the products themselves and are given on the appropriate data sheets.
- The temperature coefficient  $\alpha_F$  is measured on circuits without a (ground) air gap, with the exception of 3B7 products, for which  $\alpha_F$  is measured on toroidally-wound core halves. For FXC 3-- products, the measuring sequence is that shown in the figure. The measurement circuits for FXC 3H3 and FXC 4-- products are thermally demagnetized by being heated to 25 °C above their Curie temperature, after which they are cooled slowly to room temperature and left for 24 h.



# MnZn and NiZn ferrites

	unit	materials for deflection units	
		●2A2	●3C2
Initial permeability $\mu_i$ at $\hat{B} \leq 0,1$ mT, $\theta = 25^\circ\text{C}$		$350 \pm 20\%$	$900 \pm 25\%$
Induction B, ballistically measured at			
H = 500 A/m $\theta = 100^\circ\text{C}$	mT	$\approx 200$	$\approx 350$
H = 800 A/m $\theta = 20^\circ\text{C}$			
H = 800 A/m $\theta = 25^\circ\text{C}$			
H = 800 A/m $\theta = 70^\circ\text{C}$			
H = 800 A/m $\theta = 100^\circ\text{C}$			
H = 1600 A/m $\theta = 25^\circ\text{C}$			
H = 1600 A/m $\theta = 100^\circ\text{C}$			
H = 3200 A/m $\theta = 25^\circ\text{C}$			
H = 3200 A/m $\theta = 100^\circ\text{C}$			
H = 4800 A/m $\theta = 25^\circ\text{C}$			
H = 4800 A/m $\theta = 100^\circ\text{C}$			
Coercivity $H_c$ $\theta = 20^\circ\text{C}$	A/m	60	
Eddy current and residual loss constant			
$\frac{\tan \delta}{\mu_i}$ at $\hat{B} \leq 0,1$ mT, $\theta = 25^\circ\text{C}$	$\times 10^{-6}$	$\approx 50$	
$f = 100$ kHz			
$f = 450$ kHz			
$f = 500$ kHz			
$f = 700$ kHz			
$f = 1$ MHz			
$f = 1,5$ MHz			
$f = 2$ MHz			
$f = 3$ MHz			
$f = 5$ MHz			
$f = 10$ MHz			
$f = 20$ MHz			
$f = 25$ MHz			
$f = 40$ MHz			
Hysteresis constant $\eta_B$ at $\hat{B} = 0,3 - 1,2$ mT $f = 100$ kHz	$\times 10^{-3} \text{ T}^{-1}$		
Power loss at $f = 16$ kHz and	kW/m <sup>3</sup>	$\approx 70$	
B = 50 mT $\theta = 20^\circ\text{C}$			
B = 400 mT $\theta = 25^\circ\text{C}$			
B = 400 mT $\theta = 50^\circ\text{C}$			
B = 400 mT $\theta = 100^\circ\text{C}$			
Resistivity $\rho$ measured with d.c.	$\Omega\text{m}$	$\geq 10^6$	$\geq 0,1$
Dielectric constant at $f = 1$ MHz, $\theta = 25^\circ\text{C}$			
Temperature factor $\alpha_F$ $\theta = +25$ to $+55^\circ\text{C}$ $\theta = +25$ to $+70^\circ\text{C}$	$\times 10^{-6}/\text{K}$	$\approx 35$	0 to +4,5
Disaccommodation factor $D_F$ between 10 and 100 min after demagnetization, $\hat{B} \leq 0,1$ mT, $\theta = 25 \pm 1^\circ\text{C}$	$\times 10^{-6}$		$\leq 10$
Curie temperature	$^\circ\text{C}$	$\geq 150$	$\geq 150$
Mass density	kg/m <sup>3</sup>	$\approx 4300$	4700-4900
Core shapes		yoke rings	

● preferred material

materials for small parts						
●3B	3C6	4A4	●4B1	4D1	4D2	4E1
900 ± 20%	1700 ± 25%	500 ± 20%	250 ± 20%	50 ± 20%	60 ± 10%	15 ± 20%
≈ 345 ≈ 230	≥ 290	≈ 270 ≈ 210	≈ 325 ≈ 260	≈ 240 ≈ 220		≈ 175 ≈ 165
≤ 50		≤ 30 ≤ 40 ≤ 70	≤ 70 ≤ 90 ≤ 140	≤ 180 ≤ 210 ≤ 300	≤ 100 ≤ 200 ≤ 600	≤ 300 ≤ 300 ≤ 360
		≤ 1,8				
	≤ 170 ≤ 160 ≤ 140					
≥ 0,2		≥ 10 <sup>5</sup> 15-20	≥ 10 <sup>5</sup>	≥ 10 <sup>3</sup>	≥ 10 <sup>3</sup>	≥ 10 <sup>3</sup>
0 to +3		+5 to +15	0 to +8	0 to +15	0 to +15	0 to +15
≥ 150	≥ 190	≥ 135	≥ 250	≥ 400	≥ 350	≥ 500
4700-4900	4750-4850	4700-5100	4400-4800	4000-4400		3500-4000
tubes and rods		frames for i.f. trans- formers, tubes and rods		frames for i.f. transformers, screw cores, tubes and rods		tubes and rods

# MnZn and NiZn ferrites

	unit	high level transformer materials (power materials)	
		●3B8	●3C8
Initial permeability $\mu_i$ at $\hat{B} \leq 0,1$ mT $\theta = 25^\circ\text{C}$ at $\hat{B} \leq 0,1$ mT $\theta = 100^\circ\text{C}$ at $\hat{B} \leq 1$ mT $\theta = 5$ to $70^\circ\text{C}$ at $\hat{B} 0,7 - 1$ mT $\theta = 25$ to $70^\circ\text{C}$		2300 $\pm$ 20%	2000 $\pm$ 25%
Induction B ballistically measured at H = 50 A/m $\theta = 100^\circ\text{C}$ H = 250 A/m $\theta = 25^\circ\text{C}$ $\theta = 100^\circ\text{C}$ H = 800 A/m $\theta = 25^\circ\text{C}$ $\theta = 70^\circ\text{C}$ $\theta = 100^\circ\text{C}$	mT	$\approx$ 490 $\approx$ 380	$\geq$ 330
Eddy current and residual loss constant $\frac{\tan \delta}{\mu_i}$ at $\hat{B} \leq 0,1$ mT, $\theta = 25^\circ\text{C}$ f = 4 kHz f = 30 kHz f = 100 kHz f = 500 kHz	$\times 10^{-6}$	$\leq$ 1,2 $\leq$ 5	
Hysteresis constant $\eta_B$ at $\hat{B} = 1,5 - 30$ mT f = 4 kHz	$\times 10^{-3} \text{ T}^{-1}$	$\leq$ 1,0	
Power loss at f = 16 kHz and $\hat{B} = 200$ mT $\theta = 25^\circ\text{C}$ $\theta = 100^\circ\text{C}$	kW/m <sup>3</sup>	$\leq$ 100 $\leq$ 110	$\leq$ 110 $\leq$ 100
Resistivity $\rho$ measured with d.c.	$\Omega\text{m}$	$\geq$ 0,6	$\geq$ 1
Temperature factor $\alpha_F$ $\theta = +5$ to $+25^\circ\text{C}$ $\theta = +25$ to $+55^\circ\text{C}$ $\theta = +25$ to $+70^\circ\text{C}$	$\times 10^{-6}/\text{K}$	0 to +4 0 to +4	
Disaccommodation factor $D_F$ between 10 and 100 min after demagnetization, $\hat{B} \leq 0,1$ mT $\theta = 25 \pm 1^\circ\text{C}$	$\times 10^{-6}$	$\leq$ 8	
Curie temperature	$^\circ\text{C}$	$\geq$ 200	$\geq$ 200
Mass density	kg/m <sup>3</sup>	4700-4900	4750-4850
D.C. sensitivity constant $\beta_F = \frac{\mu_i - \mu_i \Delta}{\mu_i \mu_i \Delta}$ at $\mu_e \times \frac{N \times I_0}{l_e} = 1,20 \times 10^5$ A/m $1,80 \times 10^5$ A/m $2,60 \times 10^5$ A/m	$\times 10^{-6}$	$\leq$ 120 $\leq$ 300 $\leq$ 1000	
Core shapes		potcores, square cores	E, EC, ETD, U and I, square cores

● preferred material

low level transformer materials (broadband materials)				
3E1	•3E2	•3E4	3E5	3H2
3800 ± 20%	≥ 5000	4700 ± 20%	10000 ± 20% ≥ 8000	2300 ± 20%
≈ 350 ≈ 270	≈ 355 ≈ 260		≈ 380 ≈ 280	≈ 400
≤ 2,5 ≤ 20 ≤ 200	≤ 2,5 ≤ 15 ≤ 90	≤ 2,5 ≤ 20 ≤ 200	≤ 3 ≤ 25 ≤ 75	≤ 1 ≤ 6
≤ 1,1	≤ 1,1	≤ 0,85	≤ 0,85	≤ 0,85
≥ 0,3	≥ 0,1	≥ 0,3	≥ 0,01	≥ 1
1 ± 1 1 ± 1 1 ± 1		1 ± 1 1 ± 1 1 ± 1	0,4 ± 0,6 0,6 ± 0,6 0,6 ± 0,6	
≤ 4,3	≤ 1,9	≤ 4,3	≤ 2	≤ 4,3
≥ 125	≥ 130	≥ 125	≥ 120	≥ 160
4700-4900	4700-4900	4700-4900	4800-5000	4700-4900
E and I cores, toroids potcores square cores	toroids	potcores, square cores	square cores	toroids tubes and rods

# MnZn and NiZn ferrites

	unit	
Initial permeability $\mu_i$ at $\hat{B} \leq 0,1 \text{ mT}$ $\theta = 25^\circ\text{C}$		
Induction B ballistically measured at H = 800 A/m $\theta = 25^\circ\text{C}$ $\theta = 70^\circ\text{C}$ H = 2400 A/m $\theta = 25^\circ\text{C}$ $\theta = 70^\circ\text{C}$	mT	
Eddy current and residual loss constant $\frac{\tan \delta}{\eta_i}$ at $\hat{B} \leq 0,1 \text{ mT}$ , $\theta = 25^\circ\text{C}$ f = 4 kHz f = 30 kHz f = 100 kHz f = 500 kHz f = 1 MHz * f = 2 MHz f = 10 MHz	$\times 10^{-6}$	
Hysteresis constant $\eta_B$ at $\hat{B} = 0,3 - 1,2 \text{ mT}$ f = 100 kHz at $\hat{B} = 1,5 - 3 \text{ mT}$ f = 4 kHz at $\hat{B} = 1,5 - 3 \text{ mT}$ f = 100 kHz	$\times 10^{-3} \text{ T}^{-1}$	
Resistivity $\rho$ measured with d.c.	$\Omega\text{m}$	
Temperature factor $\alpha_F$ $\theta = +5 \text{ to } +25^\circ\text{C}$ $\theta = +25 \text{ to } +55^\circ\text{C}$ $\theta = +25 \text{ to } +70^\circ\text{C}$	$\times 10^{-6}/^\circ\text{C}$	
Disaccommodation factor DF between 10-100 min after demagnetization, $\hat{B} \leq 0,1 \text{ mT}$ $\theta = 25 \pm 1^\circ\text{C}$  between 24 and 48 h after thermal demagnetization, $\hat{B} \leq 0,1 \text{ mT}$ $\theta \leq 35^\circ\text{C}$	$\times 10^{-6}$	
Curie temperature	$^\circ\text{C}$	
Mass density	$\text{kg/m}^3$	
Core shapes		

\* 3D3 at 700 kHz  $\leq 12 \times 10^{-6}$ .

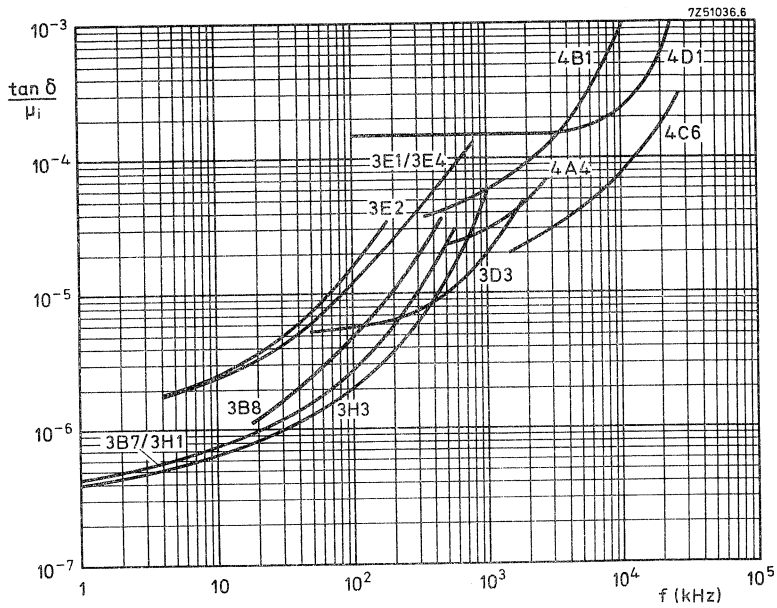
materials for tuned circuits				
3B7	●3D3	●3H1	●3H3	●4C6
2300 ± 20%	1000 ± 20%	2300 ± 20%	2000 ± 20%	120 ± 20%
≈ 430 ≈ 345	≈ 350	≈ 360 ≈ 280	≈ 400	≈ 380 ≈ 350
≤ 1,0 ≤ 5,0	≤ 3 ≤ 8 ≤ 30 *	≤ 1,0 ≤ 5,0	1,2 ± 0,4 2 ± 0,5	≤ 40 ≤ 100
≤ 1,1	≤ 0,5	≤ 0,85	≤ 0,6	≤ 6,2
≥ 1	≥ 7	≥ 1		≥ 10 <sup>5</sup>
0 ± 0,6	1 ± 0,5 1 ± 0,5 1 ± 0,5	1 ± 0,5 1 ± 0,5 1 ± 0,5	0,7 ± 0,3 0,7 ± 0,3 0,7 ± 0,3	1 ± 3 3 ± 3
≤ 4,3	≤ 8	≤ 4,3	≤ 3	≤ 10
≥ 170	≥ 180	≥ 130	≥ 160	≥ 350
4700-4900	4300-4500	4700-4900		4000-5000
potcores, square cores	potcores, square cores, screw cores	potcores, square cores, cross cores	potcores, square cores	potcores square cores, toroids, frames for i.f. transformers, rods and tubes





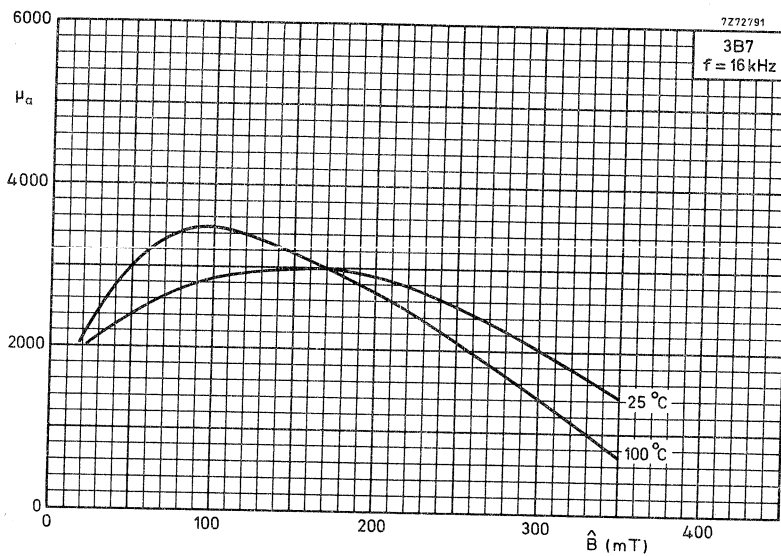
### CHARACTERISTIC CURVES

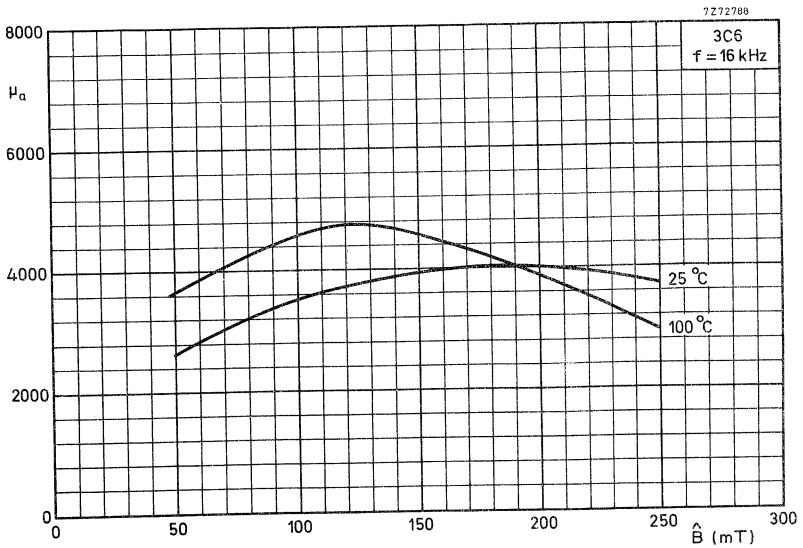
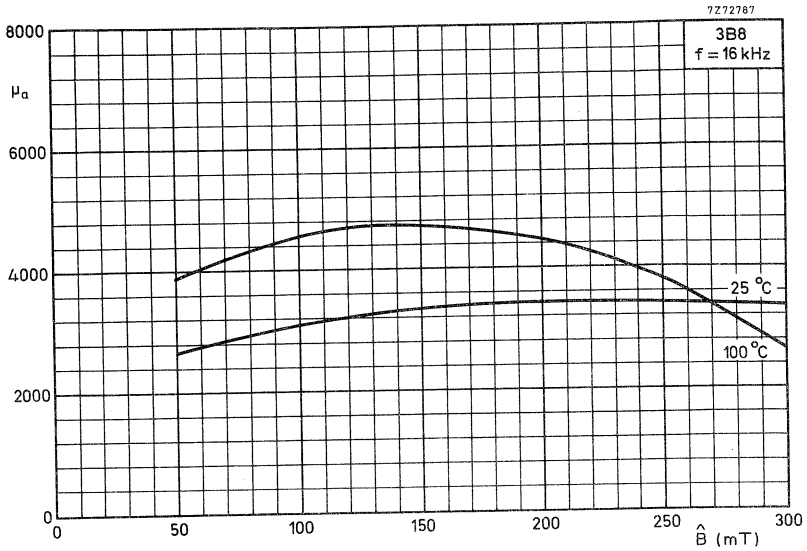
The curves are valid for toroids of not too small dimensions and should be considered as a guide. For guarantees on products, refer to the pages on the relevant products.



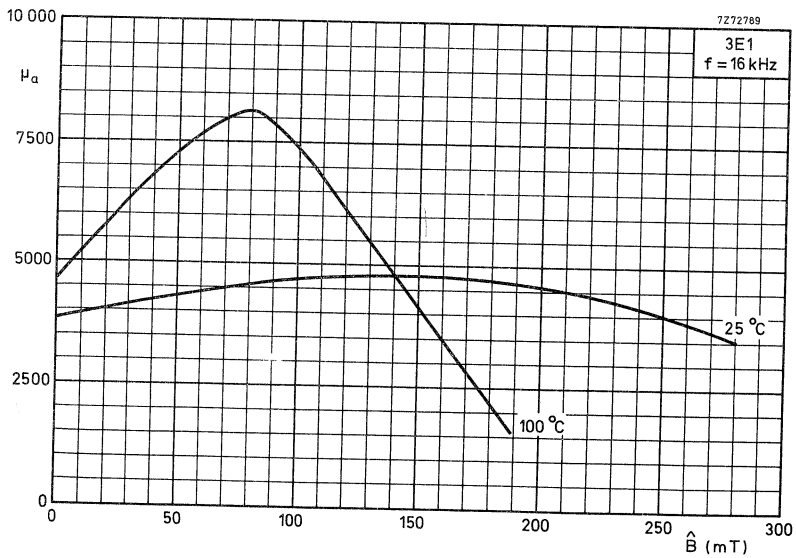
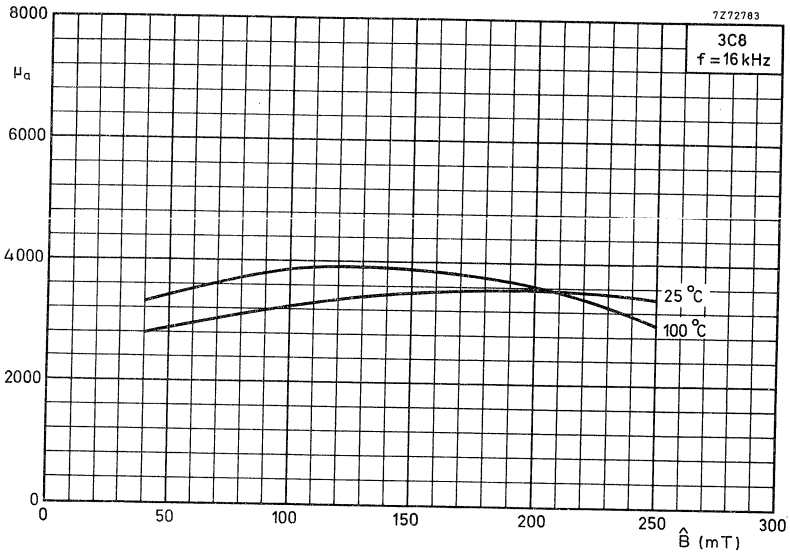
Eddy current losses and residual losses as a function of the frequency at low induction level.

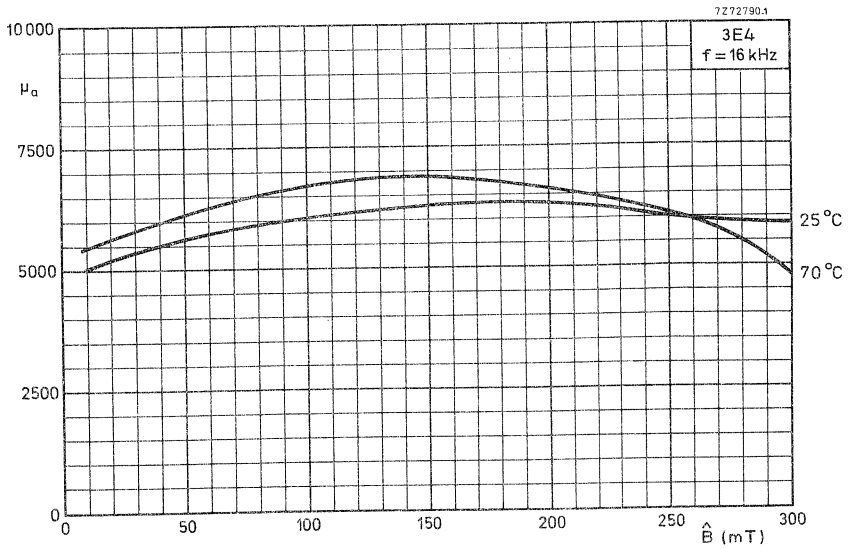
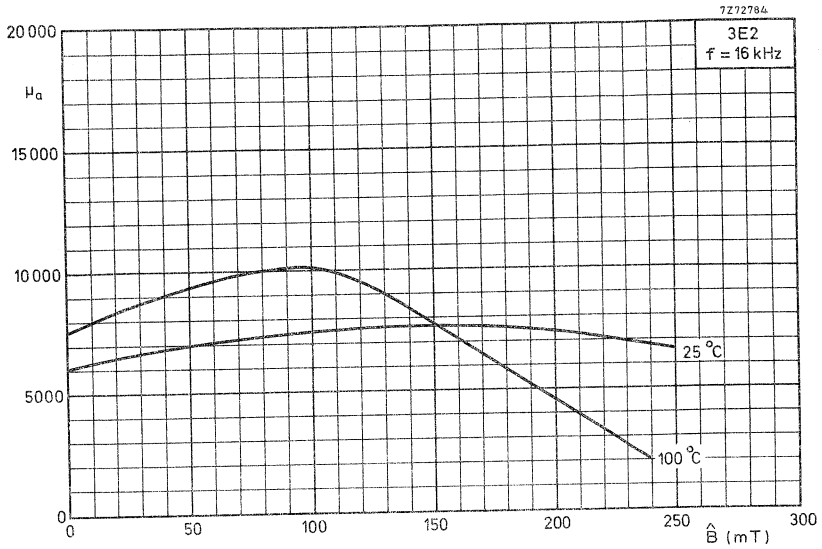
Amplitude permeability as a function of the induction.



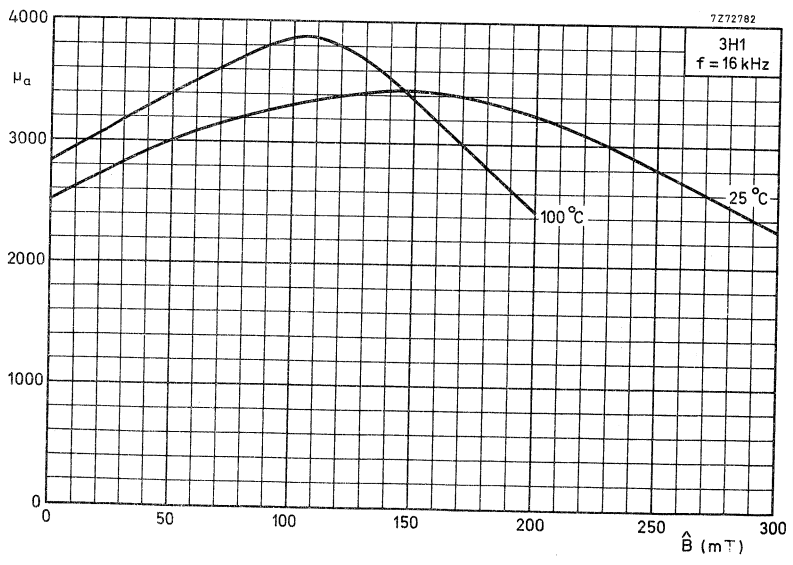
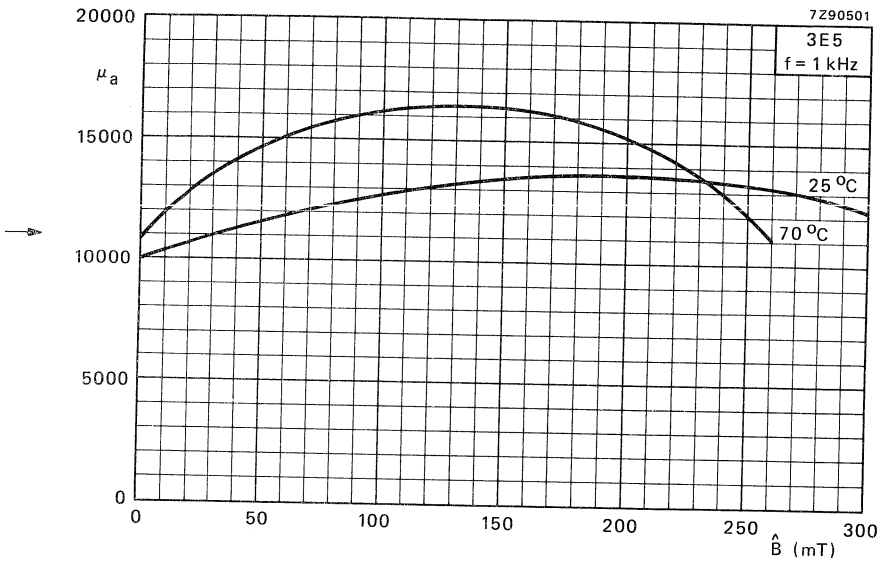


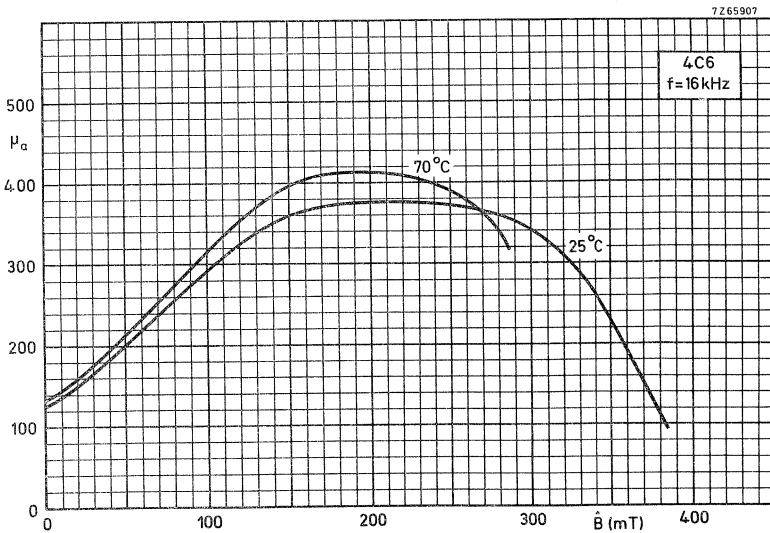
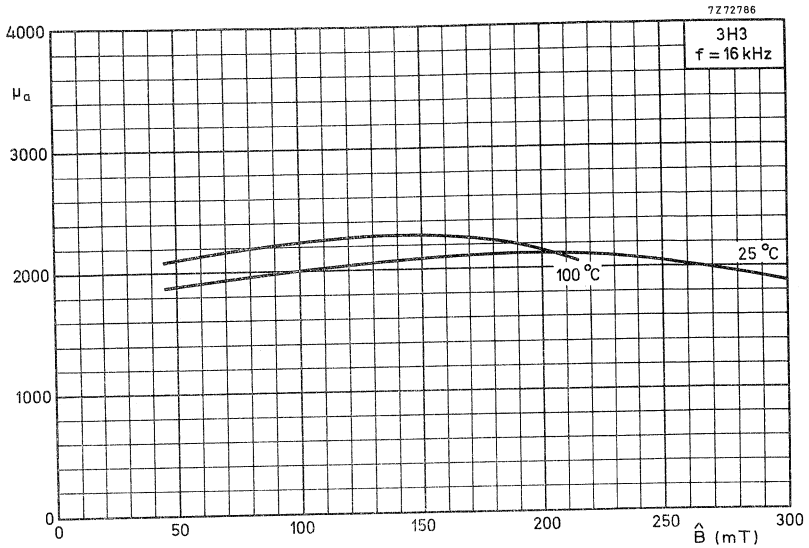
# MnZn and NiZn ferrites





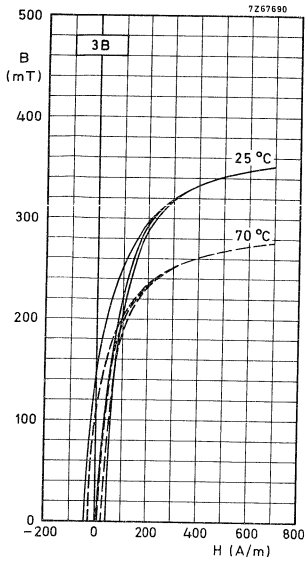
# MnZn and NiZn ferrites



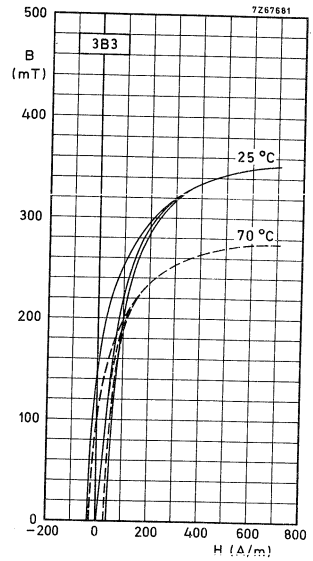


## TYPICAL BH-CURVES (measured ballistically)

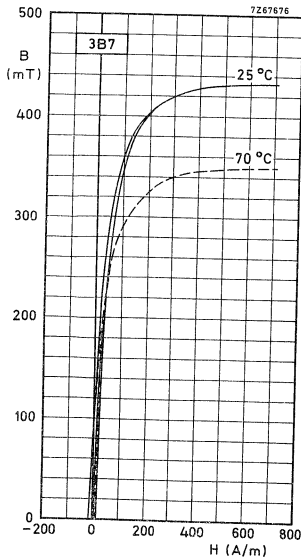
ballistic curves



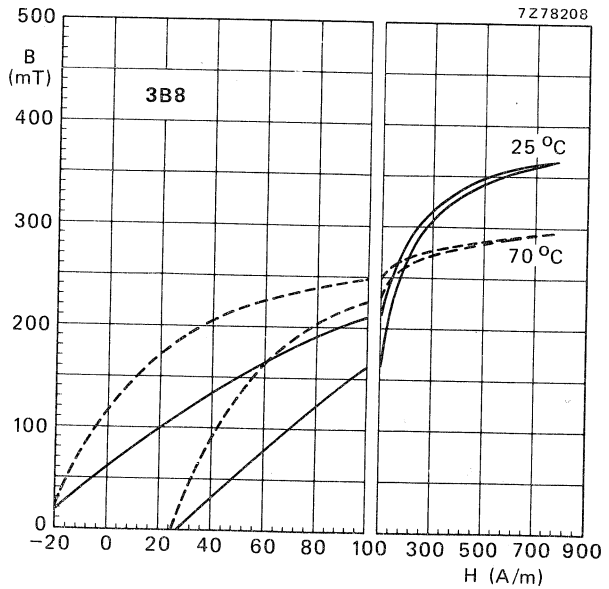
ballistic curves



ballistic curves

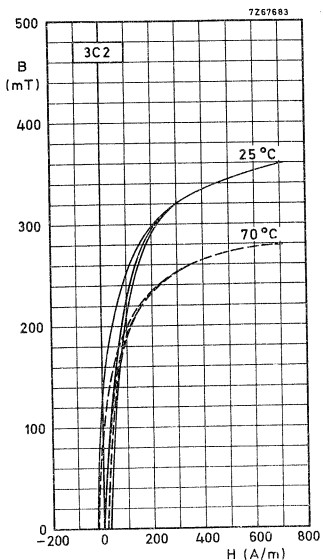


dynamic curves,  $f = 10$  kHz

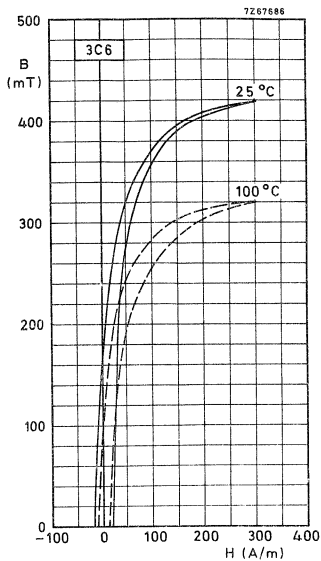




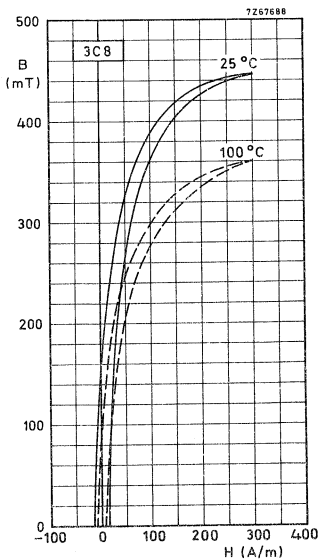
ballistic curves



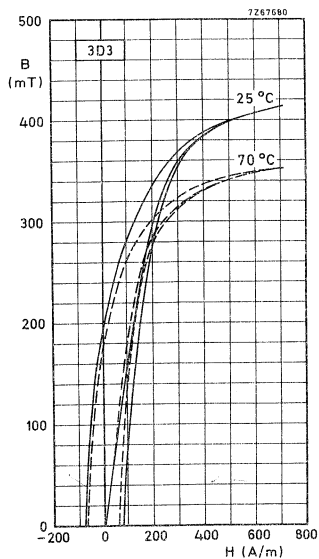
ballistic curves



ballistic curves

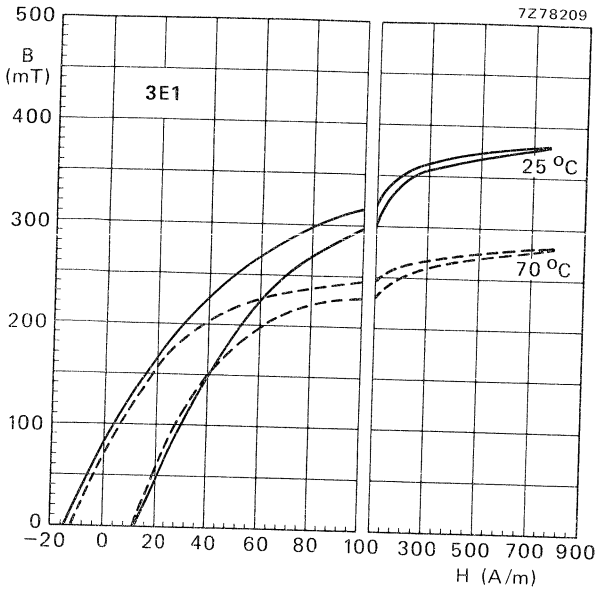


ballistic curves

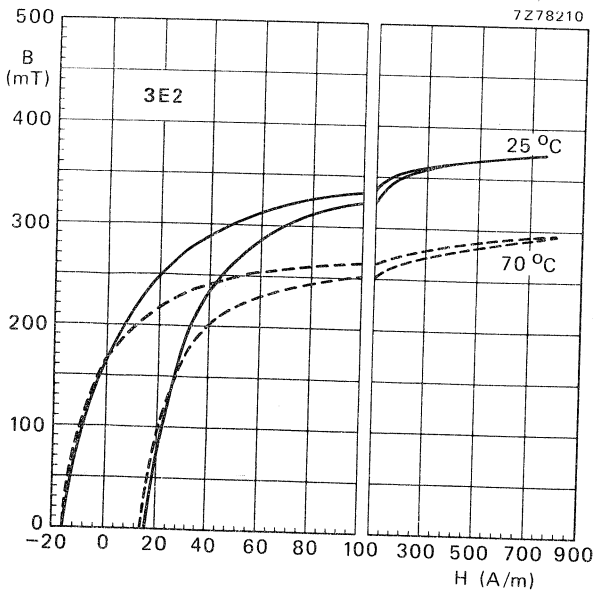


# MnZn and NiZn ferrites

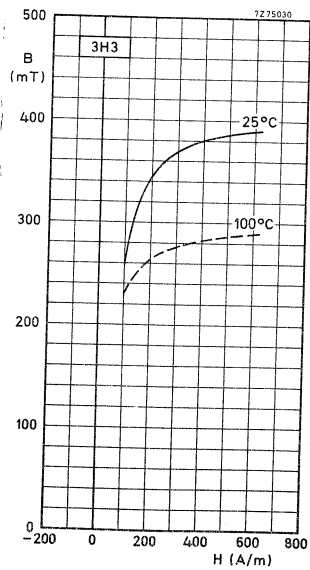
dynamic curves,  $f = 10$  kHz



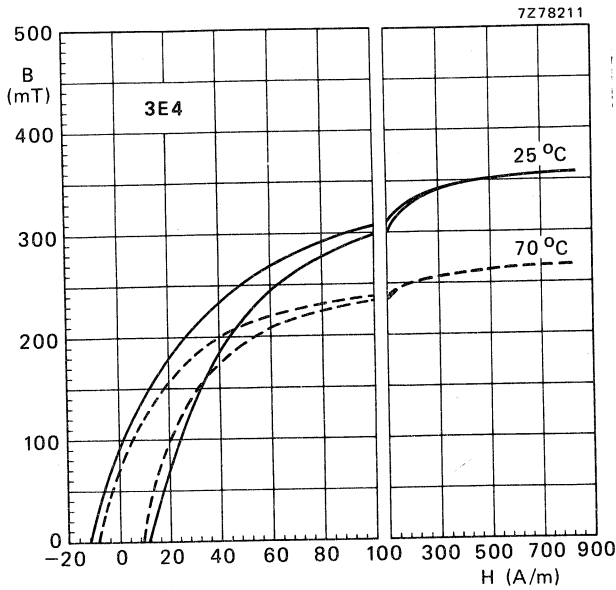
dynamic curves,  $f = 10$  kHz



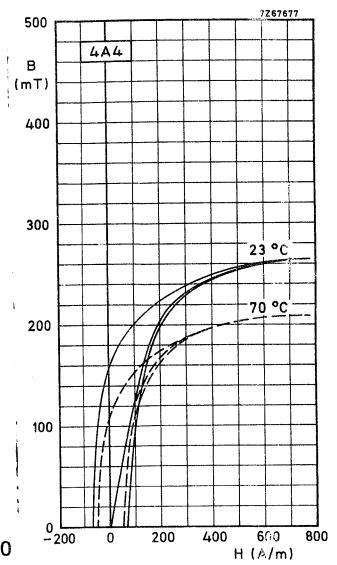
ballistic curves



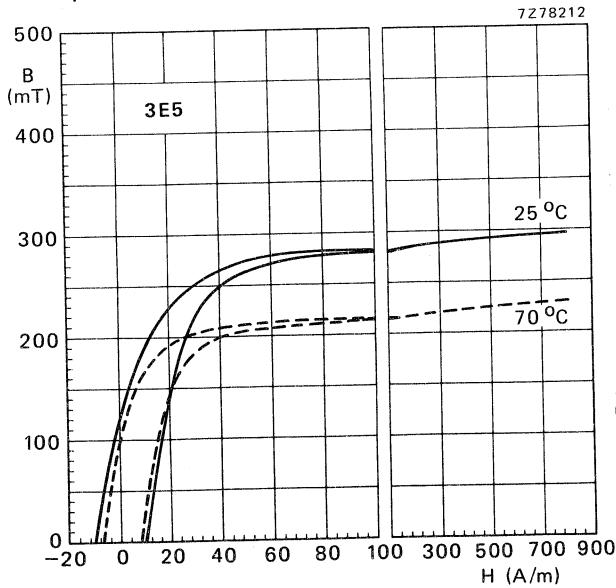
dynamic curves,  $f = 10 \text{ kHz}$



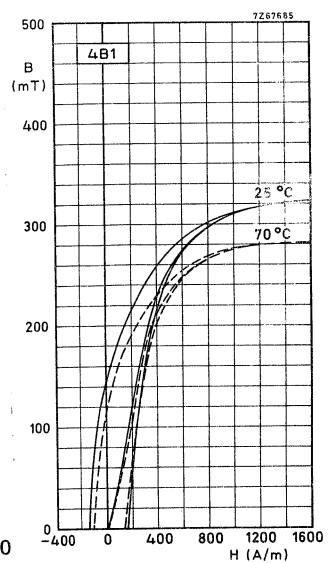
ballistic curves



dynamic curves,  $f = 10 \text{ kHz}$

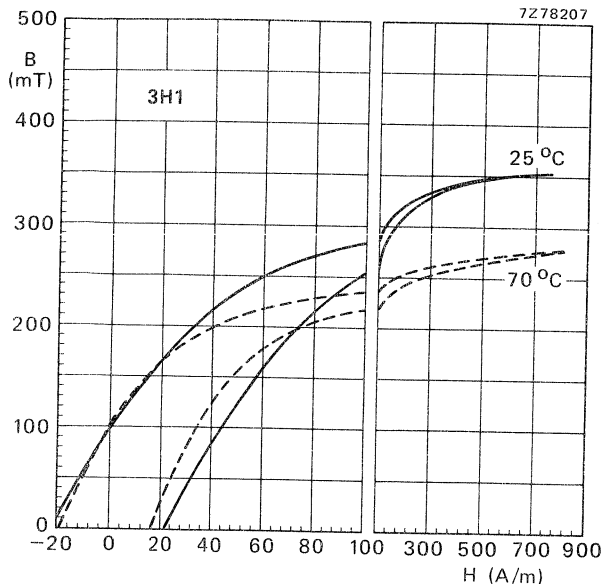


ballistic curves

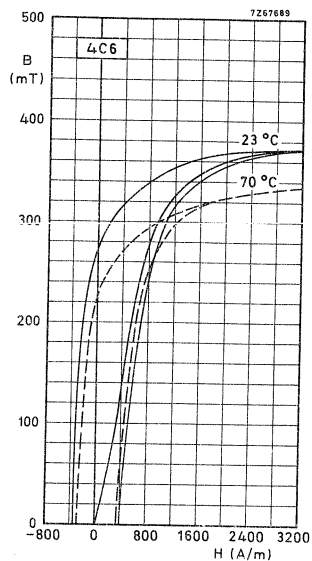


# MnZn and NiZn ferrites

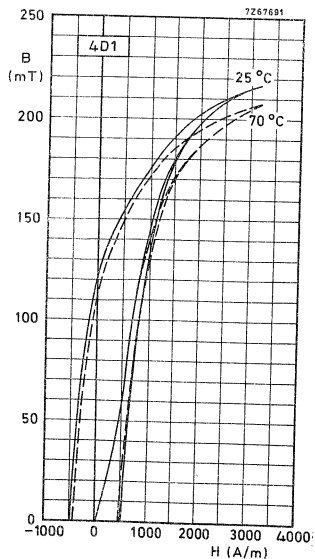
→ dynamic curves,  $f = 10 \text{ kHz}$



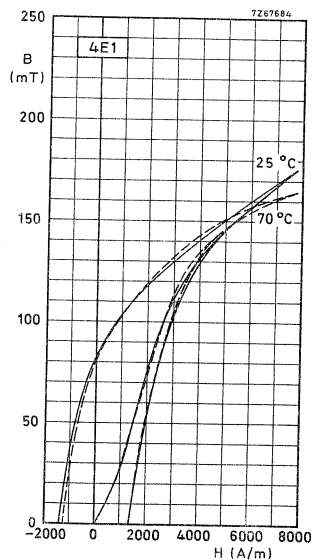
ballistic curves



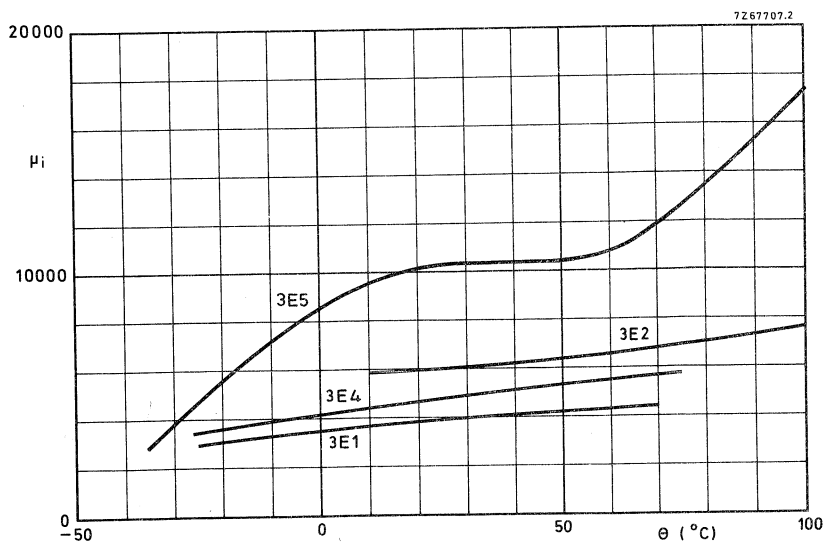
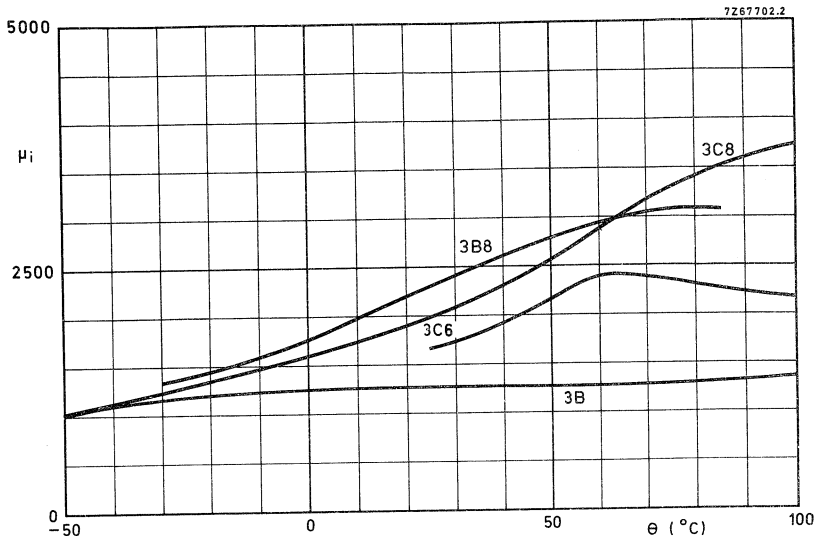
→ ballistic curves



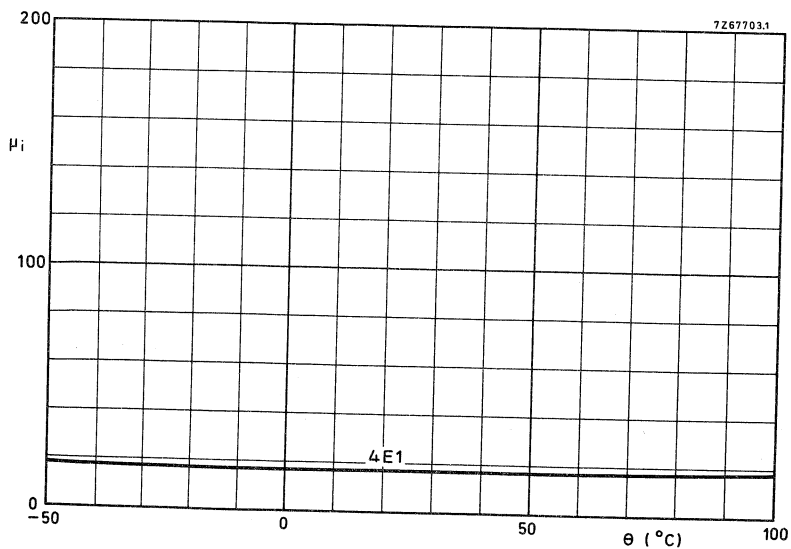
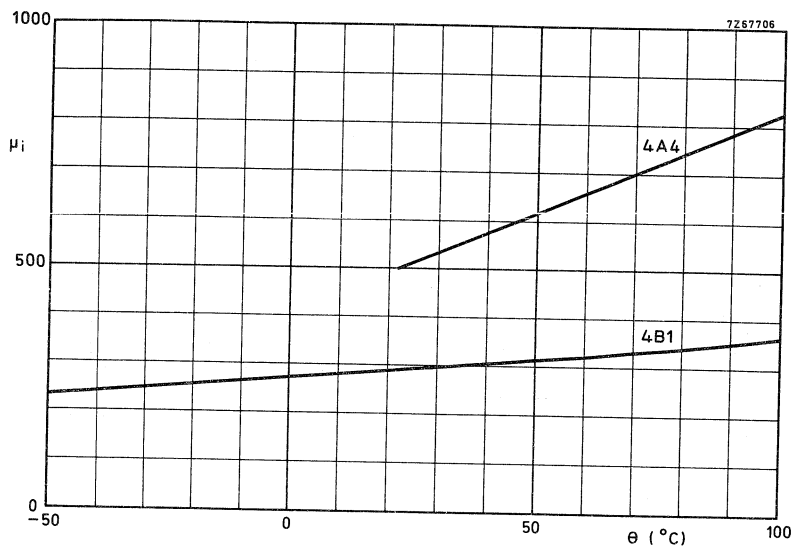
ballistic curves



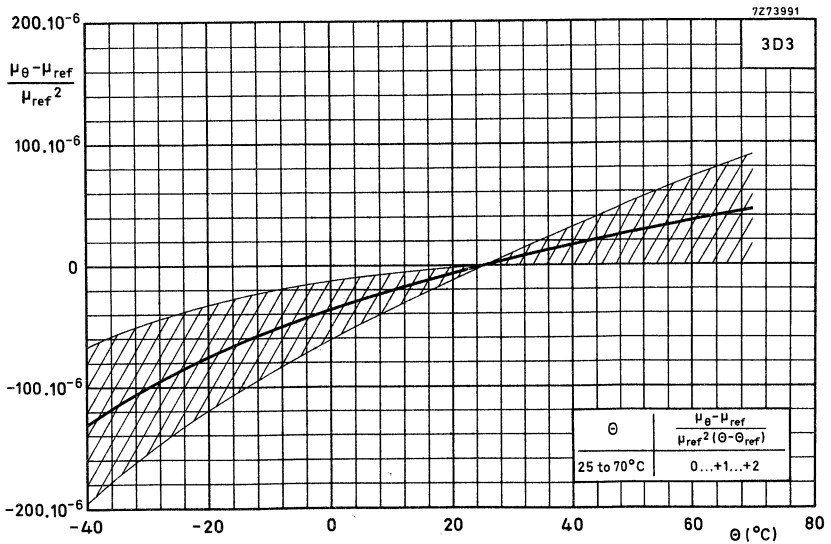
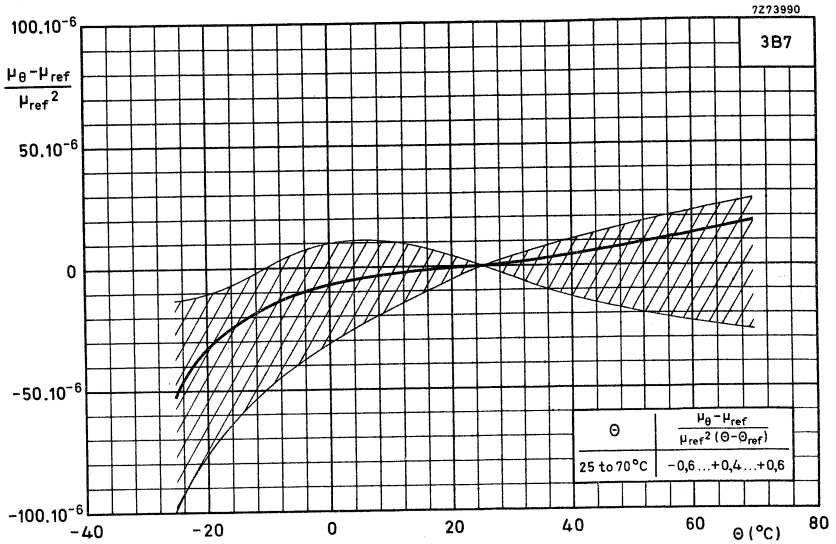
Relative initial permeability as a function of the temperature



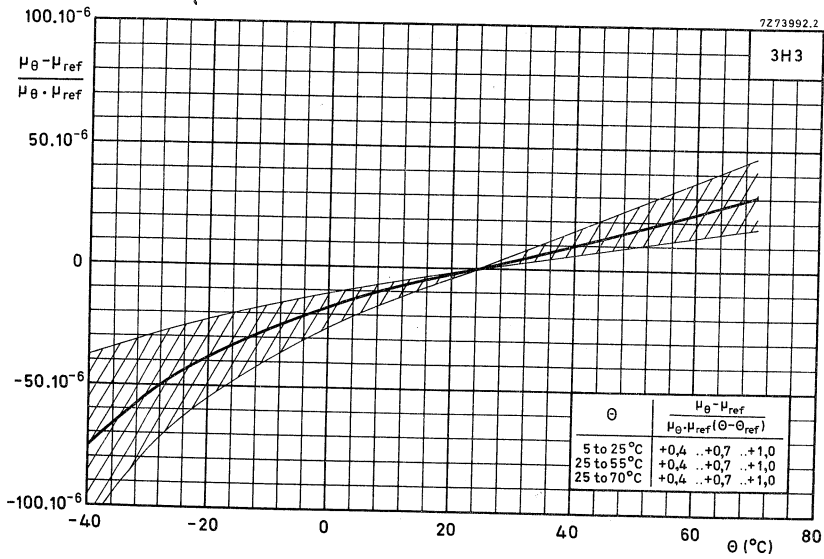
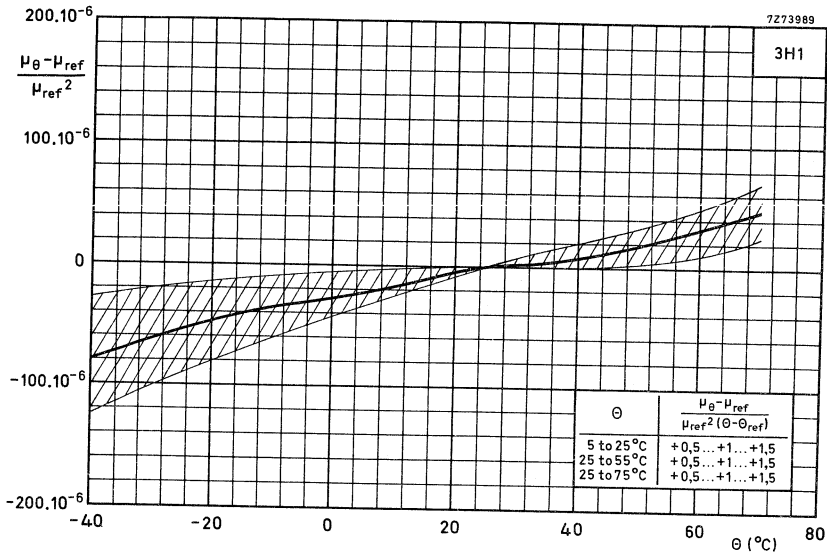
# MnZn and NiZn ferrites



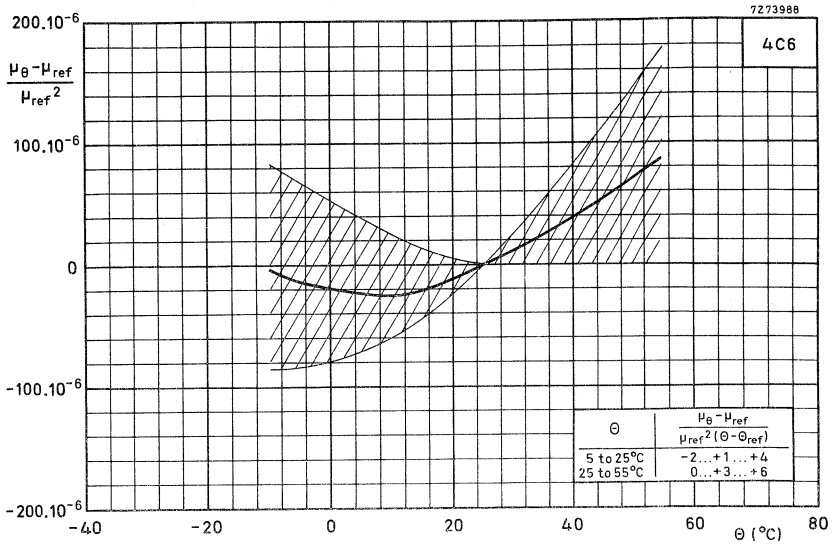
Permeability factor as a function of the temperature



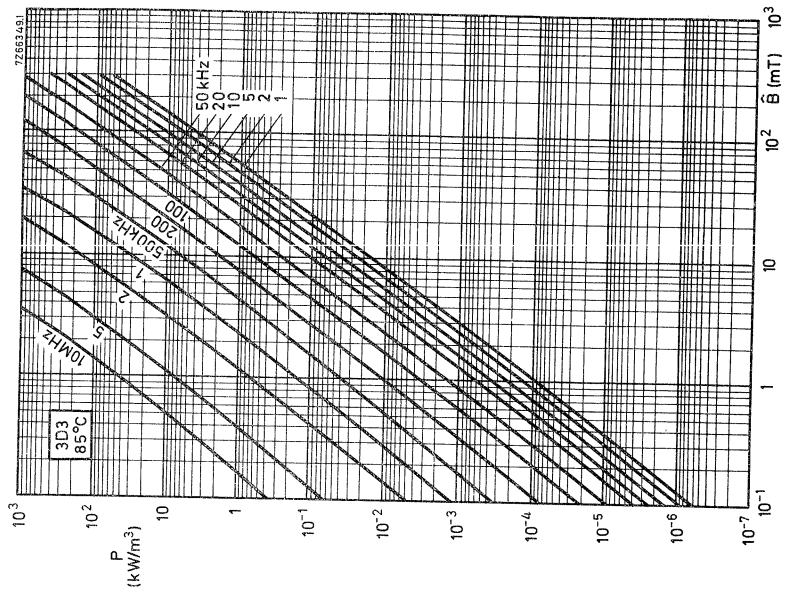
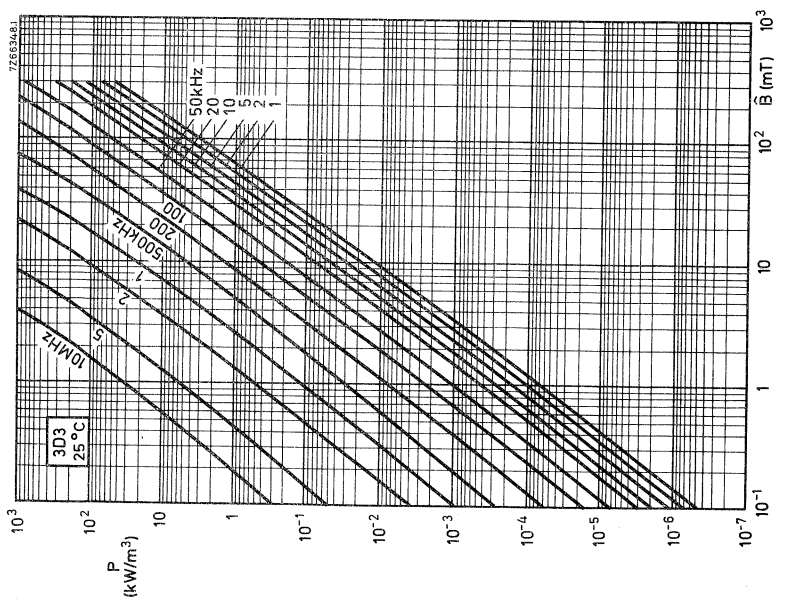
# MnZn and NiZn ferrites

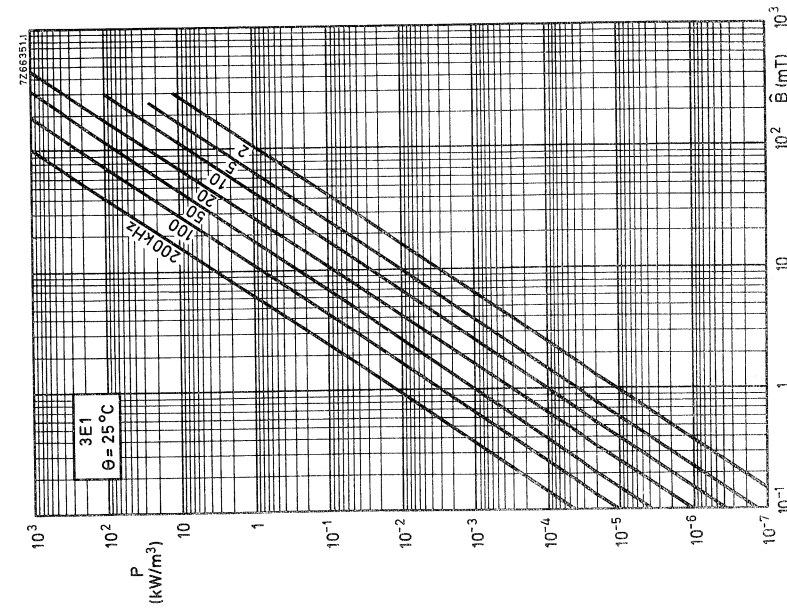
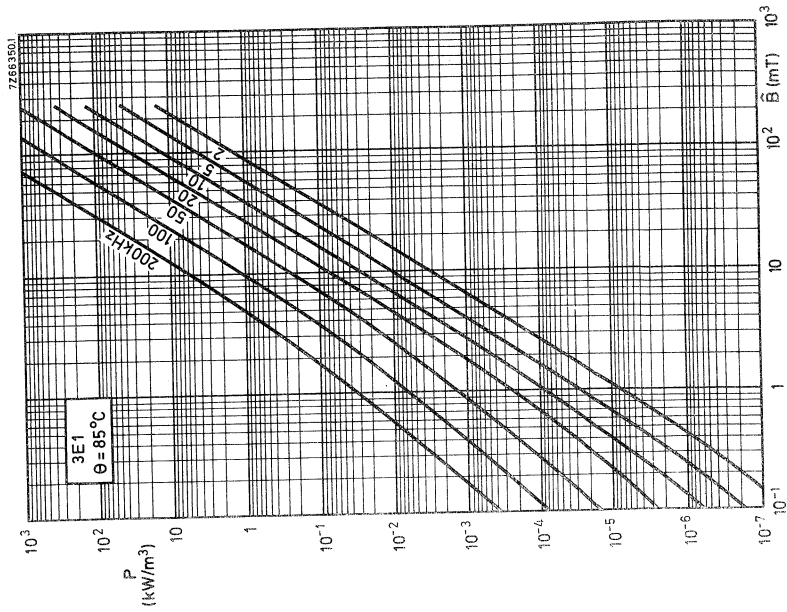




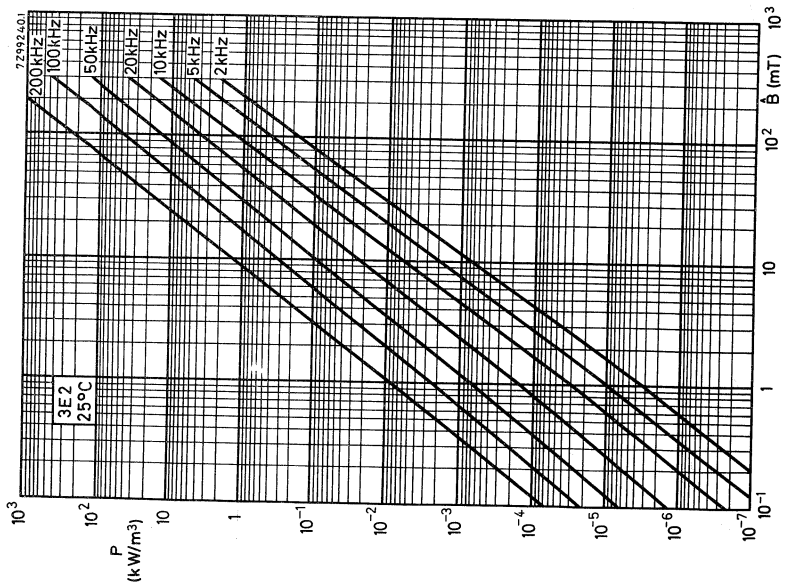
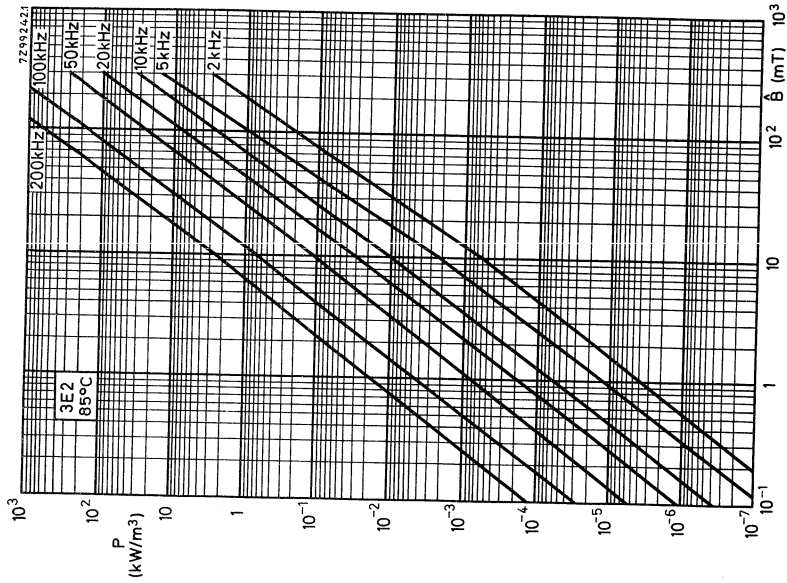


Power loss as a function of the induction

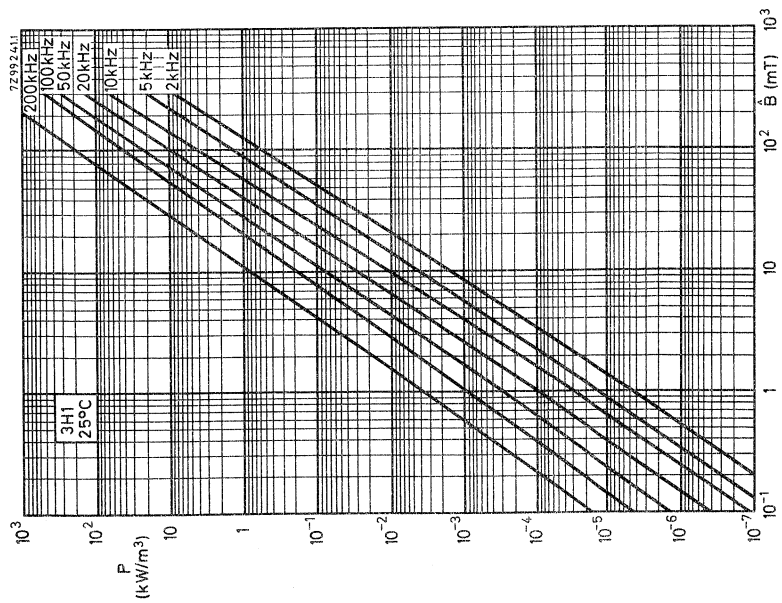
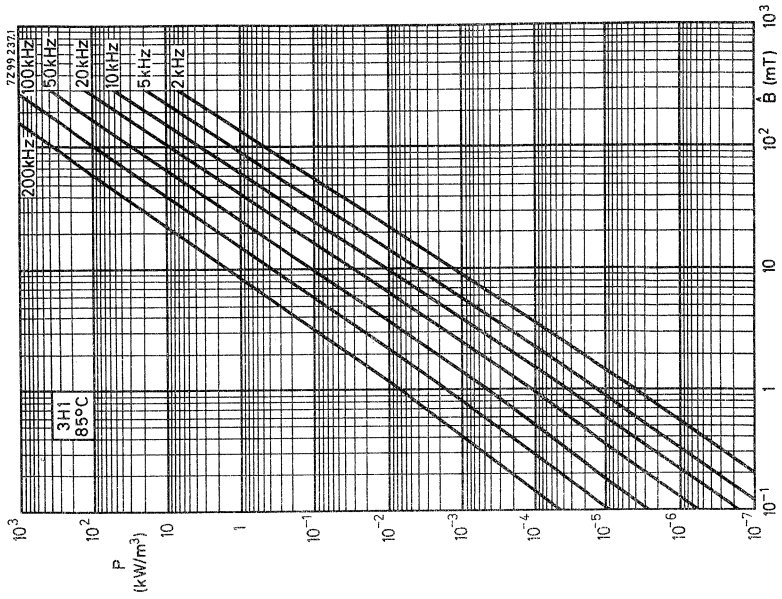




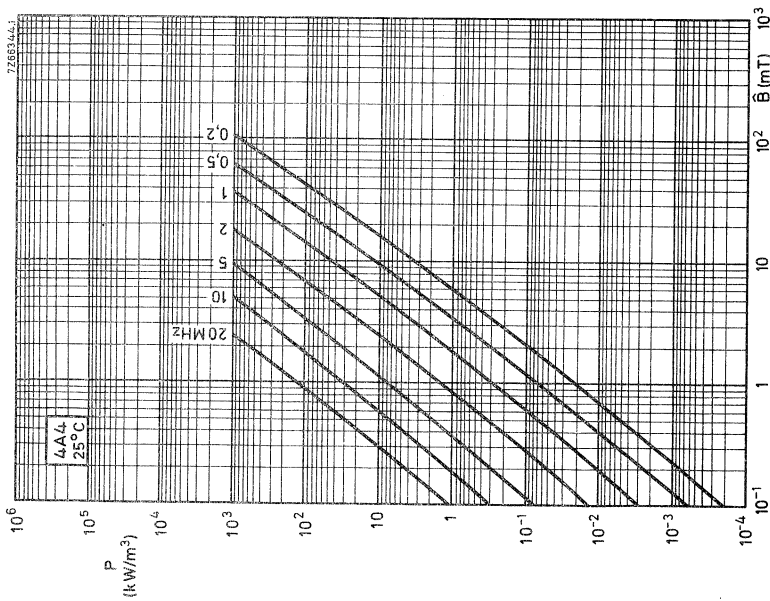
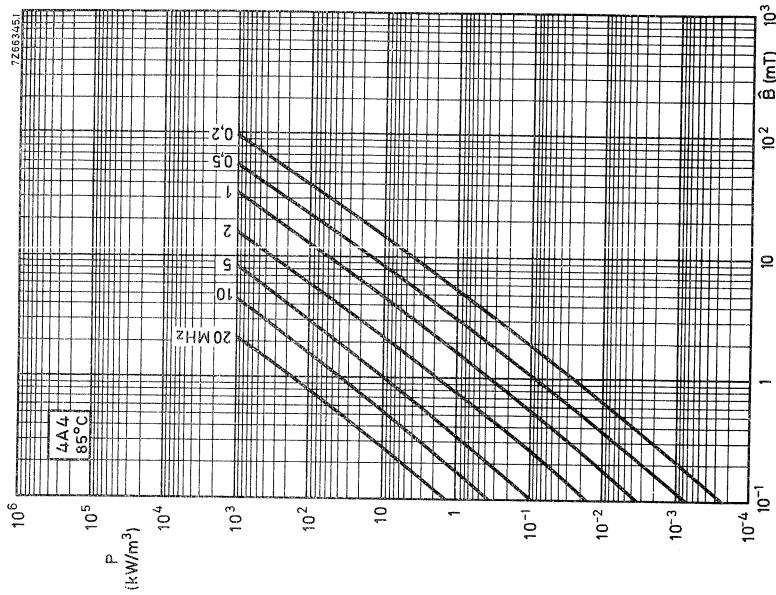
# MnZn and NiZn ferrites

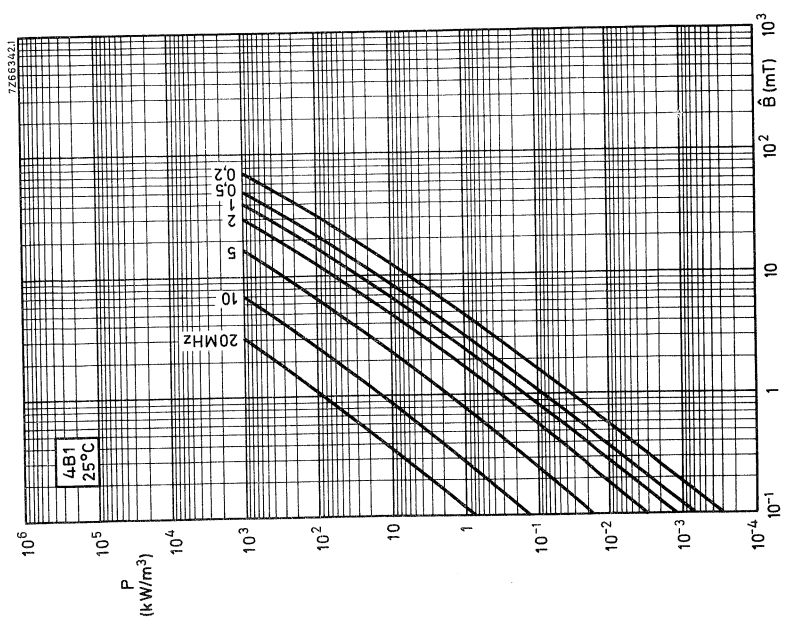
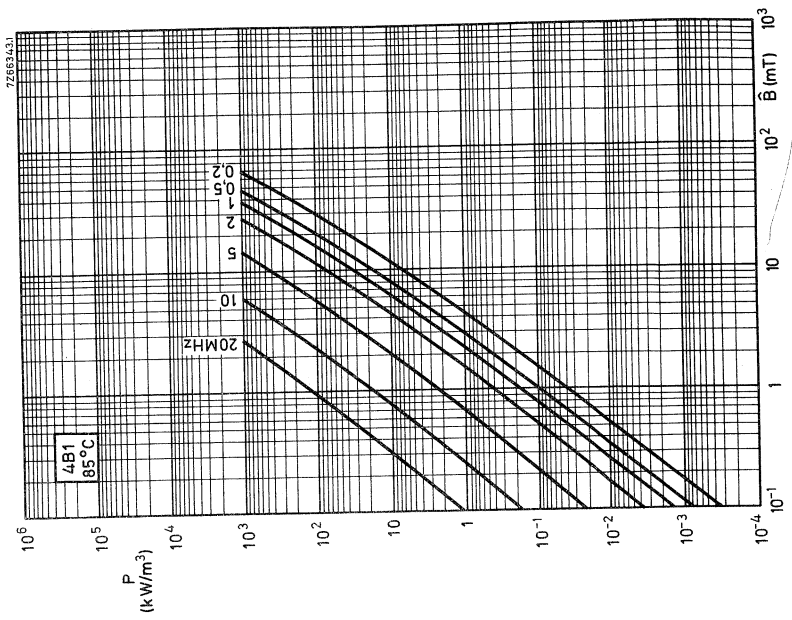


Characteristic curves

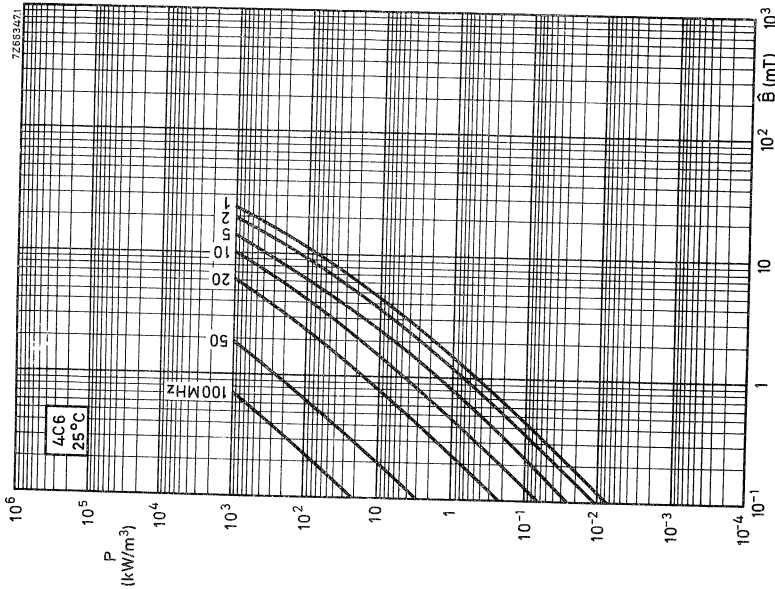
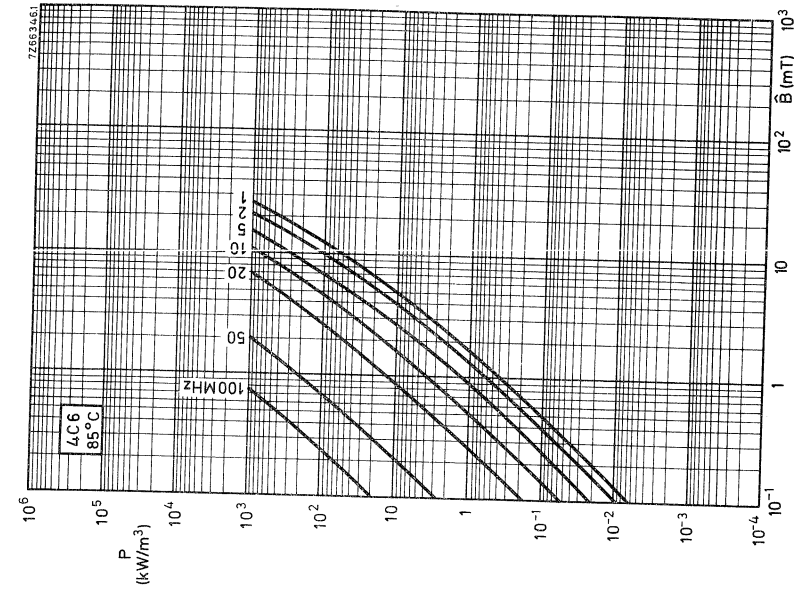


# MnZn and NiZn ferrites



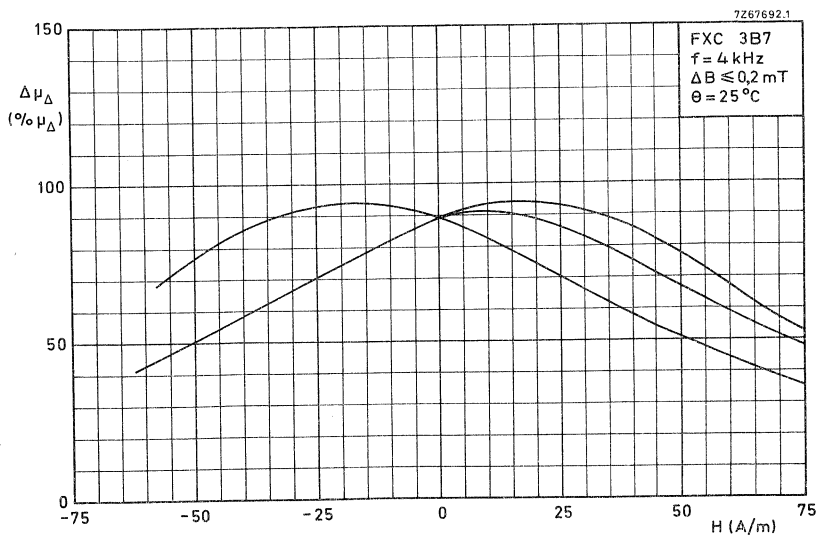
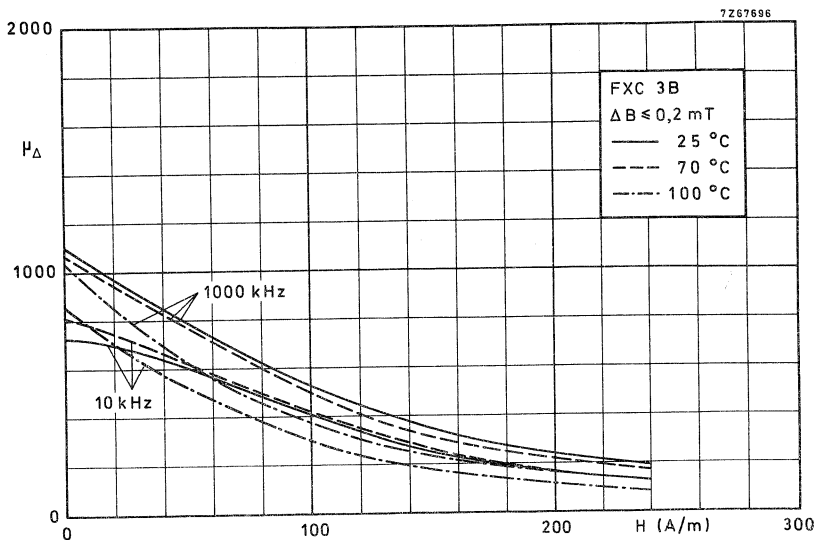


# MnZn and NiZn ferrites

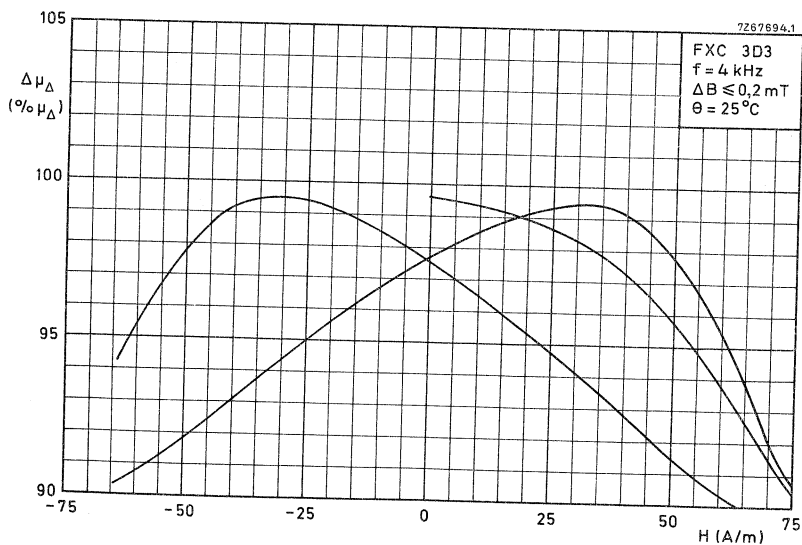
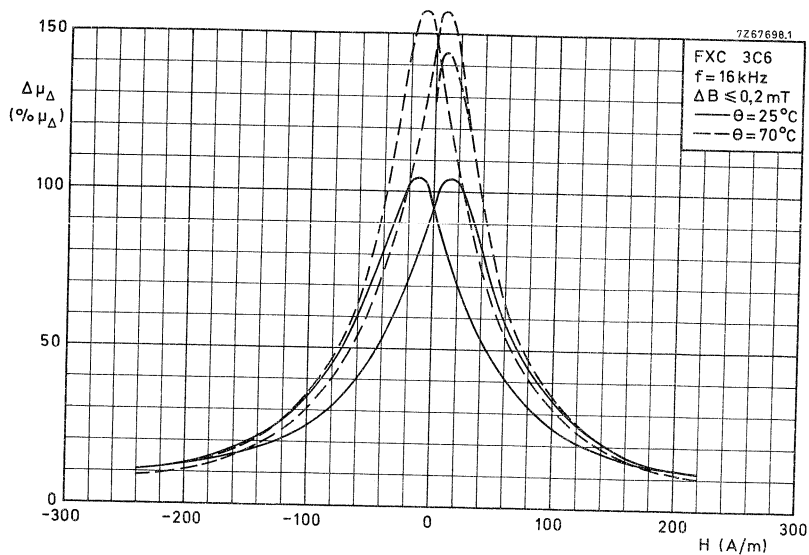


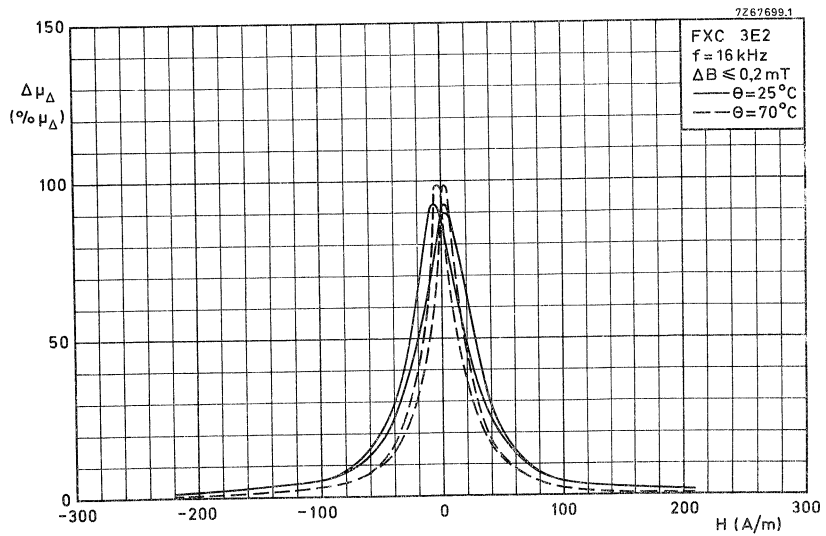
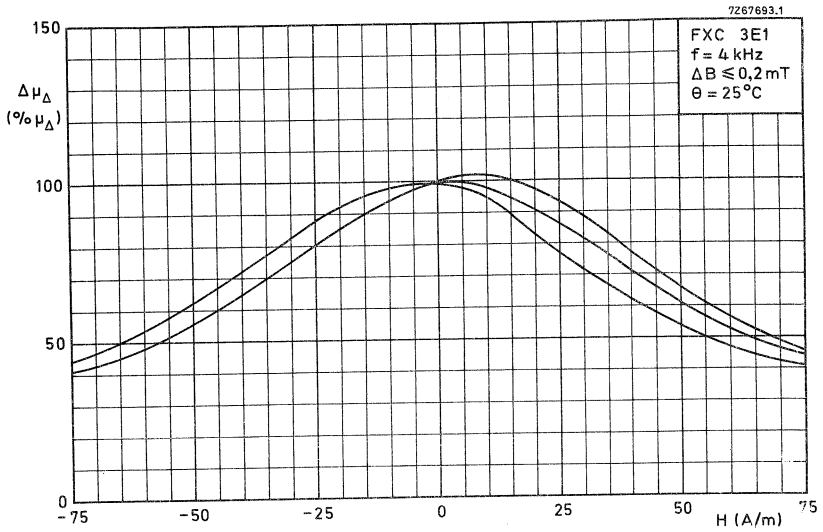


Incremental permeability as a function of the field strength

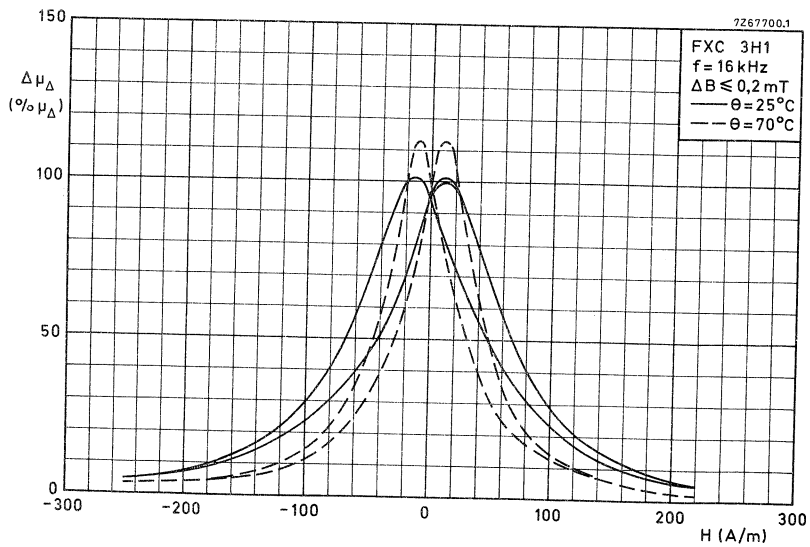
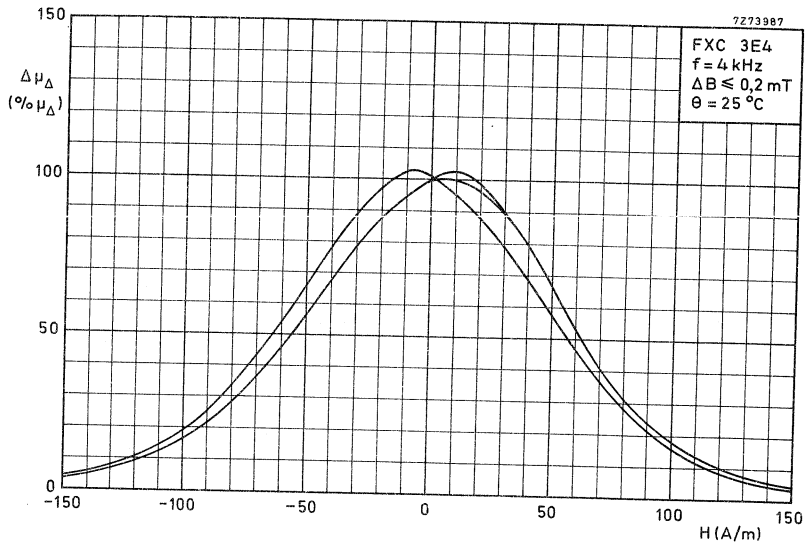


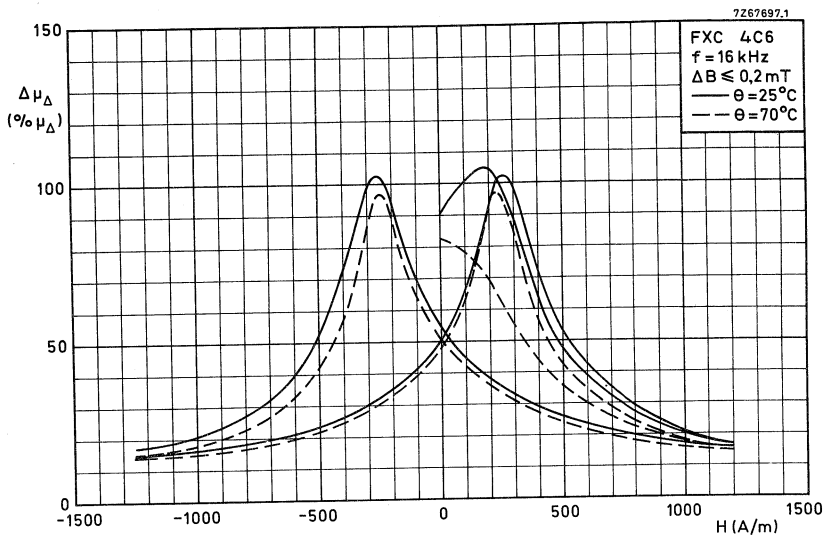
# MnZn and NiZn ferrites

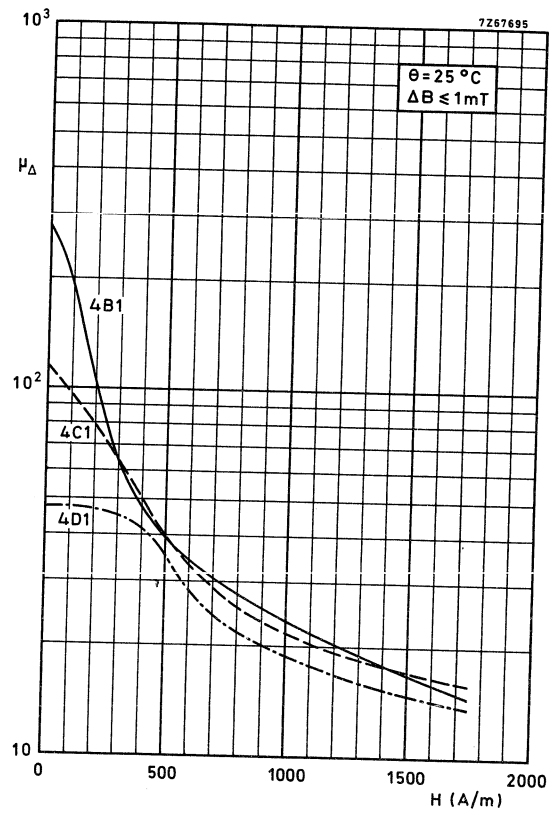




# MnZn and NiZn ferrites

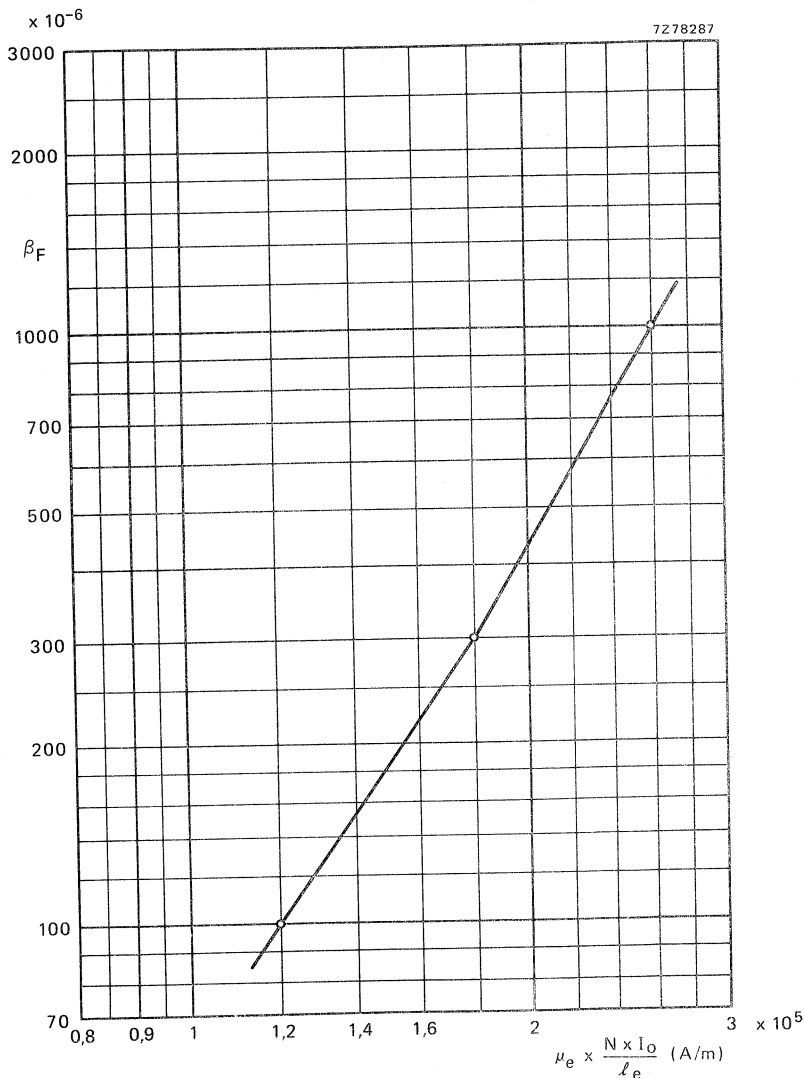






D.C. sensitivity

material grade: 3B8



$$\beta_F = \frac{\mu_e - \mu_{e\Delta}}{\mu_e \times \mu_{e\Delta}}$$

Inductance variation as a function of d.c. polarization. The measured values are situated in the area to the right of the curve.





**POTCORES, SQUARE CORES AND CROSS CORES**

**GENERAL INFORMATION**

## INTRODUCTION

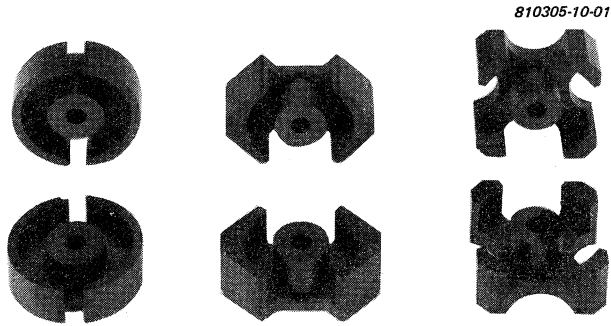
### TYPE NUMBER COMPOSITION

**Potcores:** P followed by diameter/height of complete core in mm.

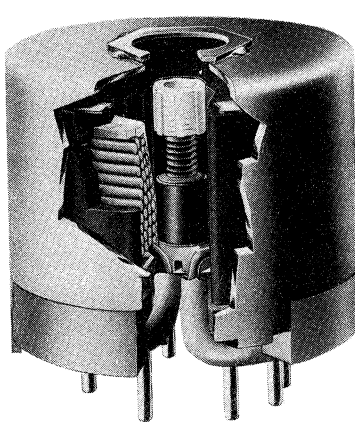
**Potcore halves** and coil formers for inductive proximity detectors: diameter x height of core half in mm.

**Square cores:** RM followed by the square dimension of the bottom expressed in terms of a grid with a 2,54 mm pitch.

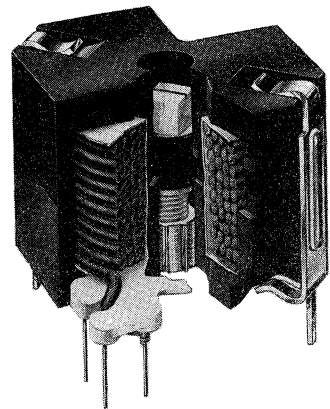
**Cross cores:** X followed by the square dimension of the core in mm.



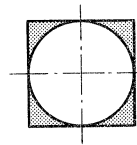
Ferroxcube potcores, square cores and cross cores were originally developed for low-loss filter coils and transformers operating at small-signal levels. However, they now also find some power applications, several types of potcore are used as inductive elements in proximity detectors. These cores are primarily intended for mounting on 2,54 mm (0,1") pitch printed-wiring boards, although potcores of size P18/11 and above can be mounted on conventional panels.



RZ25252



The main advantage of square cores and cross cores over potcores is shown in the diagram: improved packing factor due to the use of the (shaded) corner areas.



Coil formers and mounting parts are available for most of our potcores, square cores and cross cores. We can supply core sets, or core halves and loose mounting parts. Winding of the coil former and assembly of the core is performed by the user.

## PRE-ADJUSTED CORES

Since the air gap in potcores, square cores and cross cores can be ground to any length, any value of  $A_L$  or  $\mu_e$  can be provided within the limits set by the core size. In practice, the range of  $A_L$  (and, for potcores,  $\mu_e$ ) values has been standardized with values chosen to cover the majority of application requirements.

If a core set is provided with an asymmetrical air gap this air gap is ground in the upper half. This half is marked with the FXC grade and  $A_L$  value.

Most pre-adjusted cores are provided with an injection-moulded not for the adjuster. For those users who prefer to insert the nuts themselves, loose nuts are available. Further information is given in the section 'Mounting Data', and under 'Nut for adjuster' in the 'Mounting Parts' section of the appropriate data sheets.

Continuously-variable adjusters can be supplied for pre-adjusted cores of most  $\mu_e$  and  $A_L$  values. These are especially recommended for filter coils; maximum adjustment range is 10% to 20%, depending on core type.

### $\alpha$ AND $A_L$ FACTORS

The  $\alpha$  factor for a given core is the number of turns required for an inductance of 1 mH. For other values of inductance,  $N = \alpha\sqrt{L}$ , where L is the inductance in mH ( $10^{-3}$  H).

The  $A_L$  factor is the inductance per turn squared in nH for a given core.  $L = N^2 A_L$ , L in nH ( $10^{-9}$  H).

### Measurement conditions for the guaranteed $\alpha$ and $A_L$ values

The  $\alpha$  and  $A_L$  factors given in the data sheets are guaranteed in the form of a tolerance on the inductance that applied to matched pairs of cores, provided the following 11 conditions are complied with.

1. The core should be properly demagnetized (magnetically conditioned). All electrical values must be measured at least 24 h after demagnetization.  
Note that all our cores are demagnetized before they leave the factory.
2. All particles, if any, must be removed from the mating surfaces of the core. This can be achieved by rubbing on a piece of linen.
3. Measurements must be carried out using a standard core selected from the table of standard cores. The standard coils for RM cores are in accordance with IEC Publication 431A.
4. The axes of the core halves must coincide.
5. Any silver reference lines on the circumferences of the core halves must coincide. Where there are no reference lines, cores may be arbitrarily positioned.
6. A force is applied to the flat sides of the core through rings, the inner diameter of which must be equal to the average inner diameter of the core.
7. The force applied must be that given in the appropriate data sheet.
8. Measurement must be carried out at a frequency of 4 kHz.
9. Measurement must be carried out at a temperature of  $25\text{ }^\circ\text{C} \pm 10\text{ }^\circ\text{C}$ .
10. The current through, or the voltage across the coil must be such that the peak flux density ( $\hat{B}$ ) in the core does not exceed 0,1 mT.
11. The standard coil must be held against the bottom of the lower core half; that is the unmarked half, or the half without the nut.

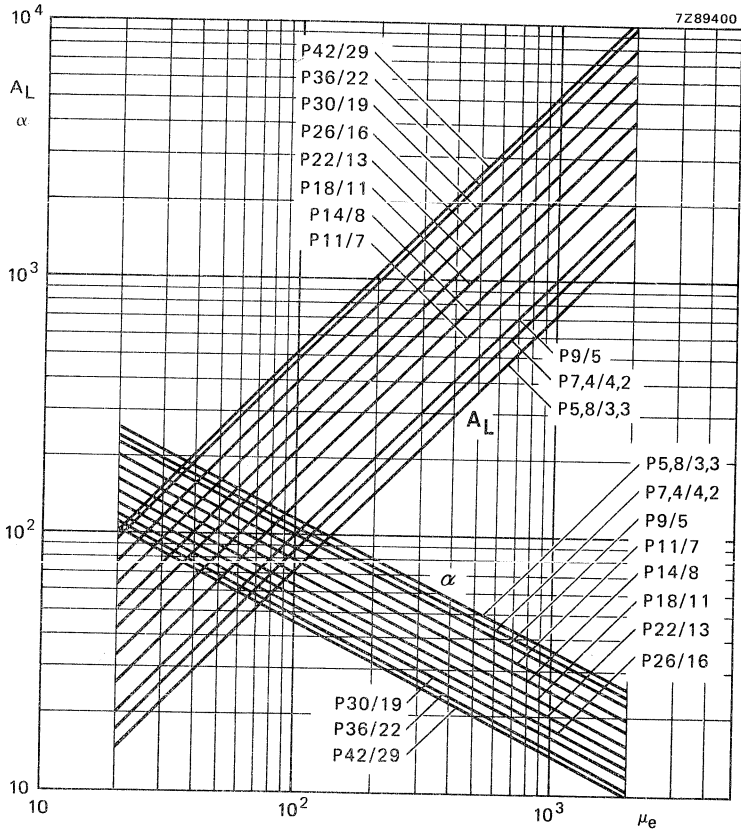
Standard coils for  $\alpha$  and  $A_L$  measurement

core type	catalogue number of standard coil	number of turns			number of layers	copper wire diameter mm
		total	per layer	upper layer		
P5,8/2,5	—	200	—	—	—	—
P5,8/3,3	—	35	—	—	—	0,10
P7,4/4,2	—	100	—	—	—	0,10
P9/5	7622 301 00101	65	11	10	6	0,20
P11/7	7622 301 00301	71	12	11	6	0,25
P14/8	7622 301 00501	90	13	12	7	0,30
P18/11	7622 301 00701	83	12	11	7	0,45
P22/13	7622 301 00901	71	12	11	6	0,60
P26/16	7622 301 01101	71	12	11	6	0,70
P30/19	7622 301 01301	104	15	14	7	0,70
P36/22	7622 301 01501	135	17	16	8	0,70
P42/29	7622 301 01701	199	20	19	10	0,80
P66/56	7622 301 01901	231	29	28	8	1,20
RM4	7622 300 50101	91	23	22	4	0,224
RM5	7622 300 50201	107	18	17	6	0,25
RM6-S/RM6-R	7622 300 50301	113	19	18	6	0,315
RM8	7622 300 50501	125	21	20	6	0,40
RM10	7622 300 50601	101	17	16	6	0,56
RM14	7622 300 50701	113	19	18	6	0,90
X22	7622 301 04001	175	16	15	11	0,40
X25	7622 300 13701	40	14	12	3	0,50
X30	7622 301 04101	175	16	15	11	0,70
X35	7622 301 04201	251	21	20	12	0,70

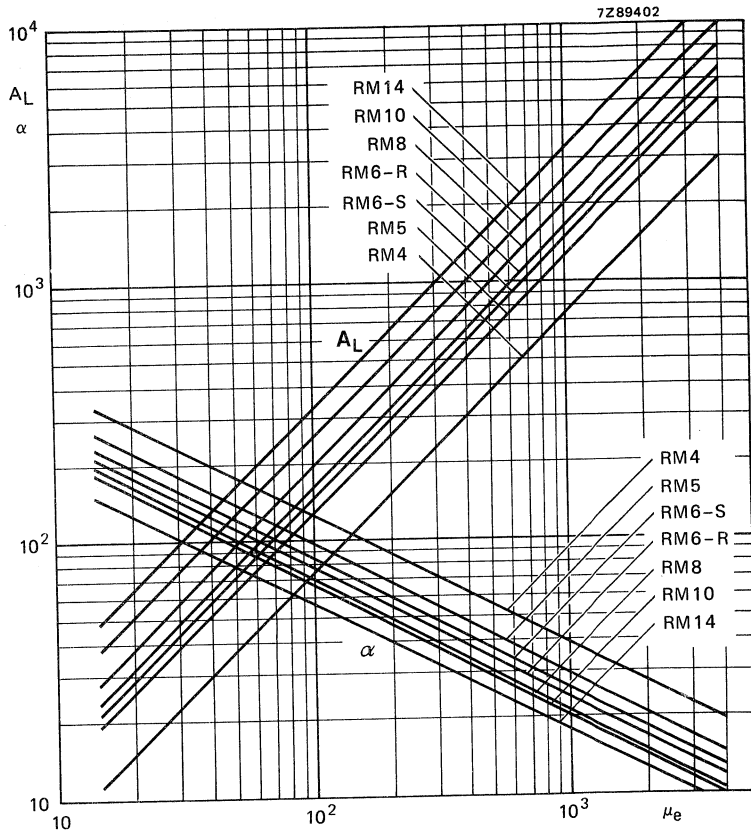
POTCORES  
 SQUARE CORES  
 AND CROSS CORES

Converting  $\mu_e$  into  $\alpha$  and  $A_L$  values

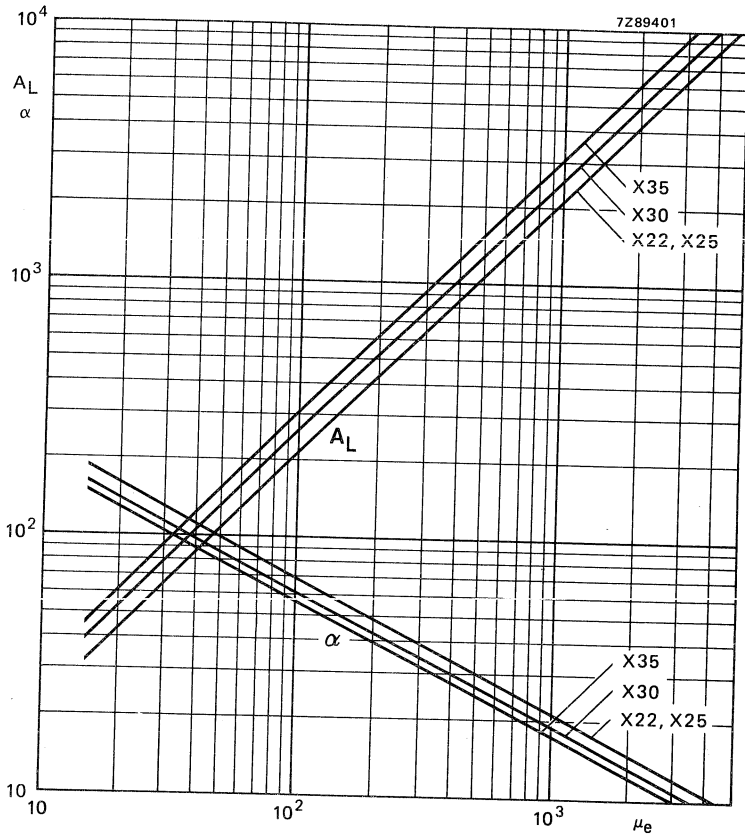
POTCORES



SQUARE CORES



CROSS CORES





### Q CURVES AND ISO Q CURVES

Due to the many assumptions that must be made in the design of filter coils, prediction of Q with an accuracy better than 15% is difficult. For this reason, selection of the optimal  $\mu_e$  or  $A_L$  factor for a given core is most easily made by comparing Q curves for various  $\mu_e$  values.

Families of Q curves or ISO Q curves are included in the data for most types of pot and square core. To simplify comparison, the curves for each type of core were measured using identical sets of coils and wires. As a result, the curves for different  $\mu_e$  (or  $A_L$ ) values and different core sizes can readily be compared. Q values for inductances other than those for which the curves are given can be found by interpolation or extrapolation as appropriate.

### CORE LOSSES

Eddy-current and residual losses are measured at a peak flux density not greater than 0,1 mT and are given in terms of  $\tan \delta/u_i$ .

Hysteresis constant  $\eta_B$  is defined in Section A. The relationships between the various hysteresis constants in current use are given below.

Peak flux density  $\hat{B}$  at which measurements are carried out is calculated using the minimum cross-sectional area of the centre pole of the core, in accordance with CECC. Measurement conditions, frequencies, temperatures and flux densities, together with guaranteed values are given in the data sheets for the cores.

**HYSTERESIS CONSTANTS**

Hysteresis losses add an effective resistance  $R_h$  in series with the coil inductance, expressed by the term  $R_h/L$  in Eqs (1) and (5). A number of other hysteresis constants are in use, however; they are related to  $R_h/L$  in Table 1. Conversion between the various constants is given in Table 2.

**Table 1**

	R	L	B	H	I	$V_e$	$I_e$	f
$\frac{R_h}{L} = q2 \cdot 24 \cdot 100 \sqrt{\frac{24\,000}{V_e}} \sqrt{\left(\frac{\mu_e}{100}\right)^3 \sqrt{(L) \times I_{rms}} \cdot \frac{f}{800}}$	$\Omega$	H			mA	mm <sup>3</sup>		Hz
$\frac{R_h}{L} = a \cdot \mu \cdot \hat{B} \cdot f$	$\Omega$	H	T					Hz
$\frac{R_h}{L} = \frac{16}{3} \cdot \frac{\nu}{\mu^3} \cdot \mu^2 \cdot \hat{H} \cdot f$	$\Omega$	H		A/m				Hz
$\frac{R_h}{L} = \frac{h}{\mu^2} \cdot \mu^2 \cdot \frac{N I_{eff}}{I_{eff}} \cdot \frac{f}{800}$	$\Omega$	H			A		mm	Hz
$\frac{R_h}{L} = \frac{h'}{\mu^2} \cdot \mu^2 \cdot H_{eff} \cdot f$	$\Omega$	H		$\frac{A}{m}$				kHz
$\frac{R_h}{L} = \eta_B \cdot \mu \cdot \hat{B} \cdot \omega \quad (\omega = 2\pi f)$	$\Omega$	H	T					Hz

**Table 2**

	q2-24-100 x	a x	$\frac{\nu}{\mu^3}$ x	$\frac{h}{\mu^2}$ x	$\frac{h'}{\mu^2}$ x	$\eta_B$ x
q2-24-100 =	1	$2,59 \times 10^6$	$6,9 \times 10^6$	$1,82 \times 10^3$	$1,46 \times 10^3$	$1,63 \times 10^3$
a =	$0,386 \times 10^{-6}$	1	2,67	$0,703 \times 10^{-3}$	$0,563 \times 10^{-3}$	$0,628 \times 10^{-3}$
$\frac{\nu}{\mu^3}$ =	$144,8 \times 10^{-9}$	0,376	1	$0,264 \times 10^{-3}$	$0,212 \times 10^{-3}$	$0,236 \times 10^{-3}$
$\frac{h}{\mu^2}$ =	$0,549 \times 10^{-3}$	$1,42 \times 10^3$	$3,79 \times 10^3$	1	0,8	0,893
$\frac{h'}{\mu^2}$ =	$0,686 \times 10^{-3}$	$1,78 \times 10^3$	$4,74 \times 10^3$	1,25	1	1,12
$\eta_B$ =	$0,615 \times 10^{-3}$	$1,59 \times 10^3$	$4,25 \times 10^3$	1,12	0,896	1

Example:  $q2-24-100 = 1,46 \times 10^3 \times \frac{h'}{\mu^2}$ .

**MEASUREMENT CONDITIONS FOR THE GUARANTEED LOSSES**

Values for loss factors given in the data apply five minutes after the core halves have been clamped together. Details of the coils used for the measurement of losses are given in the following table; all windings are on single-section coil formers.

POTCORES  
SQUARE CORES  
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core type	FXC grade	4 kHz $\tan \delta/\mu$	16 to 25 kHz watt losses	30 kHz $\tan \delta/\mu$
P5,8/2,5	3H1			
P5,8/3,3	3H1			
P7,4/4,2	3H1			
P9/5	3H1 3D3 4C6	60 turns 0,10E		
P11/7	3H1 3B8 3D3 4C6	42 turns 0,18E		
P14/8	3H1 3B8 3D3  3H3 4C6	53 turns 0,25E		53 turns 0,25E
P18/11	3H1 3B8 3D3  3H3  4C6	42 turns 0,50E	31 turns 0,50E	20 turns 100 x 0,40E
P22/13	3H1 3B8 3D3  3E4  4C6	37 turns 0,60E  37 turns 0,60E	30 turns 0,25E	
P26/16	3H1 3B8 3D3  4C6	34 turns 0,70E 34 turns 0,70E	22 turns 0,40E	

100 kHz tan $\delta/\mu$	0,5 to 1 MHz tan $\delta/\mu$	2 MHz tan $\delta/\mu$	10 MHz tan $\delta/\mu$	$\beta_F$
35 turns 0,10E				
35 turns 0,20E				
35 turns 0,20E 45 turns 0,16E 90 turns 0,12	10 turns 0,16E	17 turns 40 x 0,04E	6 turns 40 x 0,04E	
42 turns 0,18E 42 turns 0,18E 85 turns 0,10E	22 turns 0,10E	16 turns 45 x 0,04E	6 turns 45 x 0,04E	100 turns 0,20E
37 turns 0,10E 37 turns 0,10E 37 turns 0,10E 176 turns 0,14E	19 turns 8 x 0,04E	14 turns 0,40E	6 turns 0,5 x 1,9 Cu	80 turns 0,25E
35 turns 0,14E 35 turns 0,14E 20 turns 100 x 0,04E 150 turns 0,25E	16 turns 12 x 0,04E	12 turns 0,60E	5 turns 0,75 x 2,75 Cu	100 turns 0,30E
29 turns 0,20E 29 turns 0,20E 29 turns 0,20E 140 turns 0,25E	16 turns 40 x 0,04E 4 turns 1,2 x 3,5 Cu	11 turns 0,70E	4 turns 1,2 x 3,5 Cu	100 turns 0,40E
28 turns 0,28E 28 turns 0,28E 28 turns 0,28E 125 turns 0,40E	14 turns 40 x 0,04E	10 turns 0,90E	4 turns 2,0 x 4,0 Cu	100 turns 0,40E

POTCORES  
SQUARE CORES  
AND CROSS CORES

core type	FXC grade	4 kHz tan $\delta/\mu$	16 to 25 kHz watt losses	30 kHz tan $\delta/\mu$
P30/19	3H1 3B8 3D3	30 turns 1,0E	27 turns 0,40E	
P36/22	3H1 3B8 3D3	27 turns 1,2E	21 turns 0,56E	
P42/29	3H1	26 turns 1,8E		
RM4	3H1 3E4	60 turns 0,18E 60 turns 0,18E		60 turns 0,18E 60 turns 0,18E
RM5	3H1  3D3 3E4 3H3  4C6	45 turns 0,30E  45 turns 0,30E		26 turns 80 x 0,04E  26 turns 80 x 0,04E
RM6	3H1  3B8 3D3 3E4 3H3  4C6	66 turns 0,35E  40 turns 0,45E	25 turns 0,25E	66 turns 0,35E  23 turns 100 x 0,04E
RM8	3H1  3B8/3C8 3D3  3E4 3H3  4C6	35 turns 0,50E  35 turns 0,50E 35 turns 0,50E	20 turns 0,40E	35 turns 0,50E  35 turns 0,50E
RM10	3H1 3B8/3C8 3E4	40 turns 0,25E 17 turns 0,60E	26 turns 0,40E	40 turns 0,25E
RM14	3B8/3C8		22 turns 0,80E	30 turns 100 x 0,04E

100 kHz tan $\delta/\mu$	0,5 to 1 MHz tan $\delta/\mu$	2 MHz tan $\delta/\mu$	10 MHz tan $\delta/\mu$	$\beta_F$
23 turns 0,40E				100 turns 0,40E
23 turns 0,40E	8 turns 2 x 100 x 0,04E			
22 turns 0,50E				200 turns 0,40E
22 turns 0,50E	7 turns 2 x 100 x 0,04E			
20 turns 0,45E				
36 turns 0,14E 60 turns 0,18E	8 turns 0,60E			
17 turns 24 x 0,04E 45 turns 0,30E 45 turns 0,30E 26 turns 80 x 0,04E 45 turns 0,30E	15 turns 0,30E 9 turns 0,55E	15 turns 0,30E	3 turns 0,50E	
29 turns 12 x 0,04E 66 turns 0,35E 40 turns 0,45E 23 turns 100 x 0,04E 66 turns, 0,35E	8 turns 0,80E	14 turns 0,40E	4 turns 0,60E	100 turns 0,30E
31 turns 20 x 0,04E 31 turns 20 x 0,04E 35 turns 0,50E 31 turns 20 x 0,04E	15 turns 24 x 0,07E 6 turns 0,80E	15 turns 0,56E	4 turns 0,56E	100 turns 0,40E
17 turns 0,60E 17 turns 0,60E	8 turns 45 x 0,04E			100 turns 0,40E
				200 turns 0,55E

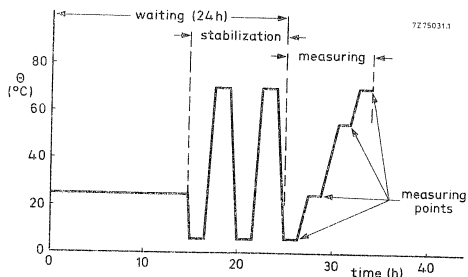
POTCORES  
SQUARE CORES  
AND CROSS CORES

core type	FXC grade	4 kHz tan $\delta/\mu$	16 to 25 kHz watt losses	30 kHz tan $\delta/\mu$
X22	3H1 3B8 3D3	42 turns 0,45E	25 turn 0,30E	
	4C6			
X25	3H1 3D3	40 turns 0,50E		
X30	3H1 3B8	35 turns 0,25E	30 turns 0,40E	
X35	3H1 3B8	30 turns 0,45E	27 turns 0,55E	

MEASUREMENT OF TEMPERATURE FACTOR

Temperature factor  $\alpha_F$  is generally determined on magnetic circuits without a ground air gap. Ferroxcube 3-- products are electrically demagnetized before measurement, and Ferroxcube 4-- products are thermally demagnetized before measurement. Thermal demagnetization is accomplished by heating in a pure nitrogen atmosphere to a temperature at least 25 K above the Curie temperature and maintaining the temperature for at least 5 minutes. Cooling takes place at 5 K/minute.

The measurement sequence for Ferroxcube 3-- and 4-- products is given in the figure. This sequence is not, however, used for Ferroxcube 3B7 products. In their case, measurement of  $\alpha_F$  is carried out on toroid-wound core halves. These are not demagnetized before the start of the measurement sequence, but electrical demagnetization takes place at each measurement temperature, 10 minutes before each measurement.





100 kHz $\tan \delta/\mu$	0,5 to 1 MHz $\tan \delta/\mu$	2 MHz $\tan \delta/\mu$	10 MHz $\tan \delta/\mu$	$\beta_F$
33 turns 0,22E	16 turns 24 x 0,04E	10 turns 0,90E	4 turns 1,4 x 4,4 Cu	100 turns 0,30E
33 turns 0,22E				
150 turns 0,30E				
36 turns 0,50E	12 turns 45 x 0,04E			
36 turns 0,50E				
35 turns 0,25E				100 turns 0,40E
30 turns 0,45E				100 turns 0,80E

#### MEASUREMENT OF DISACCOMMODATION FACTOR

Disaccommodation factor  $D_F$  of Ferroxcube 3-- magnetic circuits is measured between 10 and 100 minutes after magnetic demagnetization at a temperature of  $25\text{ }^\circ\text{C} \pm 5\text{ }^\circ\text{C}$ , unless otherwise stated. The actual measurement temperature is held constant during the measurement to within  $0,2\text{ }^\circ\text{C}$ .

The disaccommodation factor of magnetic circuits in Ferroxcube 4-- materials is measured between 24 hours and 48 hours after cooling to  $35\text{ }^\circ\text{C}$  following thermal demagnetization, as described above.

## INDUCTANCE ADJUSTERS

Inductance adjustment is by means of a continuous adjuster incorporating a tube of Ferroxcube or a mixture of plastic with carbonyl-iron powder inserted into the central hole of the core; this tube acts as a magnetic shunt across the core air gap. It is carried on a thermoplastic moulding, threaded at one end; this screws into a nut which is injection moulded or cemented into the lower half of the core. The magnetic tubes are centreless ground to give very close diameter tolerance.

### INDUCTANCE STABILITY

The stability of a correctly-assembled pot, square or cross core depends mainly on the stability of the permeability of the ferrite. The permeability of a ferrite may change with temperature, time, mechanical pressure, magnetic polarization and other factors. The most important changes affecting the inductance stability of the assembly are:

- variation of permeability with temperature — temperature coefficient;
- variation of permeability with time — disaccommodation.

Changes in inductance may also occur due to:

- movement of the adjuster after final setting;
- movement of the coil former;
- relative movement of the core halves;
- movement of the mechanical components of the assembly.

Small movements of this kind are usually caused by changes in temperature, mechanical vibration or shock.

It is clear from the formulae given in Section A that lowering the value of  $A_L$  or  $\mu_e$  will reduce both temperature coefficient and disaccommodation. However, very low values of  $A_L$  and  $\mu_e$  usually prove incompatible with Q requirements; a typical value for a high-Q inductor using an RM6 core would be  $A_L = 315$ . For material grade FXC3H1, the corresponding value of temperature coefficient would be about  $+120 \cdot 10^{-6}/K$ . A reasonable measure of compensation may be achieved by suitable choice of resonating capacitor: a polystyrene-film capacitor is available with a temperature coefficient of about  $-120 \cdot 10^{-6}/K$ .

### Old types

Both nut and adjuster threads are made to much finer tolerances than required by UN-D12 (ISO Recommendations R68, DR782 and DR979). The injection-moulded nut is very firmly fixed in the core. It is not able to move in any direction, and is precisely centred with its axis parallel to that of the core.

The achievement of acceptable long-term inductance stability is mainly a matter of careful assembly and suitable stabilizing treatment before final adjustment. If the inductor is to be used in a critical circuit, it should be artificially aged by temperature cycling as described in the Section 'Mounting Data' below. The long-term change in inductance of an assembly so treated should not be greater than  $500 \cdot 10^{-6}$ , assuming an ambient temperature between 25 °C and 40 °C that does not vary by more than 15 K.

The change in inductance of an RM core assembly using clips with earthing spikes when subjected to IEC 68-2-6, test Fc, vibration conditions is less than  $1000 \cdot 10^{-6}$ . Such severe conditions are unlikely to be encountered in practice.

Bump tests of RM-core assemblies with earthing spikes, IEC 68-2-29, test Eb, have also been carried out. The observed change in the inductance of RM6-R cores of 3H1 material was less than  $300 \cdot 10^{-6}$ .

**New types**

The old adjusters, which have now been in existence for 14 years, have some disadvantages:

- \* One or more pips of the head may shear off if the adjuster is screwed carelessly into the centre hole of the core half. Such a damaged adjuster is unreliable and will result in variation of the inductance if subjected to shock or vibration.
- \* The low screwing torque may cause instability.
- \* The material of the bolt (nylon K332) is more sensitive to temperature variation than the material of the new bolt (polypropylene reinforced with glass fibre).
- \* The adjusters are fairly expensive.

Some years ago we introduced injection moulded nuts in most potcores and square cores. This improved performance and reduced cost. The fixed nut and moving adjuster which constitute one adjusting mechanism have now been redesigned. The new adjusters, which are described in the enclosed data sheets, overcome all of the previously mentioned disadvantages:

- \* The pips have been replaced by cones which cannot shear. Moreover, all types have cross-slotted heads causing more flexibility to achieve an accurate fit in the upper core half.
- \* The screwing torque is concentrated in the head of the bolt so mechanical stresses on the shank are minimized during adjustment.
- \* The thread of both the nut and the adjuster are closely toleranced (4H) to allow smooth rotation without backlash or friction. The gauge-measured maximum torque of the threaded part for the new adjusters is:

M1,4 types  $\leq$  2 mNm

M1,7 types  $\leq$  3 mNm

M2 types  $\leq$  6 mNm

M2,6 types  $\leq$  10 mNm

- \* Improved manufacturing techniques make the new adjusters cheaper.
- \* For inductance stability see next pages.

Maximum inductance adjustment is dependent of the winding height of the coil former. That is why the given adjustment curves have been measured with standard coils for  $\alpha$  and  $A_L$  measurements (see under 'Pre-adjusted potcores' in this chapter).

Additional data for new adjusters, including adjustment curves will be released as it becomes available.

a. INDUCTANCE STABILITY AFTER ENVIRONMENTAL TESTS

IEC publication	test method	name of test	procedure
68-2-1	Aa	cold	-55 °C/2h
68-2-2	Ba	dry heat	+85 °C/16h
68-2-3	Ca	damp heat	+40 °C, 93% R.H., 21 days
68-1 appendix A	-	climatic sequence	tests Aa, Ba, Ca cumulative
68-2-6	Fc	vibration	10 to 55 Hz, 0,35 mm; 90 h; hor. and vert. cumulative

A <sub>L</sub> variations in percents of initial A <sub>L</sub> value							
M1,4 adjusters		M1,7 adjusters		M2 adjusters		M2,6 adjusters	
grey RM5 adjuster 4322 021 38792		violet RM6 adjuster 4322 021 38672		white RM8 adjuster 4322 021 38483		brown P26/16 adjuster 4322 021 39412	
tested in							
RM5-3H1-A <sub>L</sub> 250 core 4322 022 79262		RM6S-3H1-A <sub>L</sub> 250 core 4322 022 67267		RM8-3H1-A <sub>L</sub> 250 core 4322 022 71263		P26/16-3H1-A <sub>L</sub> 400 core 4322 022 29284	
$\bar{X}$	S	$\bar{X}$	S	$\bar{X}$	S	$\bar{X}$	S
+0,01(+0,01)	0,04(0,03)	+0,02(+0,00)	0,05(0,03)	+0,08(+0,04)	0,02(0,00)	-0,07(-0,07)	0,02(0,01)
-0,02(+0,02)	0,03(0,04)	+0,04(+0,04)	0,02(0,00)	+0,07(+0,06)	0,02(0,02)	+0,02(+0,05)	0,00(0,01)
+0,02(+0,17)	0,07(0,20)	-0,02(-0,04)	0,03(0,04)	-0,08(-0,06)	0,04(0,02)	-0,02(+0,04)	0,01(0,02)
+0,03(+0,03)	0,06(0,05)	+0,01(+0,05)	0,04(0,03)	+0,05(+0,08)	0,09(0,02)	-0,08(+0,01)	0,02(0,01)
+0,01(-0,06)	0,05(0,11)	+0,00(+0,03)	0,02(0,02)	+0,01(+0,01)	0,03(0,02)	0,00(0,00)	0,01(0,00)

Note:  $\bar{X}$  = mean value    S = standard deviation    Values between brackets for core without adjuster.

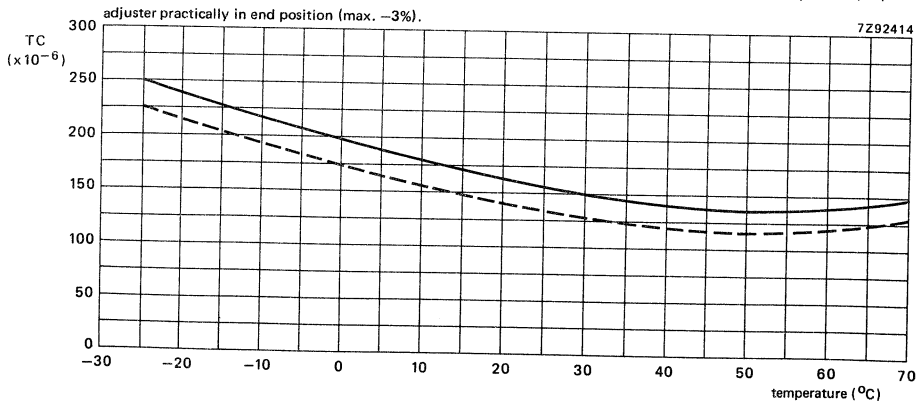
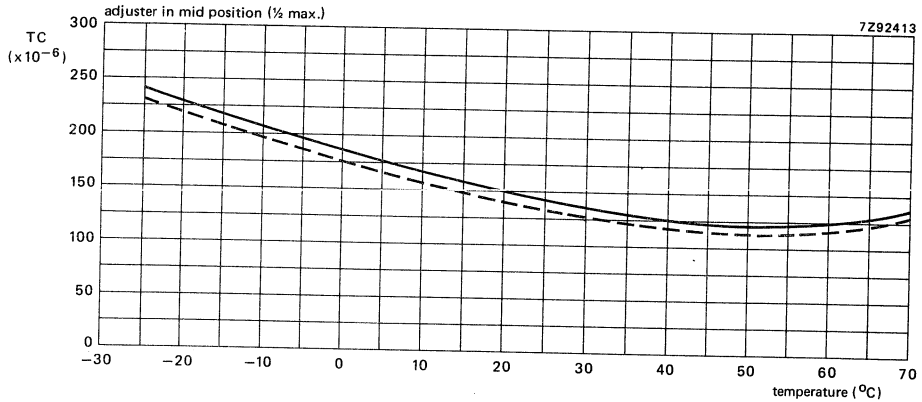
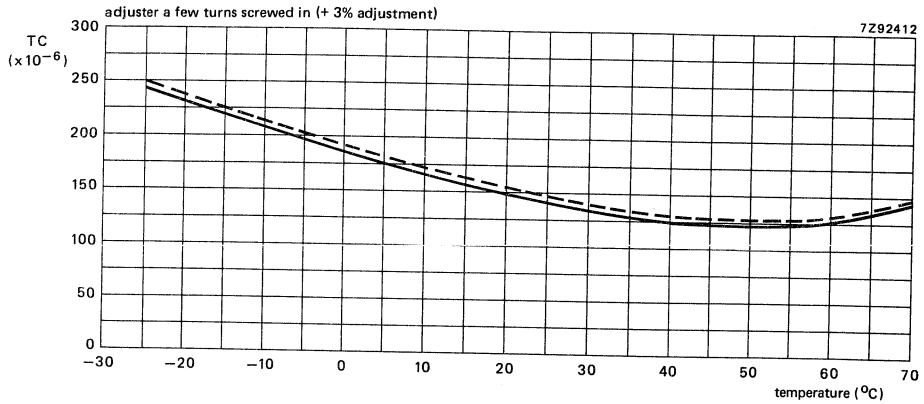
## b. INDUCTANCE STABILITY AS A FUNCTION OF TEMPERATURE

The following graphs show the inductance change versus temperature for the RM5 and RM6S cores mentioned in the table above: (1) without adjuster, and (2) with the relevant adjuster in 3 different positions:

- adjuster a few turns screwed in (+ 3% adjustment)
- adjuster in mid position ( $\frac{1}{2}$  max.)
- adjuster practically in end position (max. -3%).

POTCORES  
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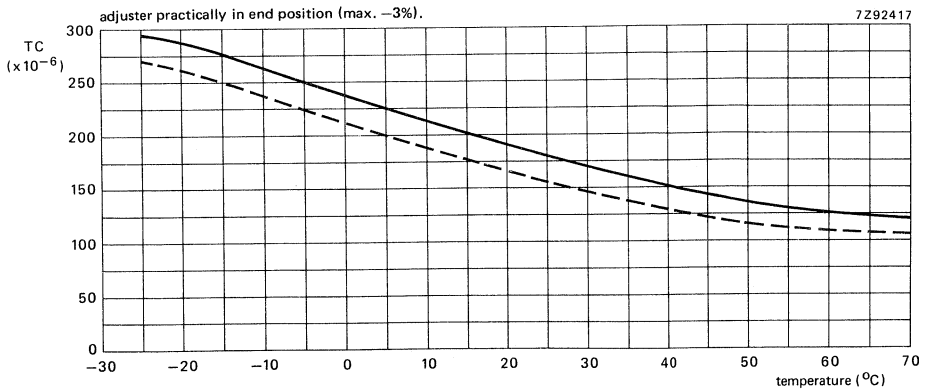
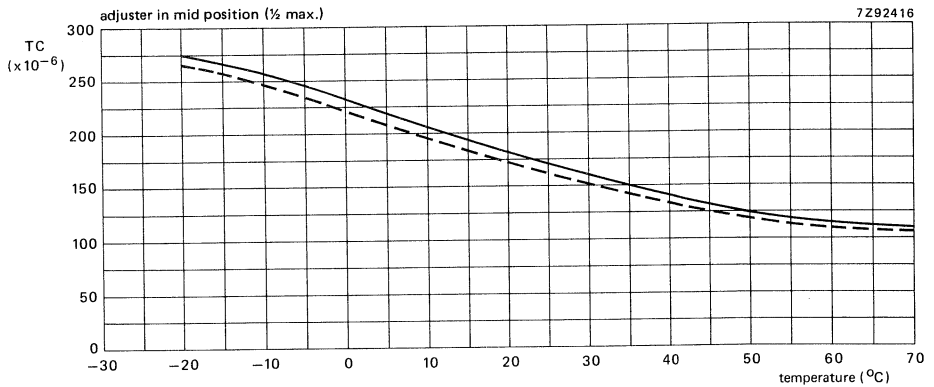
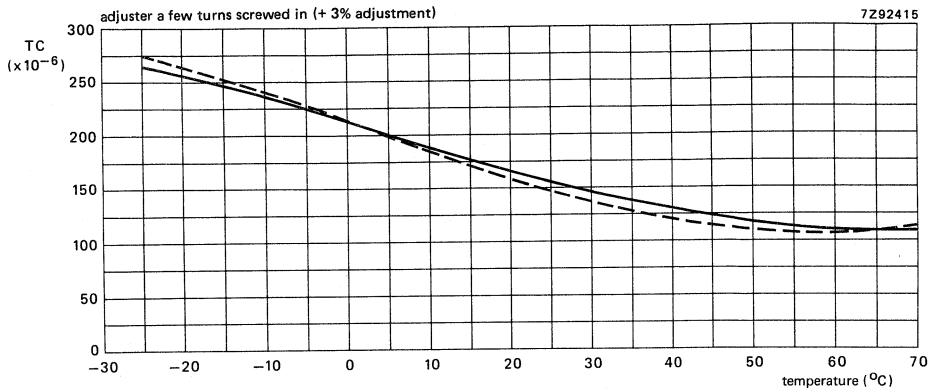
RM5-3H1-A<sub>L</sub> 250 core 4322 022 79262



— with M1,4 adjuster, grey, 4322 021 38792

- - - without adjuster.

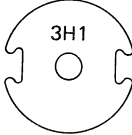
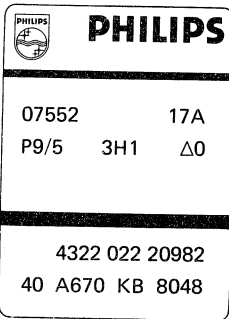
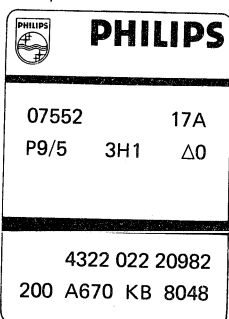
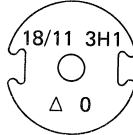
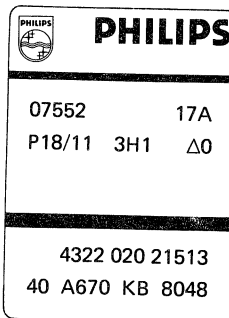
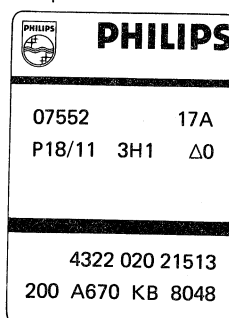
RM6S-3H1--A<sub>L</sub> 250 core 4322 022 67267



— with M1,7 adjuster, violet 4322 021 38672.  
 - - - without adjuster.

## MARKING

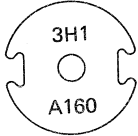
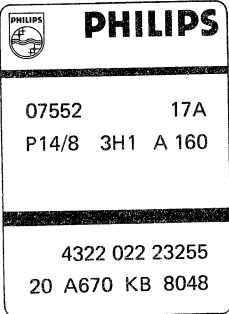
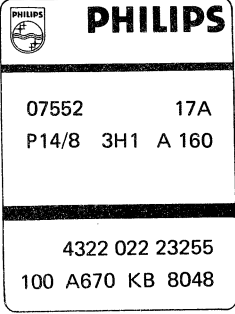

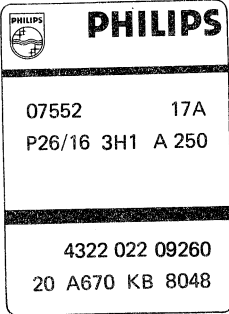
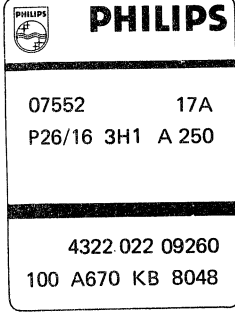
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product	marking on product	marking on label of primary pack	marking on label of storage pack
diameter $\leq 15$ mm *)	without air gap	material	delivery lot number; production lot number; designation; code number; quantity; origin/traceability code; date of packing
		example: 	example: 
diameter $\geq 15$ mm	without air gap	dimensions material Δ and 0 signs	delivery lot number; production lot number; designation; code number; quantity; origin/traceability code; date of packing
		example: 	example: 

\* Potcores with a dia.  $< 9$  mm are not marked.




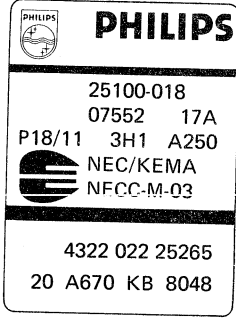
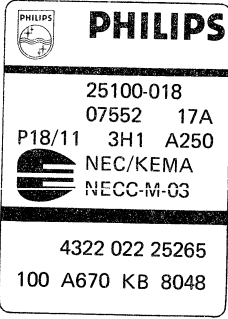
MARKING OF POTCORE SETS

product		marking on product *	marking on label of primary pack	marking on label of storage pack
diameter $\leq 15$ mm	without or with air gap	material A or $\mu$ sign $A_L$ or $\mu_e$ value **	delivery lot number; production lot number; designation; code number; quantity; origin/traceability code; date of packing	delivery lot number; production lot number; designation; code number; quantity; origin/traceability code; date of packing
		example: 	example: 	example: 
diameter $\geq 15$ mm	without or with air gap	dimensions material A or $\mu$ sign $A_L$ or $\mu_e$ value **	delivery lot number; production lot number; designation; code number; quantity; origin/traceability code; date of packing	delivery lot number; production lot number; designation; code number; quantity; origin/traceability code; date of packing
		example: 	example: 	example: 

\* Marked on the upper half (without nut).

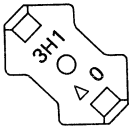
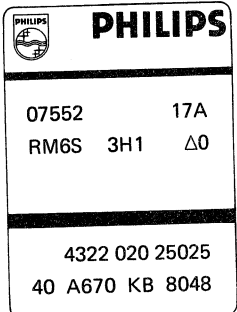
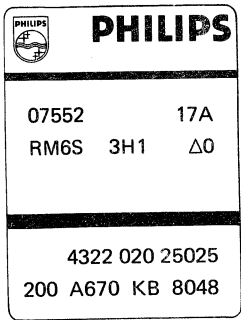
\*\* The  $A_L$  or  $\mu_e$  sign is omitted where these values are  $\geq 1000$ .

MARKING OF POTCORE SETS WITH CECC APPROVAL


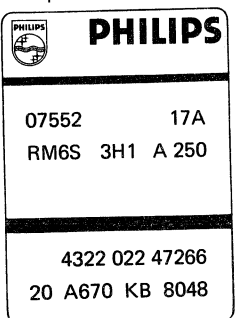
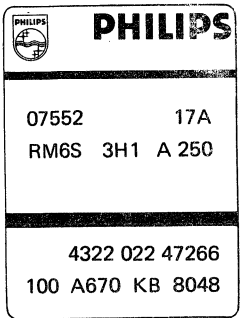
product		marking on product*	marking on label of primary pack	marking on label of storage pack
diameter ≥ 15 mm	with air gap	dimensions material PH sign A sign A <sub>L</sub> value	Philips shield emblem and wordmark; specification number; delivery lot number; production lot number; designation; CECC symbol, name of national supervising inspectorate, code of authorized factory; code number; quantity; origin/traceability code; date of packing	Philips shield emblem and wordmark; specification number; delivery lot number; production lot number; designation; CECC symbol, name of national supervising inspectorate, code of authorized factory; code number; quantity; origin/traceability code; date of packing
		example:  	example:  	example:  

\* Marked on the upper half (without nut).

MARKING OF RM-CORE HALVES

product	marking on product	marking on label of primary pack	marking on label of storage pack
square core halves	material Δ and 0 signs	delivery lot number; production lot number; designation; code number; quantity; origin/traceability code; date of packing	delivery lot number; production lot number; designation; code number; quantity; origin/traceability code; date of packing
	example: 	example: 	example: 


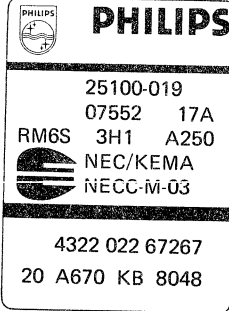
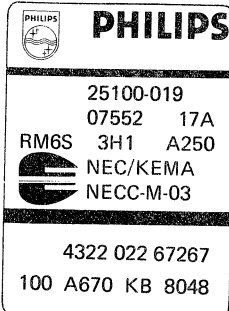
MARKING OF RM-CORE SETS

square core sets	material A sign* A <sub>L</sub> value	delivery lot number; production lot number; designation; code number; quantity; origin/traceability code; date of packing	delivery lot number; production lot number; designation; code number; quantity; origin/traceability code; date of packing
	example: 	example: 	example: 

\* The A sign is omitted from RM5 and smaller cores with A<sub>L</sub> values ≥ 1000.


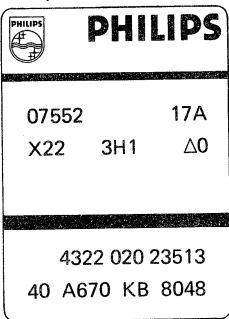
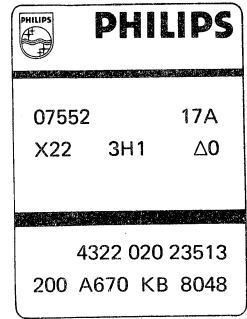

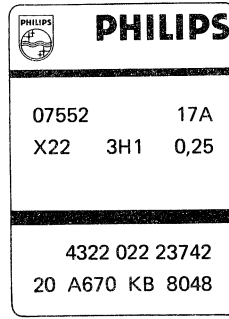
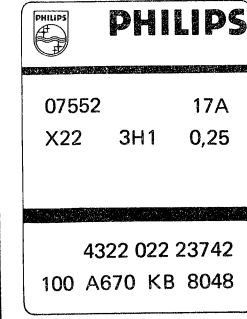
POTCORES  
SQUARE CORES  
AND CROSS CORES

MARKING OF RM-CORE SETS WITH CECC APPROVAL


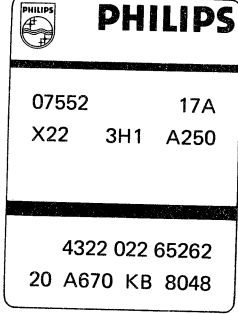
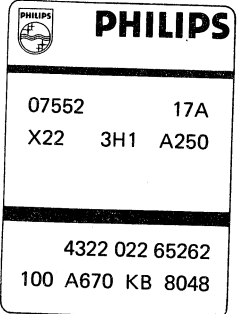
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square core sets	material PH sign (turned through 90°) A sign A <sub>L</sub> value	Philips shield emblem and wordmark; specification number; delivery lot number; production lot number; designation; CECC symbol, name of national supervising inspectorate, code of authorized factory; code number; quantity; origin/traceability code; date of packing	Philips shield emblem and wordmark; specification number; delivery lot number; production lot number; designation; CECC symbol, name of national supervising inspectorate, code of authorized factory; code number; quantity; origin/traceability code; date of packing
	example: 	example: 	example: 

\* Marked on the upper half (without nut).

MARKING OF X-CORE HALVES

product	marking on product	marking on label of primary pack	marking on label of storage pack
cross core halves	material Δ and 0 signs	delivery lot number; production lot number; designation; code number; quantity; origin/traceability code; date of packing	delivery lot number; production lot number; designation; code number; quantity; origin/traceability code; date of packing
	example:  	example: 	example: 
cross core halves	material air-gap length (mm)	delivery lot number; production lot number; designation; code number; quantity; origin/traceability code; date of packing	delivery lot number; production lot number; designation; code number; quantity; origin/traceability code; date of packing
	example:  	example: 	example: 

MARKING OF X-CORE SETS

product		marking on product	marking on label on primary pack	marking on label on storage pack
cross core sets	without or with air gap	material A sign* A <sub>L</sub> value	delivery lot number production lot number; designation; code number; quantity; origin/traceability code; date of packing	delivery lot number; production lot number; designation; code number; quantity; origin/traceability code; date of packing
		example:  	example:  	example:  

\* The A sign is omitted where A<sub>L</sub> values are  $\geq 1000$ .

## COIL DESIGN AND CALCULATIONS

### LOSSES

Losses in a wound core can be divided into

- winding losses:
  - losses due to the d.c. resistance of the wire,
  - eddy-current losses in the wire,
  - dielectric losses in insulation;
- core losses:
  - hysteresis losses in the core material,
  - eddy-current and residual losses in the core material.

With Ferroxcube pot, square and cross cores, screening losses are negligible.

Losses appear as series resistances in the coil. The ratio of the total effective series resistance due to all losses to the inductance of the coil is the sum of the resistances due to the individual losses:

$$\frac{R_{\text{tot}}}{L} = \frac{R_0}{L} + \frac{R_{\text{ec}}}{L} + \frac{R_d}{L} + \frac{R_h}{L} + \frac{R_{e+r}}{L} \quad (\Omega/\text{H}) \quad (1)$$

As a general rule, maximum Q is obtained when the sum of the winding losses is made equal to the sum of the core losses.

#### D.C. resistive losses

The d.c. resistive losses in a winding are given by

$$\frac{R_0}{L} = \frac{l}{\mu_e} \cdot \frac{l}{f_{\text{Cu}}} \times \text{constant} \quad (\Omega/\text{H}) \quad (2)$$

The space (copper) factor  $f_{\text{Cu}}$  depends on wire diameter, the amount of insulation and the method of winding. The value of the constant is given in the data for the coil formers.

#### Eddy-current losses in the winding

$$\frac{R_{\text{ec}}}{L} = \frac{C_{\text{wCu}} V_{\text{Cu}} f^2 d^2}{\mu_e} \quad (\Omega/\text{H}) \quad (3)$$

where  $C_{\text{wCu}}$  is the eddy-current loss factor for the winding and depends on the dimensions of the coil former and core, and  $V_{\text{Cu}}$  is the volume of conductor in  $\text{mm}^3$ ;  $d$  is the diameter of a single wire in mm.

#### Dielectric losses

The capacitances associated with the coil are not loss free, they have a loss factor  $\tan \delta_c$  that also increases the effective coil resistance:

$$\frac{R_d}{L} = \omega^3 LC \left( \frac{2}{Q} + \tan \delta_c \right) \quad (\Omega/\text{H}) \quad (4)$$

### Hysteresis losses

The effective series resistance due to hysteresis losses is calculated from the core hysteresis constant, the peak flux density, the effective permeability and the operating frequency:

$$\frac{R_h}{L} = \omega \eta_B \hat{B} \mu_e. \quad (\Omega/H) \quad (5)$$

### Eddy-current and residual losses

The effective series resistance due to eddy-current and residual losses is calculated from the loss factor  $\tan \delta/\mu_i$  given as a function of frequency in the core data:

$$\frac{R_{e+r}}{L} = \omega \mu_e (\tan \delta/\mu_i). \quad (\Omega/H) \quad (6)$$

### Coil design

The specification of an inductor usually includes

- the inductance;
- minimum Q at the operating frequency;
- applied alternating voltage;
- maximum size;
- maximum and minimum temperature coefficient;
- range of adjustment;
- variability.

To satisfy these requirements, the designer has the choice of

- core size,
- material grade,
- $A_L$ ,
- type of conductor (solid or bunched),
- type of adjuster.

### Frequency, core type and material grade

The operating frequency is a useful guide to the choice of core type and material.

- Frequencies below 20 kHz: the highest Q will be obtained with large, high-inductance-factor cores in Ferroxcube 3B7, 3H1 or 3H3 material. Winding wire should be solid, with minimum-thickness insulation. Note: high inductance factors are associated with high temperature coefficients of inductance.
- Frequencies between 20 kHz and 200 kHz: high Q will generally be obtained with a core also in Ferroxcube 3B7, 3H1 or 3H3. Maximum Q will not necessarily be obtained from the largest-size core, particularly at higher frequencies, so the choice of inductance factor is less important. Bunched, stranded conductors should be used to reduce eddy-current losses in the copper. Above 50 kHz, the strands should not be thicker than 0,07 mm.
- Frequencies between 200 kHz and 2 MHz: use a core of Ferroxcube 3D3 material. Bunched conductors of maximum strand diameter 0,04 mm are recommended.
- Frequencies between 2 MHz and 12 MHz: use a core of Ferroxcube 4C6. Bunched conductors of maximum strand diameter 0,04 mm are recommended for frequencies up to 5 MHz. Solid conductors should be used at frequencies between 5 MHz and 12 MHz.



### Signal level

In most applications, the alternating signal voltage is low. It is good practice, wherever possible, to keep the operating flux density of the core below 1 mT, at which level the effect of hysteresis is usually negligible. At higher flux densities, it might be necessary to allow for some hysteresis loss and inductance change. Curves showing the effect of signal level are given in the data for certain core types. The expression for third harmonic voltage  $E_3$  given in Section A may be used as a guide to the amount of distortion. For low distortion, RM cores with small hysteresis loss factors should be used.

### D.C. polarization

The effect of a steady, superimposed magnetic field, whether due to an external field or a d.c. component of winding current, on a cored inductor is to reduce the inductance obtained with a given number of turns. As with other characteristics, the amount of the decrease depends on the value of the effective permeability, becoming less at lower permeabilities. But for most applications the effect is not serious. Curves from which the amount of the decrease can be obtained are given in the core data sheets. Ferroxcube 3B8 has been developed especially for applications involving d.c. polarization.

### Design procedure

1. On the basis of the operating characteristics and design limitations, select the core size, material grade, inductance factor and conductor type using the information given in the data sheets.
2. Using the adjustment curve, check that the range of adjustment is sufficient to cover the tolerance on  $A_L$  or  $\mu_e$  and that of the resonating capacitor. Make an allowance of about 1% for circuit strays.
3. Calculate the number of turns required from the  $A_L$  or  $\alpha$  value for the core.
4. Select a conductor size to fill the coil former.
5. From the voltage across the inductor,  $E_{RMS}$ , determine peak flux density  $\hat{B}$ . If this is in excess of 1 mT, check that hysteresis loss and distortion are acceptable by reference to the a.c. signal-level characteristics in the core data.

## DESIGN EXAMPLES

### Example 1

Design a filter coil of inductance 2,75 mH operating at a frequency of 100 kHz, with a minimum Q of 900. The temperature coefficient of inductance must be less than  $+8,5 \times 10^{-3}$  between  $+5^\circ\text{C}$  and  $+55^\circ\text{C}$ . The coil will carry an a.c. current of 1 mA.

Both operating frequency and the positive temperature coefficient required indicate the use of Ferroxcube 3H1 material for the core. The maximum value of  $\mu_e$  can be calculated from the maximum temperature coefficient using the expression for core temperature coefficient  $\alpha_\mu$  given in the list of definitions in Section A:

$$\alpha_\mu = \alpha_F \mu_e.$$

Taking the mean value of  $\alpha_F$  given in the material data for 3H1,  $10^{-6}/\text{K}$ , yields

$$\mu_e = \frac{8,5 \times 10^{-3}}{50 \times 10^{-6}} = 170.$$

This being the maximum value of  $\mu_e$  for the required temperature coefficient. The next lower standard value is 150. Examination of the Q curves for the various potcores for  $\mu_e = 150$  reveals that the smallest potcore for which the required Q of 900 can be obtained is the P18/11. The catalogue number of the pre-adjusted core with adjuster nut is 4322 022 24270; that of the recommended adjuster is 4322 021 32140.

To allow for a 10% adjustment range about the nominal inductance, the inductance of the coil without adjuster should be 5% less than nominal, that is  $0,95 \times 2,75 = 2,62$  mH. The number of turns required is given by  $N = \alpha\sqrt{L} = 56,3 \sqrt{2,62} = 91$  turns. From the window area-available with single-section coil former 4322 021 30270, a suitable conductor comprises 64 strands of 0,04 mm enamelled-copper wire.

It is now possible to calculate the losses in the coil and, hence, the Q. The losses due to the d.c. resistance of the wire can be calculated from Eq. (2) above, using the loss-constant for the coil former:

$$\frac{R_0}{L} = \frac{16,4 \times 10^3}{0,38 \times 150} = 288 \Omega/\text{H},$$

where 0,38 is the space factor for the winding. The eddy-current losses in the winding are given by Eq. (3), taking  $C_{wCu} = 10^{-7}$ ,

$$\frac{R_{ec}}{L} = \frac{10^{-7} \times 267 \times 10^{10} \times 0,04^2}{150} = 3 \Omega/\text{H}.$$

where  $267 \text{ mm}^3$  is the volume of the conductor determined from the wire diameter number of strands, number of turns and mean turn length given in the coil-former data.

The dielectric losses in the coil stray capacitances are given by Eq. (4), assuming  $\tan \delta_c = 0,01$  and  $C = 8 \text{ pF}$ :

$$\frac{R_d}{L} = (2\pi \cdot 10^5)^3 \times 2,62 \times 10^{-3} \times 8 \times 10^{-12} \left( \frac{2}{900} + 0,01 \right) = 64 \Omega/\text{H}.$$

Hysteresis losses are given by Eq. (5), but first it is necessary to calculate  $\hat{B}$ . This is simply given by the number of turns, the current carried, the effective permeability and the effective length of the core magnetic path:

$$\begin{aligned} \hat{B} &= N \hat{\mu}_e \mu_0 / \ell_e \\ &= \sqrt{2} \times 91 \times 10^{-3} \times 150 \times 4\pi \times 10^{-7} / (25,8 \times 10^{-3}) \\ &= 0,94 \text{ mT}. \end{aligned} \tag{7}$$

Using this value in Eq. (5), with  $\eta_B = 0,5 \times 10^{-5}/\text{T}$ , a more realistic value than the quoted maximum, yields

$$\frac{R_h}{L} = 2\pi \times 10^{-5} \times 0,5 \times 10^{-3} \times 0,94 \times 10^{-3} \times 150 = 44 \Omega/\text{H}.$$

Eddy-current and residual losses given by Eq. (6), using  $\tan \delta/\mu_i = 3 \times 10^{-6}$ , a good average value, are

$$\frac{R_{e+r}}{L} = 2\pi \times 10^5 \times 150 \times 3 \times 10^{-6} = 283 \Omega/\text{H}.$$

Now, from Eq. (1),

$$\frac{R_{\text{tot}}}{L} = 288 + 3 + 64 + 44 + 283 = 682 \Omega/\text{H}$$

so that

$$Q = \omega L / R_{\text{tot}} = 2\pi \times 10^5 / 682 = 921.$$

The measured value, given in the Q curves with the data for the P18/11 core, was 995.

### Example 2

Design an 88 mH loading coil to exceed the following requirements by the widest possible margin in the smallest possible volume.

Inductance tolerance	1 %
D.C. resistance	≤ 4,8 Ω
A.C. resistance at 1800 Hz and 1 mA	≤ 5,8 Ω
Capacitance between the two line windings	≤ 200 pF
Inductance unbalance between the two line windings	≤ 0,1 %
Resistance unbalance between the two line windings	≤ 0,1 Ω

From the a.c. and d.c. resistance limits,

$$\frac{R_0}{L} \leq \frac{4,8}{0,088} = 54,5 \Omega/\text{H}$$

and

$$\frac{R_{\text{tot}}}{L} \leq \frac{5,8}{0,088} = 65,9 \Omega/\text{H}.$$

The  $R_0/L$  value is often the most critical requirement for loading coils on ferrite cores. Therefore the potcore size and the  $A_L$  (or  $\mu_e$ ) value are determined first.

Potcore P30/19 is examined first:

$$\frac{R_0}{L} = \frac{1}{\mu_e} \times \frac{1}{f_{\text{cu}}} \times 5,38 \cdot 10^3 \quad (\text{see P30/19, section Coil formers})$$

assume  $f_{\text{cu}} = 0,5$

$$\text{from max. } 54,5 = \frac{1}{\mu_e} \times \frac{1}{0,5} \times 5,38 \cdot 10^3 \quad \text{follows min. } \mu_e = \frac{5,38 \cdot 10^3}{54,5 \times 0,5} = 197.$$

Because a higher  $\mu_e$  value is more attractive due to a better  $R_0/L$  or smaller core size, potcore P26/16 is examined now:

$$\frac{R_0}{L} = \frac{1}{\mu_e} \times \frac{1}{f_{\text{cu}}} \times 7,79 \cdot 10^3 \quad (\text{see P26/16, section Coil formers})$$

assume again  $f_{\text{cu}} = 0,5$

$$\text{from max. } 54,5 = \frac{1}{\mu_e} \times \frac{1}{0,5} \times 7,79 \cdot 10^3 \quad \text{follows min. } \mu_e = \frac{7,79 \cdot 10^3}{54,5 \times 0,5} = 286.$$

This result looks more attractive to continue the calculation.

$$A \mu_e \text{ of min. } 286 \text{ corresponds to a min. } A_L \text{ of } 898 \text{ according to formula } A_L = \frac{0,4 \pi \mu_e}{C_1}.$$

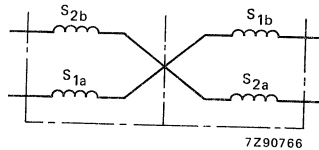
$C_1$  of potcore P26/16 is  $0,400 \text{ mm}^{-1}$  (see P26/16, section Potcores).

The closest standard  $A_L$  value of a P26/16-3H1 core is 1000 ( $\mu_e = 318$ ). Catalogue number of this core is 4322 022 29310.

The tolerance on the  $A_L$  value is  $\pm 3\%$ . For most loading coils this is too high. To solve that problem a suitable inductance adjuster is used (see P26/16, Inductance adjusters). The inductance of the coil without adjuster must be a few percent lower, because an adjuster always increases the inductance, e.g.  $-5\%$ .

88 mH – 5% = 83,6 mH.

According to formulae  $L = N^2 A_L$  the number of turns for this coil should be 289. Because a loading coil must have an even number of turns (often divisible by 4, see outline) 288 turns are chosen.



Arrangement of a four-winding loading coil on a two-section former.

According to the same formula the inductance of the loading coil without adjuster is now

$$L = N^2 A_L = 288^2 \times 1000 \times 10^{-6} \text{ mH} = 82,94 \text{ mH.}$$

The  $\pm 3\%$  tolerance on the  $A_L$  value of the core implies:

a minimum inductance of  $82,94 \text{ mH} - 3\% = 80,45 \text{ mH}$ ;

a maximum inductance of  $82,94 \text{ mH} + 3\% = 85,43 \text{ mH}$ .

In order to bring 80,45 mH to 88 mH an adjuster is needed which increases the inductance of the coil with maximum 9,3%. A suitable standard adjuster can be found under P26/16 (see Inductance adjusters).

Since the lowest value of  $R_0/L$  will be obtained with a coil former completely full of wire, solid wire 0,28 mm diameter with double polyvinylformal insulation is used. From Eq. (2),

$$\frac{R_0}{L} = \frac{7,79 \times 10^3}{318 \times 0,49} = 50 \Omega/\text{H},$$

where 0,49 is the space factor of the winding.

The eddy-current resistance is given by Eq.(3) with

$$C_{wCu} = 100 \times 10^{-9} :$$

$$\frac{R_{ec}}{L} = 100 \times 10^{-9} \times 954 \times 3,24 \times 10^6 \times 0,28^2 / 318 = 0,08 \Omega/\text{H}.$$

Dielectric losses are given by Eq. (4), assuming Q at 1800 Hz to be 200 (from P26/16 Q curves) and  $\tan \delta_c = 0,01$ :

$$\frac{R_d}{L} = (2\pi 1800)^2 \times 88 \times 10^{-3} \times 60 \times 10^{-12} \left( \frac{2}{200} + 0,01 \right) = 0,15 \Omega/\text{H}.$$

Hysteresis losses are given by Eq. (5), but first it is necessary to calculate  $\hat{B}$ : from Eq. (7):

$$\hat{B} = 292 \times 10^{-3} \times \sqrt{2} \times 318 \times 4\pi \times 10^{-7} / (37,6 \times 10^{-3}) = 4,4 \text{ mT.}$$

Then, with  $\eta_B = 0,5 \times 10^{-3}$ ,

$$\frac{R_h}{L} = 2\pi \times 1800 \times 0,5 \times 10^{-3} \times 4,4 \times 10^{-3} \times 318 = 7,9 \Omega/H.$$

Finally, eddy-current and residual losses are given by Eq. (6), assuming  $\tan \delta/\mu_i = 0,5 \times 10^{-6}$ :

$$\frac{R_{e+r}}{L} = 2\pi \times 1800 \times 318 \times 0,5 \times 10^{-6} = 1,8 \Omega/H.$$

Thus, from Eq (1), the total losses are

$$\frac{R_{tot}}{L} = 50,3 + 0,88 + 0,15 + 7,9 + 1,8 = 59,9 \Omega/H,$$

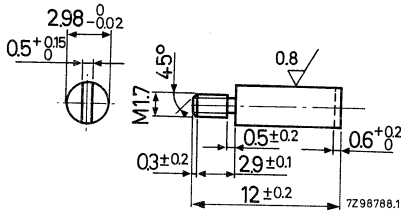
so that the total coil resistance at 1800 Hz passing a current of 1 mA is  $59,9 \times 88 \times 10^{-3} = 5,27 \Omega$ .  
Note the very low contribution of the Ferroxcube 3H1 to the losses.

## MOUNTING DATA

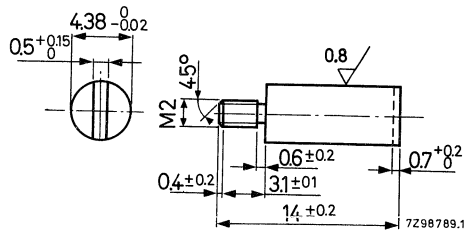
### ASSEMBLING

Stable inductance is best achieved by gluing the coil former inside the core half with the nut; one small spot of a flexible silicon rubber kit is sufficient. With cores and accessories assembled according to the instructions in the data sheets, normal requirements of temperature, shock and vibration stability are met.

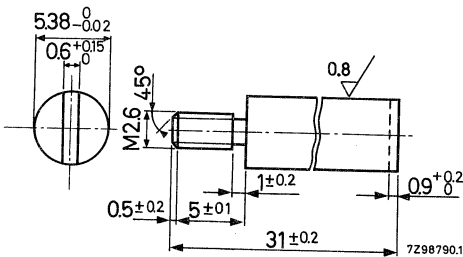
Since the clearance of the adjuster in core centre holes is small, core halves must be accurately centred during assembly. For *small-quantity production*, alignment plugs are useful aids. These are, however, not available as accessories, but should be made to the accompanying drawings. The recommended material is brass.



P14/8 and P18/11



P22/13



P26/16 to P42/29

material: brass

Core halves must be centred before mounting parts are fitted. These assembly plugs can also be used during impregnation with wax or other compounds. After impregnation, remove plugs and insert inductance adjusters; see Inductance Adjustment instructions in the data sheets.

For *large-quantity production*, special assembly tools have been designed that first centre the core halves and then bend the container lips of potcores and cross cores. For RM cores, the tools first centre the core halves and then apply the two spring clips. Drawings will be supplied on request; please use the ordering code in the accompanying table. See also the Mounting Parts section of the data sheets.

core type	drawing number of tool
P11/7	4322 058 00070
P14/8	4322 058 00000
P18/11	4322 058 00010
P22/13	4322 058 00020
P26/16	4322 058 00030
P30/19	4322 058 00040
P36/22	4322 058 00050
P42/29	4322 058 00060
RM4	4322 058 00180
RM5	4322 058 00170
RM6	4322 058 00150
RM8	4322 058 00160
RM10	4322 058 00190
RM14	4322 058 00200
X22	4322 058 00080
X30	4322 058 00090
X35	4322 058 00100

#### INSERTING THE ADJUSTER NUT

Pre-adjusted cores are available with a nut for the inductance adjuster injection-moulded or cemented into one core half. The following instructions are for users who prefer to cement the nut themselves.

Push the nut into the central hole of one of the core halves from the flat side. The recommended distance between the nut and the core mating surface is given in the data sheets. Cement the nut into the hole in the lower core half; a suitable adhesive is

1 part by weight Araldite DY023	} curing time: 2 hours at 80 °C.
5 parts by weight Araldite CY230	
2,6 parts by weight Versamid 140	

Drawings only are available for tools recommended for nut insertion and will be supplied on request.

core type	drawing number of insertion tool
P14/8 and P18/11	7V48160
P22/13	7V48161
P26/16 to P42/29	7V48198

Drawings only are also available for metering devices for applying the adhesive to the inside of the core body.

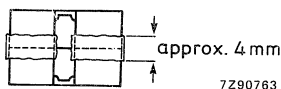
core type	drawing number of metering device
P14/8 and P18/11	7V12356
P22/13	7V12353
P26/16 to P42/29	7V12341

### CEMENTING CORE HALVES TOGETHER

→ When our mounting parts are used it is not necessary to cement the core halves together

The guidelines given below for cementing core halves together are given for those customers who do not use our mounting parts.

1. Ensure that there is no dust on either the outside or the inside of the core halves. Remove any particles with a dry brush or rotary brushing machine.
2. Ensure that core halves are free of grease. Degrease in a trichlorethylene vapour bath for at least 10 seconds. After degreasing, protect against dust and do not handle.
3. Mix Araldite AY18 and hardener HZ18 in proportions of 4 : 3 by weight. An equal amount of chalk (marble flour) may be added. Pot life is about 2 weeks, depending on ambient temperature.
4. Put the wound coil former into the core, cementing to one core half if desired.
5. Centre the core halves and clamp; the recommended pressure on the mating surfaces is 200 Pa (0,02 kg/mm<sup>2</sup>).
6. Heat the core to about 35 °C to drive off any moisture.
7. Brush adhesive around the cylindrical surface of the core, to about 2 mm either side of the joint line.



With the core still clamped, put into an oven at 70 °C for 1 hour, followed by 1½ hours at 100 °C to cure. Cool room to temperature before unclamping.

8. With 4C6 material, more than one coat of adhesive may be necessary; allow each coat to dry before applying the next. Clamping is necessary only while curing.

### IMPREGNATION AND ENCAPSULATION

Encapsulation or vacuum impregnation of a complete assembly is not recommended as it can cause the core material to become stressed and this is usually accompanied by unacceptable changes in permeability and temperature coefficient. If encapsulation is necessary, provide the core with a layer of wax by immersion before encapsulating.

Restrict vacuum impregnation to wound bobbins only. Note: bobbins wound with silk-covered wire must always be impregnated. After impregnation, take care that wax is not scraped off during coil assembly as it may become trapped between mating surfaces of the core.

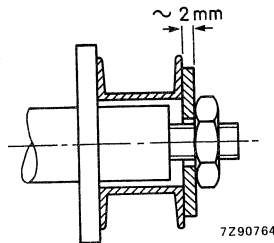
Note: when extremely good temperature stability is required, subject the complete coil to five temperature cycles with a variation from room temperature to 70 °C at a rate not exceeding 1 °C per minute. This applies to all types of inductor assembly.



## COIL WINDING RECOMMENDATIONS

## PROTECTING THE COIL FORMER

The flanges of the coil former may be as thin as 0,2 mm. For this reason, it is necessary to support them during winding; this is best done by means of a flanged mandrel. As shown in the figure, this supports both barrel and flanges. ←

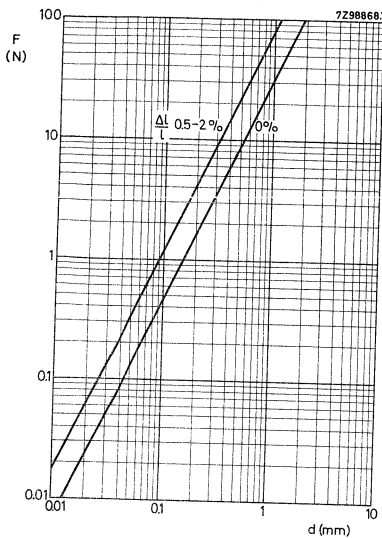


With wire of overall diameter less than about 0,4 mm, no attempt should be made to layer wind, but a random winding should be built up as evenly as possible. With wire of diameter greater than about 0,4 mm a compromise is usual: approximate layer winding, feasible at the start, should be continued as far as possible in order to achieve a satisfactory space factor.

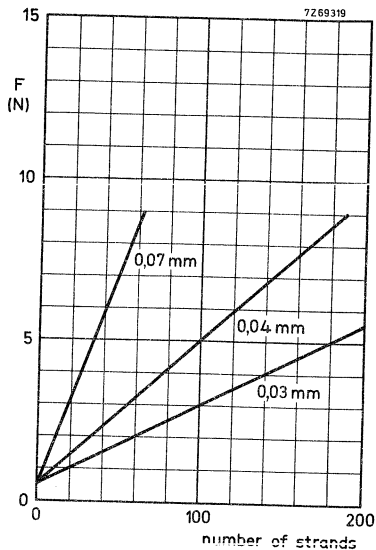
Each lead-out wire should be terminated at a convenient coil-former or tag-plate pin by soldering; dip soldering is the usual method. Solder-bath temperature and immersion time are largely dependent on the type of wire, but should not be more than necessary. A good flux is essential: preferably one that can be removed with warm water. To avoid contamination of coil former and tag plate, do not immerse the pins too far in the bath. Capillary action will ensure that good joints are made when the distance between the soldering-bath surface and coil-former or tag plate is about 1 mm.

**WIRE TENSION**

The two accompanying graphs may be used to find the wire tension required during winding.



Solid wire: tension  $F$  as a function of diameter  $d$  with extension  $\Delta l/l$  as a parameter.



Bunched wire: tension  $F$  as a function of number of strands with the strand diameter as a parameter.

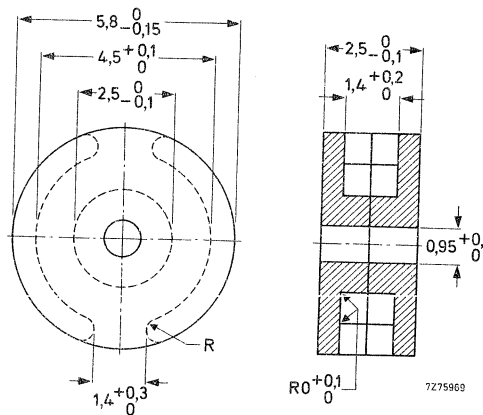
POTCORES AND ACCESSORIES

## POTCORES

- CORE HALVES without air gap can be supplied.
- Potcores and associated parts are ordered by their 12-digit catalogue number. Quantity: a primary pack contains 100 core halves; a storage pack contains 500 core halves. Please order in multiples of these quantities.

### MECHANICAL DATA

Dimensions in mm



Dimensional quantities according to IEC 205:

→  $C_1 = \Sigma \frac{l}{A} = 1,39 \text{ mm}^{-1}$ ;  $C_2 = \Sigma \frac{l}{A^2} = 0,347 \text{ mm}^{-3}$ ;  $V_e = 22,3 \text{ mm}^3$ ;  $l_e = 5,57 \text{ mm}$ ;  $A_e = 4,01 \text{ mm}^2$ .

Mass of a core set: 0,18 g.

### ELECTRICAL DATA

- The combination of two potcore halves without air gap, randomly chosen from a batch, has the following guaranteed  $A_L$  value. A measuring coil as described in general section 'Potcores, square cores and cross cores, is inserted; the halves are pressed together with a force of 15 N. The values are valid 5 minutes or more after clamping.

→ $A_L \pm 25\%$	$f = 4 \text{ kHz}$	$\hat{B} = 1 \text{ mT}$	$25 \pm 1 \text{ }^\circ\text{C}$	715
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Catalogue number of a half core without air gap in grade 3H1: 4322 020 54300.

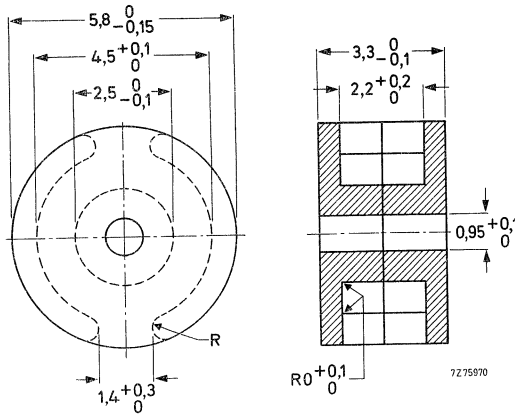
## POTCORES

- CORE HALVES without air gap can be supplied.

Potcores and associated parts are ordered by their 12-digit catalogue number. Quantity: a primary pack ← contains 100 core halves; a storage pack contains 500 core halves. Please order in multiples of these quantities.

### MECHANICAL DATA

Dimensions in mm



Dimensional quantities according to IEC 205:

$$C_1 = \Sigma \frac{1}{A} = 1,68 \text{ mm}^{-1}; C_2 = \Sigma \frac{1}{A^2} = 0,358 \text{ mm}^{-2}; V_e = 37,0 \text{ mm}^3; l_e = 7,90 \text{ mm}; A_e = 4,70 \text{ mm}^2.$$

Mass of a core set: 0,23 g.

### ELECTRICAL DATA

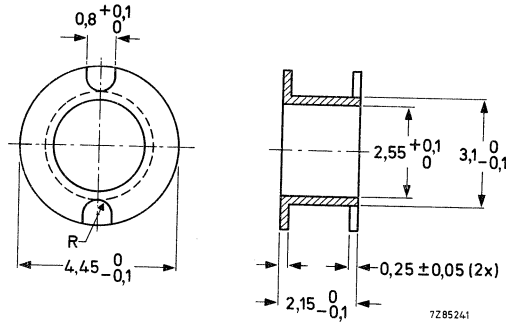
The combination of two potcore halves without air gap, randomly chosen from a batch, has the following guaranteed  $A_L$  value. A measuring coil as described in general section 'Potcores, square cores and cross cores', is inserted; the halves are pressed together with a force of 15 N. The value is valid ← 5 minutes or more after clamping.

	freq. kHz	$\hat{B}$ mT	temp. °C	grade 3H1
$A_L \pm 25\%$	4	$\leq 1$	$25 \pm 5$	820

Catalogue number of a half core without air gap: 4322 020 54400

### COIL FORMER

Dimensions in mm



Catalogue number

4322 021 33550

Material

polyamide

Window area

1,1 mm<sup>2</sup>

Mean length of turn

11,7 mm

Maximum temperature

130 °C

D.C. losses

$$\frac{R_o}{L} = \frac{1}{\mu_e} \times \frac{1}{f_{cu}} \times 237 \times 10^3 \Omega/H$$

Mass

0,03 g

## POTCORES

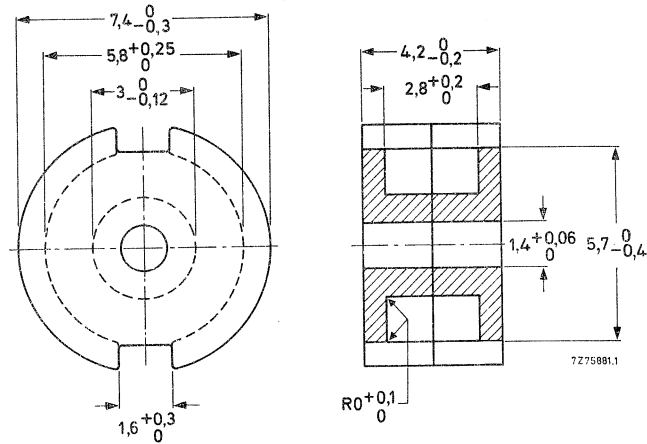
Two types of core can be supplied:

- CORE SETS without nut and pre-adjusted on an  $A_L$  value.
- CORE HALVES without air gap.

Potcores and associated parts are ordered by their 12-digit catalogue number. Quantity: a primary pack contains 100 core halves; a storage pack contains 500 core halves. Please order in multiples of these quantities.

### MECHANICAL DATA

Dimensions in mm



Dimensional quantities according to IEC 205:

$$C_1 = \Sigma \frac{l}{A} = 1,43 \text{ mm}^{-1}; C_2 = \Sigma \frac{l}{A^2} = 0,204 \text{ mm}^{-3}; V_e = 70 \text{ mm}^3; l_e = 10,0 \text{ mm}; A_e = 7,0 \text{ mm}^2.$$

Mass of a core set: 0,46 g.

### ELECTRICAL DATA

The combination of two potcore halves without air gap, randomly chosen from a batch, has the following guaranteed  $A_L$  value. A measuring coil as described in general section 'Potcores, square cores and cross cores', is inserted; the halves are pressed together with a force of 20 N. The value is valid 5 minutes or more after clamping.

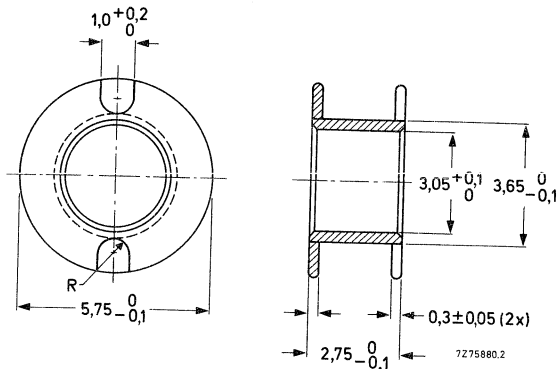
	freq. kHz	$\hat{B}$ mT	temp. °C	grade 3H1
$A_L \pm 25\%$	4	$\leq 1$	$25 \pm 5$	970

Core halves in 3H1 grade

air gap $\Delta$ in mm	catalogue number
0	4322 020 54600
$0,06 \pm 0,01$	54610
$0,12 \pm 0,01$	54620

### COIL FORMER

Dimensions in mm

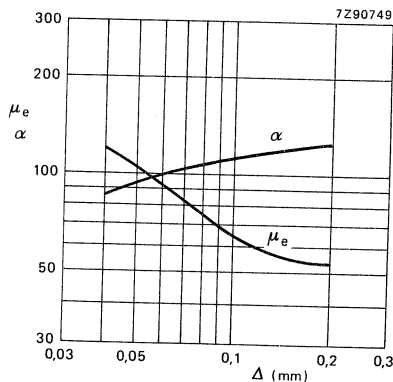


Catalogue number  
 Material  
 Window area  
 Mean length of turn  
 Maximum temperature  
 D.C. losses  
 Mass

4322 021 32990  
 polyamide  
 2,2 mm<sup>2</sup>  
 14,6 mm  
 130 °C  
 $\frac{R_o}{L} = \frac{1}{\mu_e} \times \frac{1}{f_{cu}} \times 137 \times 10^3 \Omega/H$   
 0,04 g

### CHARACTERISTIC CURVES

$\mu_e - \alpha$  curves



Relative effective permeability and turn factor for 1 mH as a function of the air gap length.  
 FXC 3H1.



## POTCORES

Three types of core can be supplied:

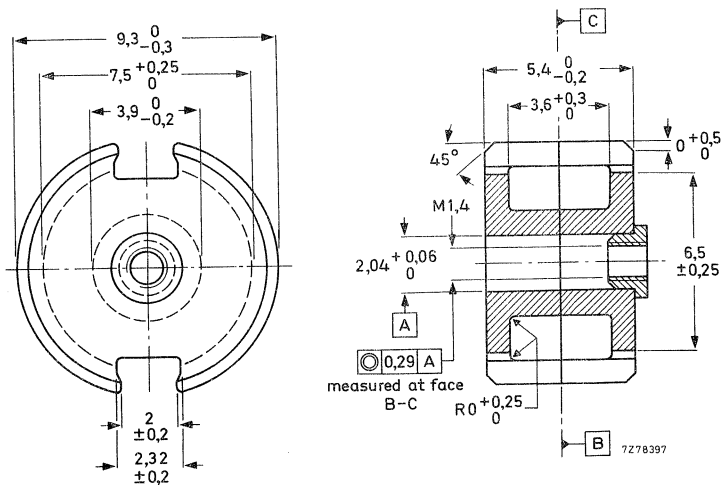
- CORE SETS provided with a nut for an adjuster and pre-adjusted on an inductance factor  $A_L$  or on a relative effective permeability value  $\mu_e$ .
- CORE SETS without nut and pre-adjusted on an  $A_L$  or a  $\mu_e$  value.
- CORE HALVES without air gap.

The potcores are in accordance with the following specifications: IEC 133 (international), NCF83311 (France), DIN 41293 (Germany) and BS4061 range 2 (Great Britain).

Potcores and associated parts are ordered by their 12-digit catalogue number. Quantity: a primary pack contains 20 core sets or 40 core halves; a storage pack contains 100 core sets or 200 core halves. Please order in multiples of these quantities.

### MECHANICAL DATA

Dimensions in mm



Dimensional quantities according to IEC 205:

$$C_1 = \Sigma \frac{1}{A} = 1,24 \text{ mm}^{-1}; C_2 = \Sigma \frac{1}{A^2} = 0,124 \text{ mm}^{-3}; V_e = 126 \text{ mm}^3; l_e = 12,5 \text{ mm}; A_e = 10,1 \text{ mm}^2;$$

$$A_{CPmin} = 7,98 \text{ mm}^2$$

Mass of a core set: 1,3 g

Pulling-out force of the nut:  $\geq 10 \text{ N}$

**ELECTRICAL DATA**

The combination of two potcore halves without air gap, randomly chosen from a batch, has the following guaranteed properties. A measuring coil as described in the General section 'Potcores' square cores and cross cores, is inserted; the halves are pressed together with a force of 25 N. The values are valid 5 minutes or more after clamping.

	freq. kHz	$\hat{B}$ mT	temp. °C	grade		
				3D3	3H1	4C6
$A_L \pm 25\%$	4	$\leq 0,1$	$25 \pm 1$	630	1260	125
$\mu_e \pm 25\%$	4	$\leq 0,1$	$25 \pm 1$	630	1260	125
$\alpha$	4	$\leq 0,1$	$25 \pm 1$	$\leq 45,5$	$\leq 32,7$	$\leq 103$
$\frac{\tan \delta}{\mu_j} \times 10^6$	100	$\leq 0,1$	$25 \pm 1$	$\leq 10$	$\leq 6,0$	
	100	$\leq 0,1$	$25 \pm 1$	$\leq 14$		
	1000	$\leq 0,1$	$25 \pm 1$	$\leq 30$		
$\eta_B \times 10^3$	4	1,5 to 3,0	$25 \pm 1$		$\leq 1,1$	
$\alpha_F \times 10^6/K$	100	0,3 to 1,2	$25 \pm 1$	$\leq 2,5$		$\leq 6,2$
	$\leq 100$	$\leq 0,1$	5 to 25		+ 0,5 to 1,5	-2 to + 4
	$\leq 100$	$\leq 0,1$	25 to 55		+ 0,5 to 1,5	0 to + 6
$D_F \times 10^6$ (10-100 min)	$\leq 100$	$\leq 0,1$	25 to 70	0 to + 2	+ 0,5 to 1,5	
	$\leq 100$	$\leq 0,1$	$25 \pm 0,1$	$\leq 20$	$\leq 4,3$	$\leq 10$

Core sets pre-adjusted on  $A_L$ .

$A_L$	corresponding $\mu_e$ -value	catalogue number 4322 022 . . . . .			
		3H1		4C6	
		with nut	without nut	with nut	without nut
16 ± 1%	16			61800	41800
25 ± 1%	25			61810	● 41810
40 ± 1%	40			61820	41820
63 ± 1%	63	61230	41230		
100 ± 1,5%	100	● 61240	41240		
160 ± 2%	160	● 61250	41250		
250 ± 5%	250	61260	41260		

Cores with  $A_L \leq 63$  have a symmetrical air gap.

Cores with  $A_L \geq 100$  have an asymmetrical air gap.

Core halves without air gap, without nut

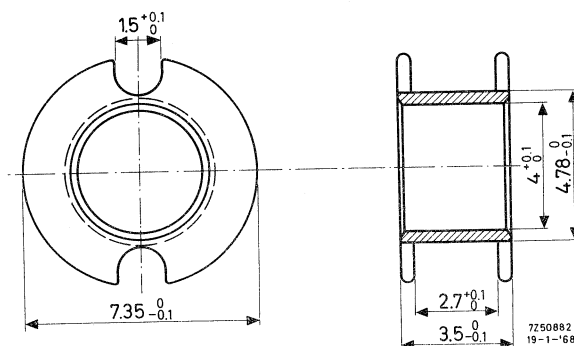
Ferroxcube grade	catalogue number
3D3	4322 020 20900
3H1	4322 020 20980
4C6	4322 020 20940

● Preferred type.

## COIL FORMER

The dimensions conform with the following specifications: IEC 133 (international), UTE C93-324 livre 1 (France), DIN41294 (Germany) and BS4061 range 2 (Great Britain).

Dimensions in mm



Catalogue number	4322 021 31700
Material	polycarbonate
Window area	$3,4 \text{ mm}^2$
Mean length of turn	19 mm
Maximum temperature	$130 \text{ }^\circ\text{C}$
D.C. losses	$\frac{R_{\Omega}}{L} = \frac{1}{\mu_e} \times \frac{1}{f_{Cu}} \times 69,5 \times 10^3 \text{ } \Omega/\text{H}$
Mass	0,07 g

## INDUCTANCE ADJUSTERS

(old types)

The tolerances on inductance of the pre-adjusted potcores (without adjuster) are given under Potcores. After inserting a coil (impregnated or not) in an electrical circuit, its inductance can be adjusted to the required value with an accuracy  $< 0,03\%$  by means of a continuous inductance adjuster. Such an adjuster increases the inductance of the coil, see following pages.

The adjuster is screwed through the potcore into the nut and is held in position by the lips of the adjuster head. For special requirements a bigger or smaller adjustment range may be obtained by using an adjuster belonging to the next higher or lower effective permeability.

The influence of the adjusters on the variability of the inductance is negligible. The maximum permissible temperature is  $110\text{ }^{\circ}\text{C}$ . Table 2 shows the type of adjuster recommended for different potcores.

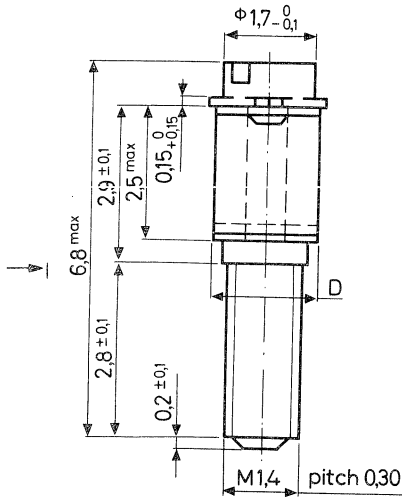


Table 1, available types

D	colour	catalogue number
1,85	natural	4322 021 31250
1,85	yellow	4322 021 31270
1,76	brown	4322 021 31540

Table 2, recommended application

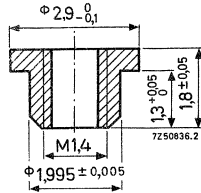
$A_L$	3H1/3D3
63	4322 021 31250
100	4322 021 31270
160	4322 021 31540

The adjusters are packed in bags of 100. Please order in multiples of this quantity.

Dimensions in mm

**LOOSE NUT FOR ADJUSTER**

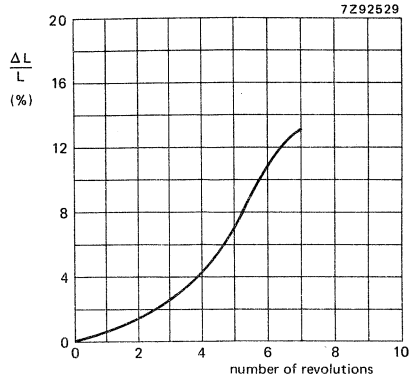
These data are given for those manufacturers who prefer to insert a nut themselves.



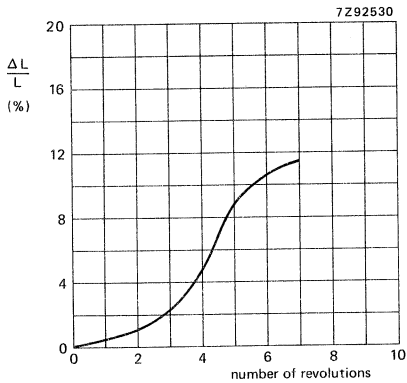
Catalogue number 4322 021 31630  
 Material brass, nickel plated

**ADJUSTMENT CURVES**

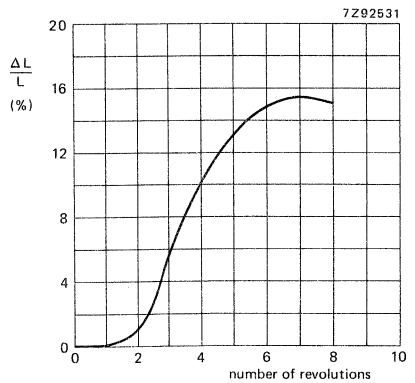
Characteristic curves



$A_L = 63$ ; FXC 3H1



$A_L = 100$ ; FXC 3H1



$A_L = 160$ ; FXC 3H1



## INDUCTANCE ADJUSTERS

(new types)

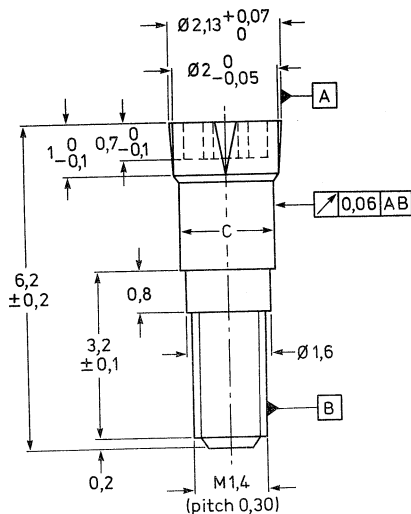


Fig. 1.

Material: polypropylene, reinforced with glass fibre.

The tolerances on inductance factor of the pre-adjusted cores without adjuster are given in the table of pre-adjusted cores with standard  $A_L$  values. The inductance of the pre-adjusted core can be increased to the required value — with a setting accuracy  $< 0,03\%$  — by means of a continuous adjuster.

The adjuster is screwed through the centre hole of the core into the nut and is held in position by the four cones near the top of the adjuster.

The combination of the polyamide moulded-in nut and the polypropylene adjuster — both reinforced with glass fibre — gives an excellent stability with temperature, shocks and vibrations. Besides this, the combination has a very smooth adjustment curve due to the excellent concentricity of the moulded-in nut and the adjuster.

The maximum permissible temperature of the adjustment combination is:  $150^\circ\text{C}$ , during 8 h. The maximum working temperature is  $110^\circ\text{C}$ .

The tables below show the available types and which adjuster is recommended for typical  $A_L$  values.

Table 1 Colour code of adjusters

catalogue number	colour	dia. C (Fig. 1) mm	material
4322 021 39810	brown	1,85	FXC
4322 021 39890	grey	1,92	FXC

Table 2 Catalogue numbers of recommended adjusters for typical  $A_L$  values

$A_L$	3H1/3B7	4C6
16	to be fixed	
25		
40		
63		
100		
160		
250		

**PACKAGING**

The adjusters are packed in plastic bags of 100. Please order in multiples of this quantity.

**ADJUSTING TOOL**

An adjusting tool combination for M1, 4 and M1, 7 is available, catalogue number 4322 058 03260.

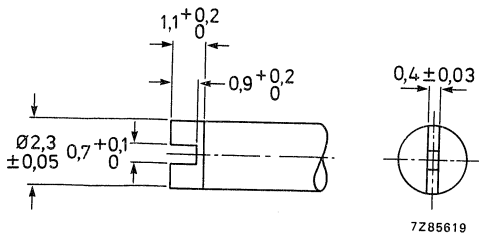


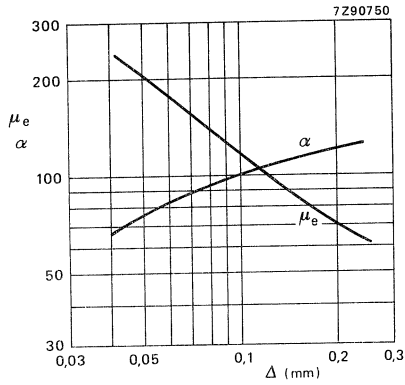
Fig. 2.

For customers who wish to make the screwdriver themselves the outlines of the essential part are given in Fig. 2.



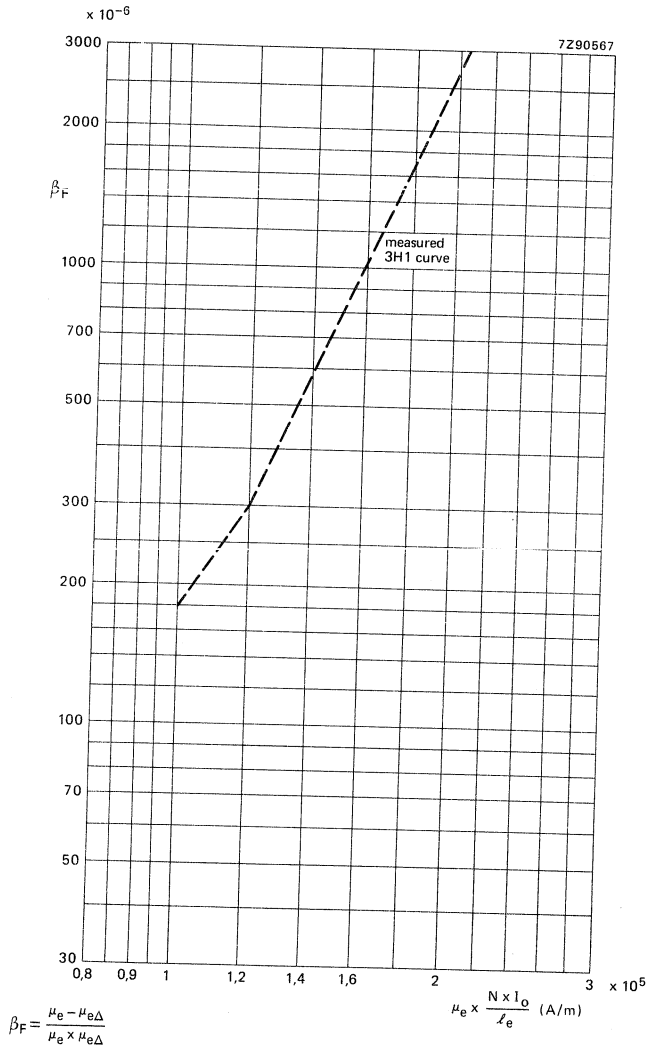
## CHARACTERISTIC CURVES

### $\mu_e$ - $\alpha$ CURVES



Relative effective permeability and turn factor for 1 mH as a function of the air gap length.  
 $\mu_e = 1260 \pm 25\%$  at  $\Delta = 3 \mu\text{m}$  for 3H1.

D.C. SENSITIVITY AT 25 °C



Inductance variation as a function of d.c. polarization.

## POTCORES

Three types of core can be supplied:

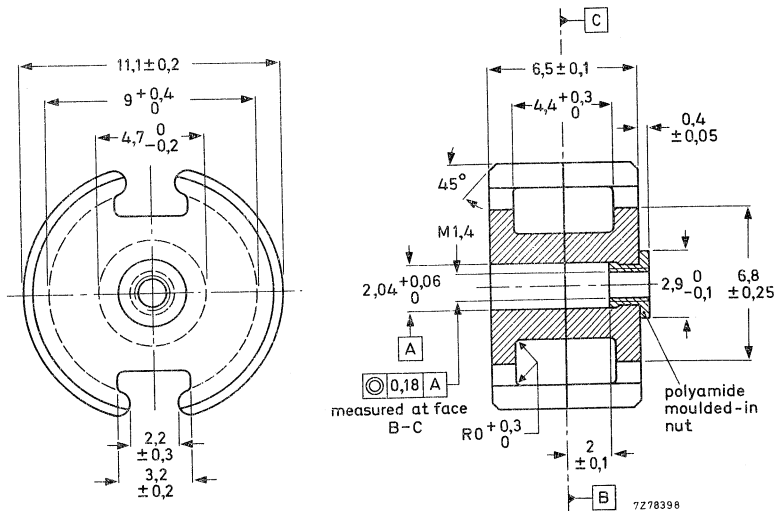
- CORE SETS provided with an injection-moulded nut for an adjuster and pre-adjusted on an inductance factor  $A_L$  or on a relative effective permeability value  $\mu_e$ .
- CORE SETS without nut and pre-adjusted on an  $A_L$  or a  $\mu_e$  value.
- CORE HALVES without air gap.

The potcores are in accordance with the following specifications: IEC 133 (international), NCF 83311 (France), DIN41293 (Germany) and BS4061 range 2 (Great Britain).

Potcores and associated parts are ordered by their 12-digit catalogue number. Quantity: a primary pack contains 20 core sets or 40 core halves; a storage pack contains 100 core sets or 200 core halves. Please order in multiples of these quantities.

### MECHANICAL DATA

Dimensions in mm



Pulling out force of the nut  $\geq 20$  N  
 Torque of the screw thread  $\leq 4$  mNm  
 Extraction force of adjuster from nut  $\geq 20$  N  
 Dimensional quantities according to IEC 205:

$$C_1 = \Sigma \frac{l}{A} = 0,956 \text{ mm}^{-1}; C_2 = \Sigma \frac{l}{A^2} = 0,059 \text{ mm}^{-3}; V_e = 251 \text{ mm}^3; l_e = 15,5 \text{ mm}; A_e = 16,2 \text{ mm}^2;$$

$$A_{CP \text{ min}} = 13,3 \text{ mm}^2$$

Mass of a core set: 1,8 g.

ELECTRICAL DATA

The combination of two potcore halves without air gap, randomly chosen from a batch, has the following guaranteed properties. A measuring coil as described in the General section 'Potcores, square cores and cross cores', is inserted; the halves are pressed together with a force of 35 N. The values are valid 5 minutes or more after clamping. Parameters  $\alpha_F$  and  $D_F$  of grade 3B7 are measured on toroid-wound halves.

	freq. kHz	$\hat{B}$ mT	temp. °C	grade					
				3B8	3D3		3H1		4C6
$A_L \pm 25\%$	4	$\leq 0,1$	$25 \pm 1$	1650	870		1700		160
$\mu_e \pm 25\%$	4	$\leq 0,1$	$25 \pm 1$	1270	660		1300		125
$\alpha$	4	$\leq 0,1$	$25 \pm 1$	$\leq 28,3$	$\leq 39,2$		$\leq 27,9$		$\leq 90,5$
$\frac{\tan \delta}{\mu_j} \times 10^6$	4	$\leq 0,1$	$25 \pm 1$						
	100	$\leq 0,1$	$25 \pm 1$		$\leq 8,0$		$\leq 5,0$		
	500	$\leq 0,1$	$25 \pm 1$		$\leq 14$				
	1000	$\leq 0,1$	$25 \pm 1$		$\leq 30$				
	2000	$\leq 0,1$	$25 \pm 1$						
	10000	$\leq 0,1$	$25 \pm 1$						$\leq 40$
$\eta_B \times 10^3$	4	1,5 to 3,0	$25 \pm 1$						$\leq 100$
	100	0,3 to 1,2	$25 \pm 1$		$\leq 1,8$		$\leq 1,1$		
$\alpha_F \times 10^6/K$	$\leq 100$	$\leq 0,1$	5 to 25				+ 0,5 to + 1,5		$\leq 6,2$
	$\leq 100$	$\leq 0,1$	25 to 55				+ 0,5 to + 1,5		-2 to + 4
	$\leq 100$	$\leq 0,1$	25 to 70		0 to + 2				0 to + 6
$D_F \times 10^6$ (10-100 min)	$\leq 100$	$\leq 0,1$	$25 \pm 0,1$		$\leq 15$		$\leq 4,3$		$\leq 10$
$\beta_F \times 10^6$ , measured on sets with $\mu_e = 300 \pm 10\%$ and $25 \pm 1$ °C:									
at $\mu_e \times \frac{N \times I_0}{I_e} = 1,00 \times 10^5$ A/m				$\leq 120$					
= $1,50 \times 10^5$ A/m				$\leq 300$					
= $2,15 \times 10^5$ A/m				$\leq 1100$					

Core sets with nut and pre-adjusted on  $A_L$ .

$A_L$	corre sponding $\mu_e$ -value	catalogue number 4322 022 . . . . .				
		3B8	3D3	3H1		4C6
$16 \pm 1\%$	12,2		21400			21800
$25 \pm 1\%$	19		21410			● 21810
$40 \pm 1\%$	30,5		● 21420			21820
$63 \pm 1\%$	48		21430			
$100 \pm 1\%$	76	01900	21440	● 21240		
$160 \pm 1,5\%$	122			● 21250		
$250 \pm 3\%$	190	● 01920		● 21260		
$400 \pm 8\%$	305	01940				

Core sets with nut and pre-adjusted on  $\mu_e$ .

$\mu_e$	$\alpha$	catalogue number 4322 022 . . . . .				
			3D3	3H1		4C6
$15 \pm 1\%$	225					20810
$22 \pm 1\%$	186					20820
$33 \pm 1\%$	152		20430			20830
$47 \pm 1\%$	127		20440			
$68 \pm 1\%$	105,8		20450	20250		
$100 \pm 1,5\%$	87,5			20260		
$150 \pm 2\%$	71,2			20270		
$220 \pm 5\%$	58,8			20280		
$660 \pm 25\%$	33,9		00400			
$1300 \pm 25\%$	24,2			00200		

Core sets without nut: replace the eighth digit of the catalogue number (2) by 0.

Cores with  $A_L \leq 63$ , or  $\mu_e \leq 68$ , have a symmetrical air gap.Cores with  $A_L \geq 100$ , or  $\mu_e \geq 100$ , have an asymmetrical air gap.

Core halves without air gap, without nut

Ferroxcube grade	catalogue number
3B8	4322 020 28760
3D3	4322 020 21020
3H1	4322 020 21010
4C6	4322 020 21140

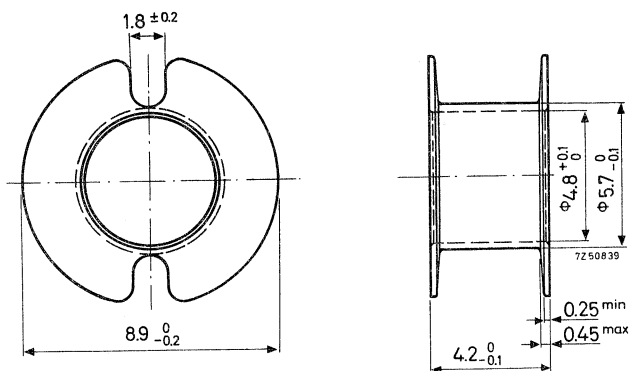
● Preferred type.



## COIL FORMER

The dimensions conform with the following specifications: IEC 133 (international), NCF 83311 livre 1 (France), DIN 41 294 (Germany) and BS 4061 range 2 (Great Britain). ←

Dimensions in mm



Catalogue number	4322 021 30240
Material	polycarbonate
Window area	5,5 mm <sup>2</sup>
Mean length of turn	23 mm
Max. temperature	130 °C
D.C. losses	$\frac{R_o}{L} = \frac{1}{\mu_e} \times \frac{1}{f_{cu}} \times 58,1 \times 10^3 \Omega/H$
Mass	0,1 g

## INDUCTANCE ADJUSTERS

(old types)

The tolerances on inductance of the pre-adjusted potcores (without adjuster) are given on the pages "Potcores". After inserting a coil (impregnated or not) in an electrical circuit, its inductance can be adjusted to the required value with an accuracy  $< 0,03\%$  by means of a continuous inductance adjuster. Such an adjuster increases the inductance of the coil, see following pages.

The adjuster is screwed through the potcore into the nut and is held in position by the lips of the adjuster head. For special requirements a bigger or smaller adjustment range may be obtained by using an adjuster belonging to the next higher or lower effective permeability.

The influence of the adjuster on the variability of the inductance is negligible. The maximum permissible temperature is  $110\text{ }^{\circ}\text{C}$ . Table 2 shows the type of adjuster recommended for different potcores.

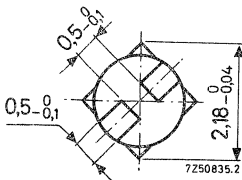
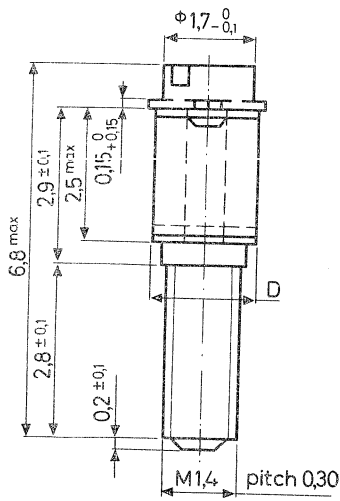
Dimensions in mm

Table 1, available types

D	colour	catalogue number
1,85	natural	4322 021 31250
1,85	red	4322 021 31260
1,85	yellow	4322 021 31270
1,85	grey	4322 021 31280
1,76	brown	4322 021 31540

Table 2, recommended application

$\mu_e$	$A_L$	3H1/3D3
33	40	4322 021 31250
	63	4322 021 31260
47		4322 021 31260
		4322 021 31270
68		4322 021 31270
	100	4322 021 31270
100		4322 021 31540
150	160	4322 021 31540
	250	4322 021 31280
220		4322 021 31280

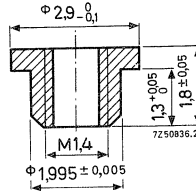


The adjusters are packed in plastic bags of 100. Please order in multiples of this quantity.



**LOOSE NUT FOR ADJUSTER**

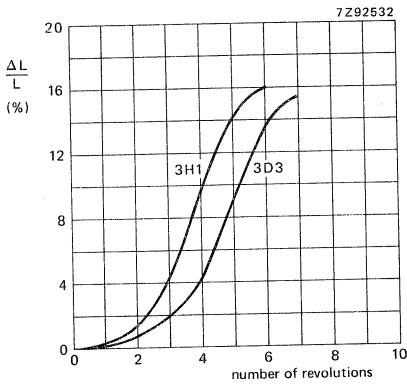
These data are given for those manufacturers who prefer to insert a nut themselves.



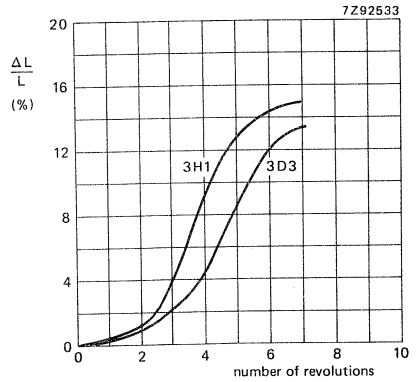
Catalogue number 4322 021 31630  
 Material brass, nickel plated

**ADJUSTMENT CURVES**

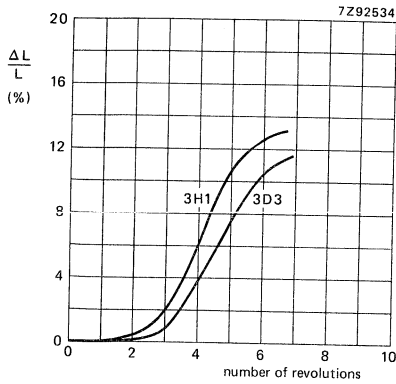
Characteristic curves



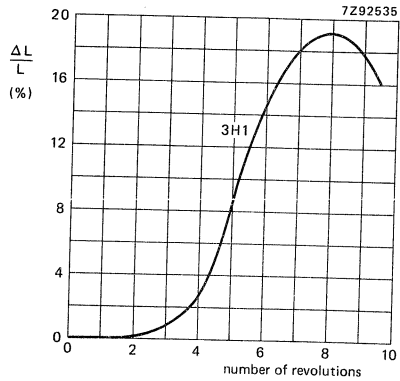
$\mu_e = 33$   
 Adjuster 4322 021 31250



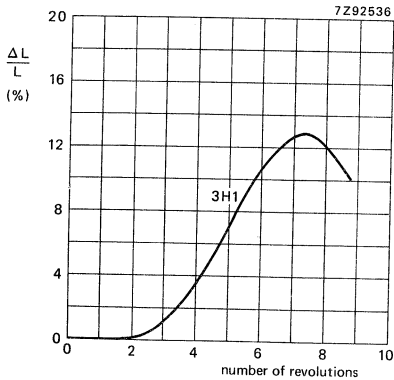
$\mu_e = 47$   
 Adjuster 4322 021 31260



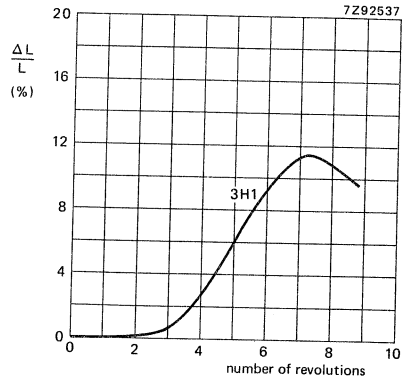
$\mu_e = 68$   
Adjuster 4322 021 31270



$\mu_e = 100$   
Adjuster 4322 021 31540



$\mu_e = 150$   
Adjuster 4322 021 31540



$\mu_e = 220$   
Adjuster 4322 021 31280

## INDUCTANCE ADJUSTERS

(new types)

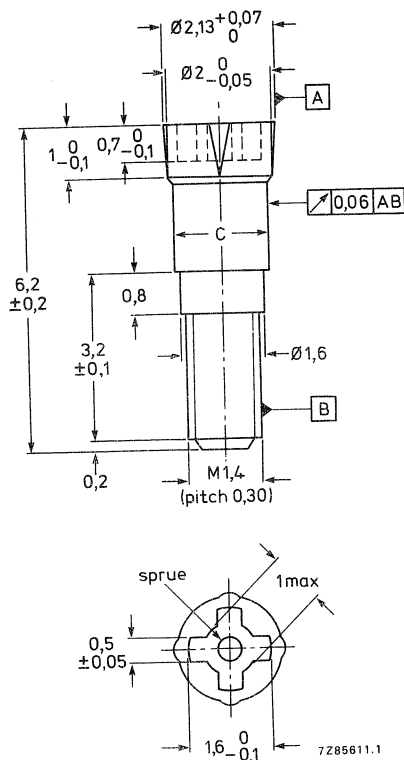


Fig. 1.

Material: polypropylene, reinforced with glass fibre.

The tolerances on inductance factor of the pre-adjusted cores without adjuster are given in the table of pre-adjusted cores with standard  $A_L$  values. The inductance of the pre-adjusted core can be increased to the required value — with a setting accuracy  $< 0,03\%$  — by means of a continuous adjuster.

The adjuster is screwed through the centre hole of the core into the nut and is held in position by the four cones near the top of the adjuster.

The combination of the polyamide moulded-in nut and the polypropylene adjuster — both reinforced with glass fibre — gives an excellent stability with temperature, shocks and vibrations. Besides this, the combination has a very smooth adjustment curve due to the excellent concentricity of the moulded-in nut and the adjuster.

The maximum permissible temperature of the adjustment combination is: 150 °C, during 8 h. The maximum working temperature is 110 °C.

The tables below show the available types and which adjuster is recommended for typical  $A_L$  values.

Table 1 Colour code of adjusters

catalogue number	colour	dia C (Fig. 1) mm	material
4322 021 39810	brown	1,85	FXC
4322 021 39890	grey	1,92	FXC

Table 2 Catalogue numbers of recommended adjusters for typical  $A_L$  values

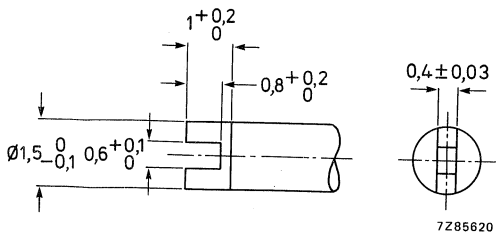
$A_L$	3H1/3H3/3B7	3D3	4C6
16			
25			
40			
63		to be fixed	
100			
160			
250			

**PACKAGING**

The adjusters are packed in plastic bags of 100. Please order in multiples of this quantity.

**ADJUSTING TOOL**

An adjusting tool combination for M1, 4 and M1, 7 is available, catalogue number 4322 058 03260.



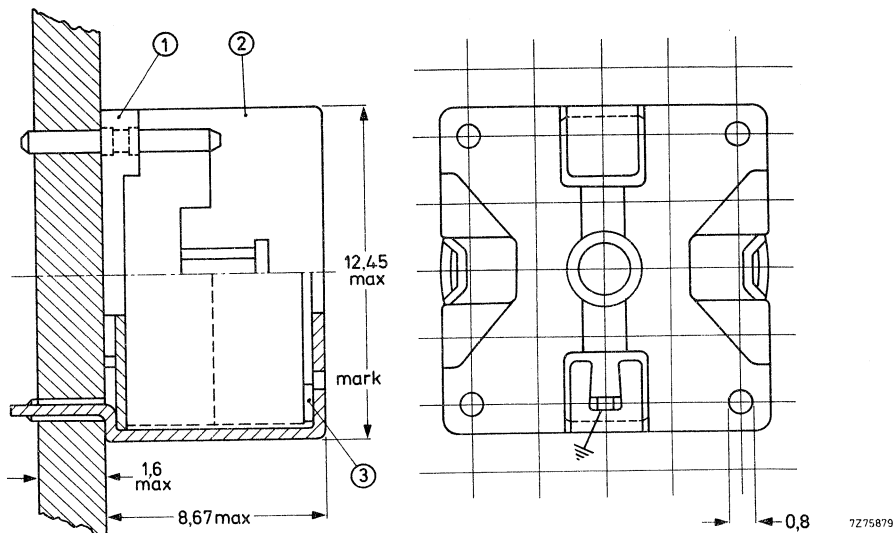
For customers who wish to make the screwdriver themselves the outlines of the essential part are given in Fig. 2.

Fig. 2.

7285620

## MOUNTING PARTS

## MOUNTING



- (1) tag plate  
 (2) brass container  
 (3) spring

4322 021 30180  
 4322 021 30510  
 4322 021 30620

The core is suitable for mounting on printed-wiring boards.

The four soldering pins and the earth tag are arranged so as to fit a grid of 2,54 mm (0,1 inch). The pin length is sufficient for a board thickness of up to 1,6 mm. The board should be provided with holes of  $1,3 \pm 0,1$  mm diameter.

The container is provided with an earth tag.

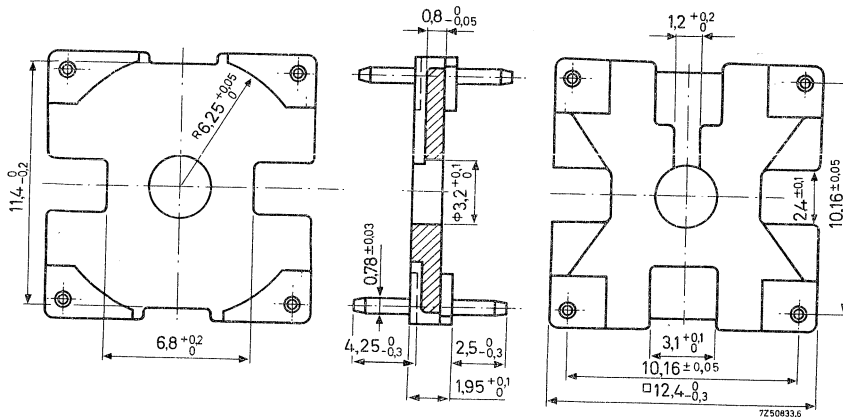
It is recommended that the spring (3) be placed in the position indicated to obtain the best stability against shock and vibration.

Before bending the lips of the container, pressure should be exerted evenly on the rim of the tag plate until it meets the container. The force which is required is approximately 35 N. After bending the lips the spring will have the correct tension.

**PART DRAWINGS** (dimensions in mm)

**(1) tag plate 4322 021 30180**

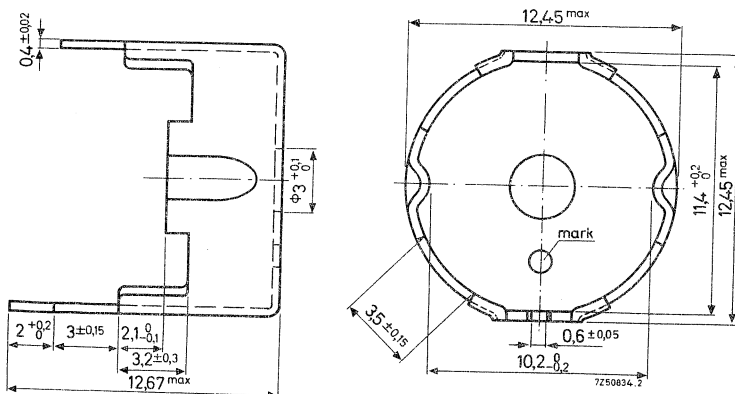
Plate: polyester reinforced with glass fibre, resistant against dip-soldering at 400 °C for 2 s.  
 Pins : phosphor bronze, dip-soldered



The tag plates are packed on a polystyrene plate of 200 and 5 plates (1000 pcs) in a cardboard box. Please order in multiples of these quantities.

**(2) container 4322 021 30510**

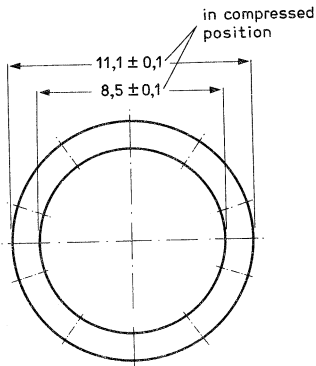
Material: brass, nickel plated, thereafter tin plated.



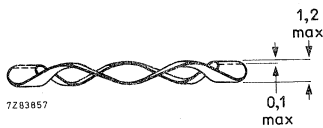
→ The containers are packed in cardboard boxes of 2000. Please order in multiples of this quantity.

(3) Spring 4322 021 30620

Material: chrome-nickel steel



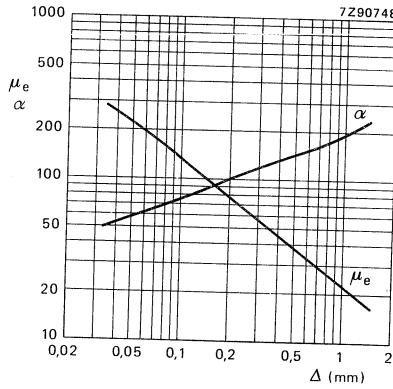
A force of min. 25 N is required to compress the spring to 0,5 mm.  
 A force of max. 55 N is required to compress the spring to 0,2 mm.



The springs are supplied in quantities of 2500.  
 Please order in multiples of this quantity. ←

# CHARACTERISTIC CURVES

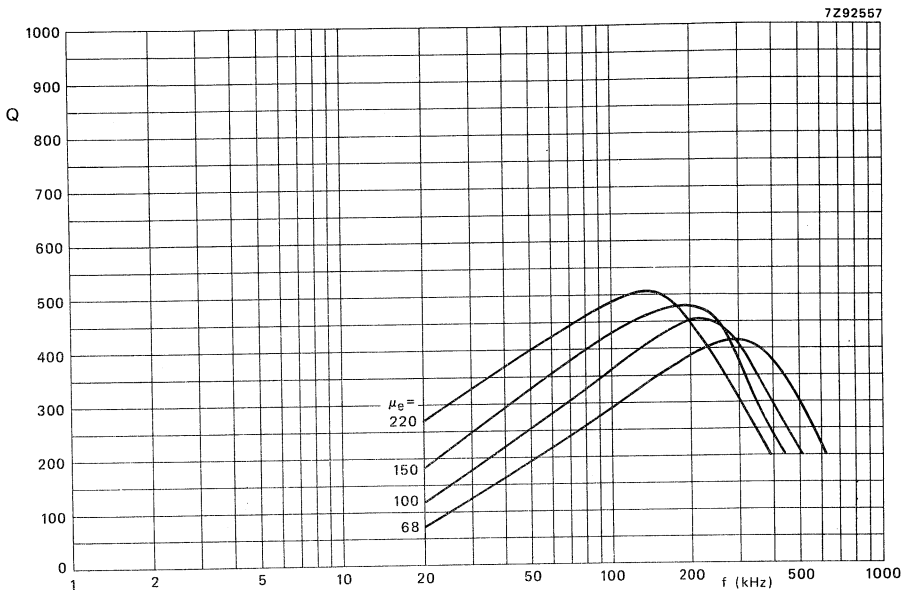
## $\mu_e$ - $\alpha$ CURVES



Relative effective permeability and turn factor for 1 mH as a function of the air gap length.  
 $\mu_e \leq 975$  at  $\Delta = 3 \mu\text{m}$  for 3 H1.

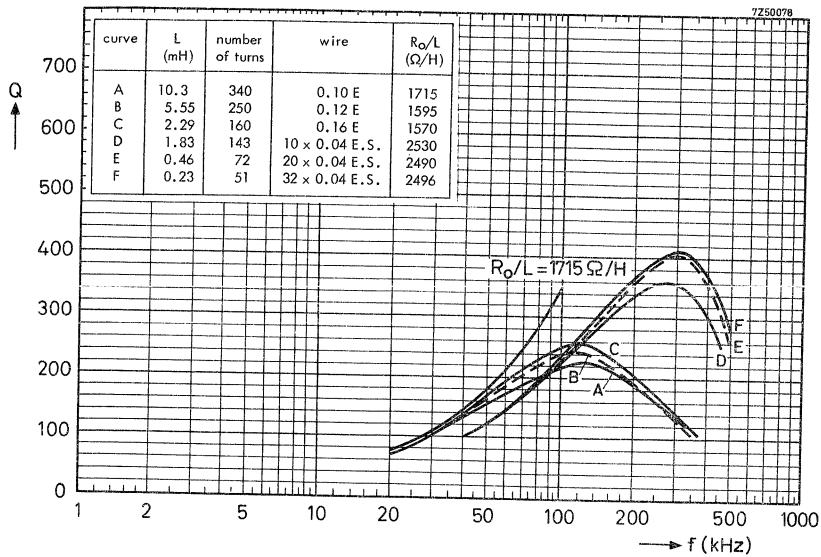


TYPICAL Q-CURVES FOR FXC 3H1



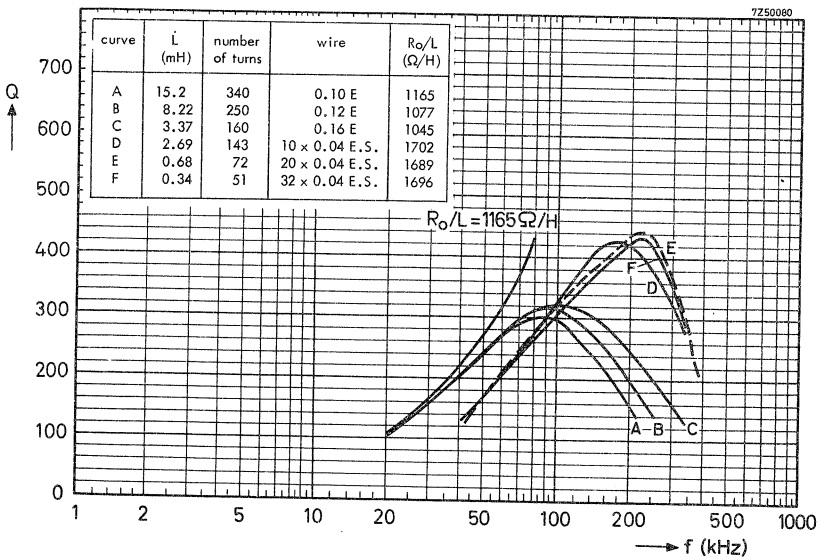
Enveloping curves.

Coil former 4322 021 30240.



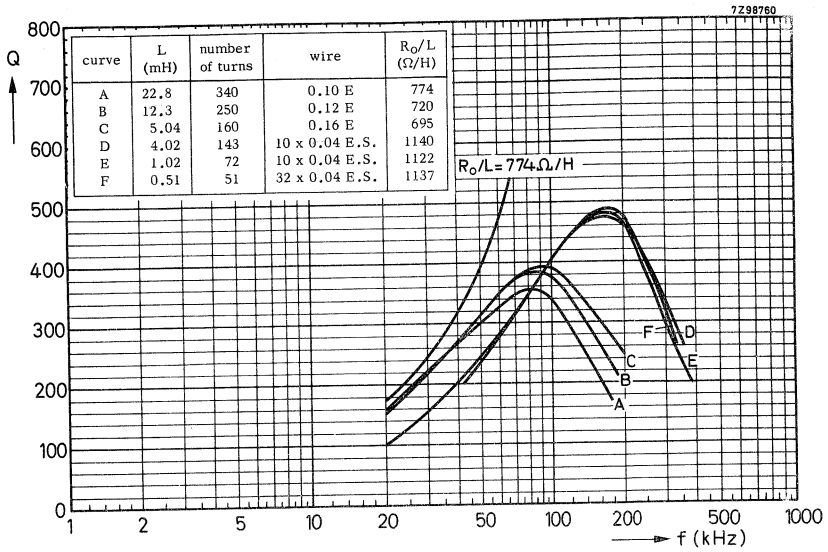
FXC 3H1  
 $\mu_e = 68$

Coil former 4322 021 30240.



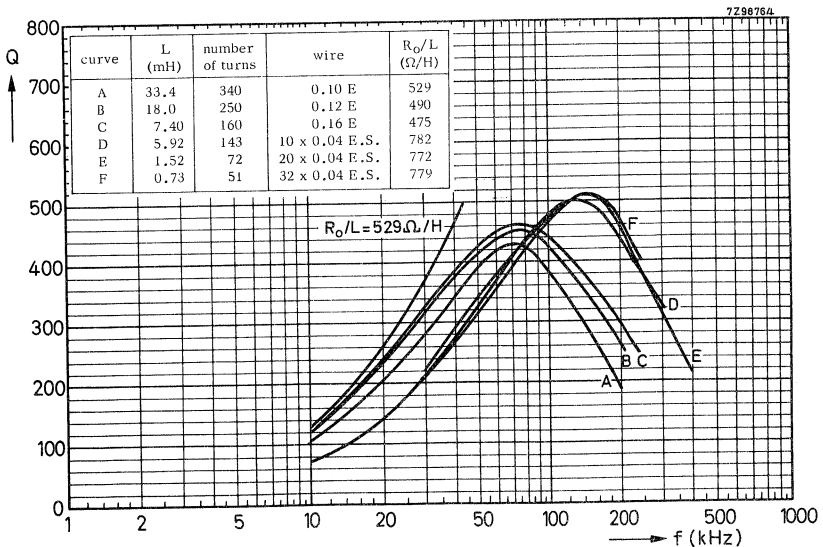
FXC 3H1  
 $\mu_e = 100$

Coil former 4322 021 30240.



FXC 3H1  
 $\mu_e = 150$

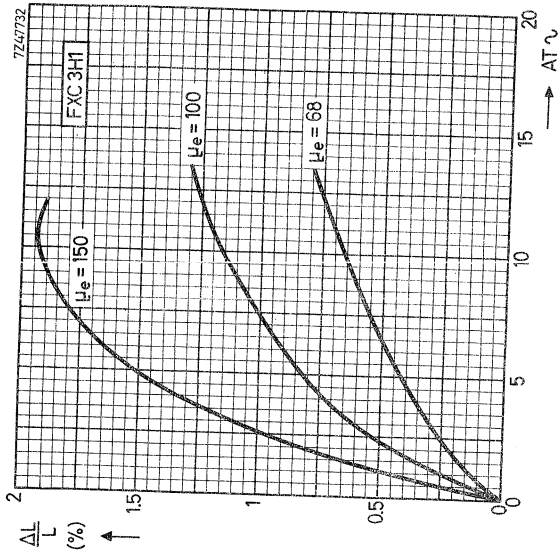
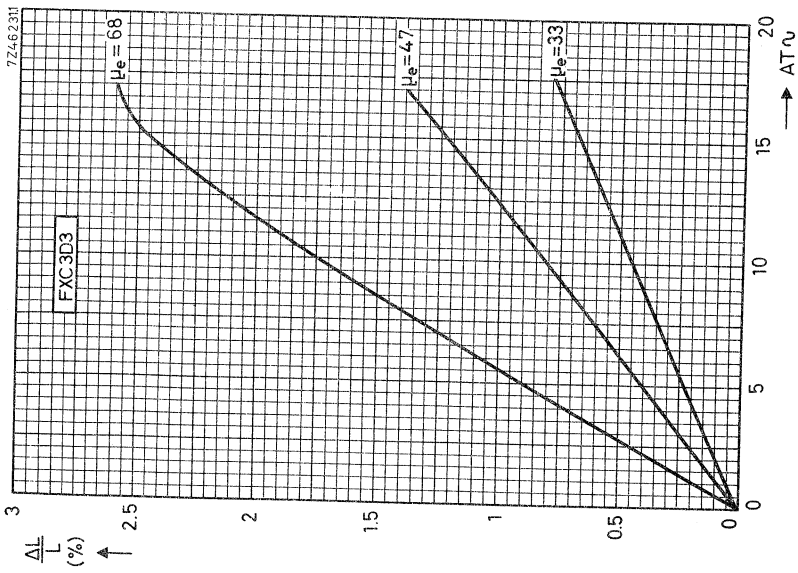
Coil former 4322 021 30240.



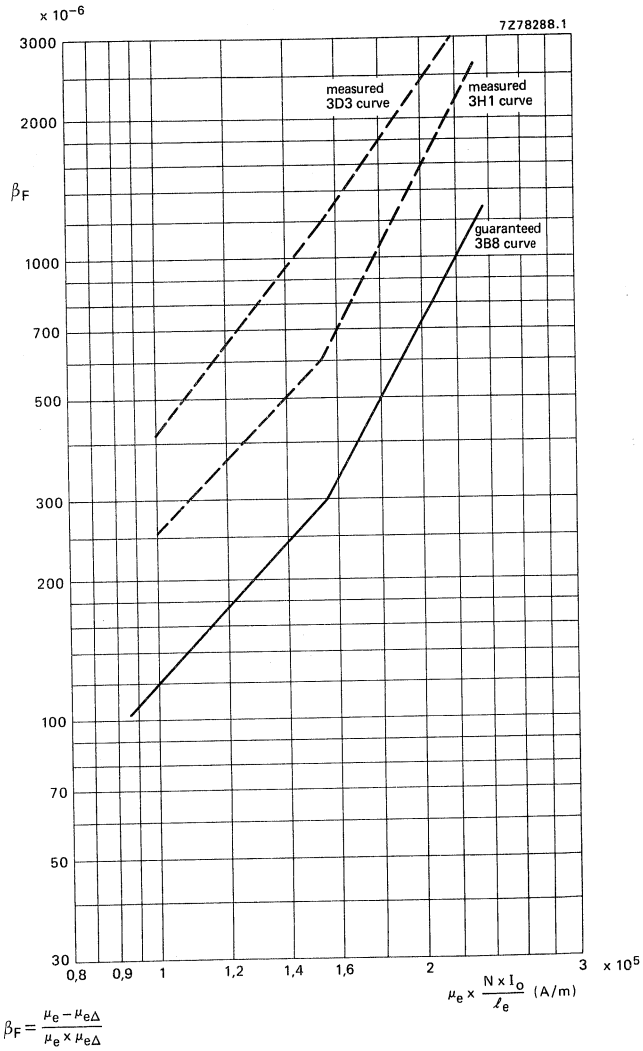
FXC 3H1  
 $\mu_e = 220$

Coil former 4322 021 30240.

INDUCTANCE VARIATION AS A FUNCTION OF  $AT \sim$



D.C. SENSITIVITY AT 25 °C



Inductance variation as a function of d.c. polarization.

## POTCORES

Three types of core can be supplied:

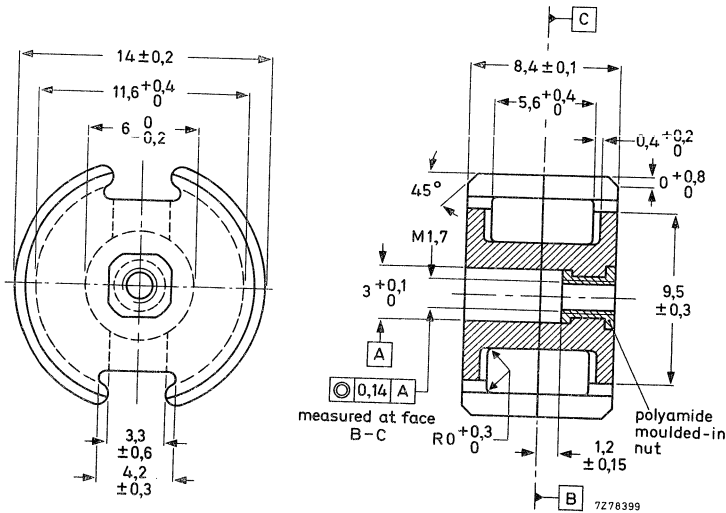
- CORE SETS provided with an injection-moulded nut for an adjuster and pre-adjusted on an inductance factor  $A_L$  or on a relative effective permeability value  $\mu_e$ .
- CORE SETS without nut and pre-adjusted on an  $A_L$  or a  $\mu_e$  value.
- CORE HALVES without air gap.

→ The potcores are in accordance with the following specifications: IEC 133 (international), NCF 83311 (France), DIN41293 (Germany) and BS4061 range 2 (Great Britain).

Potcores and associated parts are ordered by their 12-digit catalogue number. Quantity: a primary pack contains 20 core sets or 40 core halves; a storage pack contains 100 core sets or 200 core halves. Please order in multiples of these quantities.

### MECHANICAL DATA

Dimensions in mm



- Pulling out force of the nut  $\geq 30$  N
- Torque of the screw thread  $\leq 8$  mNm
- Extraction force of adjuster from nut  $\geq 20$  N
- Dimensional quantities according to IEC 205:

$$C_1 = \sum \frac{l}{A} = 0,789 \text{ mm}^{-1}; C_2 = \sum \frac{l}{A^2} = 0,0315 \text{ mm}^{-3}; V_e = 495 \text{ mm}^3; l_e = 19,8 \text{ mm}; A_e = 25,1 \text{ mm}^2;$$

→  $A_{CP \text{ min}} = 20,0 \text{ mm}^2$ .

Mass of a core set: 3,2 g

Note: the 4C6 version has a cemented nut.

## ELECTRICAL DATA

The combination of two potcore halves without air gap, randomly chosen from a batch, has the following guaranteed properties. A measuring coil as described in the General section 'Potcores, square cores and cross cores', is inserted; the halves are pressed together with a force of 60 N. The values are valid 5 minutes or more after clamping. Parameters  $\alpha_F$  and  $D_F$  of grade 3B7 are measured on toroid-wound halves.

	freq. kHz	$\hat{B}$ mT	temp. °C	grade			
				3B8	3D3	3H1	4C6
$A_L \pm 25\%$	4	$\leq 0,1$	$25 \pm 1$	2200	1080	2200	200
$\mu_e \pm 25\%$	4	$\leq 0,1$	$25 \pm 1$	1400	680	1400	125
$\alpha$	4	$\leq 0,1$	$25 \pm 1$	$\leq 24,5$	$\leq 35,1$	$\leq 24,4$	$\leq 81,8$
$\frac{\tan \delta}{\mu_i} \times 10^6$	4	$\leq 0,1$	$25 \pm 1$				
	30	$\leq 0,1$	$25 \pm 1$				
	100	$\leq 0,1$	$25 \pm 1$		$\leq 8,0$	$\leq 5,0$	
	500	$\leq 0,1$	$25 \pm 1$		$\leq 14$		
	1000	$\leq 0,1$	$25 \pm 1$		$\leq 30$		
	2000	$\leq 0,1$	$25 \pm 1$				$\leq 40$
$\eta_B \times 10^3$	10 000	$\leq 0,1$	$25 \pm 1$				$\leq 100$
	4	1,5 to 3,0	$25 \pm 1$			$\leq 0,86$	
	30	1,5 to 3,0	$25 \pm 1$				
$\alpha_F \times 10^6/K$	100	0,3 to 1,2	$25 \pm 1$		$\leq 1,8$		$\leq 6,2$
	$\leq 100$	$\leq 0,1$	5 to 25			+ 0,5 to + 1,5	-2 to + 4
	$\leq 100$	$\leq 0,1$	25 to 55			+ 0,5 to + 1,5	0 to + 6
$D_F \times 10^6$ (10-100 min)	$\leq 100$	$\leq 0,1$	25 to 70		0 to + 2		
	$\leq 100$	$\leq 0,1$	$25 \pm 0,1$		$\leq 12$	$\leq 4,3$	$\leq 10$
$\beta_F \times 10^6$ , measured on sets with $\mu_e = 300 \pm 10\%$ and $25 \pm 1$ °C:							
at $\mu_e \times \frac{N \times I_o}{l_e} = 0,90 \times 10^5$ A/m				$\leq 100$			
$= 1,50 \times 10^5$ A/m				$\leq 300$			
$= 2,15 \times 10^5$ A/m				$\leq 1050$			

Core sets with nut and pre-adjusted on  $A_L$ .

$A_L$	corresponding $\mu_e$ -value	catalogue number 4322 022 . . . . .			
		3B8	3D3	3H1	4C6
25 ± 1%	15,7				23810
40 ± 1%	25		23420		• 23820
63 ± 1%	39,5		• 23430		23830
100 ± 1%	63		23440		
160 ± 1,5%	100,5			23240	
250 ± 2%	157	• 03860		• 23250	
315 ± 2%	198			• 23260	
400 ± 2%	252			23270	
630 ± 3%	396	03880		23280	
		03890		23300	

Core sets with nut and pre-adjusted on  $\mu_e$ .

$\mu_e$	$\alpha$	catalogue number 4322 022 . . . . .			
		3B8	3D3	3H1	4C6
15 ± 1%	205				22810
22 ± 1%	169				22820
33 ± 1%	137,9				22830
47 ± 1%	115,5		22430	22230	
68 ± 1%	96,1		22440	22240	
100 ± 1,5%	79,2		22450	22250	
150 ± 2%	64,6			22260	
220 ± 3%	53,3			22270	
680 ± 25%	30,3			22280	
1400 ± 25%	21,2		02400		
				02200	

Core sets without nut: replace the eighth digit of the catalogue number (2) by 0.

Cores with  $A_L \leq 100$ , or  $\mu_e \leq 68$ , have a symmetrical air gap.Cores with  $A_L \geq 160$ , or  $\mu_e \geq 100$ , have an asymmetrical air gap.

Core halves without air gap, without nut:

Ferroxcube grade	catalogue number
3B8	4322 020 21400
3D3	4322 020 21270
3H1	4322 020 21260
4C6	4322 020 21350

→ • Preferred type.



## COIL FORMERS

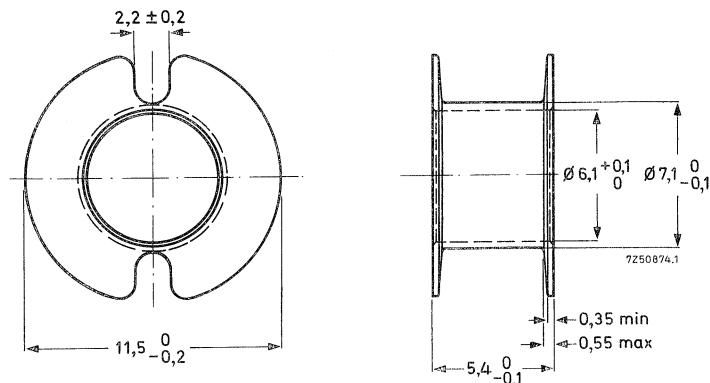
Two types of coil former can be supplied:

- with one section;
- with two sections.

The dimensions conform with the following specifications: IEC 133 (international), NCF 83311 (France), DIN 41294 (Germany) and BS 4061 range 2 (Great Britain).

### SINGLE-SECTION COIL FORMER

Dimensions in mm



Catalogue number	4322 021 30250
Material	polycarbonate
Window area	9,7 mm <sup>2</sup>
Mean length of turn	29 mm
Max. temperature	130 °C

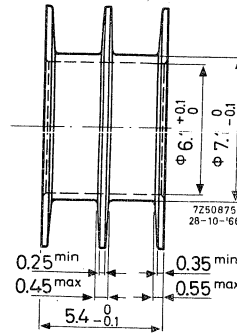
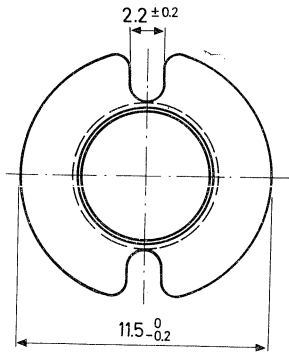
D.C. losses

$$\frac{R_o}{L} = \frac{1}{\mu_e} \times \frac{1}{f_{cu}} \times 32,3 \times 10^3 \Omega/H$$

Mass 0,15 g

TWO-SECTION COIL FORMER

Dimensions in mm



Catalogue number 4322 021 30260

Material polycarbonate

Window area 2 x 4,5 mm<sup>2</sup>

Mean length of turn 29 mm

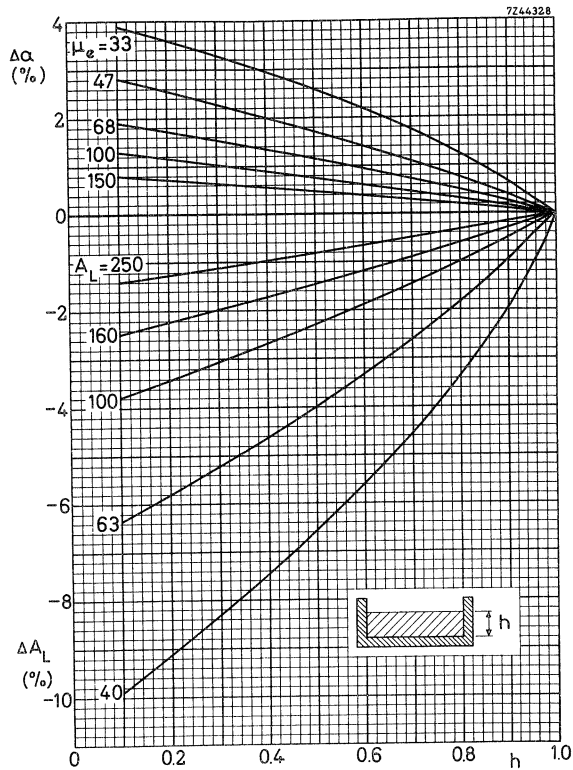
→ Max. temperature 130 °C

D.C. losses

$$\frac{R_0}{L} = \frac{1}{\mu_e} \times \frac{1}{f_{cu}} \times 35,1 \times 10^3 \Omega/H$$

Mass 0,2 g

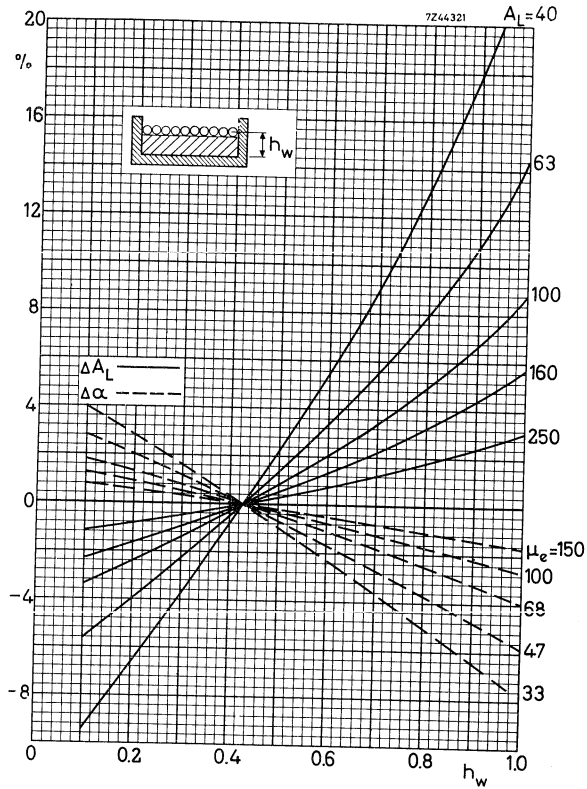
DATA FOR WHEN THE COIL FORMER IS PARTLY FILLED



Increase of the  $\alpha$  and decrease of the  $A_L$  factor for different  $\mu_e$  values and  $A_L$  factors as a function of the relative winding height on a single-section coil former.

Valid for Ferroxcube 3B7, 3H1 and 3D3 only.

Example: On a single-section coil former only 0,4 part of the available height is used. A potcore with  $\mu_e = 68$  in that case obtains an  $\alpha$  factor of  $96,1 + 1,3\%$ .



Variation of the  $\alpha$  and  $A_L$  factors for a coupling winding of one layer as a function of its winding height  $h_w$  on a single-section coil former.  
 Valid for Ferroxcube 3B7, 3H1 and 3D3 only.  
 Example: On a single-section coil former a coupling winding is laid on 0,7 of the available height.  
 A potcore with  $\mu_e = 68$  obtains for that winding an  $\alpha$  factor of 96,1 – 1,7%.

## INDUCTANCE ADJUSTERS

(old types)

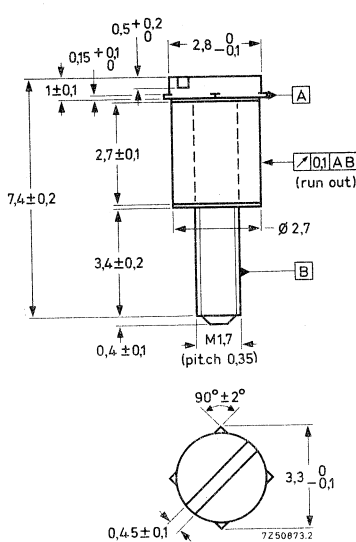


Fig. A

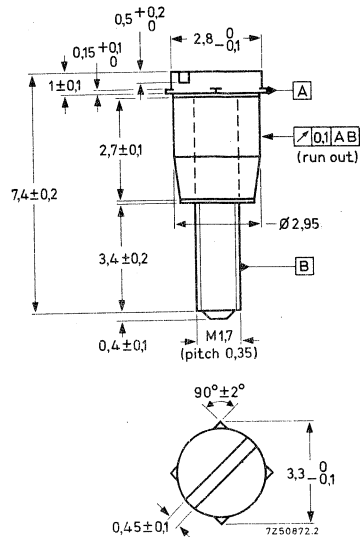


Fig. B

The tolerances on inductance of the pre-adjusted potcores (with adjuster) are given under Potcores. After inserting a coil (impregnated or not) in an electrical circuit, its inductance can be adjusted to the required value with an accuracy  $< 0,03\%$  by means of a continuous inductance adjuster. Such an adjuster increases the inductance of the coil, see following pages.

The adjuster is screwed through the potcore into the nut and is held in position by the four protrusions near the top of the adjuster. For special requirements a bigger or smaller adjustment range may be obtained by using an adjuster belonging to the next higher or lower effective permeability.

The influence of the adjusters on the variability of the inductance is negligible. The maximum permissible temperature is  $110\text{ }^{\circ}\text{C}$ .

Table 2 shows the type of adjuster recommended for different potcores.

Table 1, available types

Fig.	colour	catalogue number
→ A	natural	4322 021 30750
B	yellow	4322 021 30940
B	white	4322 021 30950
A	brown	4322 021 31070
B	grey	4322 021 31130

The adjusters are packed in plastic bags of 100. Please order in multiples of this quantity.

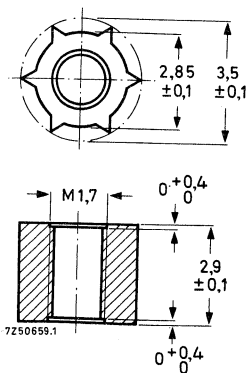
Table 2, recommended application

$\mu_e$	$A_L$	3H1/3D3	4C6
		cat. number 4322 021 . . . . .	
15		—	30750
	25	—	30750
22		—	30750
	40	30750	30940
33		30750	30940
	63	30750	30940
47		30750	—
	100	30940	—
68		30940	—
100		30950	—
	160	30950	—
150		31070	—
	250	31070	—
220		31130	—
	315	31130	—
	400	31130	—

**LOOSE NUT FOR ADJUSTER**

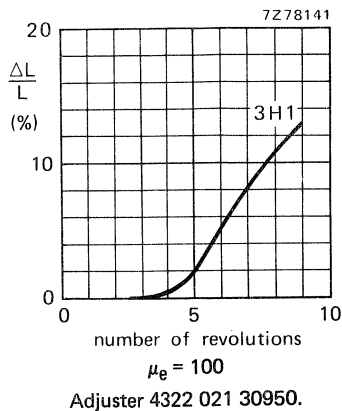
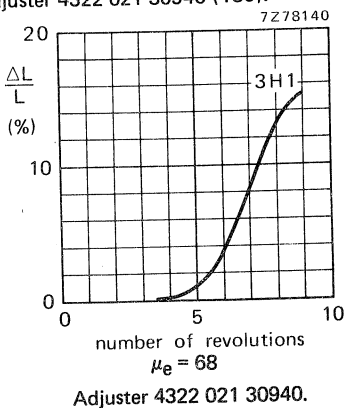
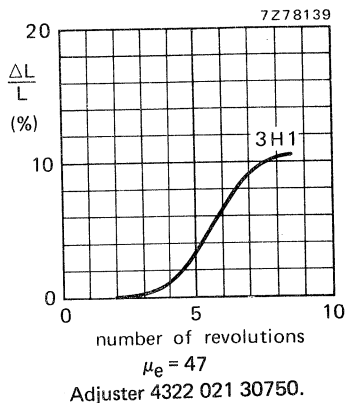
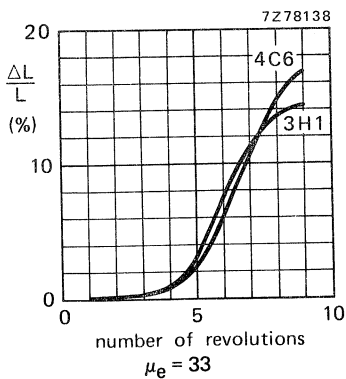
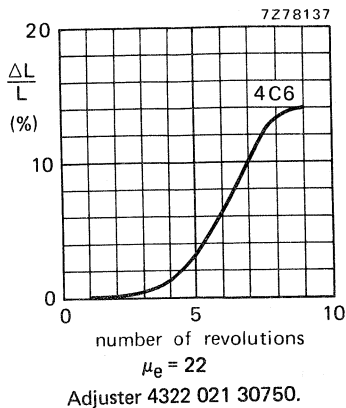
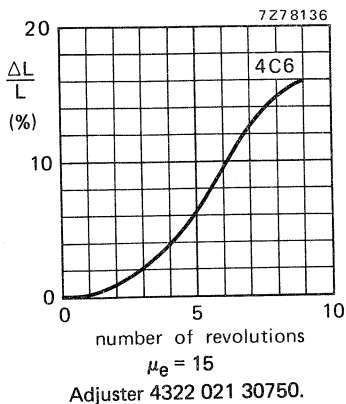
These data are given for those manufacturers who prefer to insert a nut themselves.

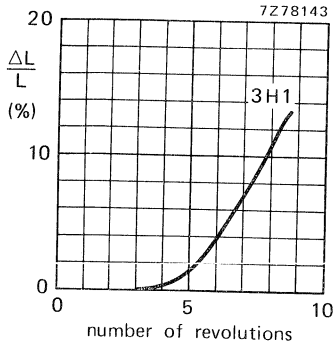
Dimensions in mm



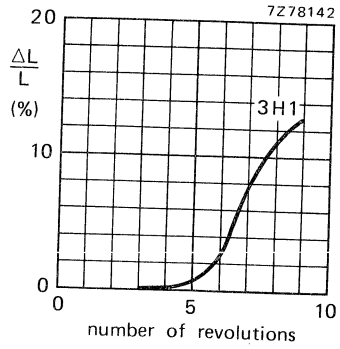
Catalogue number 4322 021 30140  
 Material polycarbonate  
 Max. impregnation temperature during 24 hours 120 °C  
 Recommended distance from mating surface to nut  $1,2 \pm 0,15$  mm  
 For more information see Potcores General, mounting data.  
 The nuts are packed in plastic bags of 100. Please order in multiples of this quantity.

ADJUSTMENT CURVES





$\mu_e = 150$   
Adjuster 4322 021 31070.



$\mu_e = 220$   
Adjuster 4322 021 31130.



## INDUCTANCE ADJUSTERS

(new types)

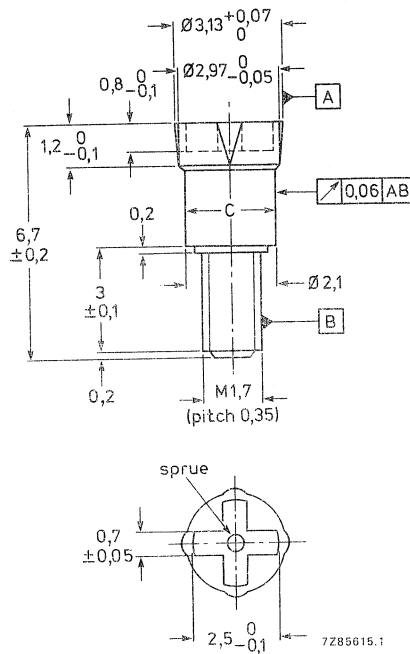


Fig. 1.

Material: polypropylene, reinforced with glass fibre.

The tolerances on inductance factor of the pre-adjusted cores without adjuster are given in the table of pre-adjusted cores with standard  $A_L$  values. The inductance of the pre-adjusted core can be increased to the required value — with a setting accuracy  $< 0,03\%$  — by means of a continuous adjuster.

The adjuster is screwed through the centre hole of the core into the nut and is held in position by the four cones near the top of the adjuster.

The combination of the polyamide moulded-in nut and the polypropylene adjuster — both reinforced with glass fibre — gives an excellent stability with temperature, shocks and vibrations. Besides this, the combination has a very smooth adjustment curve due to the excellent concentricity of the moulded-in nut and the adjuster.

The maximum permissible temperature of the adjustment combination is: 150 °C, during 8 h. The maximum working temperature is 110 °C.

The tables below show the available types and which adjuster is recommended for typical  $A_L$  values.

Table 1 Colour code of adjusters

catalogue number	colour	dia. C (Fig. 1) mm	material
4322 021 39700	black	2,86	FXC
39710	brown	2,80	FXC
39740	yellow	2,52	FXC
39780	white	2,68	FXC
39790	grey	2,90	FXC

Table 2 Catalogue numbers of recommended adjusters for typical  $A_L$  values

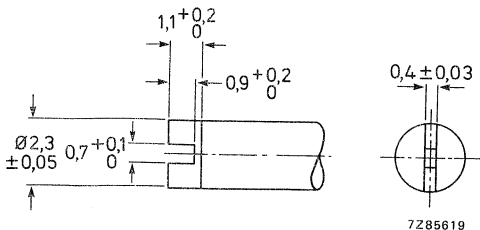
$A_L$	3H1/3B7	3D3	4C6
25			
40			
63			
100	4322 021 39740	4322 021 39740	4322 021 39740
160	39780		
250	39710		
315	39700		
400	39790		

**PACKAGING**

The adjusters are packed in plastic bags of 100. Please order in multiples of this quantity.

**ADJUSTING TOOL**

An adjusting tool combination for M1, 4 and M1, 7 is available, catalogue number 4322 058 03260.



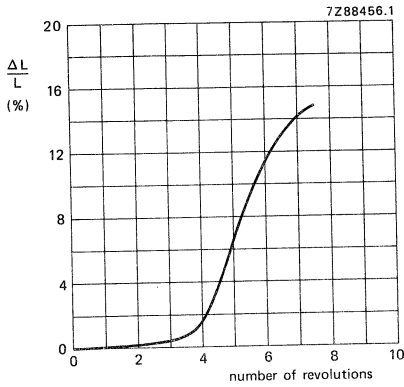
For customers who wish to make the screwdriver themselves the outlines of the essential part are given in Fig. 2.

7285619

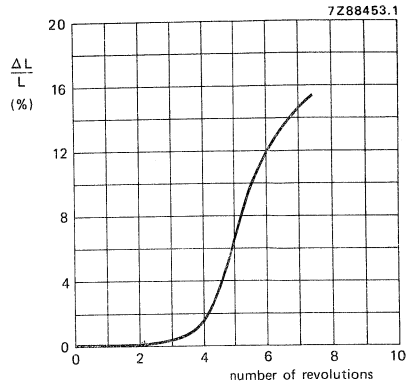
Fig. 2.

ADJUSTMENT CURVES

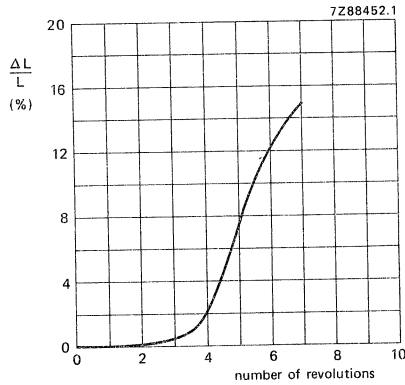
Characteristic curves



$A_L = 250$ ; FXC 3H1



$A_L = 315$ ; FXC 3H1



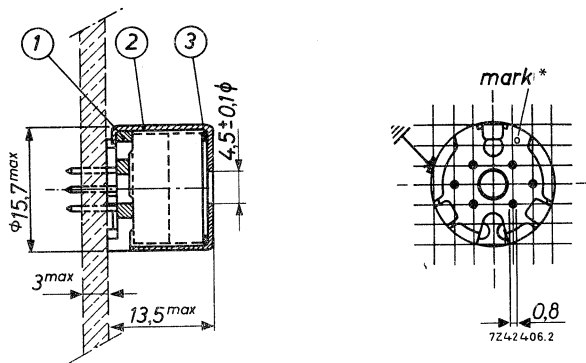
$A_L = 400$ ; FXC 3H1

Note: 0 revolutions corresponds to at least one turn of interaction.



## MOUNTING PARTS

## MOUNTING ON PRINTED-WIRING BOARDS



- |                     |                |
|---------------------|----------------|
| (1) tag plate       | 4322 021 30440 |
| (2) brass container | 4322 021 30520 |
| (3) spring          | 4322 021 30630 |

The container is suitable only for mounting on printed-wiring boards.

The six soldering pins are arranged so as to fit a grid of 2,54 mm (0,1 inch). The pin length is sufficient for a board thickness of up to 3 mm. The board should be provided with holes of  $1,3 \pm 0,1$  mm diameter.

The container is provided with an earth tag on its circumference. This tag also serves the purpose of mounting the coil assembly on the printed-wiring board.

It is recommended that the spring (3) be placed in the position indicated to obtain the best stability against shock and vibration.

Before bending the lips of the container, pressure should be exerted evenly on the rim of the tag plate until it meets the container. The force which is required is approximately 60 N. After bending the lips the spring will have the correct tension.

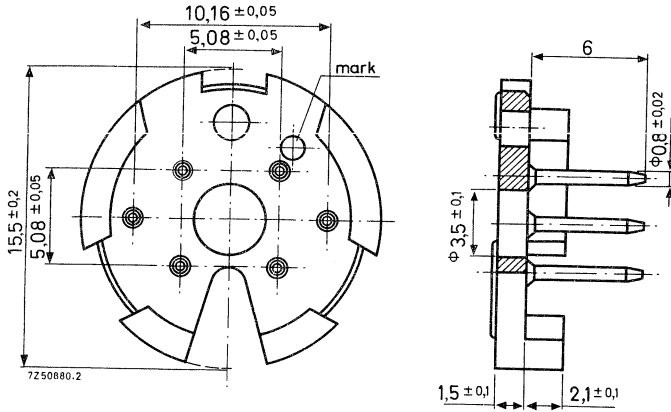
\* There is another mark hole in a similar position on the top of the container.

**PART DRAWINGS**

Dimensions in mm

**Tag plate 4322 021 30440**

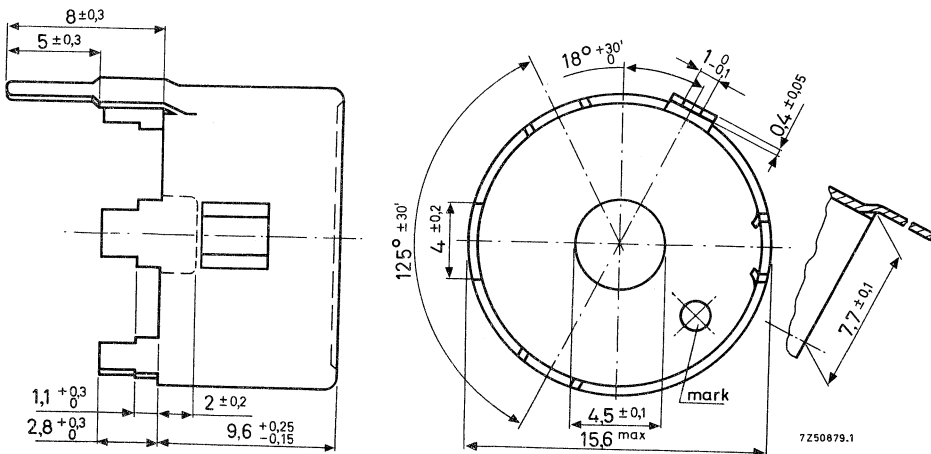
Plate: polyester reinforced with glass fibre resistant against dip-soldering at 400 °C for 2 s.  
 Pins: phosphor bronze, dip-soldered.



The tag plates are packed in units of 100 pieces on a polystyrene plate, and with 500 to a cardboard box. Please order in multiples of these quantities.

**Container for mounting on printed-wiring boards 4322 021 30520**

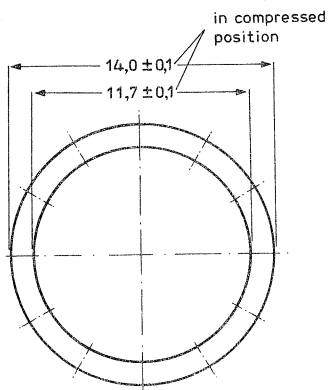
Material: brass, nickel plated then tin plated.



→ The containers are packed in a primary pack of 70 pieces and a storage pack of 350 pieces. Please order in multiples of these quantities.

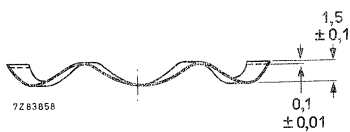
Spring 4322 021 30630

Material: chrome-nickel steel



A force of 45 to 75 N is required to compress the spring to 0,35 mm.

The springs are packed in units of 2000 pieces. Please order in multiples of this quantity.

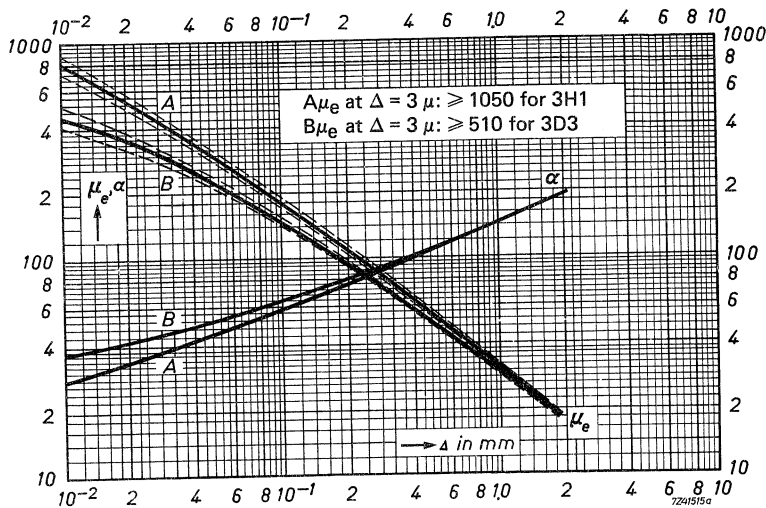






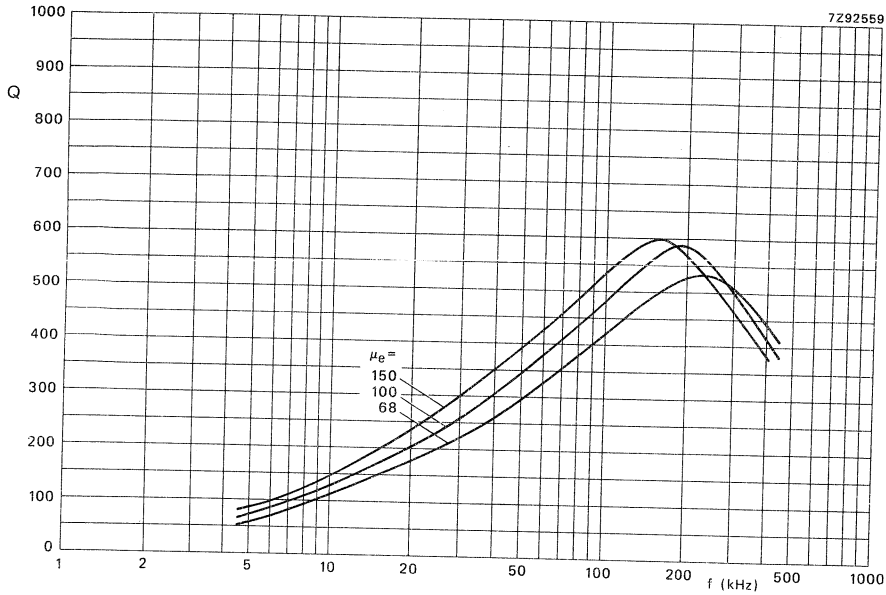
# CHARACTERISTIC CURVES

$\mu_e$ - $\alpha$  CURVES



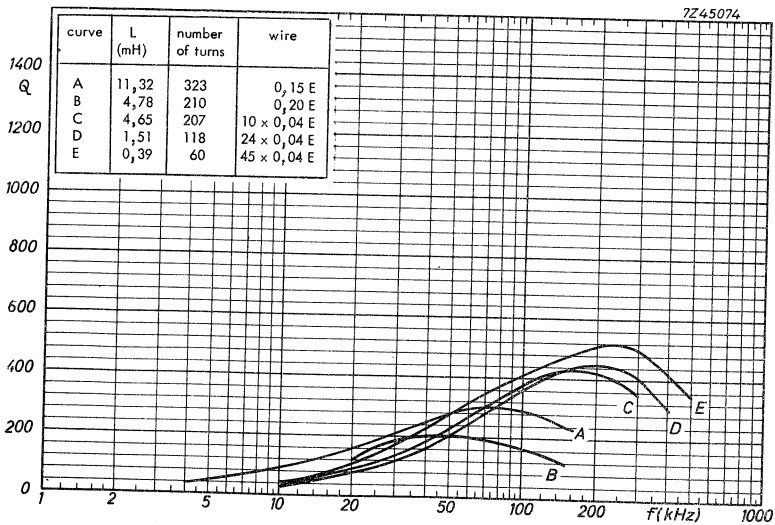
Relative effective permeability and turn factor for 1 mH as a function of the air gap length.

TYPICAL Q-CURVES



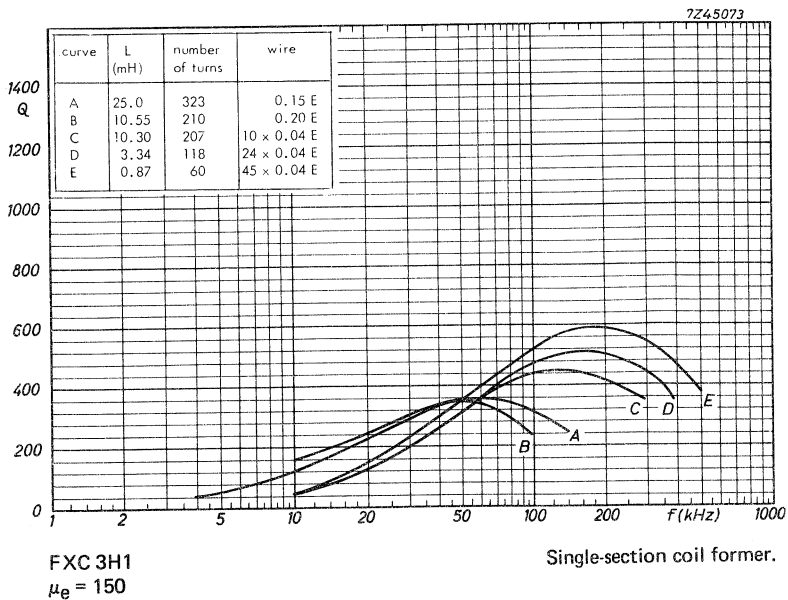
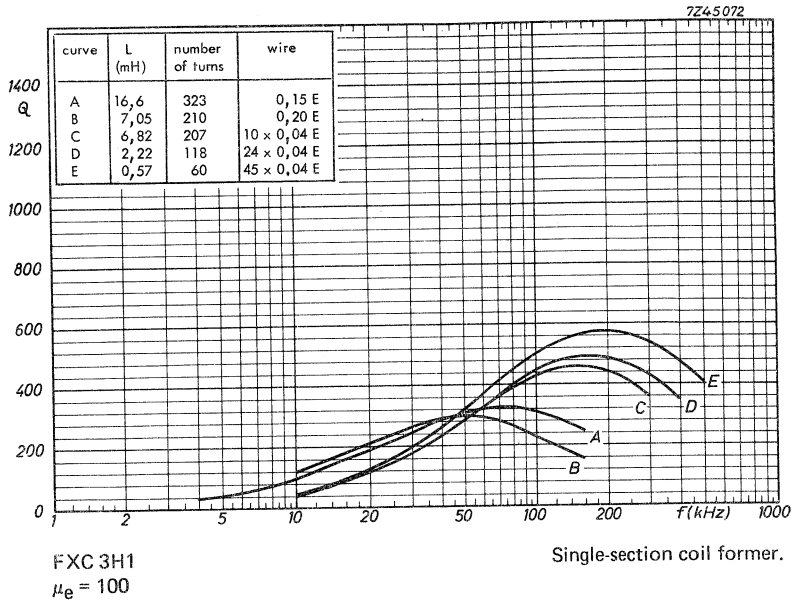
Enveloping curves. FXC 3H1

Single-section coil former.

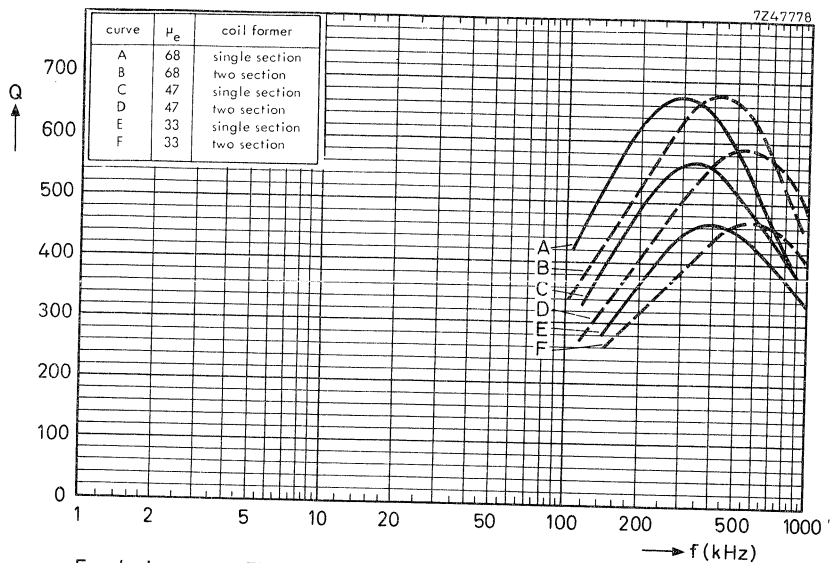


FXC 3H1  
μ<sub>e</sub> = 68

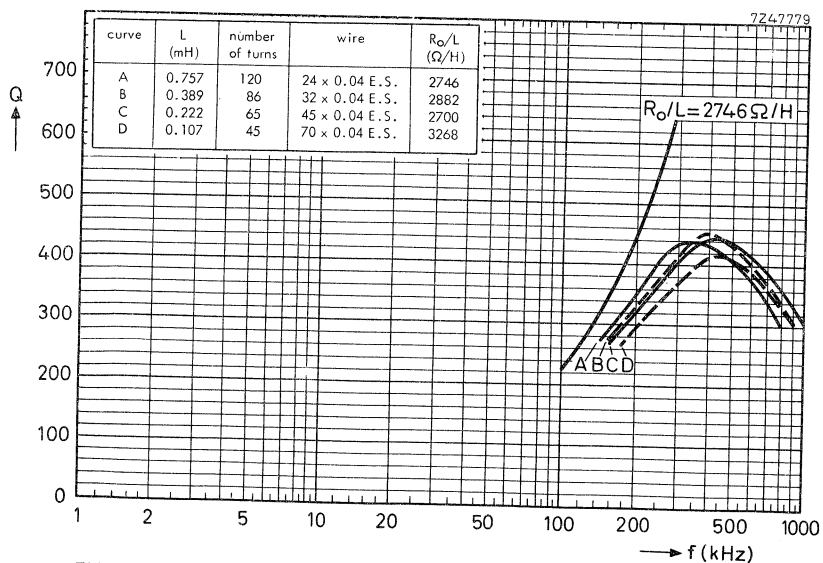
Single-section coil former.



Enveloping curves.

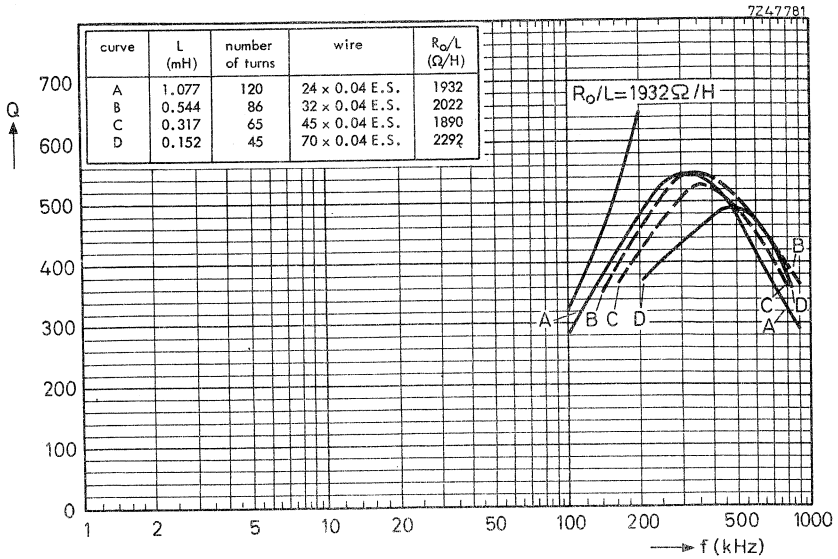


Enveloping curves, FXC 3D3



FXC 3D3  
 $\mu_e = 33$

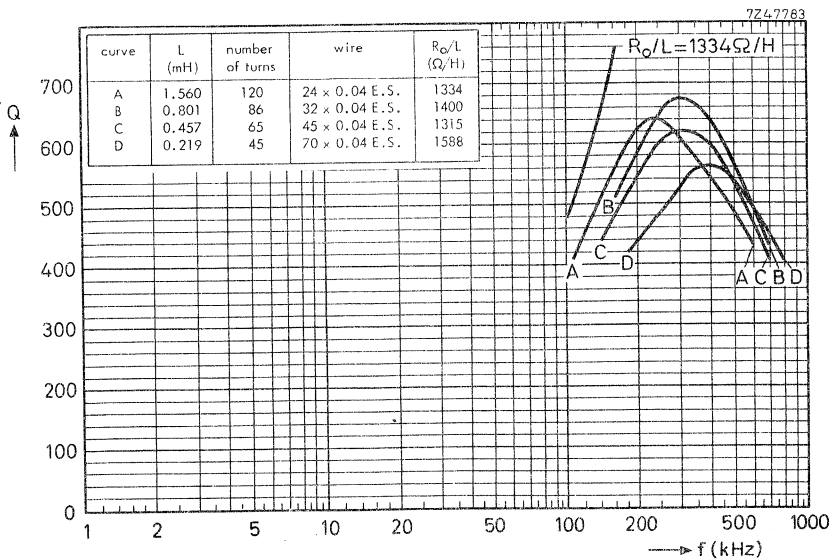
Single-section coil former.



FXC 3D3

$\mu_e = 47$

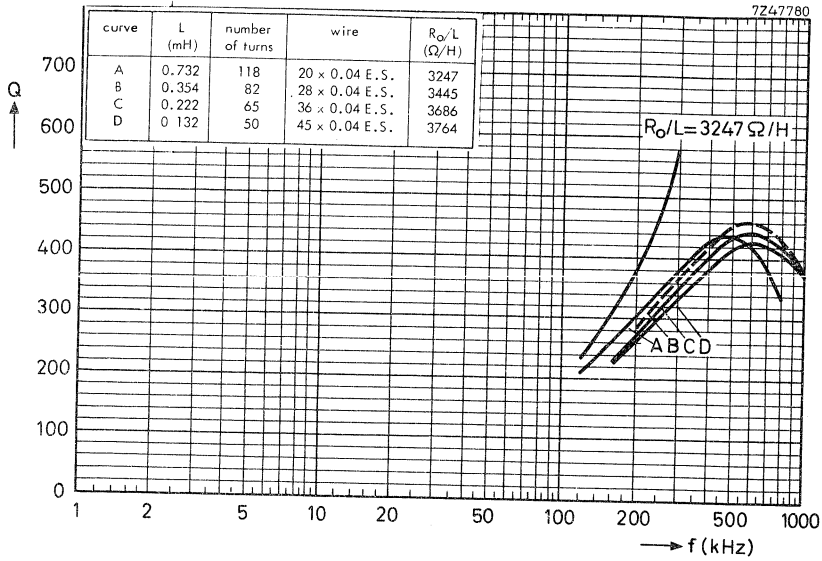
Single-section coil former.



FXC 3D3

$\mu_e = 68$

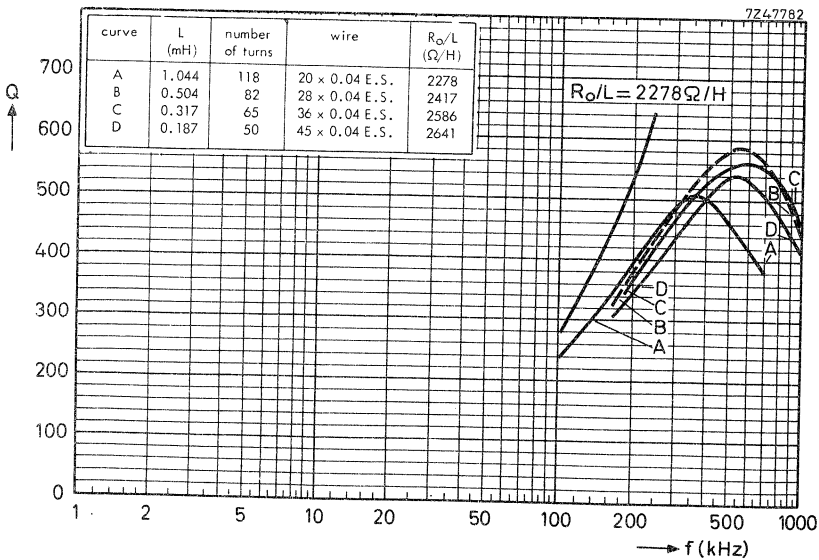
Single-section coil former.



FXC 3D3

$\mu_e = 33$

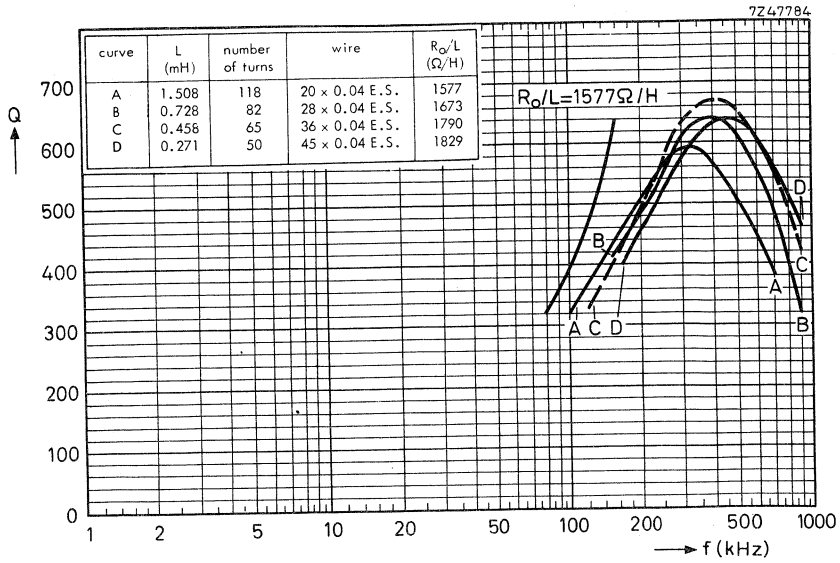
Two-section coil former.



FXC 3D3

$\mu_e = 47$

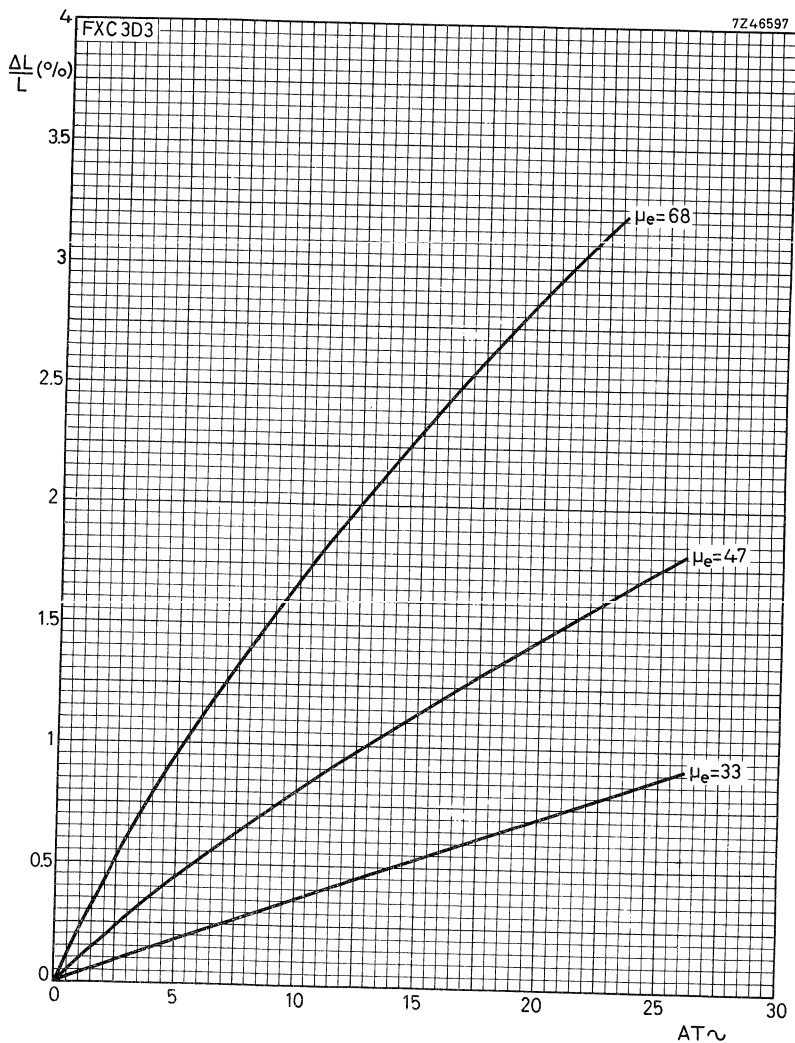
Two-section coil former.



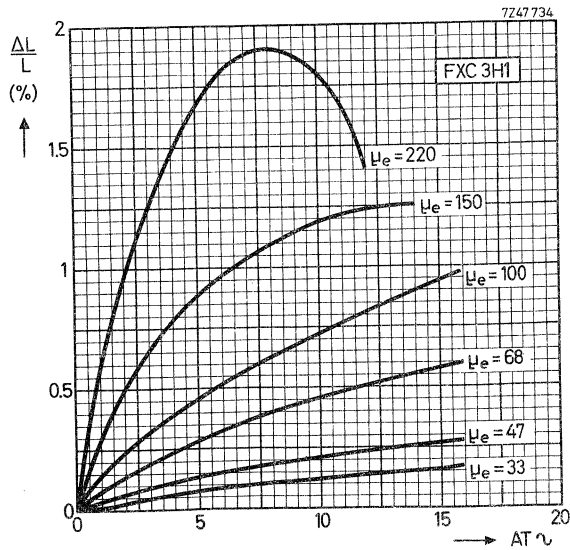
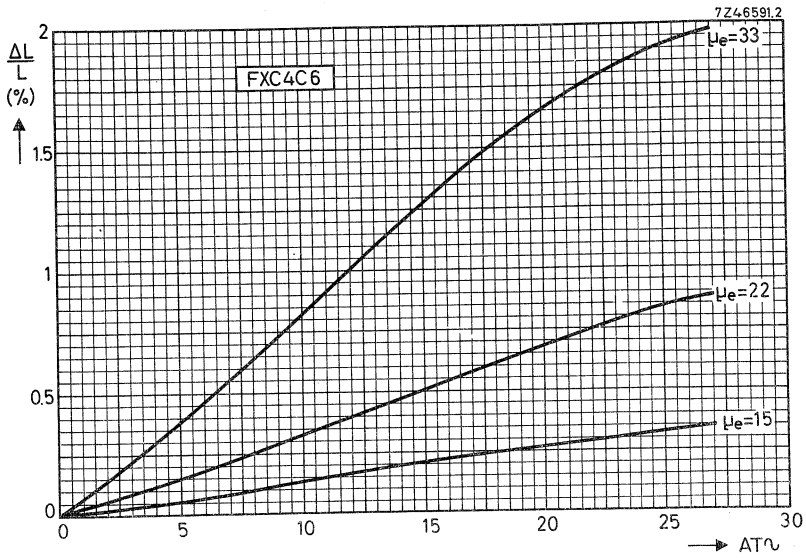
FXC 3D3  
 $\mu_e = 68$

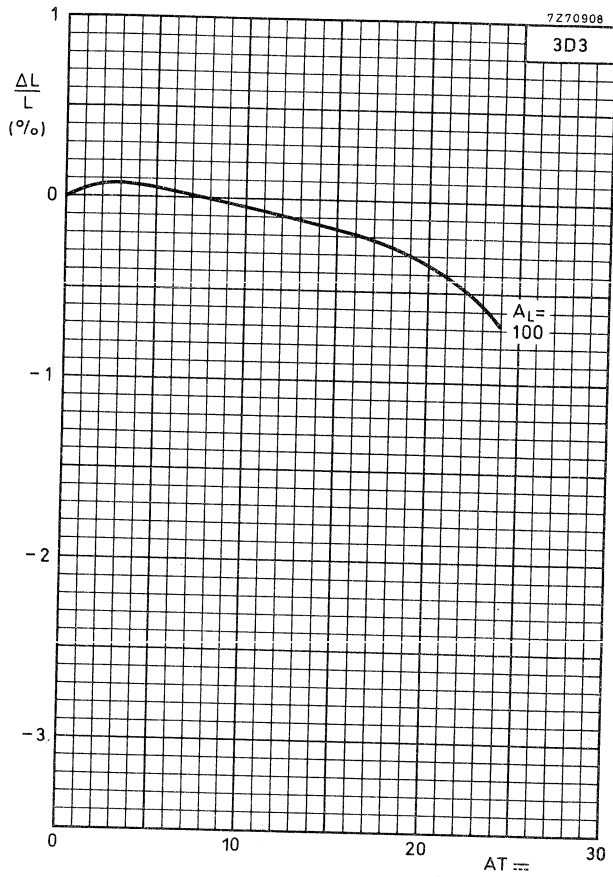
Two-section coil former.

INDUCTANCE VARIATION AS A FUNCTION OF AT~

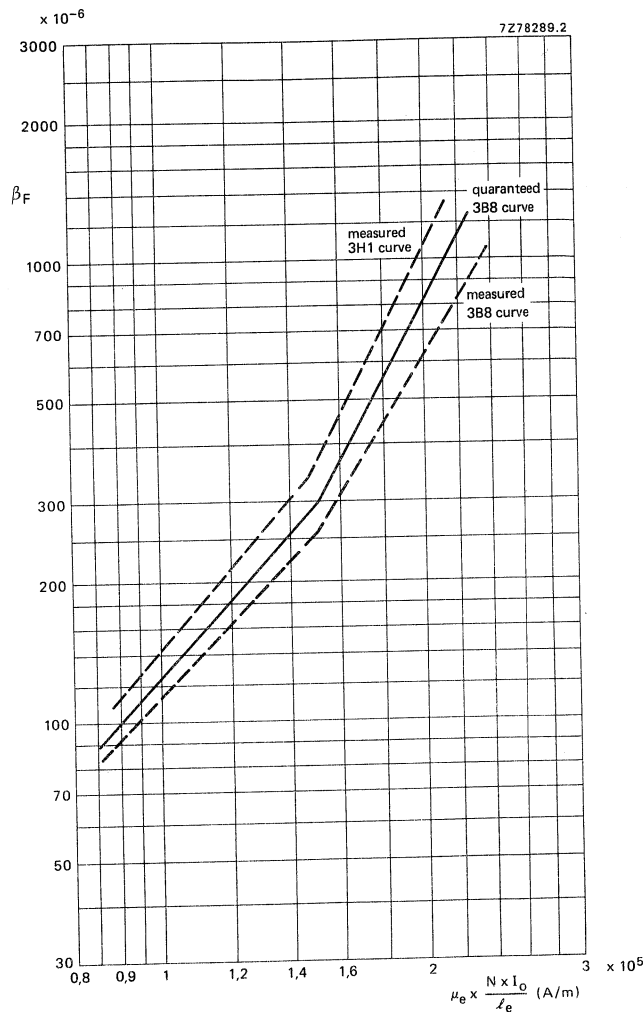








D.C. SENSITIVITY AT 25 °C



$$\beta_F = \frac{\mu_e - \mu_e \Delta}{\mu_e \times \mu_e \Delta}$$

Inductance variation as a function of d.c. polarization.



## POTCORES

Three types of core can be supplied:

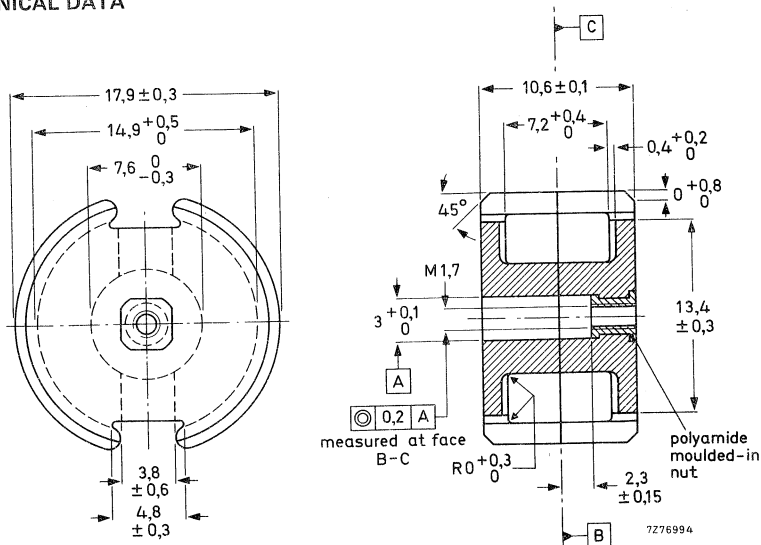
- CORE SETS provided with an injection-moulded nut for an adjuster and pre-adjusted on an inductance factor  $A_L$  or on a relative effective permeability value  $\mu_e$ .
- CORE SETS without nut and pre-adjusted on an  $A_L$  or a  $\mu_e$  value.
- CORE HALVES without air gap.

The potcores are in accordance with the following specifications: IEC 133 (international), NCF83311 (France), DIN 41293 (Germany) and BS 4061 range 2 (Great Britain).

Potcores and associated parts are ordered by their 12-digit catalogue number. Quantity: a primary pack contains 20 core sets or 40 core halves; a storage pack contains 100 core sets or 200 core halves. Please order in multiples of these quantities.

### MECHANICAL DATA

Dimensions in mm



- Pulling-out force of the nut  $\geq 30$  N  
 Torque of the screw thread  $\leq 8$  mNm  
 Extraction force of adjuster from nut  $\geq 20$  N  
 Dimensional quantities according to IEC 205:

$$C_1 = \Sigma \frac{l}{A} = 0,597 \text{ mm}^{-1}; C_2 = \Sigma \frac{l}{A^2} = 0,0138 \text{ mm}^{-3}; V_e = 1120 \text{ mm}^3; l_e = 25,8 \text{ mm}; A_e = 43,3 \text{ mm}^2;$$

$$A_{CPmin} = 36,3 \text{ mm}^2$$

Mass of a core set: 6,4 g.

Note: the 4C6 version has a cemented nut.

## ELECTRICAL DATA

The combination of two potcore halves without air gap, randomly chosen from a batch, has the following guaranteed properties. A measuring coil as described in the General section Potcores, square cores and cross cores is inserted; the halves are pressed together with a force of 100 N. The values are valid 5 minutes or more after clamping. Parameters  $\alpha_F$  and  $D_F$  of grade 3B7 are measured on toroid-wound halves.

	freq. kHz	$\hat{B}$ mT	temp. °C	grade				
				3B8	3D3	3H1	3H3	4C6
$A_L \pm 25\%$	4	$\leq 0,1$	$25 \pm 1$	3080	1500	3650	3100	260
$\mu_e \pm 25\%$	4	$\leq 0,1$	$25 \pm 1$	1470	700	1750	1475	125
$\alpha$	4	$\leq 0,1$	$25 \pm 1$	$\leq 20,8$	$\leq 29,9$	$\leq 19,0$	$\leq 20,0$	$\leq 71,1$
$\frac{\tan \delta}{\mu_i} \times 10^6$	4	$\leq 0,1$	$25 \pm 1$					
	30	$\leq 0,1$	$25 \pm 1$				$\leq 1,8$	
	100	$\leq 0,1$	$25 \pm 1$		$\leq 8,0$	$\leq 5,0$	$\leq 2,9$	
	500	$\leq 0,1$	$25 \pm 1$		$\leq 14$			
	1 000	$\leq 0,1$	$25 \pm 1$		$\leq 30$			
	2 000	$\leq 0,1$	$25 \pm 1$					
	10 000	$\leq 0,1$	$25 \pm 1$					$\leq 40$
P (W)	25	200**	$25 \pm 1$	$\leq 0,30$				$\leq 100$
			$100 \pm 1$	$\leq 0,35$				
$\eta_B \times 10^3$	4	1,5 to 3,0	$25 \pm 1$			$\leq 0,86$		
	30	1,5 to 3,0	$25 \pm 1$				$\leq 0,75$	
	100	0,3 to 1,2	$25 \pm 1$		$\leq 1,8$			$\leq 6,2$
$\alpha_F \times 10^6/K$	$\leq 100$	$\leq 0,1$	5 to 25			+ 0,5 to 1,5	+ 0,7 $\pm$ 0,3	-2 to +4
	$\leq 100$	$\leq 0,1$	25 to 55			+ 0,5 to 1,5	+ 0,7 $\pm$ 0,3	0 to +6
	$\leq 100$	$\leq 0,1$	25 to 70		0 to +2		+ 0,7 $\pm$ 0,3	
$D_F \times 10^6$ (10-100 min)	$\leq 100$	$\leq 0,1$	$25 \pm 0,1$		$\leq 12$	$\leq 4,3$	$\leq 3,0^*$	$\leq 10$
$\beta_F \times 10^6$ , measured on sets with $\mu_e = 300 \pm 10\%$ and $25 \pm 1$ °C:								
at $\mu_e \times \frac{N \times I_o}{l_e} = 1,00 \times 10^5$ A/m				$\leq 120$				
= $1,60 \times 10^5$ A/m				$\leq 300$				
= $2,30 \times 10^5$ A/m				$\leq 1100$				

\* This value is valid within the temperature range of 25 to 70 °C.

\*\*  $\hat{B}$  is calculated with  $ACP_{min} = 36,3$  mm<sup>2</sup>.

Core sets with nut and pre-adjusted on  $A_L$ .

$A_L$	corresponding $\mu_e$ -value	catalogue number 4322 022 . . . . .				
		3B8	3D3	3H1	3H3	4C6
25 ± 1%	11,9					25810
40 ± 1%	19,0		25420			● 25820
63 ± 1%	30		● 25430	25230		25830
100 ± 1%	47,5		25440	25240		
160 ± 1%	76	05910	25450	25250		
250 ± 1,5%	119			● 25260*	● 25560	
315 ± 2%	149			● 25270	● 25570	
400 ± 2%	190	● 05940		25280	25580	
630 ± 3%	298	05950		25300	25600	
1000 ± 5%	475			25310		
1250 ± 5%	593			05370		

Core sets with nut and pre-adjusted on  $\mu_e$ .

$\mu_e$	$\alpha$	catalogue number 4322 022 . . . . .				
		3B8	3D3	3H1	3H3	4C6
15 ± 1%	178					24810
22 ± 1%	147					24820
33 ± 1%	120		24430	24230		24830
47 ± 1%	100,5		24440	24240		
68 ± 1%	83,6		24450	24250		
100 ± 1,5%	68,9			24260		
150 ± 2%	56,3			24270		
220 ± 3%	46,5			24280		
705 ± 25%	25,9		04400			
1750 ± 25%	16,5			04200		

Core sets without nut: replace the eighth digit of the catalogue number (2) by 0.

Cores with  $A_L \leq 160$ , or  $\mu_e \leq 68$ , have a symmetrical air gap.Cores with  $A_L \geq 250$ , or  $\mu_e \geq 100$  and all 3B8 cores have an asymmetrical air gap.

Core halves without air gap, without nut:

Ferroxcube grade	catalogue number
3B8	4322 020 21670
3D3	4322 020 21520
3H1	4322 020 21510
3H3	4322 020 21650
4C6	4322 020 21610

● Preferred type.

\* Approval according to CECC 25 100-018.

## COIL FORMERS

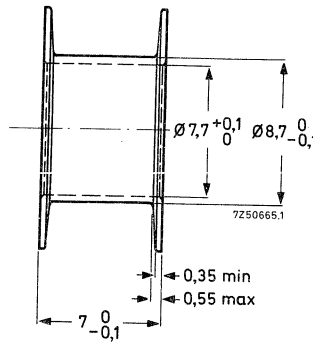
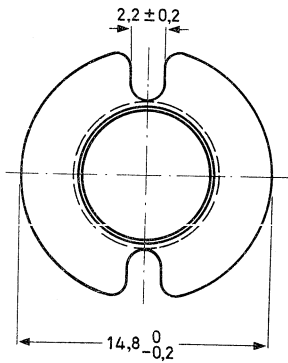
Three types of coil former can be supplied:

- with one section;
- with two sections;
- with three sections.

→ The dimensions conform with the following specifications: IEC 133 (international), NCF83311 (France), DIN 41294 (Germany) and BS 4061 range 2 (Great Britain).

### SINGLE-SECTION COIL FORMER

Dimensions in mm



Catalogue number	4322 021 30270
Material	polycarbonate
Window area	18 mm <sup>2</sup>
Mean length of turn	37 mm
Max. temperature	130 °C

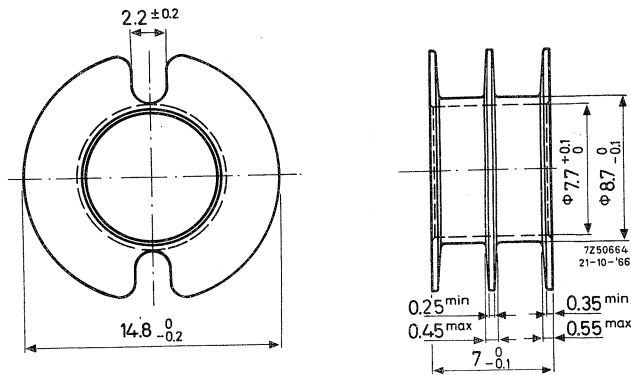
D.C. losses

$$\frac{R_O}{L} = \frac{1}{\mu_e} \times \frac{1}{f_{cu}} \times 16,4 \times 10^3 \Omega/H$$

Mass 0,35 g



## TWO-SECTION COIL FORMER



Catalogue number 4322 021 30280

Material polycarbonate

Window area  $2 \times 8,7 \text{ mm}^2$ 

Mean length of turn 37 mm

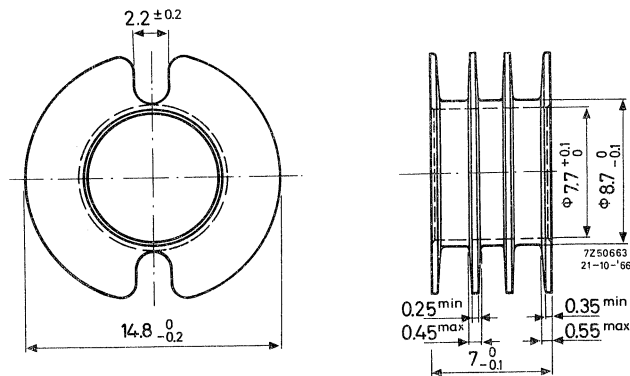
Max. temperature  $130 \text{ }^\circ\text{C}$ 

D.C. losses

$$\frac{R_o}{L} \times \frac{1}{\mu_e} \times \frac{1}{f_{cu}} \times 17,2 \times 10^3 \Omega/\text{H}$$

Mass 0,35 g

## THREE-SECTION COIL FORMER



Catalogue number 4322 021 30290

Material polycarbonate

Window area  $3 \times 5,4 \text{ mm}^2$ 

Mean length of turn 37 mm

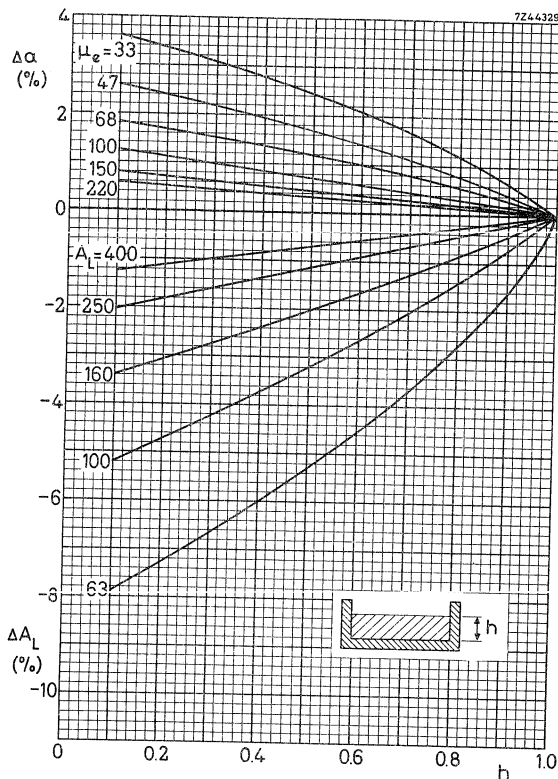
Max. temperature  $130 \text{ }^\circ\text{C}$ 

D.C. losses

$$\frac{R_o}{L} \times \frac{1}{\mu_e} \times \frac{1}{f_{cu}} \times 18,4 \times 10^3 \Omega/\text{H}$$

Mass 0,4 g

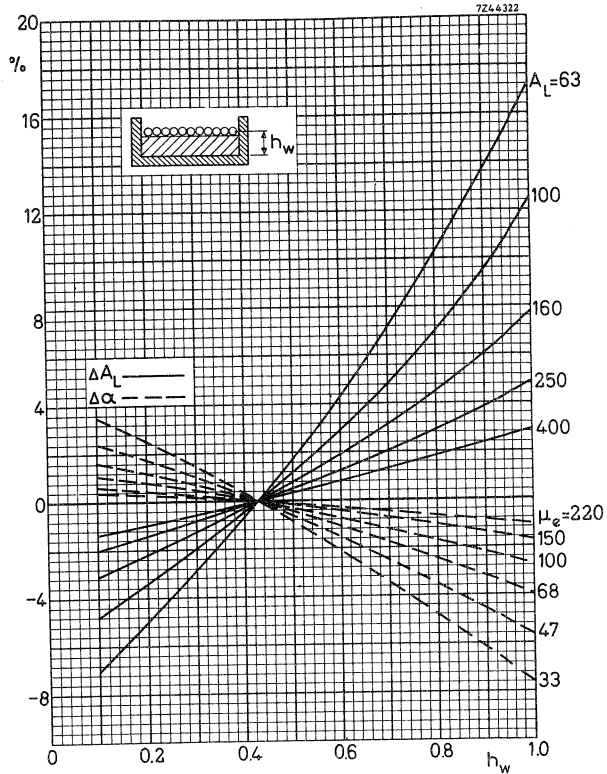
DATA FOR WHEN THE COIL FORMER IS PARTLY FILLED



Increase of the  $\alpha$  and decrease of the  $A_L$  factor for different  $\mu_e$  values and  $A_L$  factors as a function of the relative winding height on a single-section coil former.

Valid for Ferroxcube 3B7, 3H1 and 3D3 only.

Example: Of a single-section coil former only 0,4 part of the available height is used. A potcore with  $\mu_e = 68$  in that case obtains an  $\alpha$  factor of  $83,6 + 1,30\%$ .



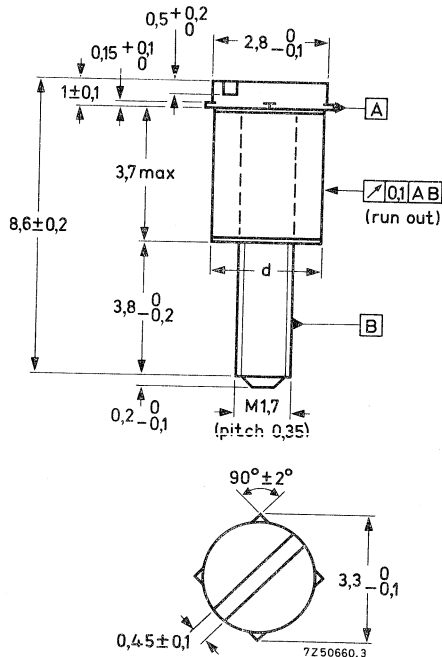
Variation of the  $\alpha$  and  $A_L$  factors for a coupling winding of one layer as a function of its winding height  $h_w$  on a single-section coil former.  
 Valid for Ferroxcube 3B7, 3H1 and 3D3 only.

Example: On a single-section coil former a coupling winding is laid on 0,7 of the available height. A potcore with  $\mu_e = 68$  obtains for that winding an  $\alpha$  factor of 83,6 – 1,7%.

## INDUCTANCE ADJUSTERS

(old types)

Dimensions in mm



See next page for diameter,  $d$ , of magnetic tubes.

The tolerances on inductance of the pre-adjusted potcores (without adjuster) are given under Potcores. After inserting a coil (impregnated or not) in an electrical circuit, its inductance can be adjusted to the required value with an accuracy  $< 0,03\%$  by means of an continuous inductance adjuster. Such an adjuster increases the inductance of the coil, see following pages.

The adjuster is screwed through the potcore into the nut and is held in position by the four protrusions near the top of the adjuster. For special requirements a bigger or smaller adjustment range may be obtained by using an adjuster belonging to the next higher or lower effective permeability.

The influence of the adjusters on the variability of the inductance is negligible. The maximum permissible temperature is  $110^\circ C$ .

Table 2 shows the type of adjuster recommended for different potcores.

Table 1, available types

d mm	colour	catalogue number
2,5	white	4322 021 32130
2,7	brown	4322 021 32140
2,77	black	4322 021 32150
2,7	naturel	4322 021 32160
2,7	red	4322 021 32170

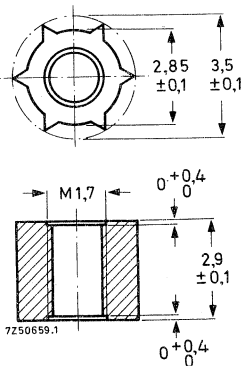
The adjusters are packed in plastic bags of 100. Please order in multiples of this quantity.

Table 2, recommended application

$\mu_e$	$A_L$	3H1/3D3	4C6
		cat. number 4322 021 . . . . .	
15	25		32160
	40		32160
22	63	32160	32160
	100	32160	32170
47	160	32170	
	250	32130	
68	315	32140	
	400	32150	
100	630	32150	

**LOOSE NUT FOR ADJUSTER**

These data are given for those manufacturers who prefer to insert a nut themselves.



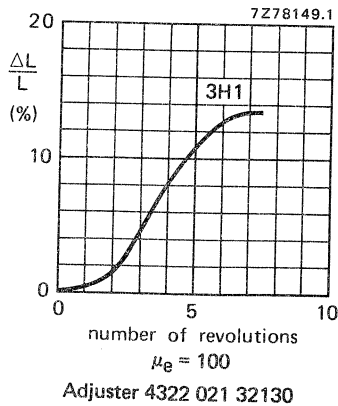
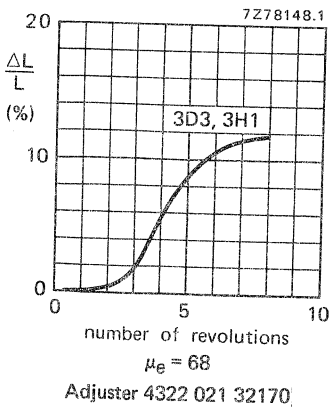
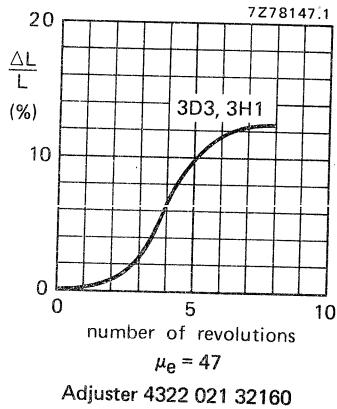
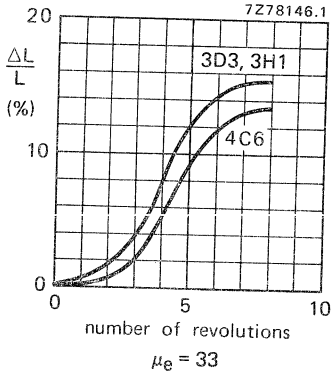
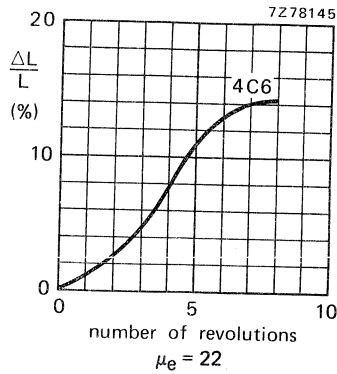
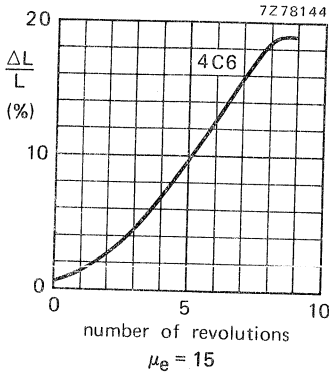
Catalogue number	4322 021 30140
Material	polycarbonate
Max. impregnation temperature during 24 hours	120 °C
Recommended distance from mating surface to nut	2,3 ± 0,15 mm

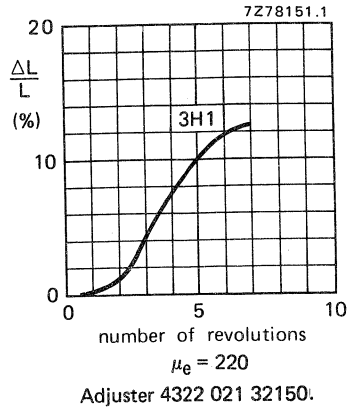
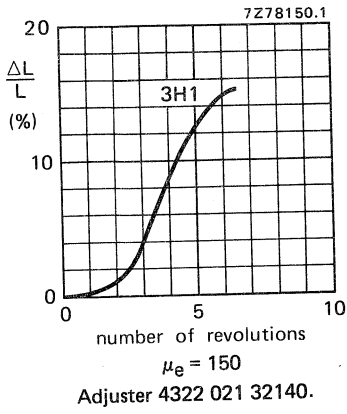
For more information see Potcores General, inductance adjustment.

The nuts are packed in plastic bags of 100 each. Please order in multiples of this quantity.

Dimensions in mm

ADJUSTMENT CURVES









## INDUCTANCE ADJUSTERS

(new types)

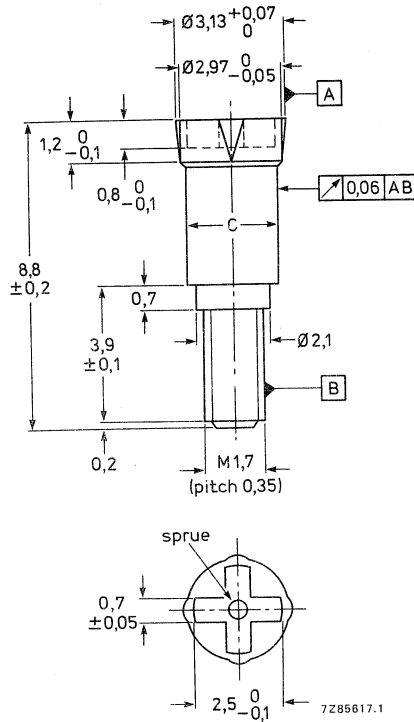


Fig. 1.

Material: polypropylene, reinforced with glass fibre.

The tolerances on inductance factor of the pre-adjusted cores without adjuster are given in the table of pre-adjusted cores with standard  $A_L$  values. The inductance of the pre-adjusted core can be increased to the required value — with a setting accuracy  $< 0,03\%$  — by means of a continuous adjuster.

The adjuster is screwed through the centre hole of the core into the nut and is held in position by the four cones near the top of the adjuster.

The combination of the polyamide moulded-in nut and the polypropylene adjuster — both reinforced with glass fibre — gives an excellent stability with temperature, shocks and vibrations. Besides this, the combination has a very smooth adjustment curve due to the excellent concentricity of the moulded-in nut and the adjuster.

The maximum permissible temperature of the adjustment combination is: 150 °C, during 8 h. The maximum working temperature is 110 °C.

The tables below show the available types and which adjuster is recommended for typical  $A_L$  values.

Table 1 Colour code of adjusters

catalogue number	colour	dia. C (Fig. 1) mm	material
4322 021 39600	black	2,90	FXC
39610	brown	2,72	FXC
39620	red	2,52	FXC
39670	violet	2,83	FXC
39680	white	2,62	FXC

Table 2 Catalogue numbers of recommended adjusters for typical  $A_L$  values

$A_L$	3H1/3H3/3B7	3D3	4C6
25			
40			
63			
100			
160	4322 021 39620	4322 021 39620	
250	39680		
315	39610		
400	39670		
630	39600		

**PACKAGING**

The adjusters are packed in plastic bags of 100. Please order in multiples of this quantity.

**ADJUSTING TOOL**

An adjusting tool combination for M1, 4 and M1, 7 is available, catalogue number 4322 058 03260.

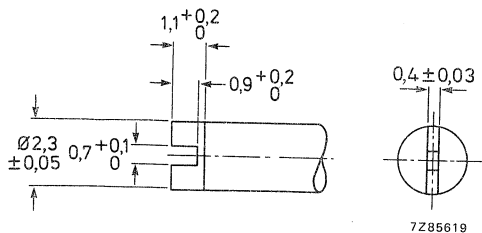
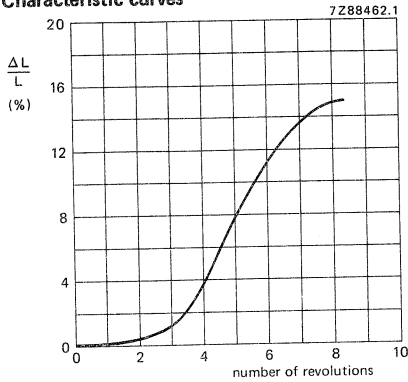


Fig. 2.

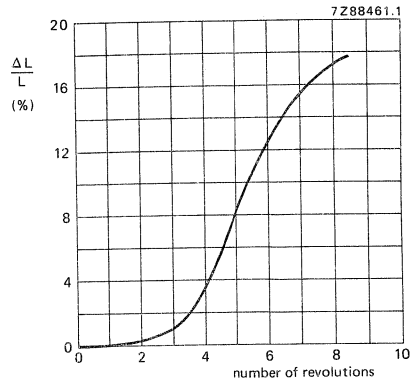
For customers who wish to make the screwdriver themselves the outlines of the essential part are given in Fig. 2.

ADJUSTMENT CURVES

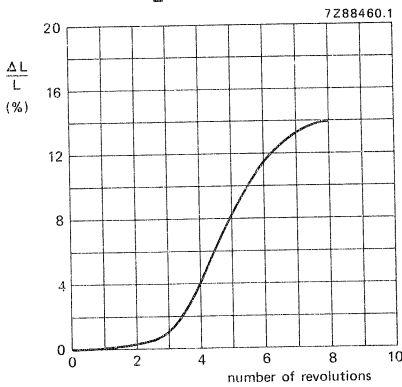
Characteristic curves



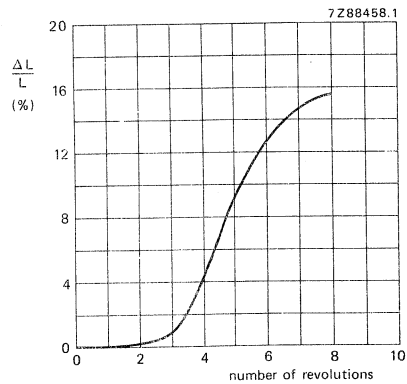
$A_L = 160$ ; FXC 3D3



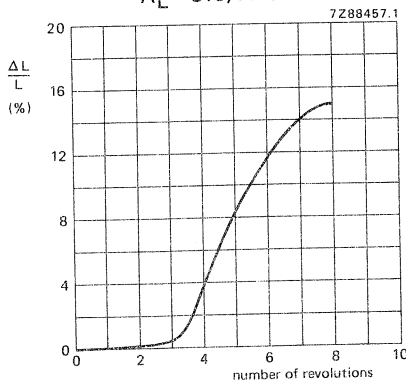
$A_L = 160$ ; FXC 3H1



$A_L = 315$ ; FXC 3H1



$A_L = 400$ ; FXC 3H1

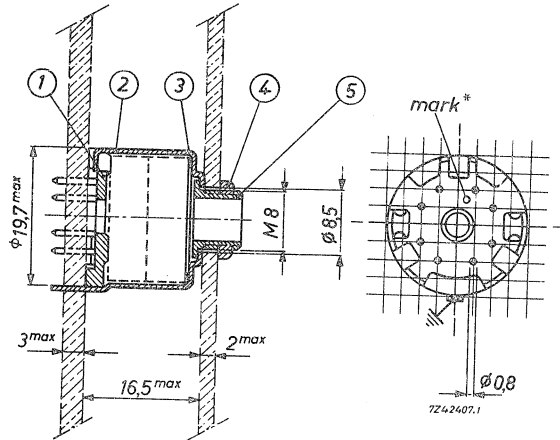


$A_L = 630$ ; FXC 3H1

Note: 0 revolutions corresponds to at least one turn of interaction.

## MOUNTING PARTS

### MOUNTING



(1) tag plate	4322 021 30450	(4) nut	4322 021 30710
(2) brass container	4322 021 30530	(5) fixing bush	4322 021 30720
(3) spring	4322 021 30640		

The core is suitable for mounting on printed-wiring boards and on conventional panels.

The parts 1, 2 and 3 are sufficient to construct an assembly for use in combination with printed wiring.

The eight soldering pins are arranged so as to fit a grid of 2,54 mm (0,1 inch). The pin length is sufficient for a board thickness up to 3 mm. The board should be provided with holes of  $1,3 + 0,1$  mm diameter.

\* There is another mark hole in a similar position on the top of the container.

If one-hole mounting is preferred, the parts 4 and 5 should be added. The coil assembly may then be mounted on panels having a thickness of up to 2 mm. The panel should be provided with a hole of 8,5 mm diameter.

It is recommended that the spring (3) be placed in the position indicated to obtain the best stability against shock and vibration.

Before bending the lips of the container, pressure should be exerted evenly on the rim of the tag plate until it meets the container. The force which is required is approximately 100 N. After bending the lips the spring will have the correct tension.

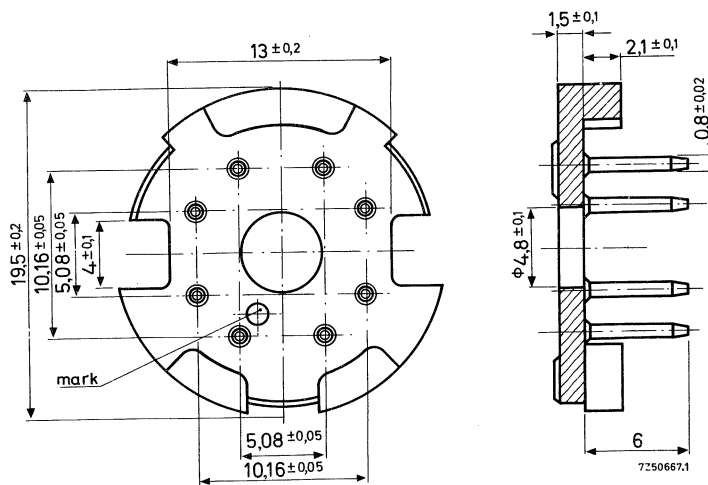
**PART DRAWINGS**

Dimensions in mm

(1) Tag plate 4322 021 30450

Plate: polyester reinforced with glass fibre,  
resistant against dip-soldering at 400 °C for 2 s.

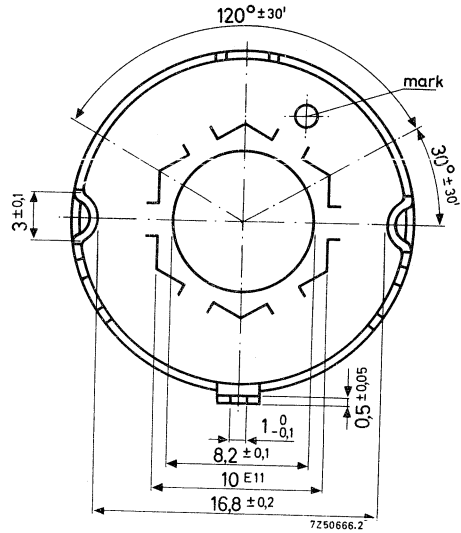
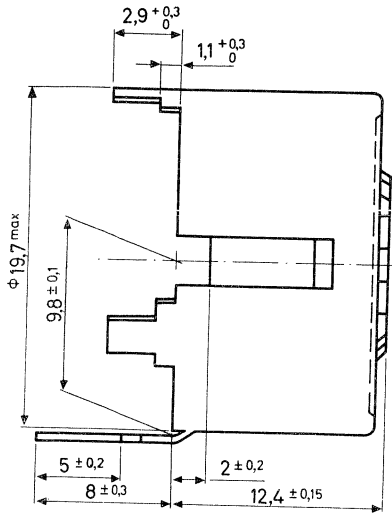
Pins: phosphor-bronze, dip-soldered.



The tag plates are packed in units of 75 pieces on a polystyrene plate, and with 500 pieces to a cardboard box. Please order in multiples of these quantities.

(2) Container 4322 021 30530

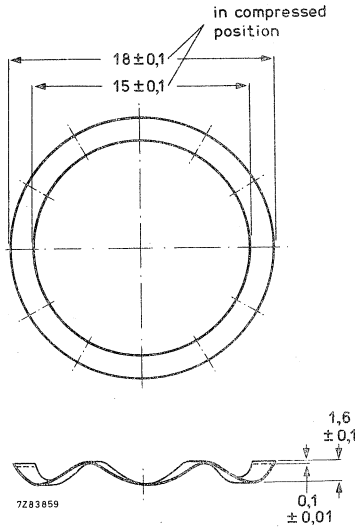
Material: brass, nickel plated; thereafter tin plated



The containers are packed in a primary pack of 70 pieces, in a storage pack of 350 pieces. Please order in multiples of these quantities.

(3) Spring 4322 021 30640

Material: chrome-nickel steel

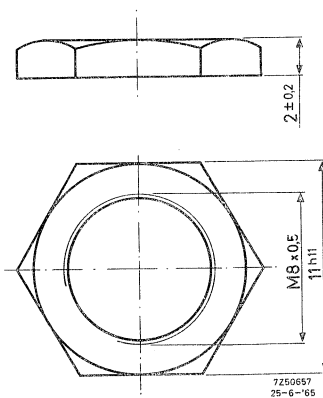


A force of 68 N to 113 N is required to compress the spring to 0,55 mm.

The springs are supplied in quantities of 1000 pieces. Please order in multiples of this quantity.

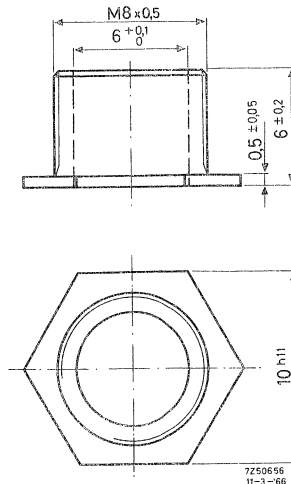
(4) Nut 4322 021 30710

Material: brass, nickel plated



(5) Fixing bush 4322 021 30720

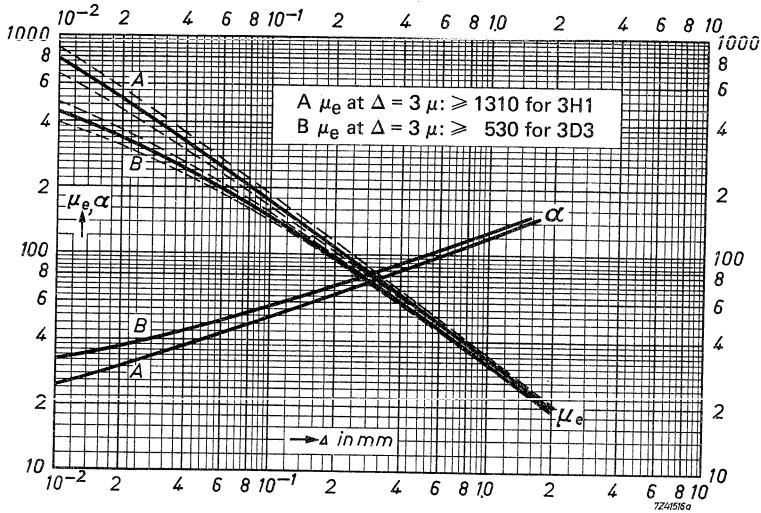
Material: brass, nickel plated



The fixing bushes are supplied in quantities of 2500. Please order in multiples of this quantity.

### CHARACTERISTIC CURVES

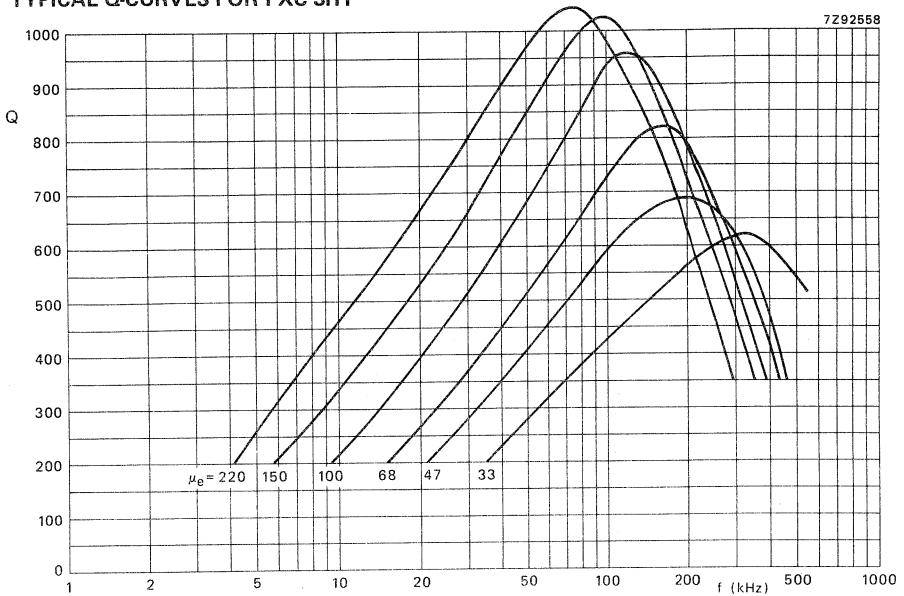
$\mu_e - \alpha$  CURVES



Relative effective permeability and turn factor for 1 mH as a function of the air gap length.

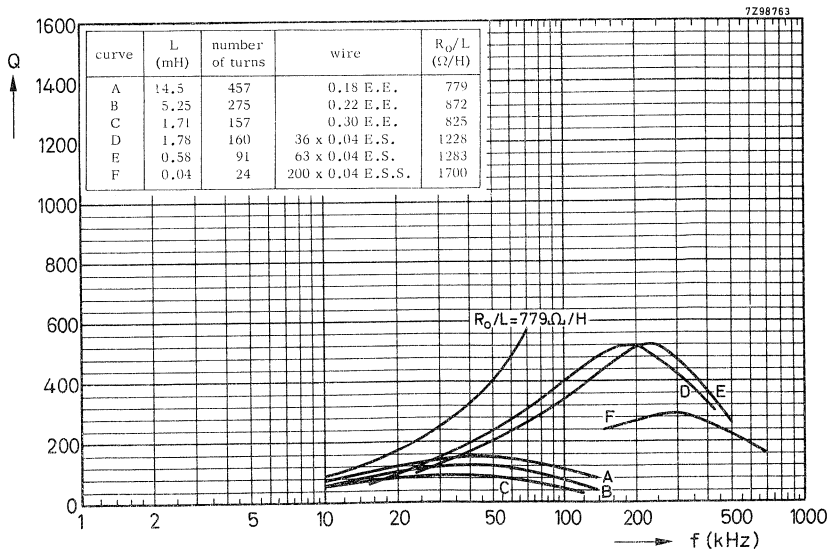


TYPICAL Q-CURVES FOR FXC 3H1



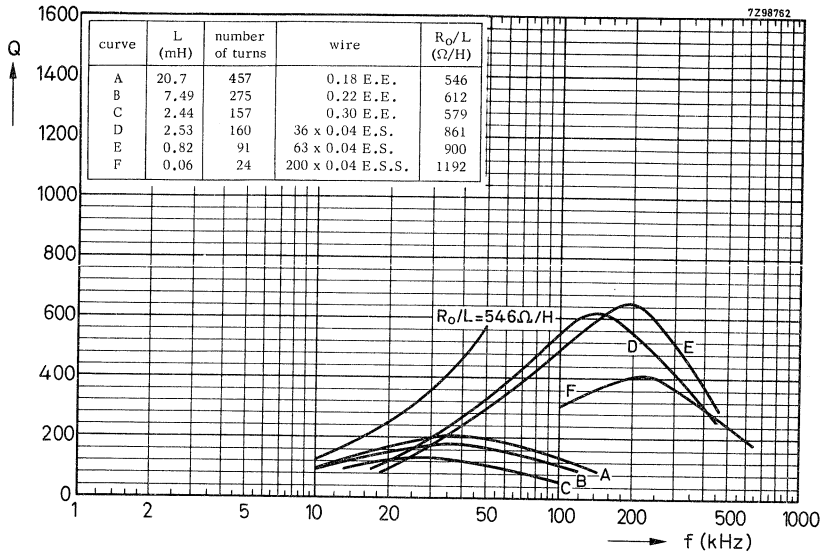
Enveloping curves.

Single-section coil former.



FXC 3H1  
 $\mu_e = 33$

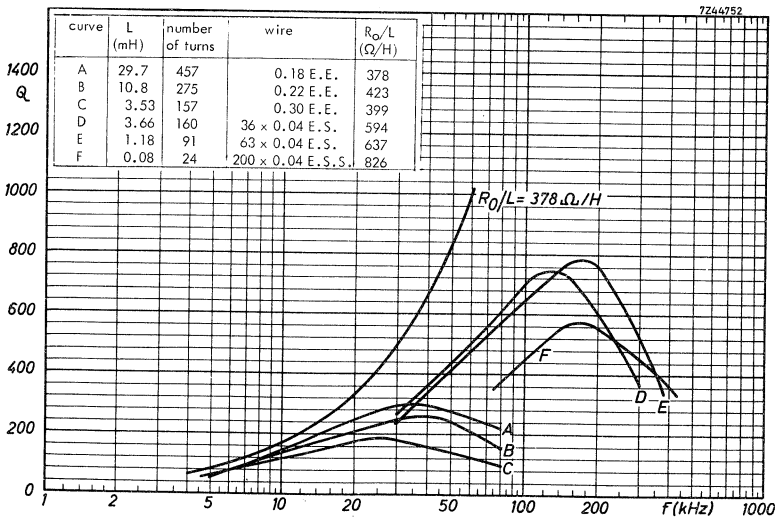
Single-section coil former.



FXC 3H1

$\mu_e = 47$

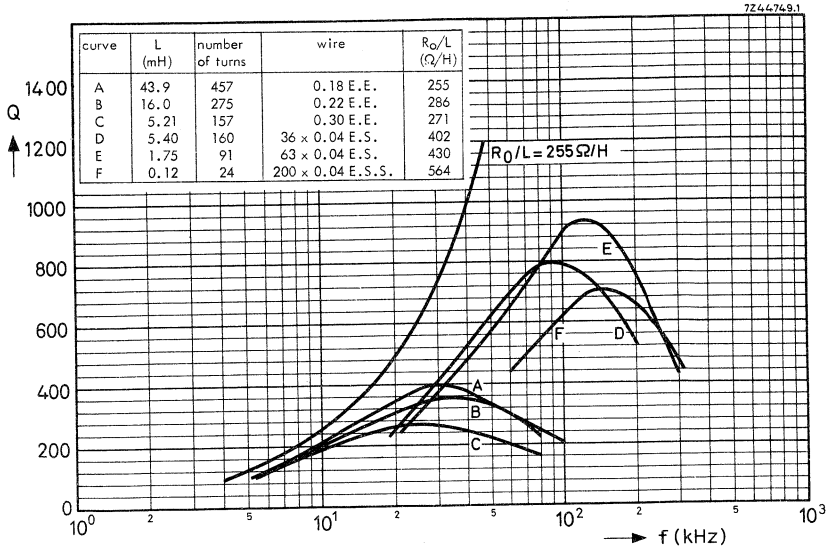
Single-section coil former.



FXC 3H1

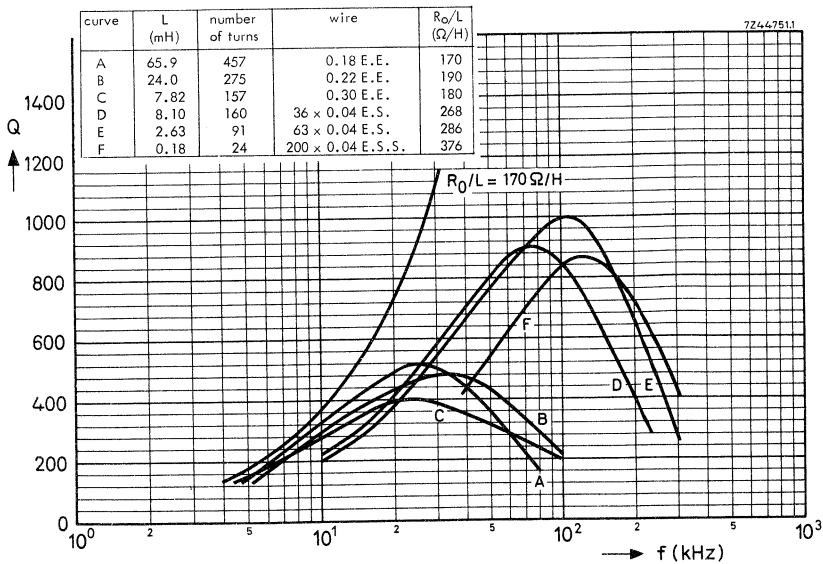
$\mu_e = 68$

Single-section coil former.



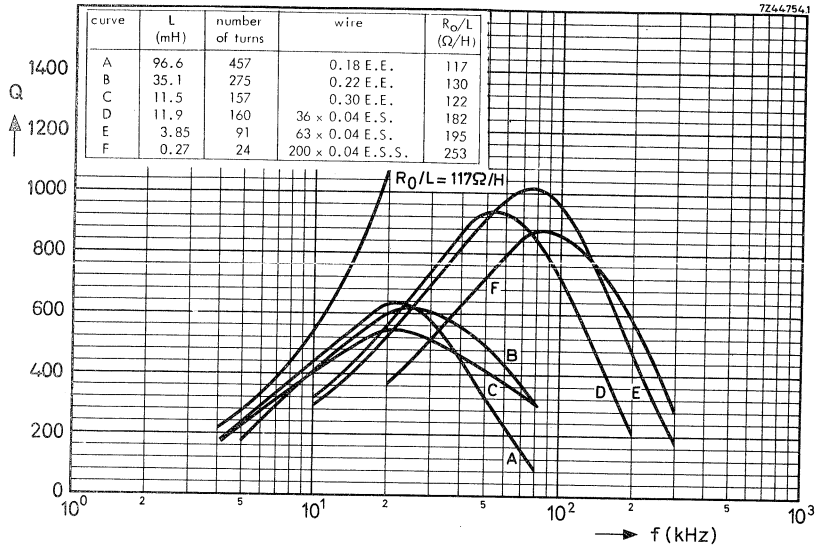
FXC 3H1  
 $\mu_e = 100$

Single-section coil former.



FXC 3H1  
 $\mu_e = 150$

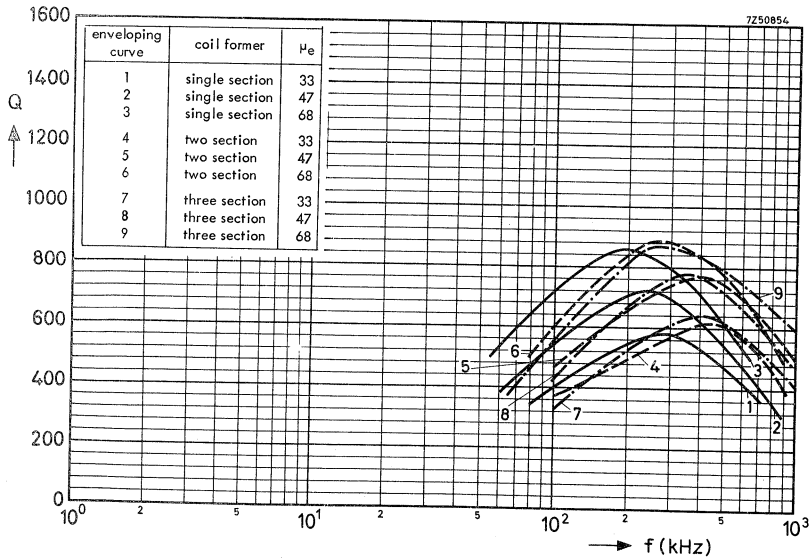
Single-section coil former.



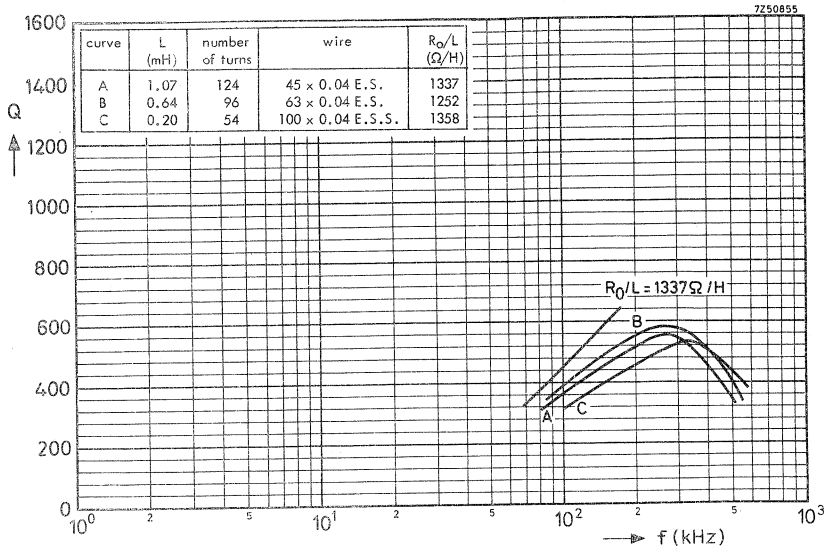
FXC 3H1  
 $\mu_e = 220$

Single-section coil former.

TYPICAL Q-CURVES FOR FXC 3D3



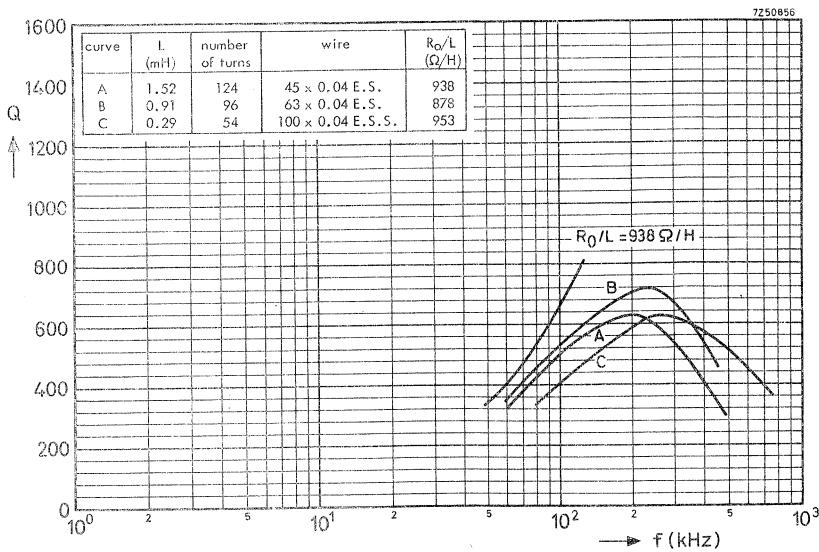
Enveloping curves.



FXC 3D3

$\mu_e = 33$

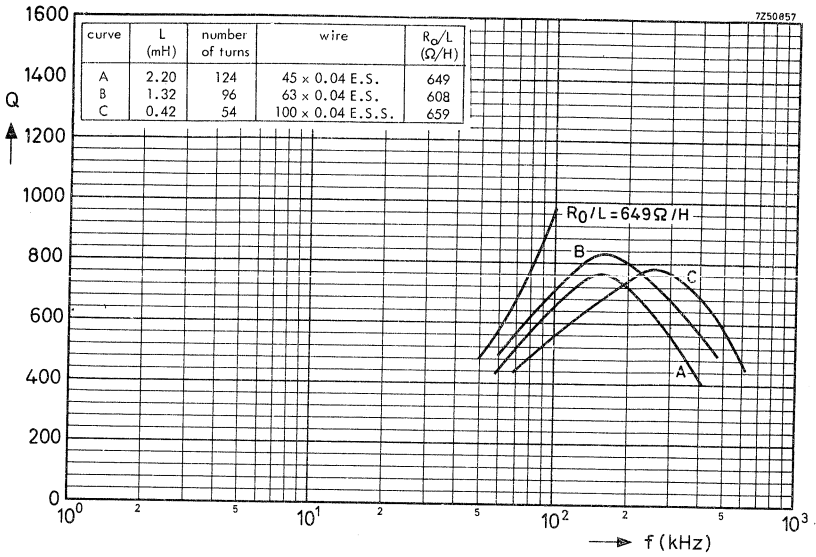
Single-section coil former.



FXC 3D3

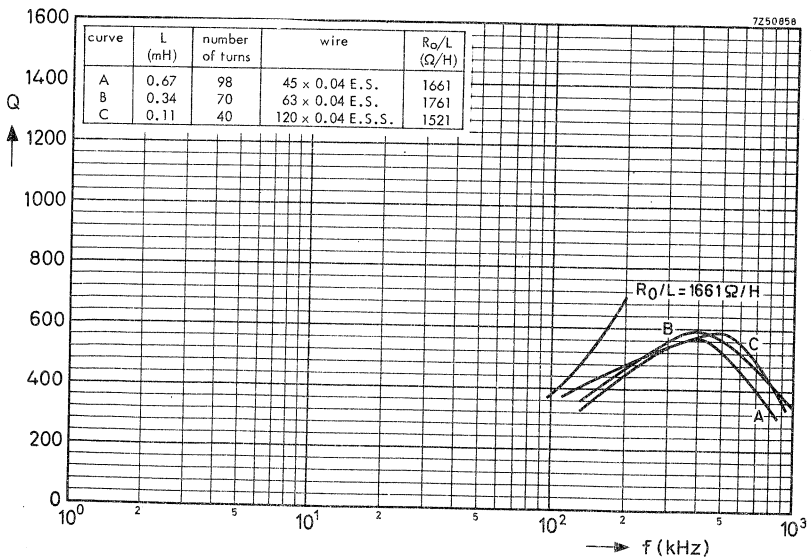
$\mu_e = 47$

Single-section coil former.



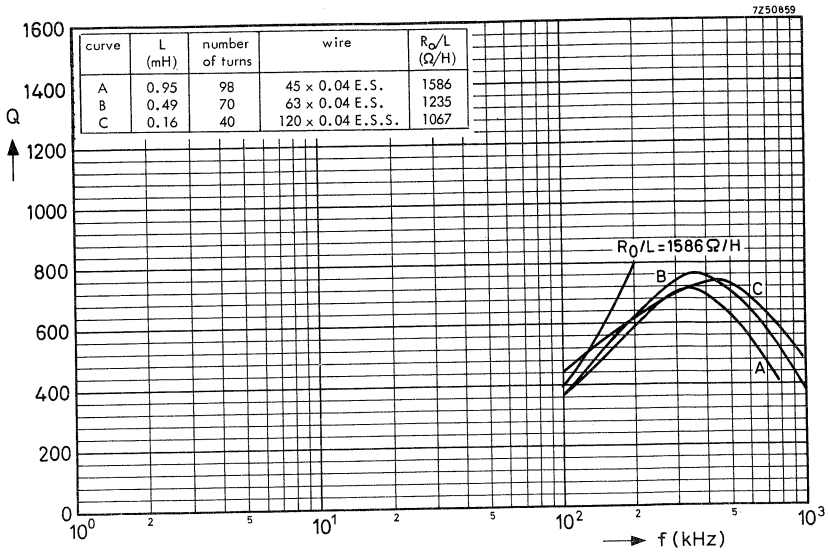
FXC 3D3  
 $\mu_e = 68$

Single-section coil former.



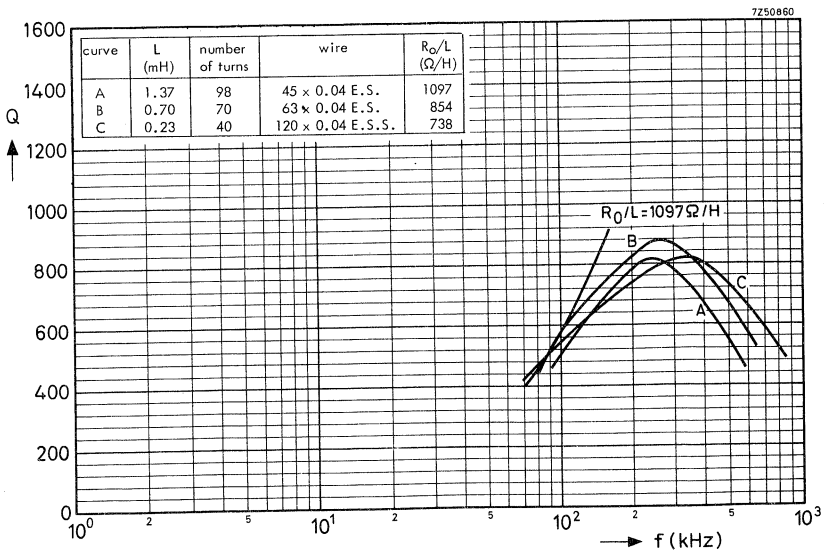
FXC 3D3  
 $\mu_e = 33$

Two-section coil former.



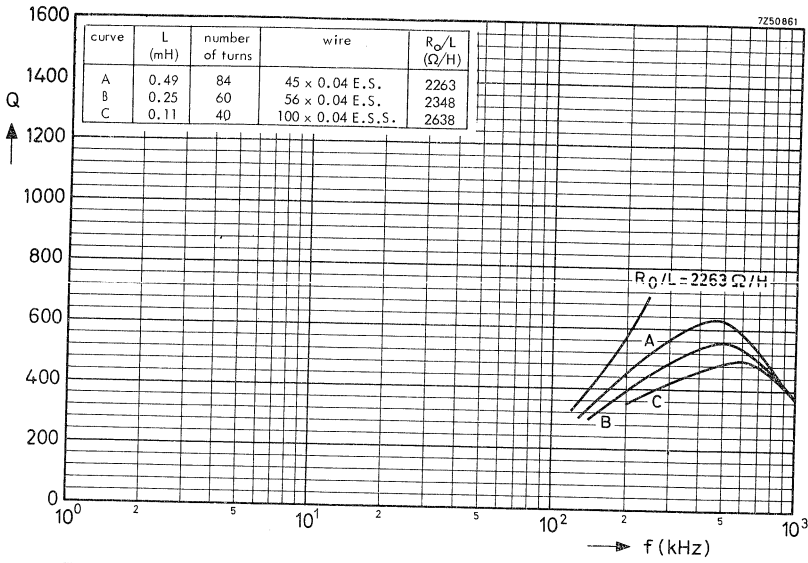
FXC 3D3  
 $\mu_e = 47$

Two-section coil former.



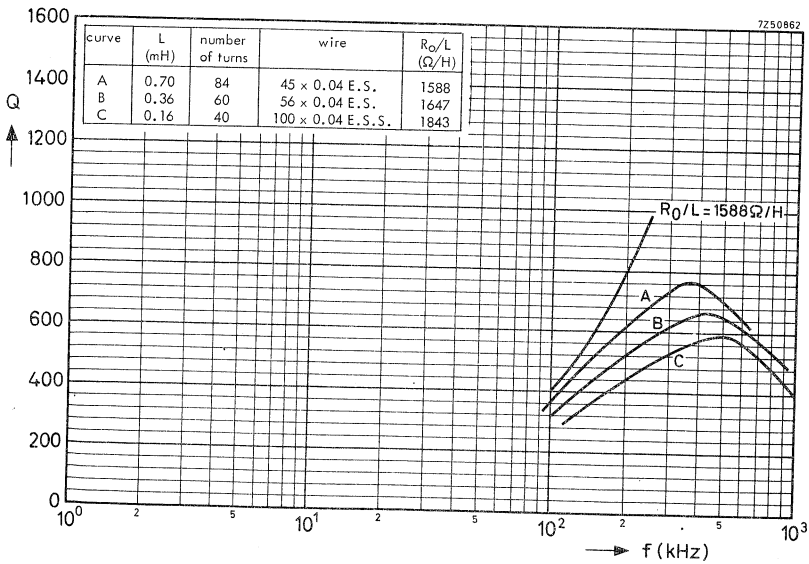
FXC 3D3  
 $\mu_e = 68$

Two-section coil former.



FXC 3D3  
 $\mu_e = 33$

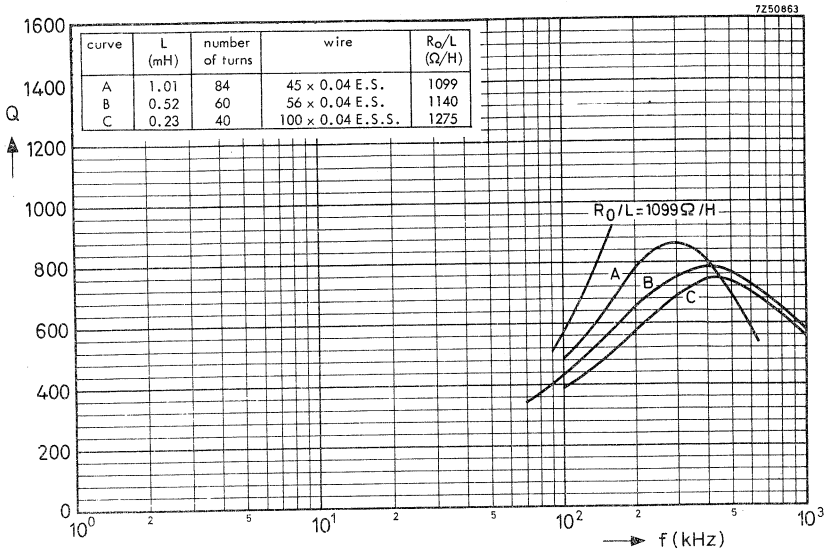
Three-single coil former.



FXC 3D3  
 $\mu_e = 47$

Three-single coil former.



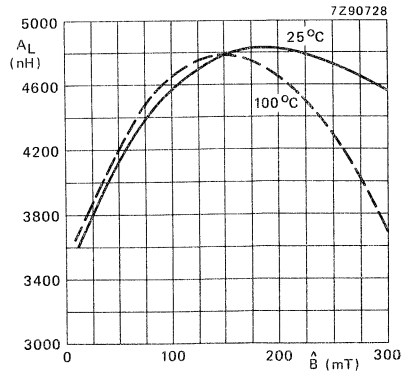
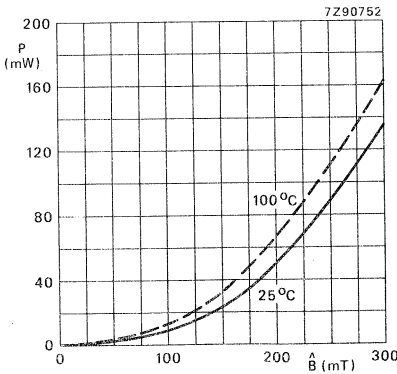


FXC 3D3  
 $\mu_e = 68$

Three-section coil former.

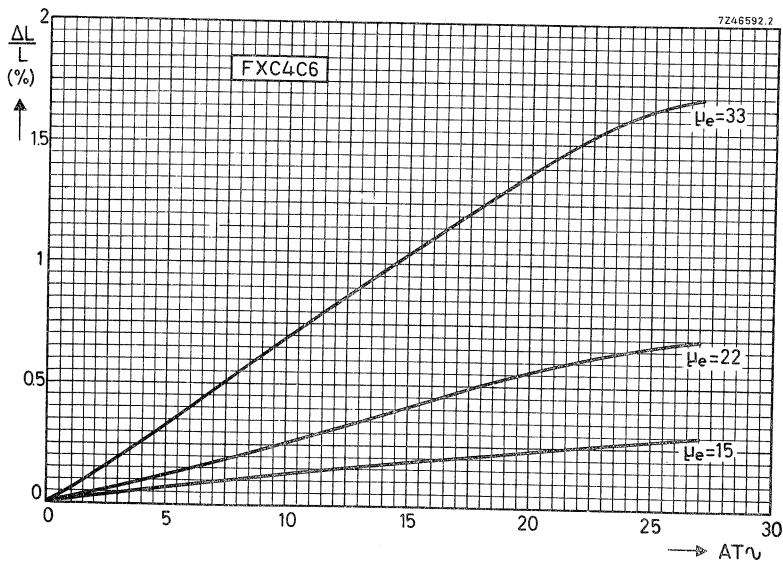
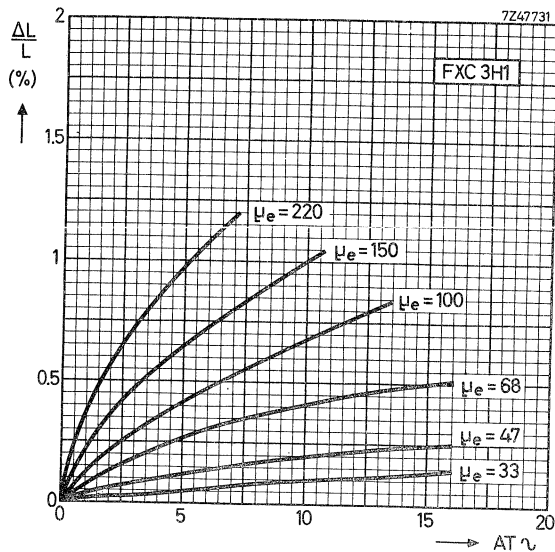
P AS A FUNCTION OF  $\hat{B}$  AT 16 kHz

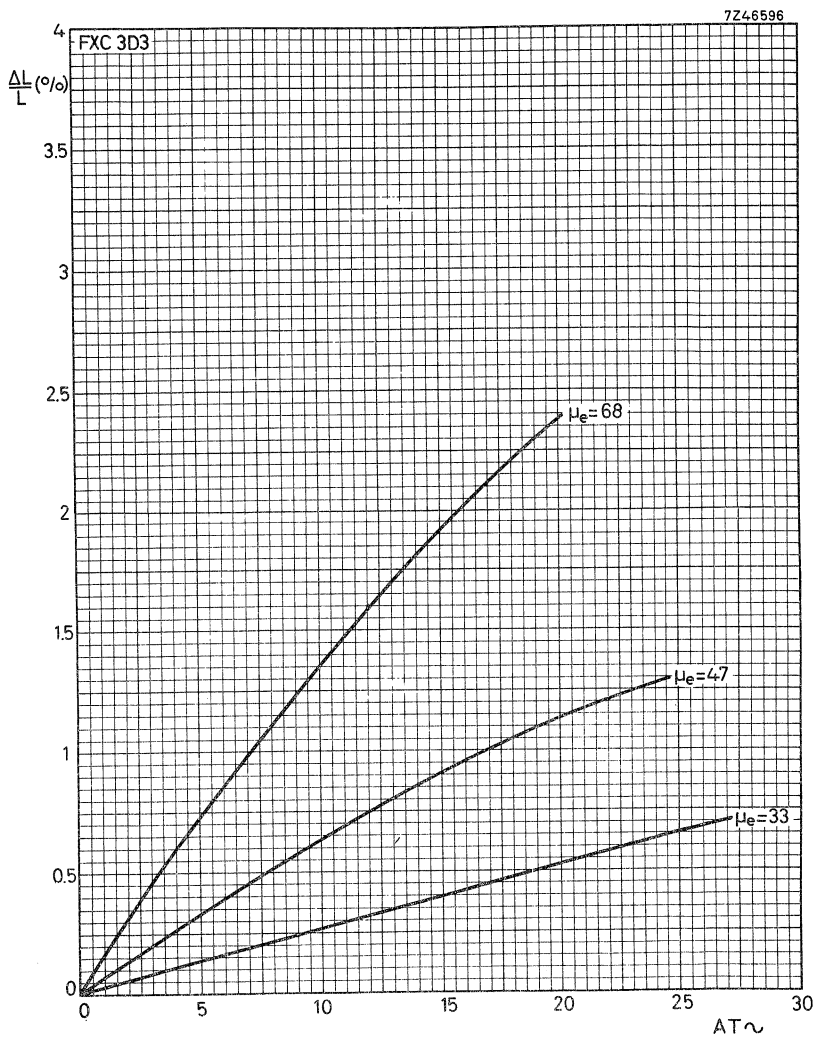
$A_L$  AS A FUNCTION OF  $\hat{B}$



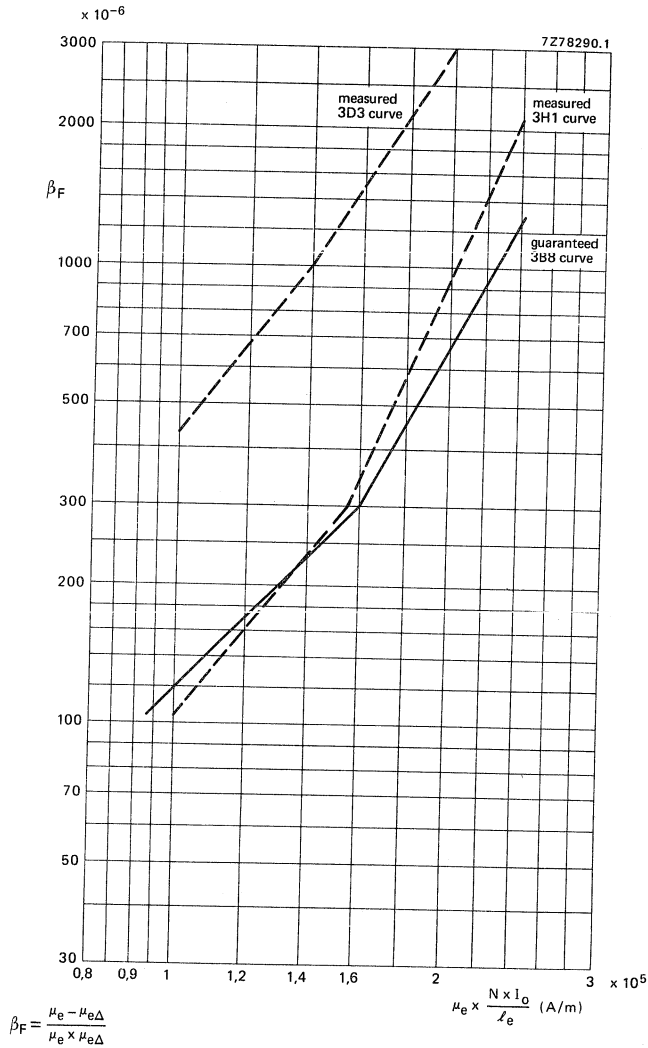
$\hat{B}$  calculated with  $A_{CPmin} = 36,2 \text{ mm}^2$ .

INDUCTANCE VARIATION AS A FUNCTION OF AT~



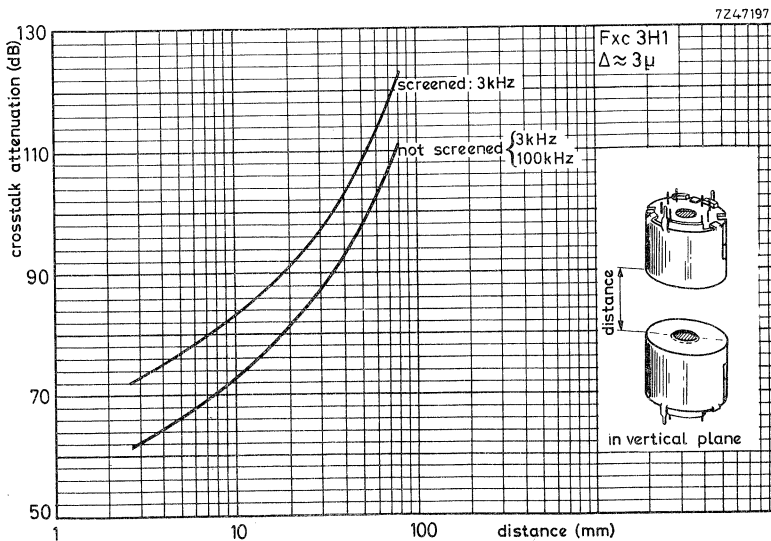
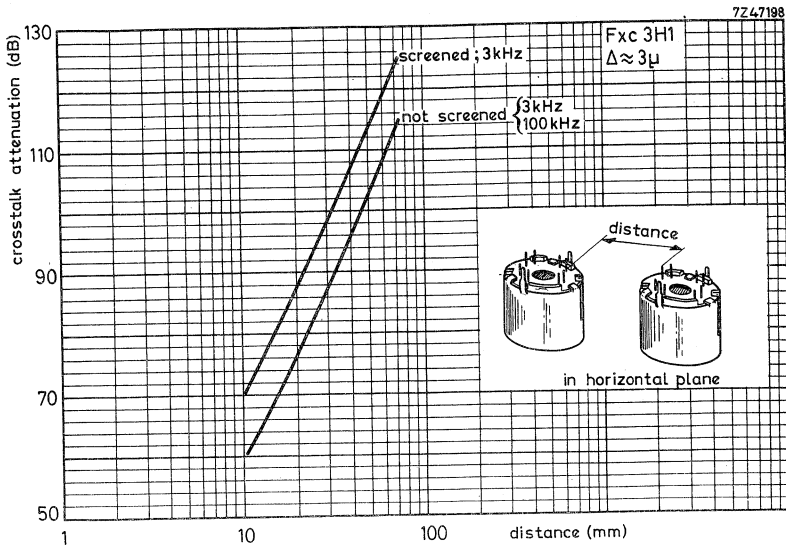


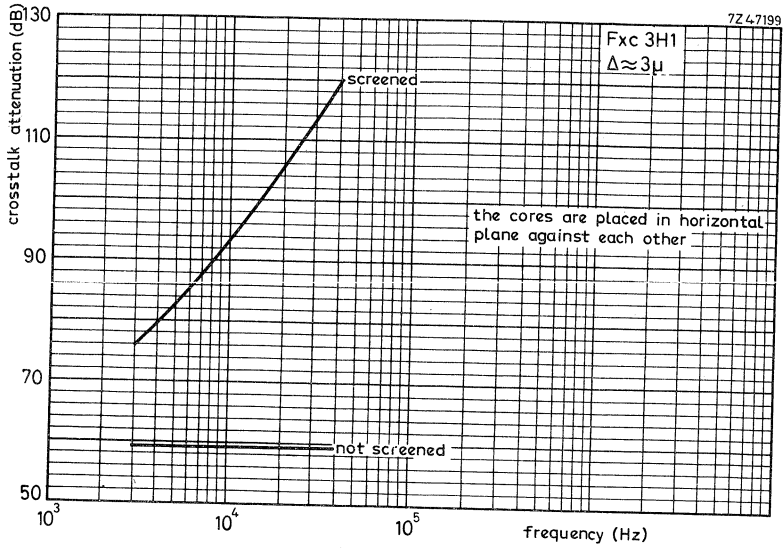
D.C. SENSITIVITY AT 25 °C



Inductance variation as a function of d.c. polarization.

CROSSTALK ATTENUATION





## POTCORES

Three types of core can be supplied:

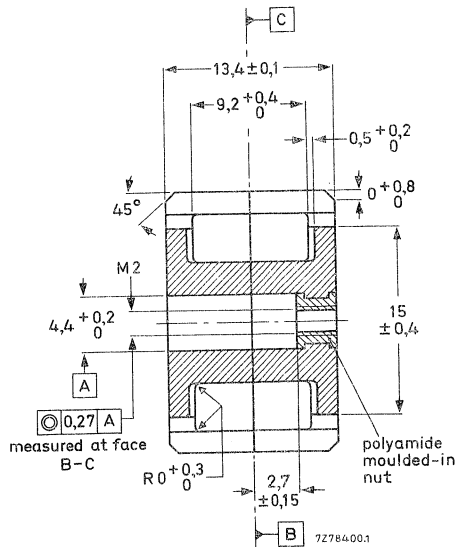
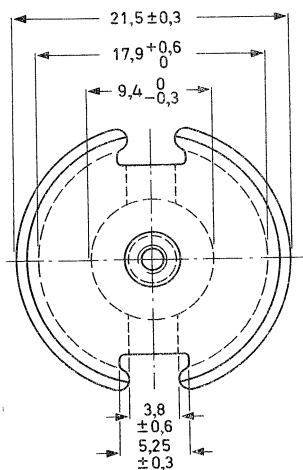
- CORE SETS provided with an injection-moulded nut for an adjuster and pre-adjusted on an inductance factor  $A_L$  or on a relative effective permeability value  $\mu_e$ .
- CORE SETS without nut and pre-adjusted on an  $A_L$  or a  $\mu_e$  value.
- CORE HALVES without air gap.

The potcores are in accordance with the following specifications: IEC 133 (international), NCF83311 (France), DIN 41293 (Germany) and BS 4061 range 2 (Great Britain).

Potcores and associated parts are ordered by their 12-digit catalogue number. Quantity: a primary pack contains 20 core sets or 40 core halves; a storage pack contains 100 core sets or 200 core halves. Please order in multiples of these quantities.

### MECHANICAL DATA

Dimensions in mm



- Pulling-out force of the nut  $\geq 40$  N
- Torque of the screw thread  $\leq 10$  mNm
- Extraction force of adjuster from nut  $\geq 30$  N

Note: The 4C6 version has a cemented nut.

Dimensional quantities according to IEC 205:

$$C_1 = \Sigma \frac{l}{A} = 0,497 \text{ mm}^{-1}; C_2 = \Sigma \frac{l}{A^2} = 0,00784 \text{ mm}^{-3}; V_e = 2000 \text{ mm}^3; l_e = 31,5 \text{ mm}; A_e = 63,4 \text{ mm}^2;$$

$$A_{CPmin} = 51,3 \text{ mm}^2.$$

Mass of a core set: 12 g.

## ELECTRICAL DATA

The combination of two potcore halves without air gap, randomly chosen from a batch, has the following guaranteed properties. A measuring coil as described in the General section 'Potcores, square cores and cross cores' is inserted; the halves are pressed together with a force of 140 N. The values are valid 5 minutes or more after clamping.

	freq. kHz	$\hat{B}$ mT	temp. °C	grade				
				3B8	3D3	3H1	3E4	4C6
$A_L \pm 25\%$	4	$\leq 0,1$	$25 \pm 1$	3870	1810	4650	10 000	320
$\mu_e \pm 25\%$	4	$\leq 0,1$	$25 \pm 1$	1530	720	1860	3955	125
$\alpha$	4	$\leq 0,1$	$25 \pm 1$	$\leq 18,6$	$\leq 27,0$	$\leq 16,8$	$\leq 11,5$	$\leq 64,7$
$\frac{\tan \delta}{\mu_i} \times 10^6$	4	$\leq 0,1$	$25 \pm 1$			$\leq 1,2$	$\leq 2,5$	
	100	$\leq 0,1$	$25 \pm 1$		$\leq 8,0$	$\leq 5,0$	$\leq 20$	
	500	$\leq 0,1$	$25 \pm 1$		$\leq 14$		$\leq 200$	
	1000	$\leq 0,1$	$25 \pm 1$		$\leq 30$			
	2000	$\leq 0,1$	$25 \pm 1$					$\leq 40$
	10 000	$\leq 0,1$	$25 \pm 1$					$\leq 100$
P (W)	25	200*	$25 \pm 1$	$\leq 0,30$				
			$100 \pm 1$	$\leq 0,40$				
$\eta_B \times 10^3$	4	1,5 to 3,0	$25 \pm 1$			$\leq 0,86$	$\leq 1,1$	
	100	0,3 to 1,2	$25 \pm 1$		$\leq 1,8$			$\leq 6,2$
$\alpha_F \times 10^6/K$	$\leq 100$	$\leq 0,1$	5 to 25			+ 0,5 to 1,5		-2 to + 4
	$\leq 100$	$\leq 0,1$	25 to 55			+ 0,5 to 1,5		0 to + 6
	$\leq 100$	$\leq 0,1$	25 to 70		0 to + 2		0 to + 2	
$D_F \times 10^6$ (10-100 min)	$\leq 100$	$\leq 0,1$	$25 \pm 0,1$		$\leq 12$	$\leq 4,3$	$\leq 4,3$	$\leq 10$
$\beta_F \times 10^6$ , measured on sets with $\mu_e = 300 \pm 10\%$ and $25 \pm 1$ °C:								
at $\mu_e \times \frac{N \times I_0}{I_e} = 1,00 \times 10^5$ A/m				$\leq 120$				
= $1,55 \times 10^5$ A/m				$\leq 300$				
= $2,20 \times 10^5$ A/m				$\leq 1050$				

\*  $\hat{B}$  is calculated with  $A_{CPmin} = 51,3$  mm<sup>2</sup>.



Core sets with nut and pre-adjusted on  $A_L$ .

$A_L$	corresponding $\mu_e$ -value	catalogue number 4322 022 . . . . .				
		3B8	3D3	3E4	3H1	4C6
25 ± 1%	9,9					27810
40 ± 1%	15,8		27420			● 27820
63 ± 1%			● 27430			27830
100 ± 1%	39,5		27440		27240	27840
160 ± 1%	63,5		27450		27250	
250 ± 1,5%	99		27460		● 27260	
315 ± 2%	125				● 27270	
400 ± 2%	158	● 07940			● 27280	
630 ± 3%	249				27300	
1 000 ± 3%	395				27310	
1 250 ± 3%	495				27390	
2 500 ± 10%	990					
10 000 ± 25%	3955			● 07900		

Core sets with nut and pre-adjusted on  $\mu_e$ .

$\mu_e$	$\alpha$	catalogue number 4322 022 . . . . .					
		3B7		3D3		3H1	4C6
15 ± 1%	162						26810
22 ± 1%	134						26820
33 ± 1%	109,4			26430			26830
47 ± 1%	91,7			26440			
68 ± 1%	76,2	26050		26450		26250	
100 ± 1,5%	62,8	26060				26260	
150 ± 2%	51,3	26070				26270	
220 ± 3%	42,4	26080				26280	
330 ± 3%	34,6	26090				26290	
720 ± 25%	23,4			06400			
1840 ± 25%	14,6	06000				06200	

Core sets without nut: replace the eighth digit of the catalogue number (2) by 0.

Cores with  $A_L \leq 315$ , or  $\mu_e \leq 100$ , have a symmetrical air gap.Cores with  $A_L \geq 400$ , or  $\mu_e \geq 150$ , have an asymmetrical air gap.

Core halves without air gap, without nut:

Ferroxcube grade	catalogue number
3B8	4322 020 21940
3D3	4322 020 21770
3H1	4322 020 21760
4C6	4322 020 21830

● Preferred type.

## COIL FORMERS

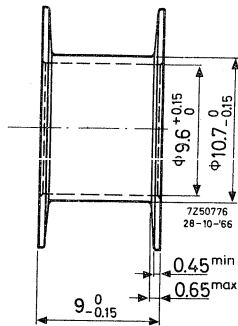
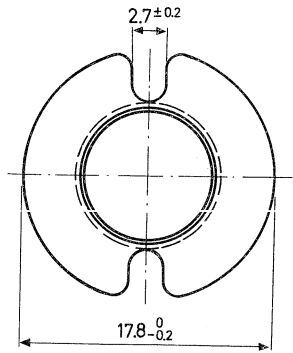
Three types of coil former can be supplied:

- with one section;
- with two sections;
- with three sections.

→ The dimensions conform with the following specifications: IEC 133 (international), NCF83311 (France), DIN 41294 (Germany) and BS 4061 range 2 (Great Britain).

### SINGLE-SECTION COIL FORMER

Dimensions in mm



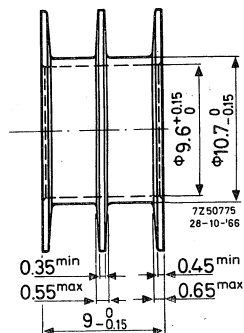
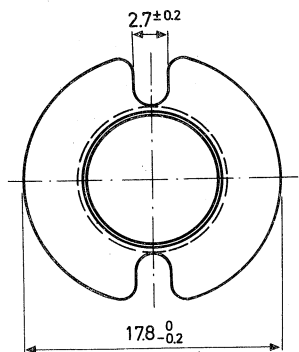
Catalogue number	4322 021 30300
Material	polycarbonate
Window area	28 mm <sup>2</sup>
Mean length of turn	44 mm
Max. temperature	130 °C

D.C. losses

$$\frac{R_o}{L} = \frac{1}{\mu_e} \times \frac{1}{f_{cu}} \times 11,0 \times 10^3 \Omega/H$$

Mass 0,35 g

## TWO-SECTION COIL FORMER



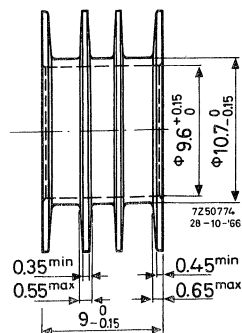
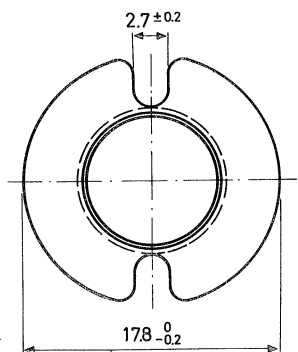
Catalogue number	4322 021 30310
Material	polycarbonate
Window area	2 x 13 mm <sup>2</sup>
Mean length of turn	44 mm
Max. temperature	130 °C

D.C. losses

$$\frac{R_o}{L} = \frac{1}{\mu_e} \times \frac{1}{f_{cu}} \times 11,6 \times 10^3 \Omega/H$$

Mass 0,4 g

## THREE-SECTION COIL FORMER



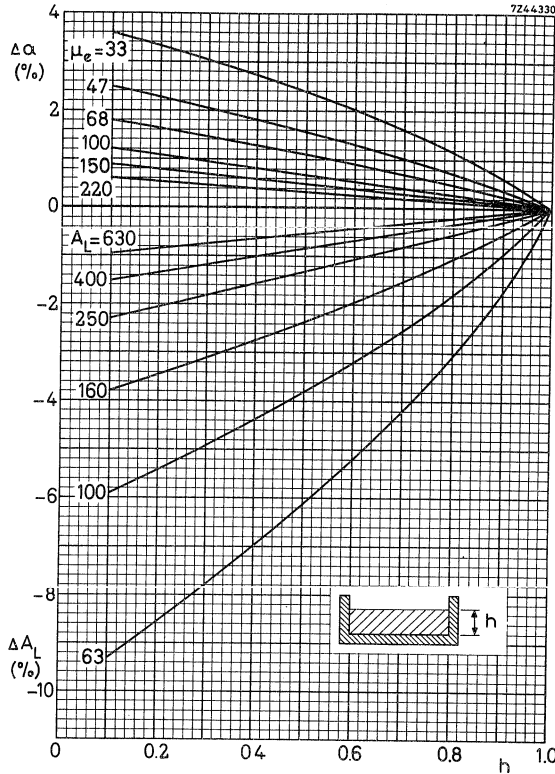
Catalogue number	4322 021 30320
Material	polycarbonate
Window area	3 x 8,2 mm <sup>2</sup>
Mean length of turn	44 mm
Max. temperature	130 °C

D.C. losses

$$\frac{R_o}{L} = \frac{1}{\mu_e} \times \frac{1}{f_{cu}} \times 12,4 \times 10^3 \Omega/H$$

Mass 0,45 g

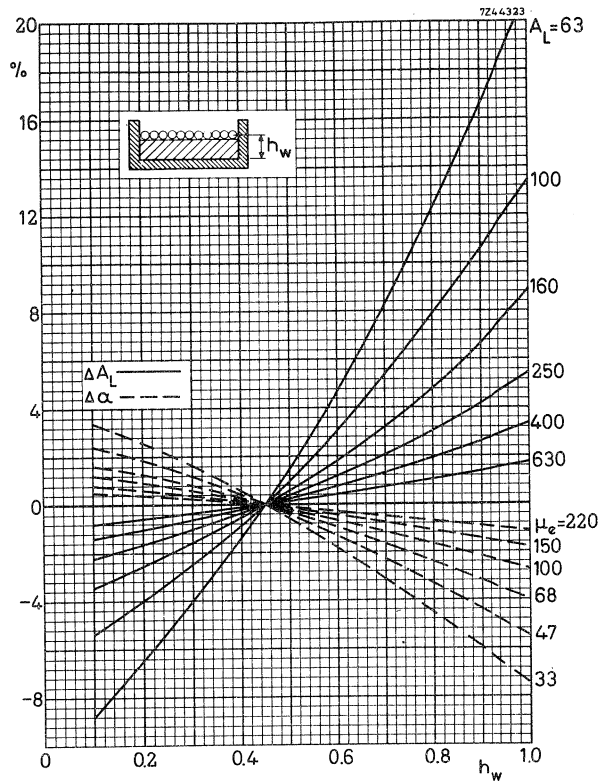
DATA FOR WHEN THE COIL FORMER IS PARTLY FILLED



Increase of the  $\alpha$  and decrease of the  $A_L$  factor for different  $\mu_e$  values and  $A_L$  factors as a function of the relative winding height on a single-section coil former.

Valid for Ferroxcube 3B7, 3H1 and 3D3 only.

Example: On a single section coil former only 0,4 part of the available height is used. A potcore with  $\mu_e = 68$  in that case obtains an  $\alpha$  factor of  $76,2 + 1,25\%$ .



Variation of the  $\alpha$  and  $A_L$  factors for a coupling winding of one-layer as a function of its winding height  $h_w$  on a single-section coil former.

Valid for Ferroxcube 3B7, 3H1 and 3D3 only.

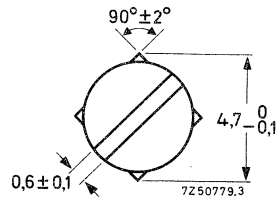
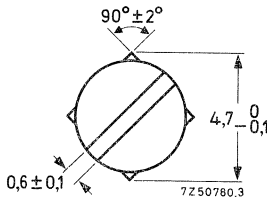
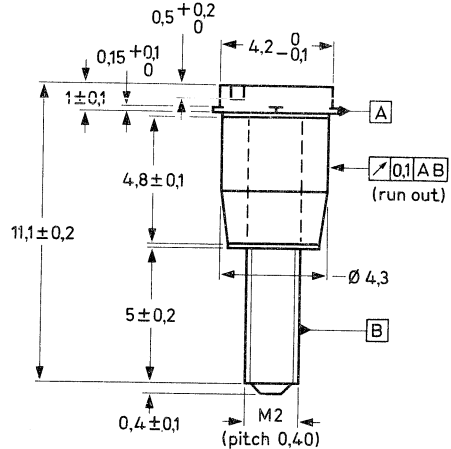
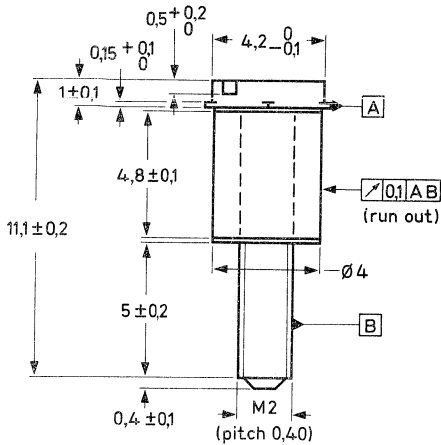
Example: On a single-section coil former a coupling winding is laid on 0,7 of the available height.

A potcore with  $\mu_e = 68$  obtains for that winding an  $\alpha$  factor of 76,2 - 1,7%.

# INDUCTANCE ADJUSTERS

(old types)

Dimensions in mm



The tolerances on inductance of the pre-adjusted potcores (without adjuster) are given under Potcores. After inserting a coil (impregnated or not) in an electrical circuit, its inductance can be adjusted to the required value with an accuracy  $< 0,03\%$  by means of a continuous inductance adjuster. Such an adjuster increases the inductance of the coil, see following pages.

The adjuster is screwed through the potcore into the nut and is held in position by the four protrusions near the top of the adjuster. For special requirements a bigger or smaller adjustment range may be obtained by using an adjuster belonging to the next higher or lower effective permeability.

The influence of the adjusters on the variability of the inductance is negligible. The maximum permissible temperature is  $110\text{ }^{\circ}\text{C}$ .

Table 2 shows the type of adjuster recommended for different potcores.

Table 1, available types

Fig.	colour	catalogue number
B	yellow	4322 021 31000
B	white	4322 021 31020
B	natural	4322 021 31040
B	red	4322 021 31060
A	brown	4322 021 31100
B	black	4322 021 31240

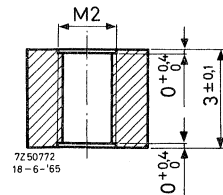
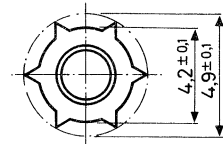
The adjusters are supplied in quantities of 100. Please order in multiples of this quantity.

Table 2, recommended application

$\mu_e$	$A_L$	3H1/3D3	4C6
		catalogue no. 4322 021 . . . . .	
	25	—	31060
15	40	—	31060
		—	31060
22		—	31000
	63	31040	31000
33		31040	31020
	100	31060	—
47		31060	—
68		31000	—
	160	31000	—
	250	31020	—
100		31020	—
	315	31020	—
150		31100	—
	400	31100	—
220		31100	—
	630	31100	—
330		31240	—

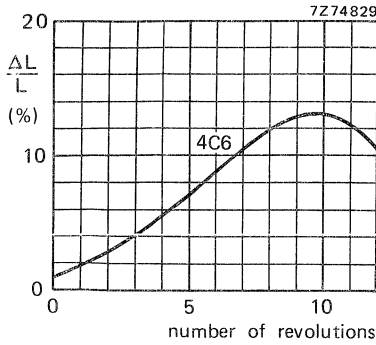
#### LOOSE NUT FOR ADJUSTER

These data are given for those manufacturers who prefer to insert a nut themselves.

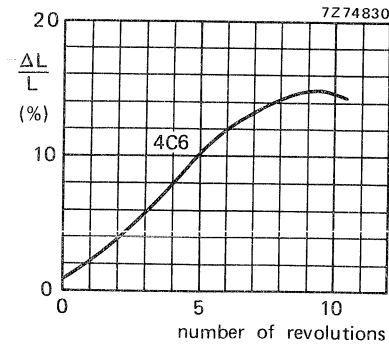


Catalogue number	4322 021 30150
Material	polycarbonate
Max. impregnation temperature for 24 hours	120 °C
Recommended distance from mating surface to nut	2,7 ± 0,15 mm
For more information see Potcores General, inductance adjustment.	
The nuts are packed in plastic bags of 100. Please order in multiples of this quantity.	

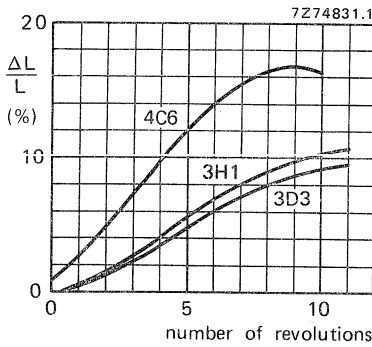
ADJUSTMENT CURVES



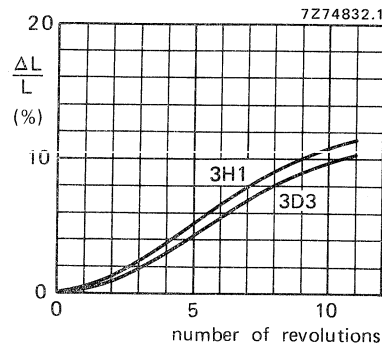
Adjuster 4322 021 31060,  $\mu_e = 15$ .



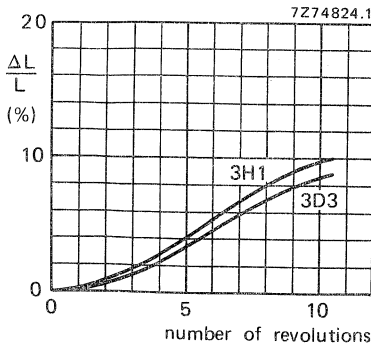
Adjuster 4322 021 31000,  $\mu_e = 22$ .



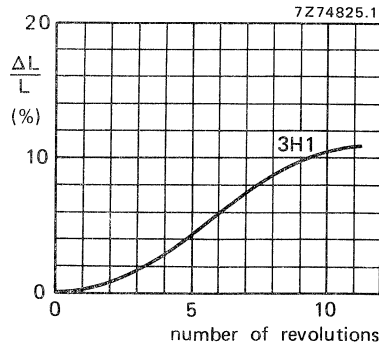
Adjuster 4322 021 31040 (3B7, 3H1, 3D3)  
Adjuster 4322 021 31020 (4C6),  $\mu_e = 33$ .



Adjuster 4322 021 31060,  $\mu_e = 47$ .

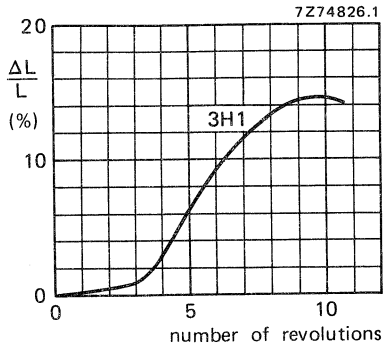


Adjuster 4322 021 31000,  $\mu_e = 68$ .

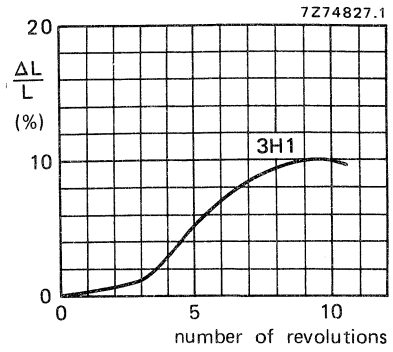


Adjuster 4322 021 31020,  $\mu_e = 100$ .

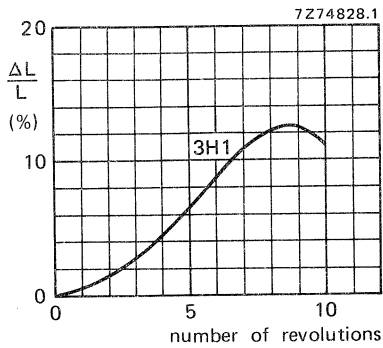




Adjuster 4322 021 31100,  $\mu_e = 150$ .



Adjuster 4322 021 31100,  $\mu_e = 220$ .



Adjuster 4322 021 31240,  $\mu_e = 330$ .

## INDUCTANCE ADJUSTERS (new types)

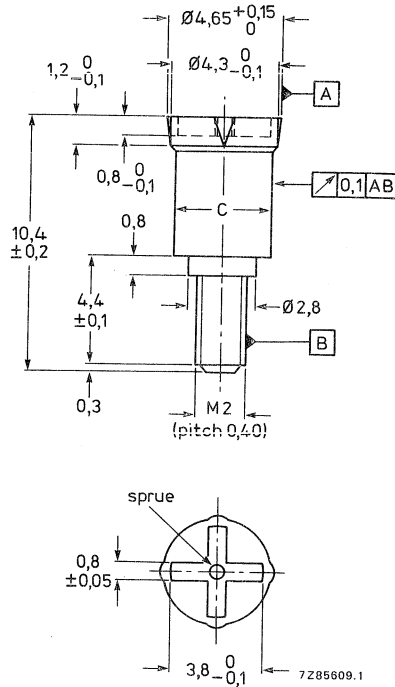


Fig. 1.

Material: polypropylene, reinforced with glass fibre.

The tolerances on inductance factor of the pre-adjusted cores without adjuster are given in the table of pre-adjusted cores with standard  $A_L$  values. The inductance of the pre-adjusted core can be increased to the required value – with a setting accuracy  $< 0,03\%$  – by means of a continuous adjuster.

The adjuster is screwed through the centre hole of the core into the nut and is held in position by the four cones near the top of the adjuster.

The combination of the polyamide moulded-in nut and the polypropylene adjuster – both reinforced with glass fibre – gives an excellent stability with temperature, shocks and vibrations. Besides this, the combination has a very smooth adjustment curve due to the excellent concentricity of the moulded-in nut and the adjuster.

The maximum permissible temperature of the adjustment combination is:  
150 °C, during 8 h. The maximum working temperature is 110 °C.

The tables below show the available types and which adjuster is recommended for typical  $A_L$  values.

Table 1 Colour code of adjusters

catalogue number	colour	dia. C (Fig. 1) mm	material
4322 021 38400	black	4,22	FXC
38410	brown	4,04	FXC
38440	yellow	3,52	FXC
38480	white	3,80	FXC
38490	grey	3,94	FXC

Table 2 Catalogue numbers of recommended adjusters for typical  $A_L$  values

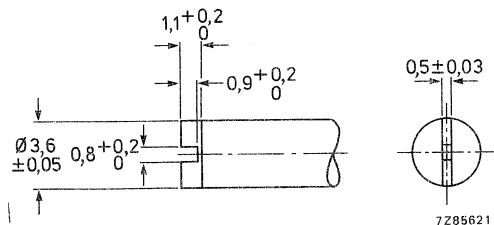
$A_L$	3H1/3B7	3D3	4C6
25			
40			
63			
100			
160	4322 021 38440	4322 021 38440	4322 021 38480
250	38480	38490	
315	38490		
400	38410		
630	38400		

**PACKAGING**

The adjusters are packed in plastic bags of 100. Please order in multiples of this quantity.

**ADJUSTING TOOL**

An adjusting tool combination for M1, 4 and M1, 7 is available, catalogue number 4322 058 03260.

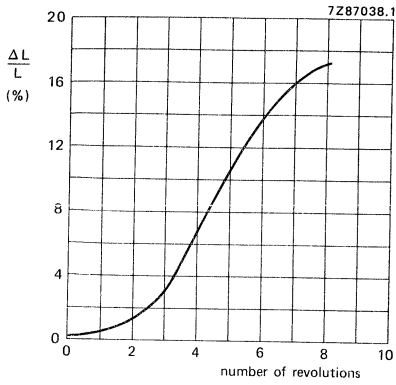


For customers who wish to make the screwdriver themselves the outlines of the essential part are given in Fig. 2.

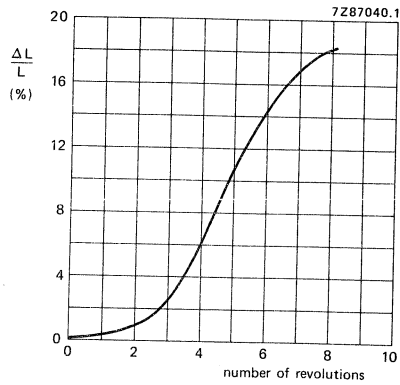
Fig. 2.

ADJUSTMENT CURVES

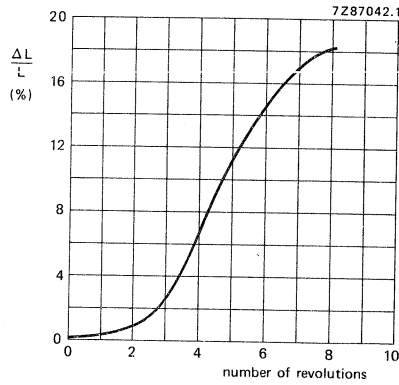
Characteristics curves



$A_L = 160$ ; FXC 3D3



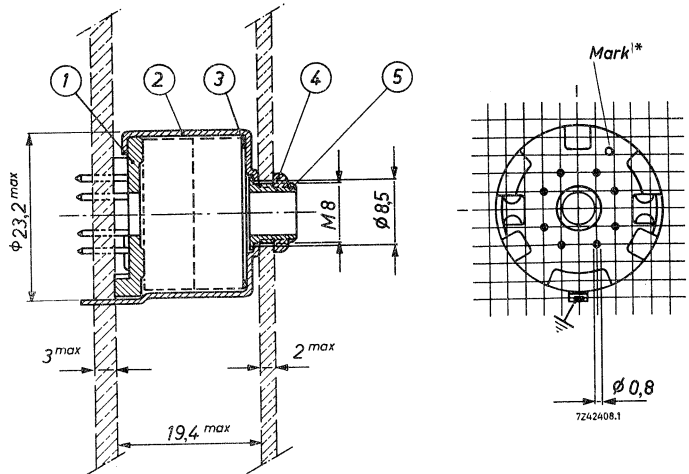
$A_L = 250$ ; FXC 3H1



$A_L = 315$ ; FXC 3H1

## MOUNTING PARTS

## MOUNTING



(1) tag plate            4322 021 30460  
 (2) brass container    4322 021 30540  
 (3) spring              4322 021 30650

(4) nut                    4322 021 30710  
 (5) fixing bush         4322 021 30720

The core is suitable for mounting on printed-wiring boards and on conventional panels.

The parts 1, 2 and 3 are sufficient to construct an assembly for use in combination with printed wiring.

The eight soldering pins are arranged to fit printed-wiring boards with a grid of 2,54 mm (0,1 inch).

The pin length is sufficient for a board thickness up to 3 mm. The board should be provided with holes of  $1,3 + 0,1$  mm diameter.

\* There is another mark hole in a similar position on the top of the container.

If one-hole mounting is preferred, the parts 4 and 5 should be added. The coil assembly may then be mounted on panels having a thickness of up to 2 mm. The panel should be provided with a hole of 8,5 mm diameter.

It is recommended that the spring (3) be placed in the position indicated to obtain the best stability against shock and vibration.

Before bending the lips of the container, pressure should be exerted evenly on the rim of the tag plate until it meets the container. The force which is required is approximately 140 N. After bending the lips the spring will have the correct tension.

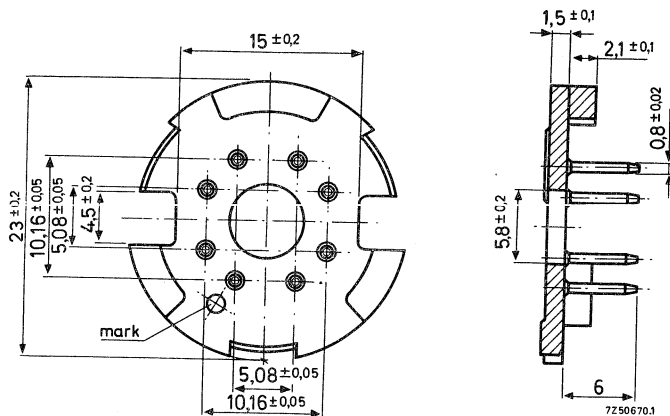
## PART DRAWINGS

### (1) Tag plate 4322 021 30460

Dimensions in mm

Plate: polyester reinforced with glass fibre,  
resistant against dip-soldering at 400 °C for 2 s.

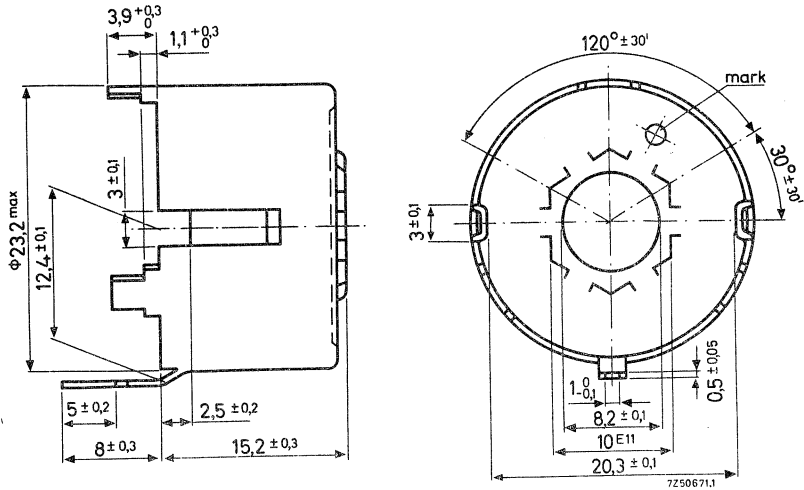
Pins: phosphor bronze, dip-soldered



The tag plates are packed in units of 65 pieces on a polystyrene plate. 450 pieces are packed in a cardboard box. Please order in multiples of these quantities.

(2) Container 4322 021 30540

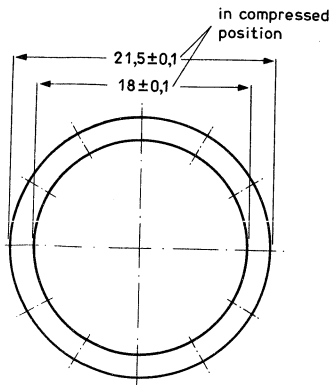
Material: brass, nickel plated, then tin plated.



The containers are packed with 40 pieces in a primary pack and 200 pieces in a storage pack. Please order in multiples of these quantities.

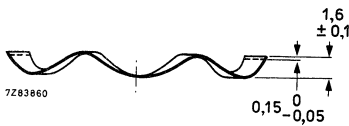
(3) Spring 4322 021 30650

Material: chrome-nickel steel



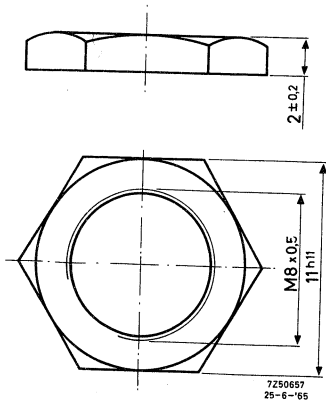
A force of 94 to 156 N is required to compress the spring to 0,45 mm.

The springs are supplied in quantities of 750. Please order in multiples of this quantity.



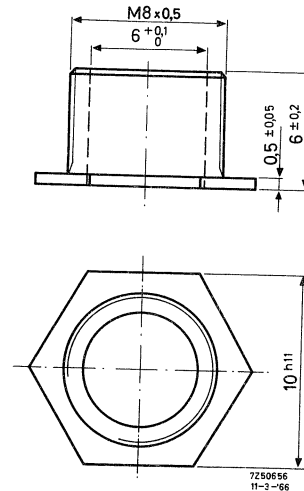
(4) Nut 4322 021 30710

Material: brass, nickel plated



(5) Fixing bush 4322 021 30720

Material: brass, nickel plated

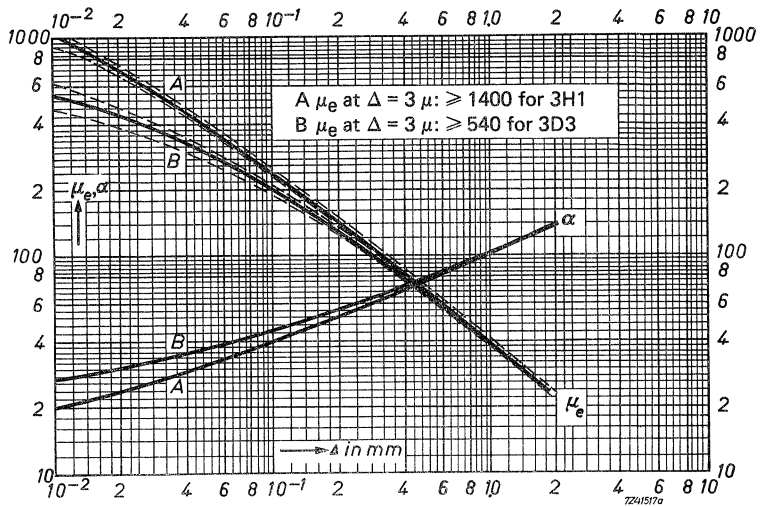


The fixing bush is supplied in quantities of 2500. Please order in multiples of this quantity.



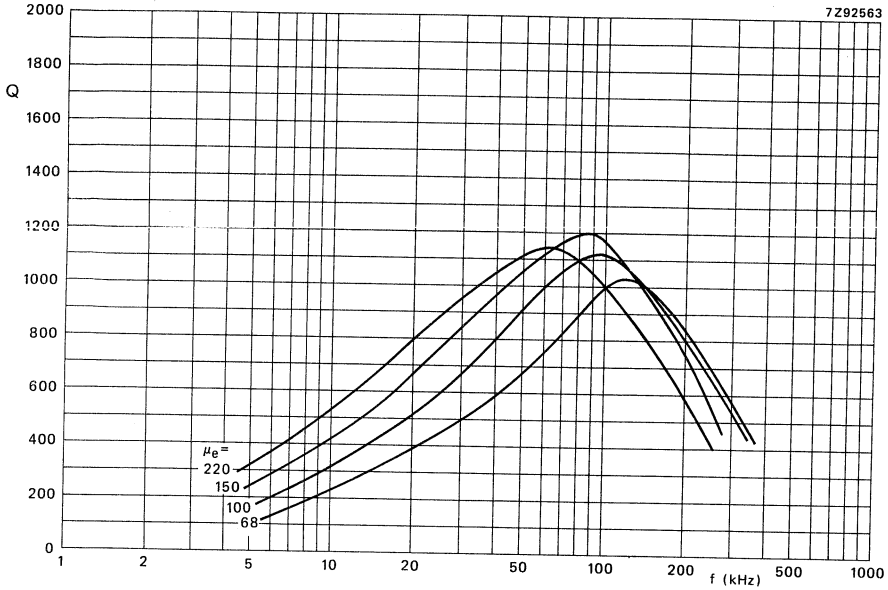
### CHARACTERISTIC CURVES

$\mu_e - \alpha$  curves



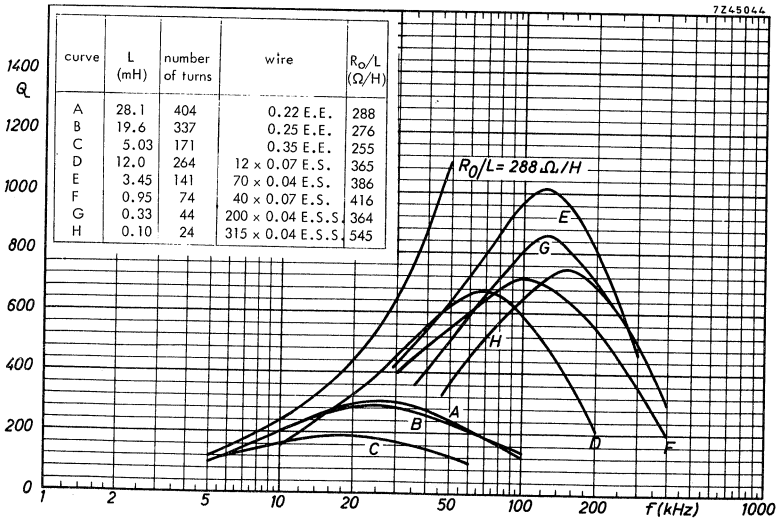
Relative effective permeability and turn factor for 1 mH as a function of the air gap length.

Q-CURVES FOR FXC 3H1



Enveloping curves.

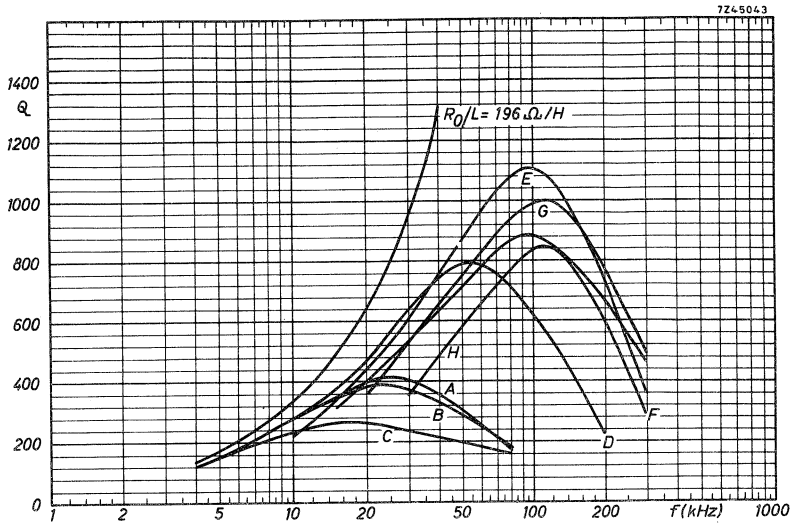
Single-section coil former.



FXC 3H1

$\mu_e = 68$

Single-section coil former.

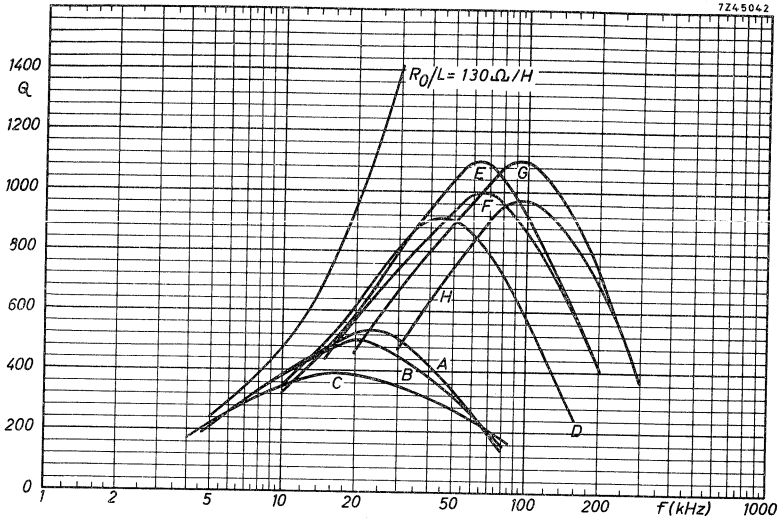


FXC 3H1  
 $\mu_e = 100$

Single-section coil former.

curve	L (mH)	number of turns	wire	$R_0/L$ ( $\Omega/H$ )
A	41.2	404	0.22 E.E.	196
B	28.7	337	0.25 E.E.	187
C	7.39	171	0.35 E.E.	173
D	17.6	264	12 × 0.07 E.S.	248
E	5.07	141	70 × 0.04 E.S.	263
F	1.39	74	40 × 0.07 E.S.	284
G	0.50	44	200 × 0.04 E.S.S.	245
H	0.15	24	315 × 0.04 E.S.S.	369

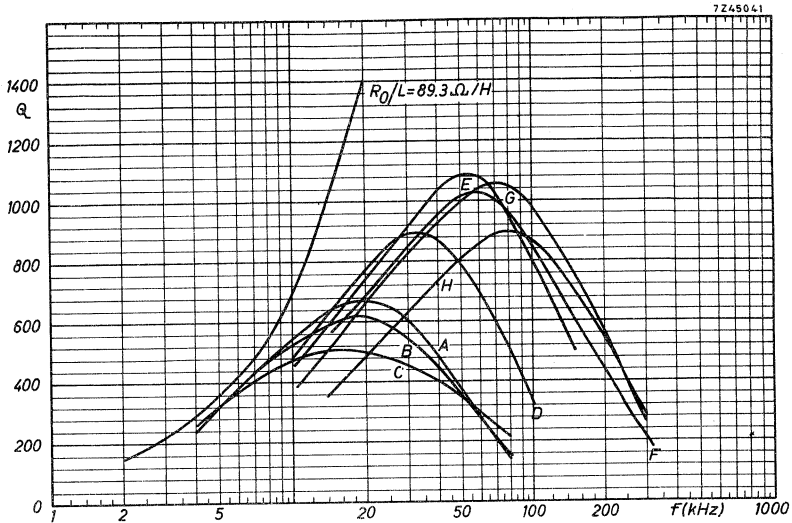
724.5042



FXC 3H1  
 $\mu_e = 150$

Single-section coil former.

curve	L (mH)	number of turns	wire	$R_0/L$ ( $\Omega/H$ )
A	62.0	404	0.22 E.E.	130
B	43.2	337	0.25 E.E.	125
C	11.1	171	0.35 E.E.	115
D	26.5	264	12 x 0.07 E.S.	165
E	7.61	141	70 x 0.04 E.S.	175
F	2.08	74	40 x 0.07 E.S.	189
G	0.74	44	200 x 0.04 E.S.S.	165
H	0.22	24	315 x 0.04 E.S.S.	246

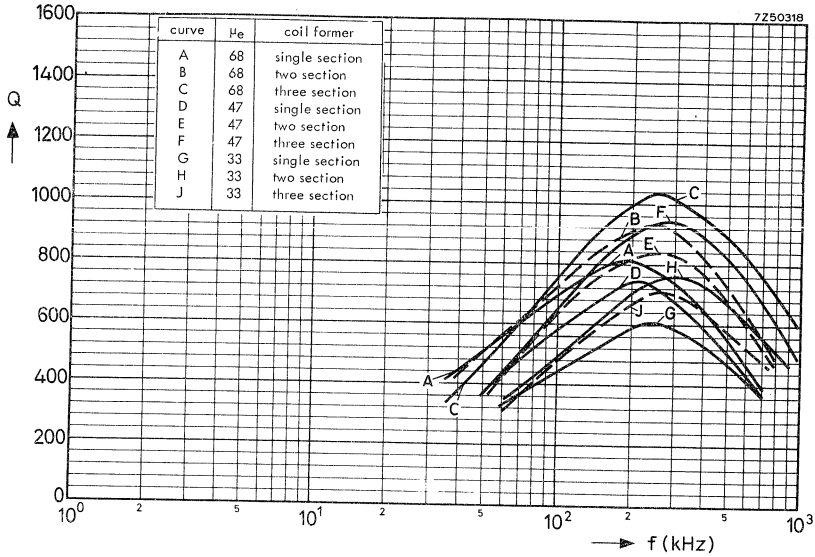


FXC 3H1  
 $\mu_e = 220$

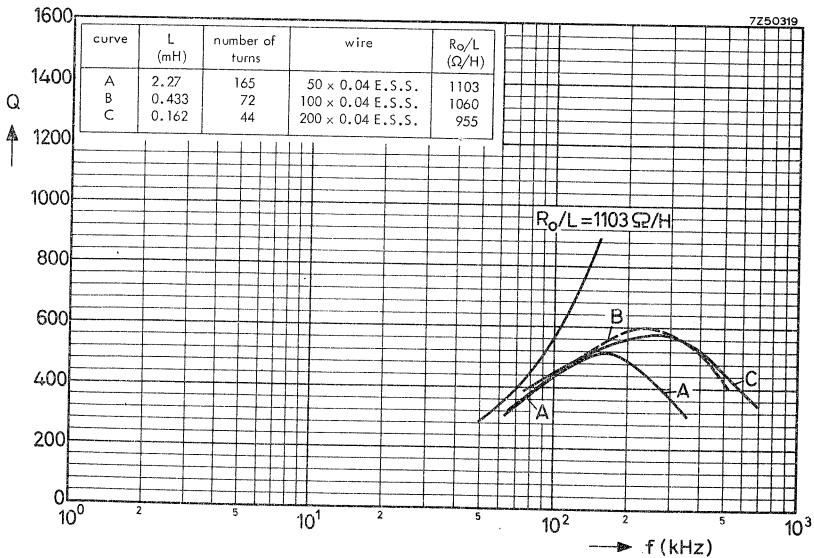
Single-section coil former.

curve	L (mH)	number of turns	wire	$R_0/L$ ( $\Omega/H$ )
A	90.9	404	0.22 E.E.	89.3
B	63.2	337	0.25 E.E.	85.5
C	16.3	171	0.35 E.E.	77.8
D	11.2	264	12 x 0.07 E.S.	113
E	3.87	141	70 x 0.04 E.S.	119
F	3.05	74	40 x 0.07 E.S.	129
G	1.08	44	200 x 0.04 E.S.S.	113
H	0.32	24	315 x 0.04 E.S.S.	168

Q-CURVES FOR FXC 3D3

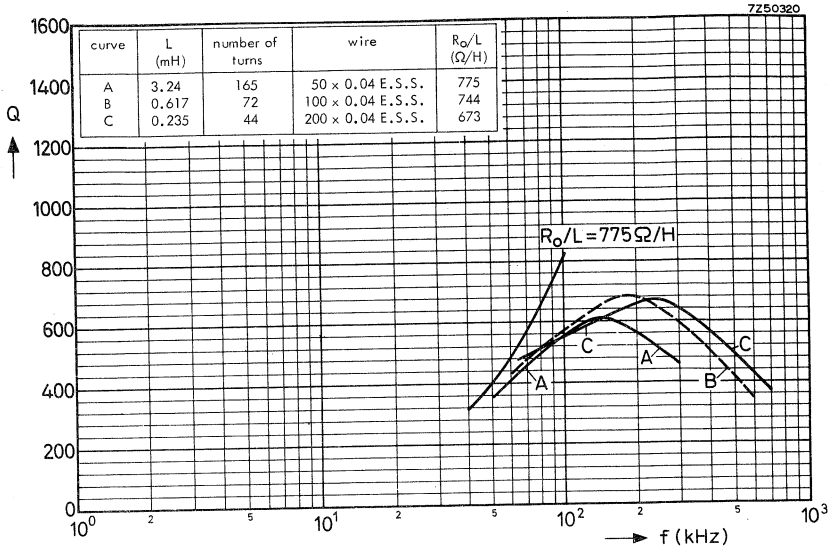


Enveloping curves.



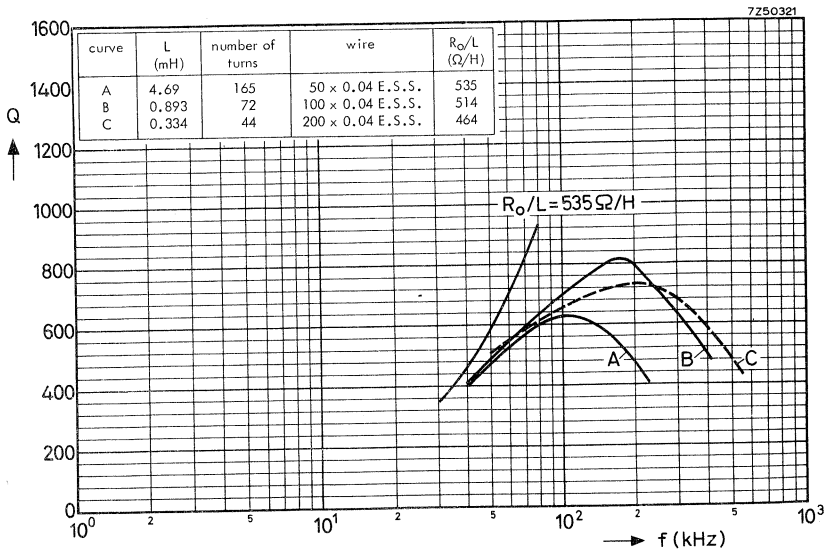
Single-section coil former.

FXC 3D3  
 $\mu_e = 33$



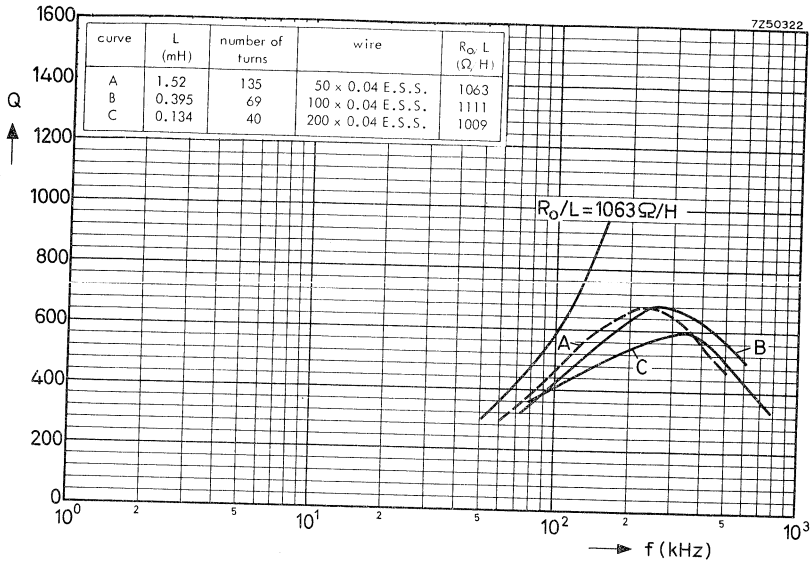
FXC 3D3  
 $\mu_e = 47$

Single-section coil former.



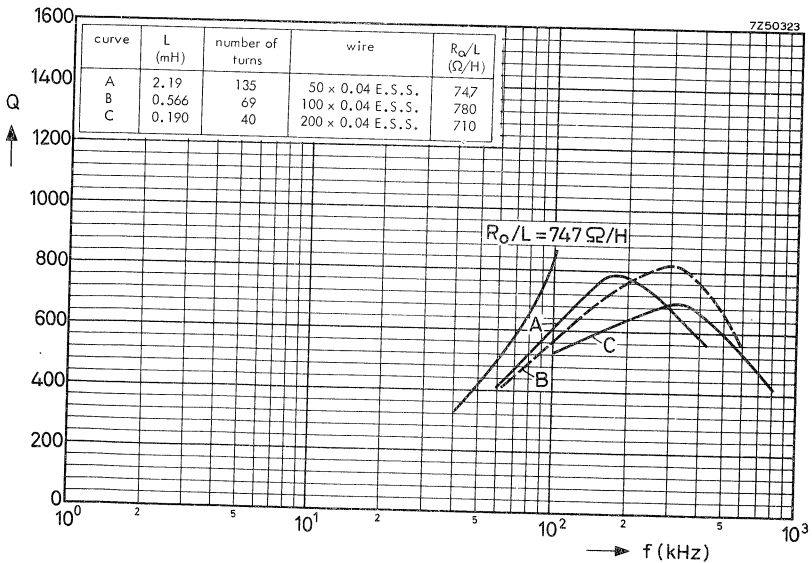
FXC 3D3  
 $\mu_e = 68$

Single-section coil former.



FXC 3D3  
 $\mu_e = 33$

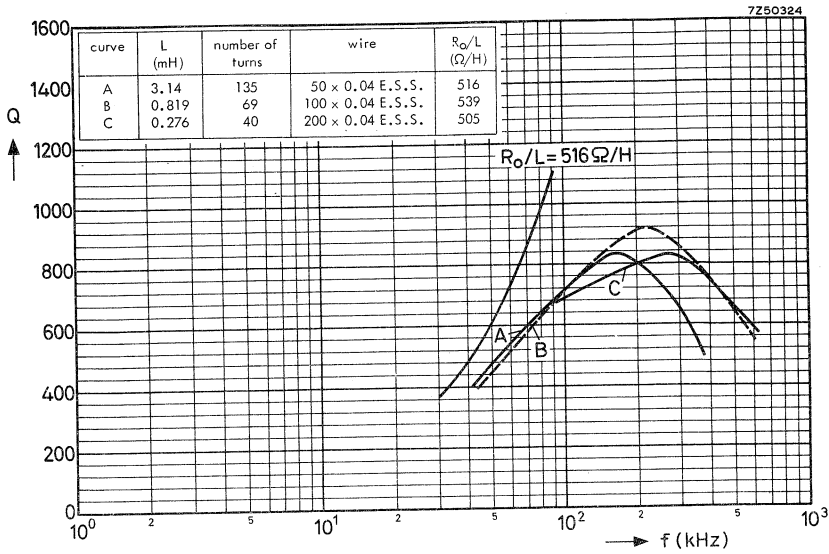
Two-section coil former.



FXC 3D3  
 $\mu_e = 47$

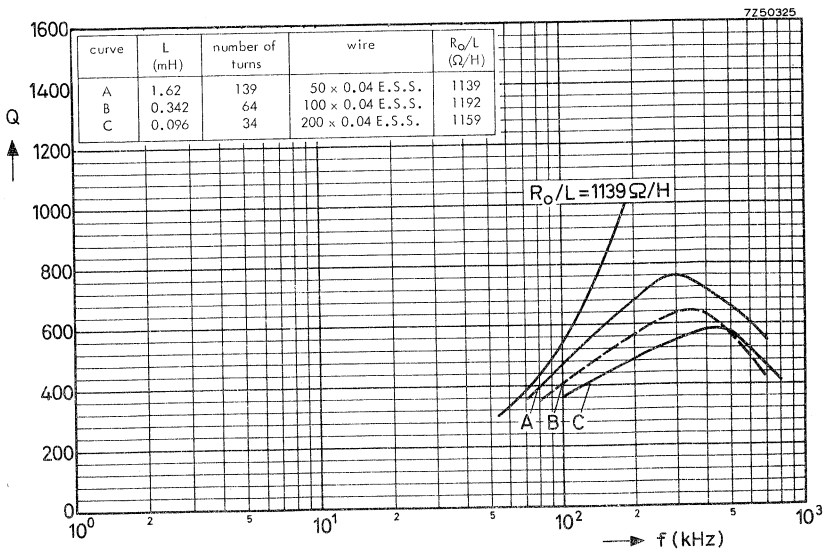
Two-section coil former.





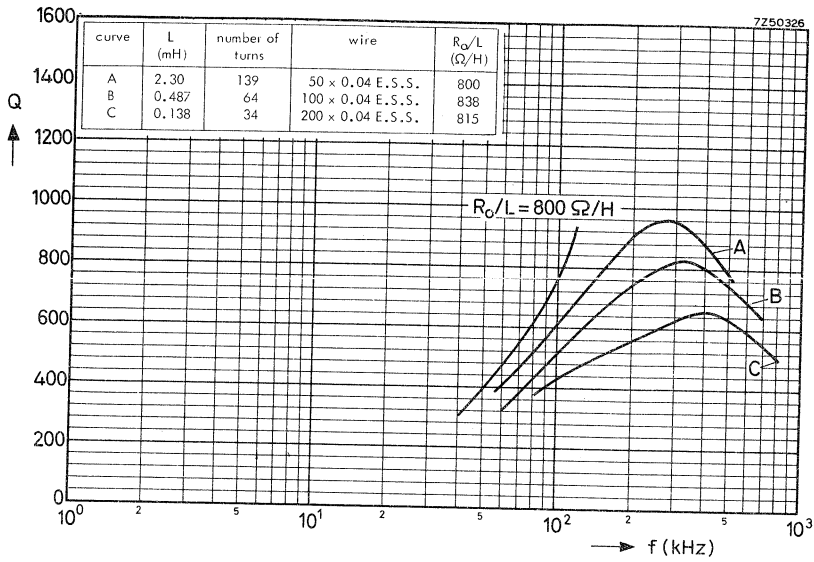
FXC 3D3  
 $\mu_e = 68$

Two-section coil former.



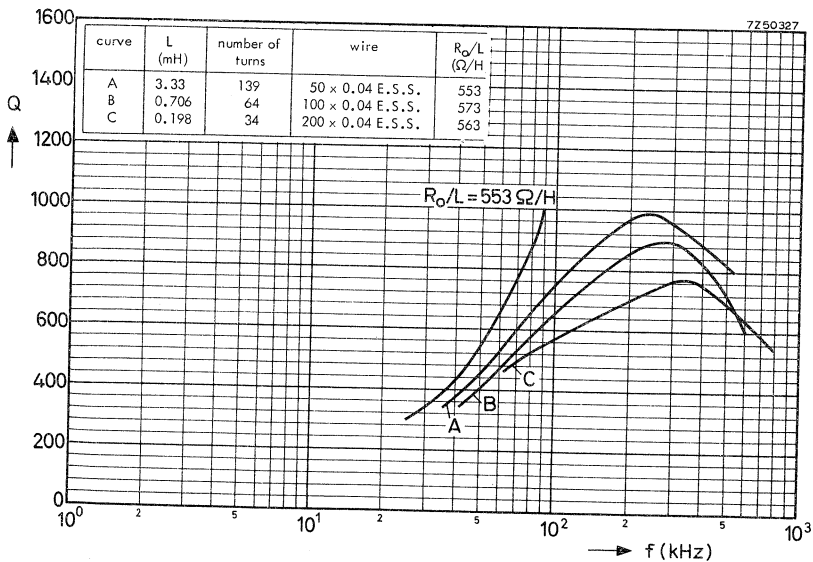
FXC 3D3  
 $\mu_e = 33$

Three-section coil former.



FXC 3D3  
 $\mu_e = 47$

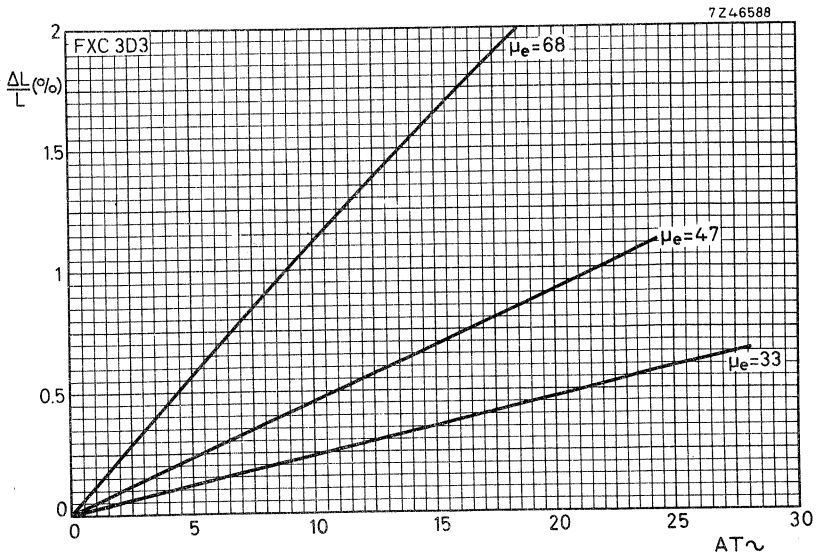
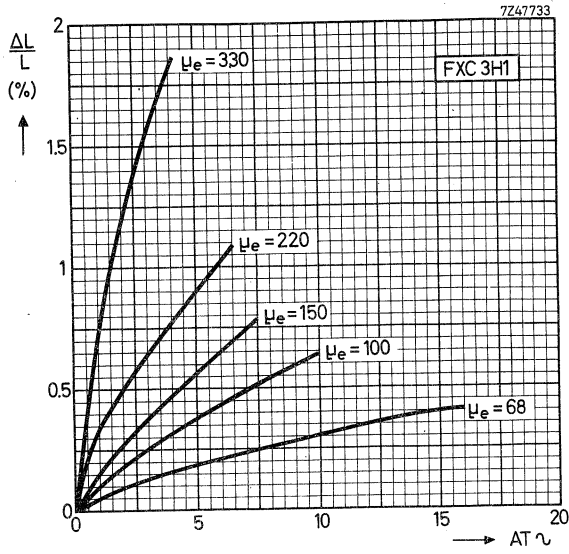
Three-section coil former.

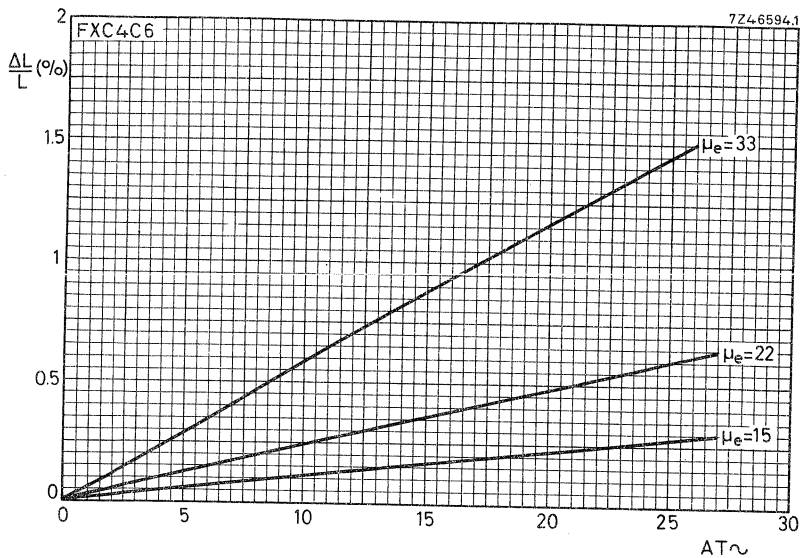


FXC 3D3  
 $\mu_e = 68$

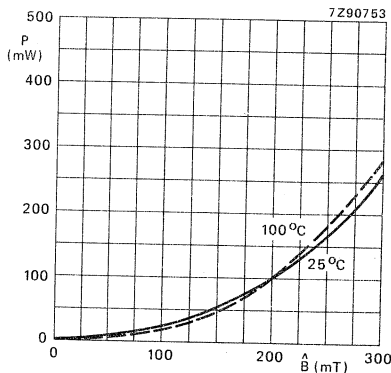
Three-section coil former.

INDUCTANCE VARIATION AS A FUNCTION OF  $AT \sim$



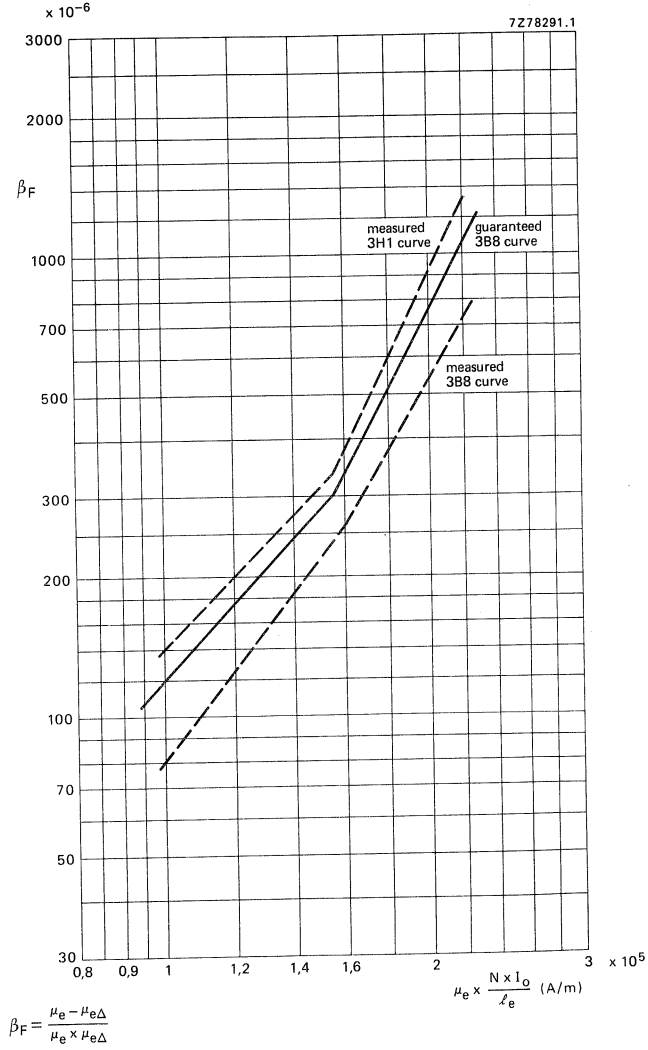


P AS A FUNCTION OF  $\hat{B}$



$\hat{B}$  calculated with  $A_{CPmin} = 51,3 \text{ mm}^2$ . FXC 3B8.

D.C. SENSITIVITY AT 25 °C



Inductance variation as a function of d.c. polarization.



## POTCORES

Three types of core can be supplied:

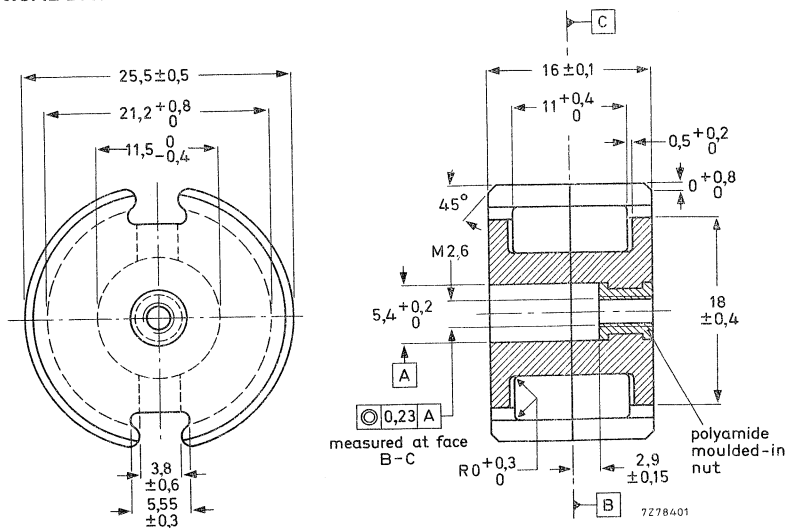
- CORE SETS provided with an injection-moulded nut for an adjuster and pre-adjusted on an inductance factor  $A_L$  or on a relative effective permeability value  $\mu_e$ .
- CORE SETS without nut and pre-adjusted on an  $A_L$  or a  $\mu_e$  value.
- CORE HALVES without air gap.

The potcores are in accordance with the following specifications: IEC 133 (international), NCF83311 (France), DIN 41293 (Germany) and BS 4061 range 2 (Great Britain).

Potcores and associated parts are ordered by their 12-digit catalogue number. Quantity: a primary pack contains 20 core sets or 40 core halves; a storage pack contains 100 core sets or 200 core halves. Please order in multiples of these quantities.

### MECHANICAL DATA

Dimensions in mm



- Pulling-out force of the nut  $\geq 50$  N
- Torque of the screw thread  $\leq 10$  mNm
- Extraction force of adjuster from nut  $\geq 40$  N
- Dimensional quantities according to IEC 205:

$$C_1 = \Sigma \frac{l_e}{A_e} = 0,400 \text{ mm}^{-1}; C_2 = \Sigma \frac{l_e}{A_e^2} = 0,00426 \text{ mm}^{-3}; V_e = 3530 \text{ mm}^3; l_e = 37,6 \text{ mm}; A_e = 93,9 \text{ mm}^2;$$

$$A_{CPmin} = 76,5 \text{ mm}^2.$$

Mass of a core set: 20 g.

Note: The 4C6 version has a cemented nut.

**ELECTRICAL DATA**

The combination of two potcore halves without air gap, randomly chosen from a batch, has the following guaranteed properties. A measuring coil as described in the General section 'Potcores, square cores and cross cores' is inserted; the halves are pressed together with a force of 200 N. The values are valid 5 minutes or more after clamping.

	freq. kHz	$\hat{B}$ mT	temp. °C	grade			
				3B8	3D3	3H1	4C6
$A_L \pm 25\%$	4	$\leq 0,1$	$25 \pm 1$	5025	2300	5900	
$\mu_e \pm 25\%$	4	$\leq 0,1$	$25 \pm 1$	1600	730	1900	400
$\alpha$	4	$\leq 0,1$	$25 \pm 1$	$\leq 16,3$	$\leq 24,1$	$\leq 14,9$	125
$\tan \delta$							$\leq 58,0$
$\frac{\delta}{\mu_i} \times 10^6$	4	$\leq 0,1$	$25 \pm 1$			$\leq 1,2$	
	100	$\leq 0,1$	$25 \pm 1$		$\leq 8,0$	$\leq 5,0$	
	500	$\leq 0,1$	$25 \pm 1$		$\leq 16$		
	1000	$\leq 0,1$	$25 \pm 1$		$\leq 30$		
	2000	$\leq 0,1$	$25 \pm 1$				
	10 000	$\leq 0,1$	$25 \pm 1$				$\leq 40$
P (W)	25	200*	$25 \pm 1$	$\leq 0,60$			$\leq 100$
			$100 \pm 1$	$\leq 0,70$			
$\eta_B \times 10^3$	4	1,5 to 3,0	$25 \pm 1$			$\leq 0,86$	
	100	0,3 to 1,2	$25 \pm 1$		$\leq 1,8$		
$\alpha_F \times 10^6/K$	$\leq 100$	$\leq 0,1$	5 to 25			+ 0,5 to 1,5	$\leq 6,2$
	$\leq 100$	$\leq 0,1$	25 to 55			+ 0,5 to 1,5	-2 to +4
	$\leq 100$	$\leq 0,1$	25 to 70		0 to +2		0 to +6
$D_F \times 10^6$ (10-100 min)	$\leq 100$	$\leq 0,1$	$25 \pm 0,1$		$\leq 12$	$\leq 4,3$	$\leq 10$
$\beta_F \times 10^6$ , measured on sets with $\mu_e = 300 \pm 10\%$ and $25 \pm 1$ °C:							
at $\mu_e \times \frac{N \times I_o}{I_e} = 1,00 \times 10^5$ A/m				$\leq 120$			
= $1,55 \times 10^5$ A/m				$\leq 300$			
= $2,25 \times 10^5$ A/m				$\leq 1100$			

\*  $\hat{B}$  is calculated with  $A_{CPmin} = 76,5$  mm<sup>2</sup>.



Core sets with nut and pre-adjusted on  $A_L$ .

$A_L$	corresponding $\mu_e$ -value	catalogue number 4322 022 . . . . .			
		3B8	3D3	3H1	4C6
63 ± 1%	20		09430	29230	29830
100 ± 1%	31,8		● 29440	29240	● 29840
160 ± 1%	51		29450	29250	
250 ± 1%	79,5	09860	● 29460	29260	
315 ± 1,5%	100			29270	
400 ± 2%	127	● 09880	29480	● 29280	
630 ± 3%	200	● 09890		● 29300	
1000 ± 3%	318			29310	
1600 ± 3%	510	09900		29320	

Core sets with nut and pre-adjusted on  $\mu_e$ .

$\mu_e$	$\alpha$	catalogue number 4322 022 . . . . .			
		3B8	3D3	3H1	4C6
15 ± 1%	146		08410		28810
22 ± 1%	120				28820
33 ± 1%	98,2				28830
47 ± 1%	82,3		28430	28230	
68 ± 1%	68,4		28440	28240	
100 ± 1,5%	56,4		28450	28250	
150 ± 2%	46,1			28260	
220 ± 3%	38,1			28270	
330 ± 3%	31,0			28280	
730 ± 25%	20,8			28290	
1910 ± 25%	12,9		08400	08200	

Core sets without nut: replace the eight digit of the catalogue number (2) by 0.

Cores with  $A_L \leq 400$  or  $\mu_e \leq 100$ , have a symmetrical air gap, except those in 3B8.Cores with  $A_L \geq 630$  or  $\mu_e \geq 150$ , and all cores in 3B8 have an asymmetrical air gap.

Core halves without air gap, without nut.

Ferroxcube grade	catalogue number
3B8	4322 020 22220
3D3	4322 020 22020
3H1	4322 020 22010
4C6	4322 020 22110

● Preferred type.

## COIL FORMERS

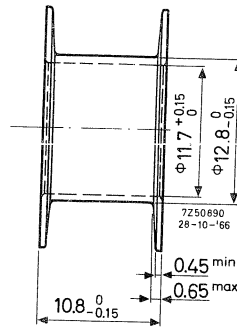
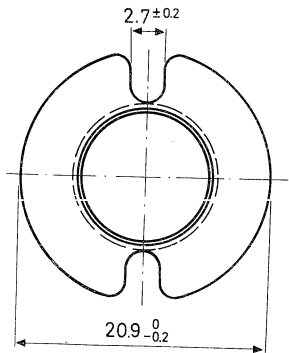
Three types of coil former can be supplied:

- with one section;
- with two sections;
- with three sections.

→ The dimensions conform with the following specifications: IEC 133 (international), NCF83311 (France), DIN 41294 (Germany) and BS 4061 range 2 (Great Britain).

### SINGLE-SECTION COIL FORMER

Dimensions in mm



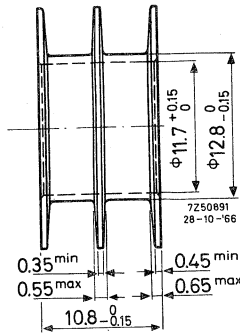
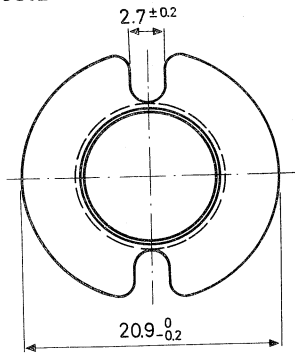
Catalogue number	4322 021 30330
Material	polycarbonate
Window area	39 mm <sup>2</sup>
Mean length of turn	53 mm
Max. temperature	130 °C

D.C. losses

$$\frac{R_o}{L} = \frac{1}{\mu_e} \times \frac{1}{f_{cu}} \times 7,42 \times 10^3 \Omega/H$$

Mass 0,5 g

**TWO-SECTION COIL FORMER**



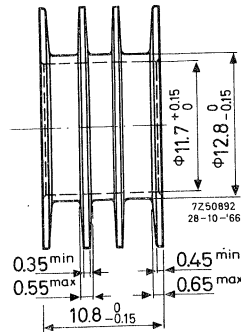
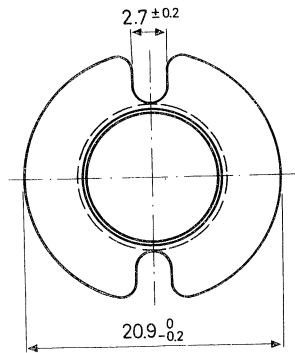
Catalogue number 4322 021 30340  
 Material polycarbonate  
 Window area 2 mm x 19 mm  
 Mean length of turn 53 mm  
 Max. temperature 130 °C

D.C. losses

$$\frac{R_o}{L} \times \frac{1}{\mu_e} \times \frac{1}{f_{cu}} \times 7,79 \times 10^3 \Omega/H$$

Mass 0,6 g

**THREE-SECTION COIL FORMER**



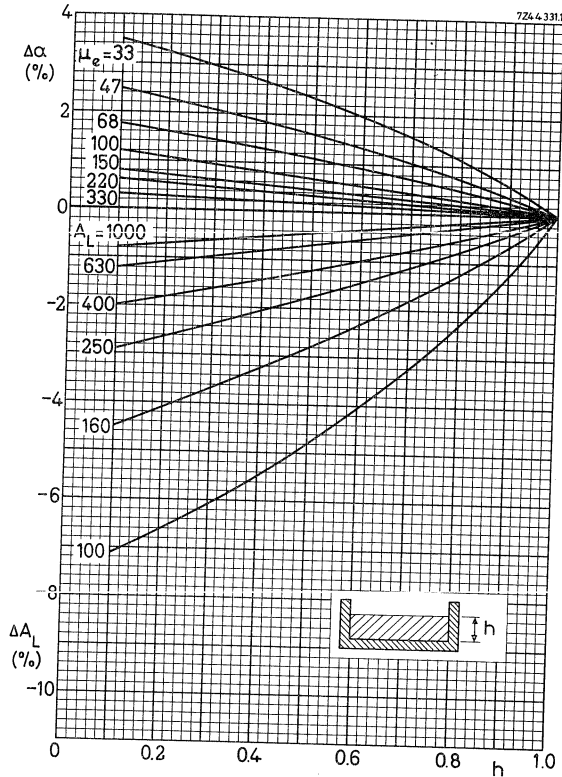
Catalogue number 4322 021 30350  
 Material polycarbonate  
 Window area 3 mm x 12 mm  
 Mean length of turn 53 mm  
 Max. temperature 130 °C

D.C. losses

$$\frac{R_o}{L} \times \frac{1}{\mu_e} \times \frac{1}{f_{cu}} \times 8,18 \times 10^3 \Omega/H$$

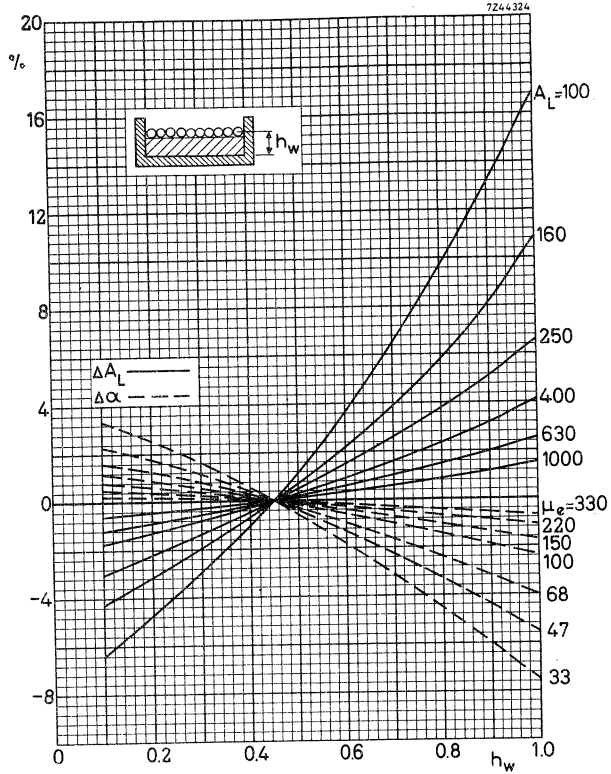
Mass 0,7 g

DATA FOR WHEN THE COIL FORMER IS PARTLY FILLED



Increase of the  $\alpha$  and decrease of the  $A_L$  factor for different  $\mu_e$  values and  $A_L$  factors as a function of the relative winding height on a single-section coil former.

Valid for Ferroxcube 3H1 and 3D3 only.  
 Example: On a single-section coil former only 0,4 part of the available height is used. A potcore with  $\mu_e = 68$  in that case obtains an  $\alpha$  factor of 68,4 + 1,25%.



Variation of the  $\alpha$  and  $A_L$  factors for a coupling winding of one layer as a function of its winding height  $h_w$  on a single-section coil former.  
 Valid for Ferroxcube 3H1 and 3D3 only.

Example: On a single-section coil former a coupling winding is laid on 0,7 of the available height.  
 A potcore with  $\mu_e = 68$  obtains for that winding an  $\alpha$  factor of 68,4 - 1,7%.

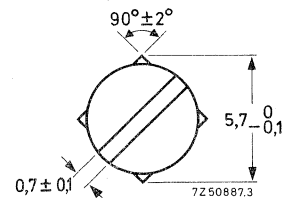
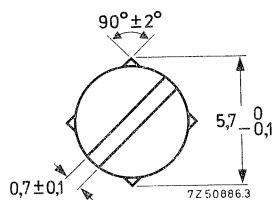
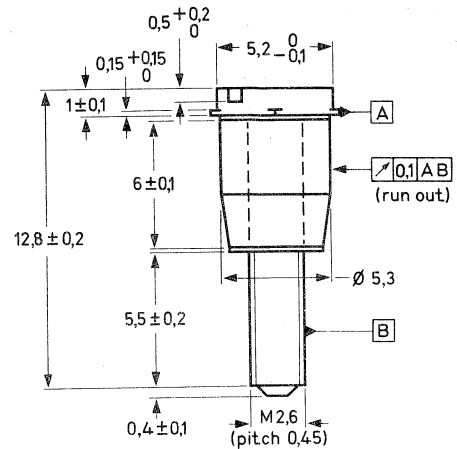
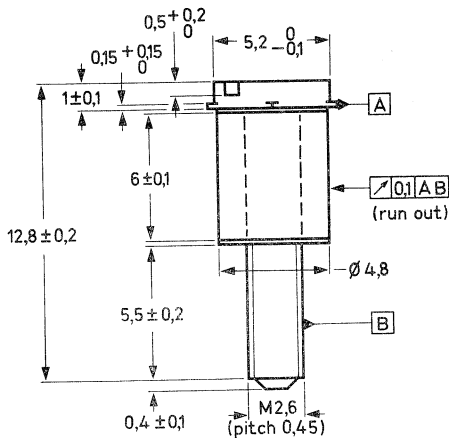


## INDUCTANCE ADJUSTERS

(old types)

## CONTINUOUS ADJUSTERS

Dimensions in mm



The tolerances on inductance of the pre-adjusted potcores (without adjuster) are given under Potcores. After inserting a coil (impregnated or not) in an electrical circuit, its inductance can be adjusted to the required value with an accuracy  $< 0,03\%$  by means of a continuous inductance adjuster. Such an adjuster increases the inductance of the coil, see following pages.

The adjuster is screwed through the potcore into the nut and is held in position by the four protrusions near the top of the adjuster. For special requirements a bigger or smaller adjustment range may be obtained by using an adjuster belonging to the next higher or lower effective permeability.

The influence of the adjusters on the variability of the inductance is negligible. The maximum permissible temperature is  $110\text{ }^{\circ}\text{C}$ .

Table 2 shows the type of adjuster recommended for different potcores.

Table I, types of adjuster

Fig.	colour	catalogue number
A	natural	4322 021 30780
A	yellow	4322 021 30790
A	red	4322 021 30800
A	brown	4322 021 30810
B	white	4322 021 30980
B	grey	4322 021 31090

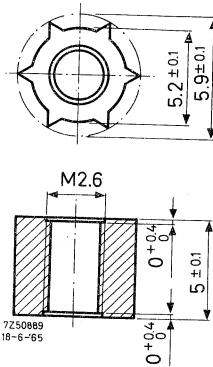
The adjusters are packed in plastic bags of 100. Please order in multiples of this quantity.

Table II, recommended application

$\mu_e$	$A_L$	3H1/3D3	4C6
		catalogue number 4322 021 .....	
15		—	30780
22		—	30780
	63	—	30780
33		30780	30790
	100	30780	30790
47		30800	
	160	30800	
68		30980	
	250	30980	
100		30980	
150		30810	
	400	30810	
220		30810	
	630	30810	
330		31090	
	1000	31090	

**Nut for adjuster**

These data are given for those manufacturers who prefer to insert the nut themselves.



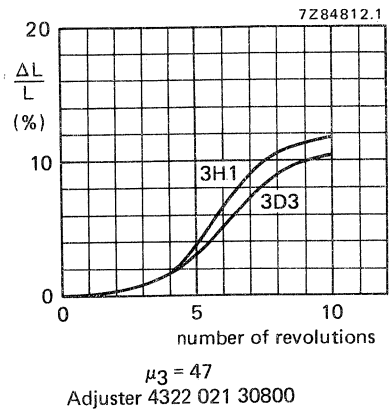
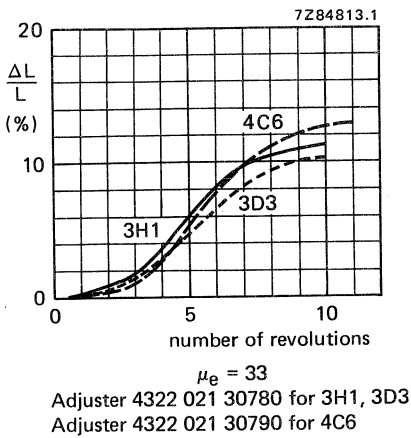
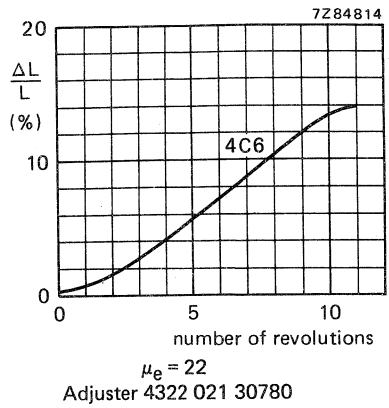
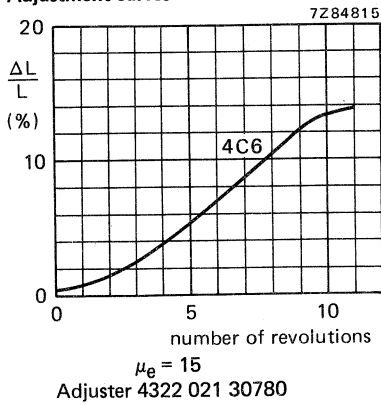
- Catalogue number 4322 021 30160
- Material polycarbonate
- Maximum impregnation temperature for 24 hours 120 °C
- Recommended distance from mating surface to nut 2,9 ± 0,15 mm

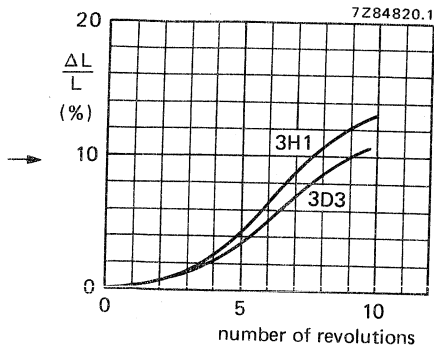
For more information see Potcores General, Mounting data.

The nuts are packed in plastic bags of 100. Please order in multiples of this quantity.

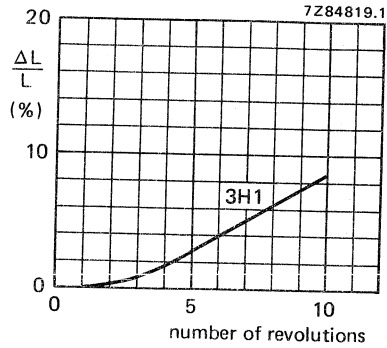


Adjustment curves

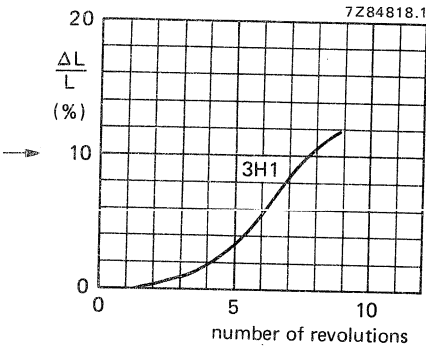




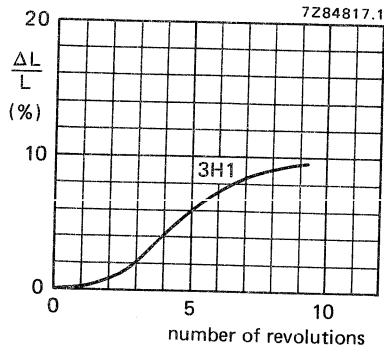
$\mu_e = 68$   
Adjuster 4322 021 30980



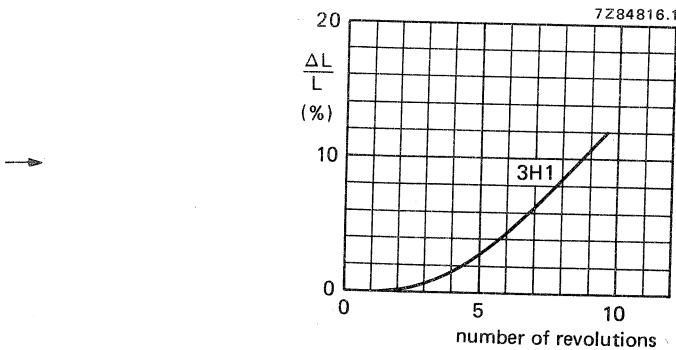
$\mu_e = 100$   
Adjuster 4322 021 30980



$\mu_e = 150$   
Adjuster 4322 021 30810



$\mu_e = 220$   
Adjuster 4322 021 30810



$\mu_e = 330$   
Adjuster 4322 021 31090

## INDUCTANCE ADJUSTERS

(new types)

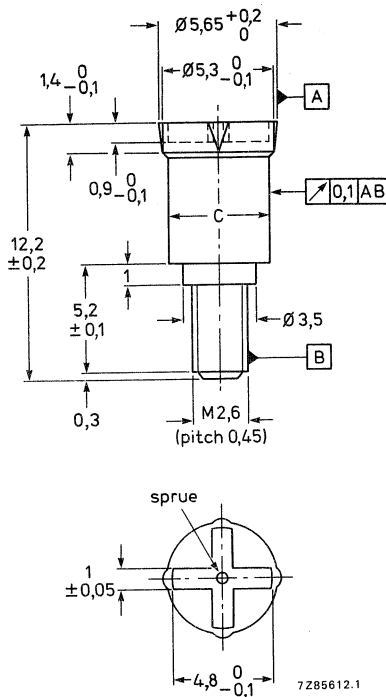


Fig. 1.

Material: polypropylene, reinforced with glass fibre.

The tolerances on inductance factor of the pre-adjusted cores without adjuster are given in the table of pre-adjusted cores with standard  $A_L$  values. The inductance of the pre-adjusted core can be increased to the required value — with a setting accuracy  $< 0,03\%$  — by means of a continuous adjuster.

The adjuster is screwed through the centre hole of the core into the nut and is held in position by the four cones near the top of the adjuster.

The combination of the polyamide moulded-in nut and the polypropylene adjuster — both reinforced with glass fibre — gives an excellent stability with temperature, shocks and vibrations. Besides this, the combination has a very smooth adjustment curve due to the excellent concentricity of the moulded-in nut and the adjuster.

The maximum permissible temperature of the adjustment combination is: 150 °C, during 8 h. The maximum working temperature is 110 °C.

The tables below show the available types and which adjuster is recommended for typical  $A_L$  values.

Table 1 Colour code of adjusters

catalogue number	colour	dia. C (Fig. 1) mm	material
4322 021 39410	brown	4,80	FXC
39480	white	4,60	FXC
39490	grey	5,15	FXC

Table 2 Catalogue numbers of recommended adjusters for typical  $A_L$  values

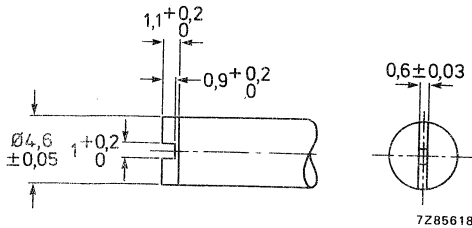
$A_L$	3H1	3D3	4C6
63			
100			
160			
250	4322 021 39480	4322 021 39480	
315	39480		
400	39410	39490	
630	39490		
1000	39490		

**PACKAGING**

The adjusters are packed in plastic bags of 100. Please order in multiples of this quantity.

**ADJUSTING TOOL**

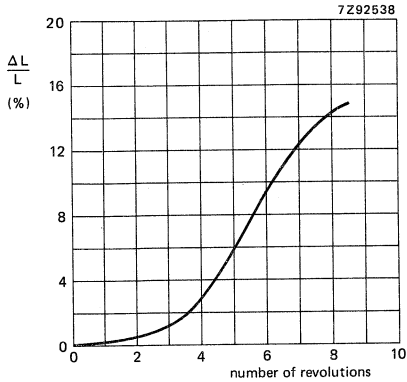
An adjusting tool combination for M2 and M2, 6 is available, catalogue number 4322 058 03270.



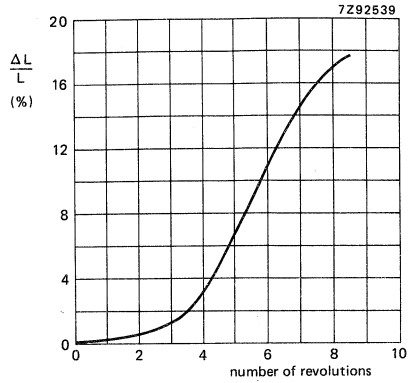
For customers who wish to make the screwdriver themselves the outlines of the essential part are given in Fig. 2.

ADJUSTMENT CURVES

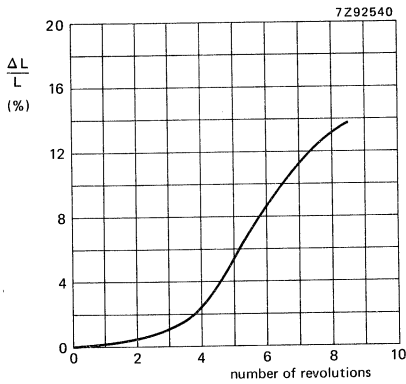
Characteristic curves



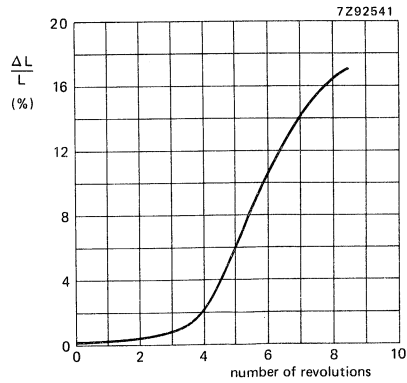
$A_L = 250$ ; FXC 3D3.



$A_L = 250$ ; FXC 3H1.

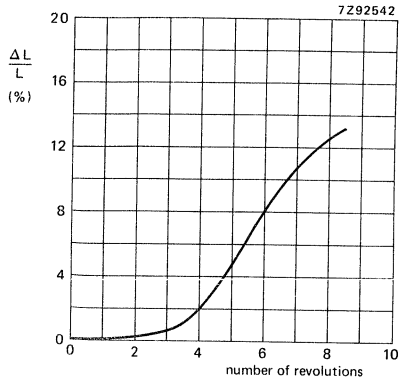


$A_L = 315$ ; FXC 3H1.

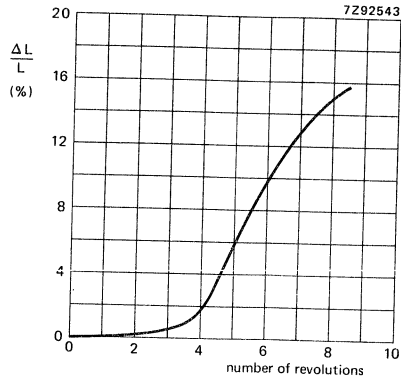


$A_L = 400$ ; FXC 3D3.

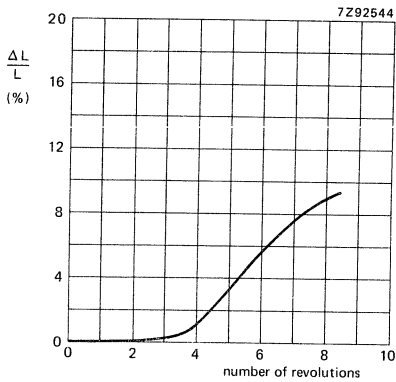
Note: 0 revolutions corresponds to at least one turn of interaction.



$A_L = 400$ ; FXC 3H1.



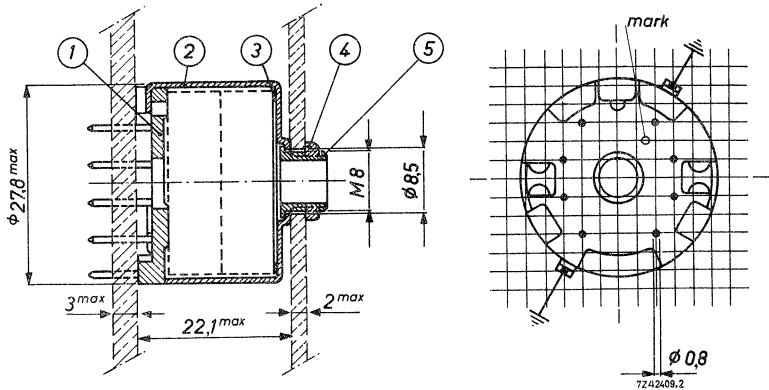
$A_L = 630$ ; FXC 3H1.



$A_L = 1000$ ; FXC 3H1.

## MOUNTING PARTS

## MOUNTING



(1) tag plate	4322 021 30470	(4) nut	4322 021 30710
(2) brass container	4322 021 30550	(5) fixing brush	4322 021 30720
(3) spring	4322 021 30660		

The core is suitable for mounting on printed-wiring boards and on conventional panels.

The parts 1, 2 and 3 are sufficient to construct an assembly for use in combination with printed wiring.

The eight soldering pins are arranged to fit a grid of 2,54 mm (0,1 inch).

The pin length is sufficient for a board thickness of up to 3 mm. The board should be provided with holes of  $1,3 + 0,1$  mm diameter.

If one-hole mounting is preferred, the parts 4 and 5 should be added. The coil assembly may then be mounted on panels having a thickness of up to 2 mm. The panel should be provided with a hole of 8,5 mm diameter.

\* There is another mark hole in a similar position on the top of the container.

It is recommended that the spring (3) be placed in the position indicated to obtain the best stability against shock and vibration.

Before bending the lips of the container, pressure should be exerted evenly on the rim of the tag plate until it meets the container. The force which is required is approximately 200 Newton. After bending the lips the spring will have the correct tension.

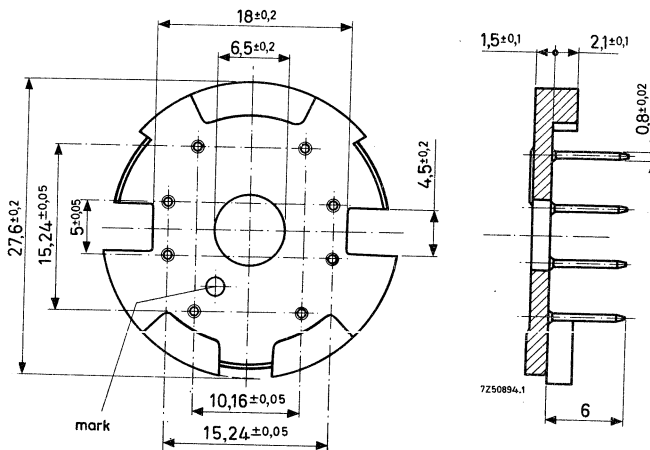
**PART DRAWINGS**

Dimensions in mm

(1) Tag plate 4322 021 30470

Plate: polyester reinforced with glass fibre, resistant against dip-soldering at 400 °C for 2 s.

Pins: phosphor bronze, dip-soldered

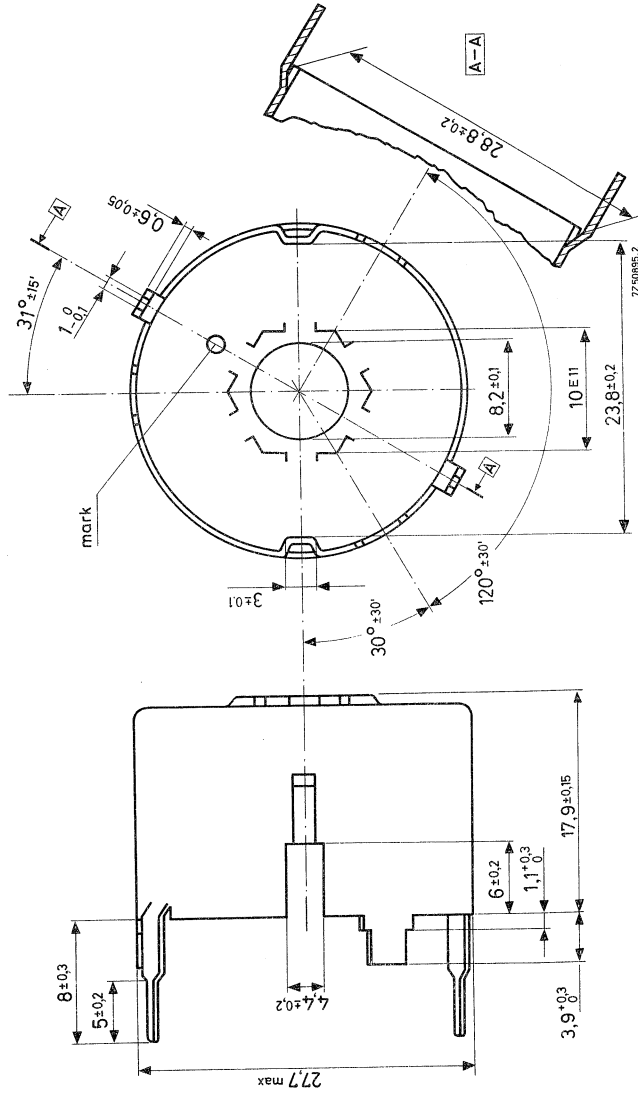


The tag plates are packed in units of 40 pieces on a polystyrene plate, and with 250 pieces in a cardboard box. Please order in multiples of these quantities.



(2) Container 4322 021 30550

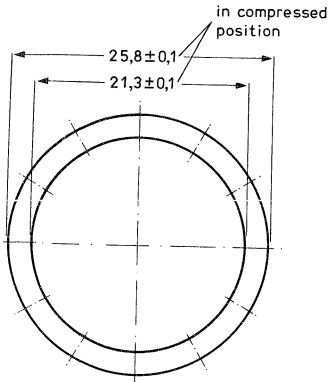
Material: brass, nickel plated; thereafter tin plated.



The containers are packed with 40 pieces in a primary pack, and 200 pieces in a storage pack. Please order in multiples of these quantities.

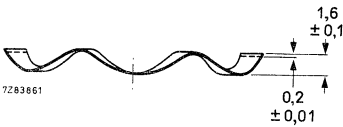
(3) Spring 4322 021 30660

Material: chrome-nickel steel.



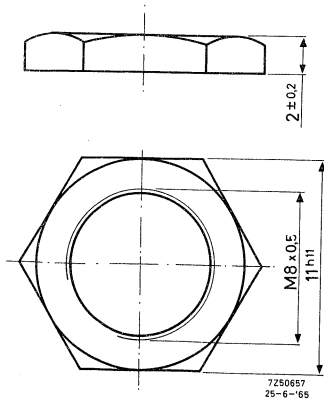
A force of 136 to 225 N is required to compress the spring to 0,55 mm.

The springs are supplied in quantities of 500. Please order in multiples of this quantity.



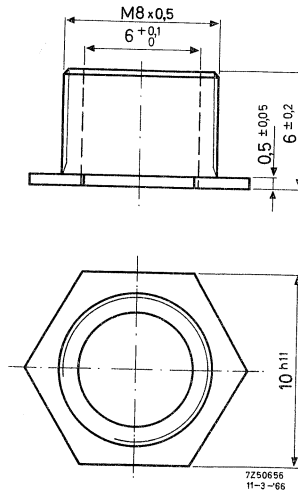
(4) Nut 4322 021 30710

Material: brass, nickel plated.



(5) Fixing bush 4322 021 30720

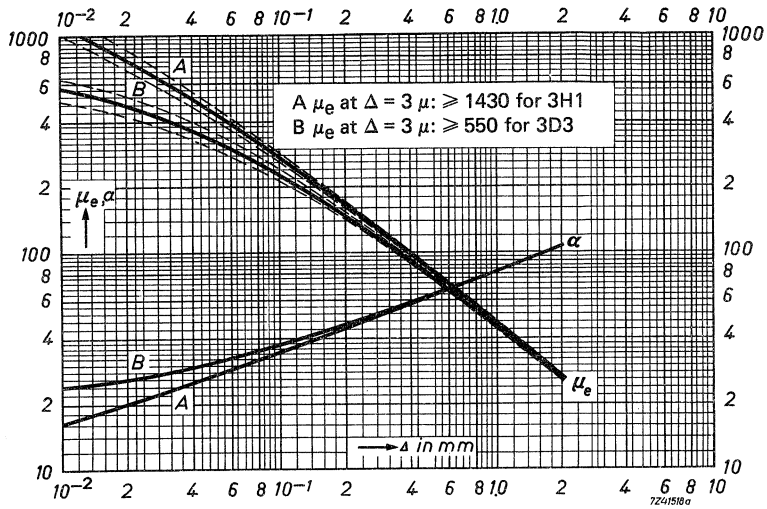
Material: brass, nickel plated.



The fixing bushes are supplied in quantities of 2500. Please order in multiples of this quantity.

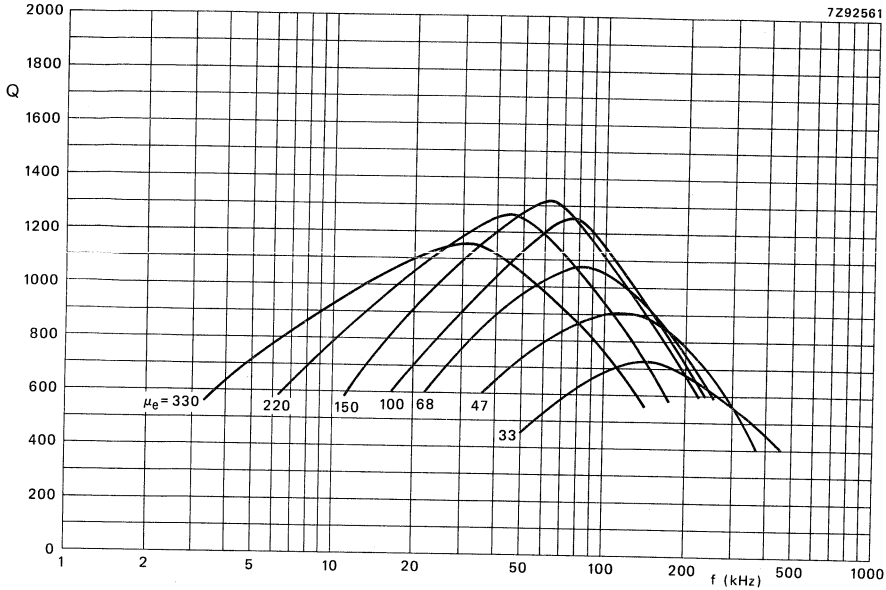
### CHARACTERISTIC CURVES

$\mu_e$  -  $\alpha$  CURVES



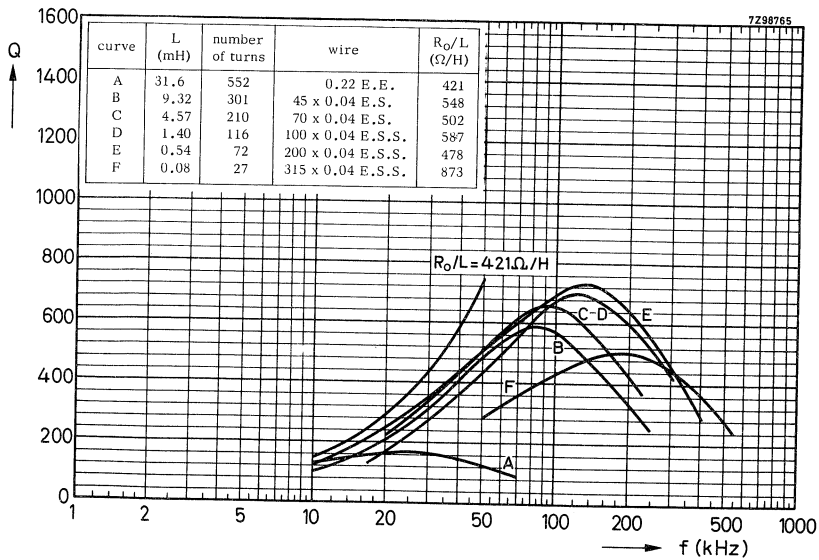
Relative effective permeability and turn factor for 1 mH as a function of the air-gap.

TYPICAL Q-CURVES FOR FXC 3H1



Enveloping curves.

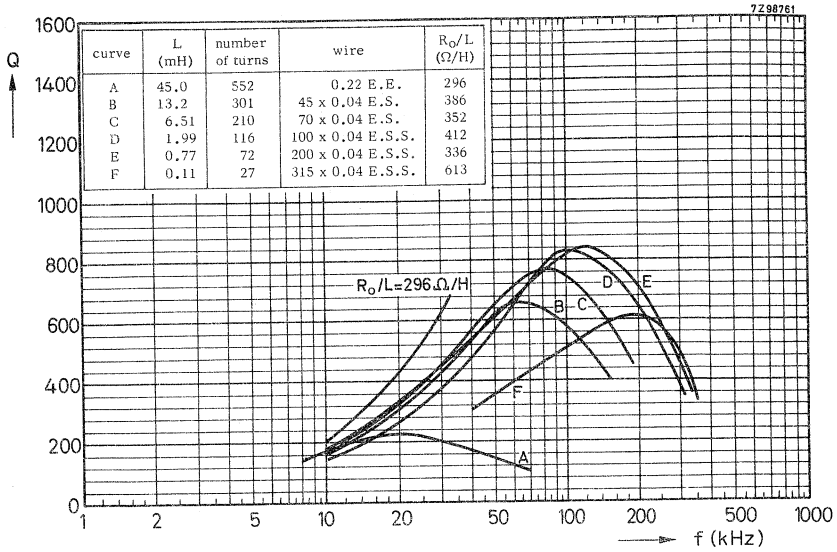
Single-section coil former.



FXC 3H1

$\mu_e = 33$

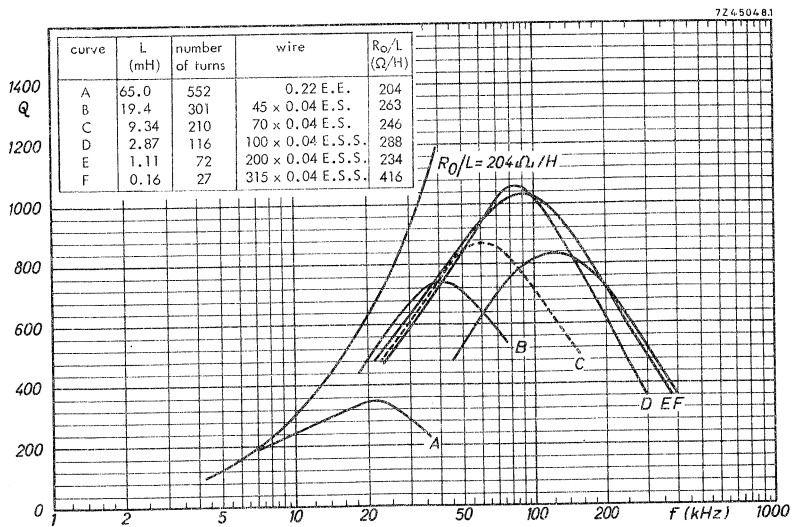
Single-section coil former.



FXC 3H1

$\mu_e = 47$

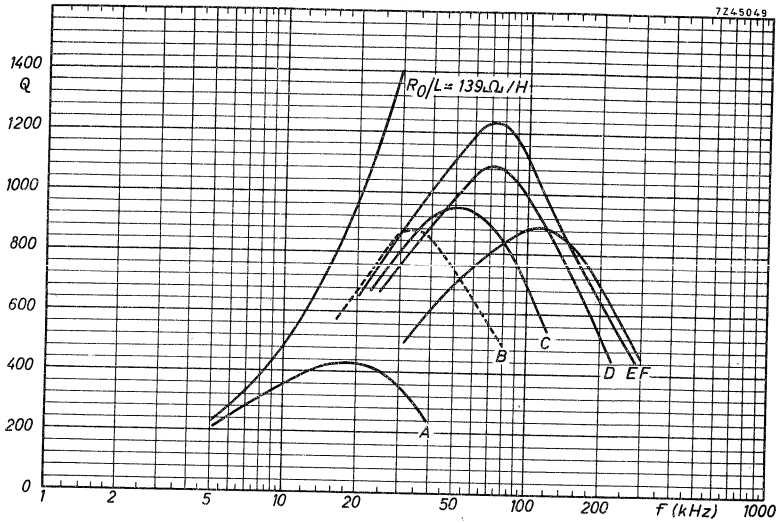
Single-section coil former.



FXC 3H1

$\mu_e = 68$

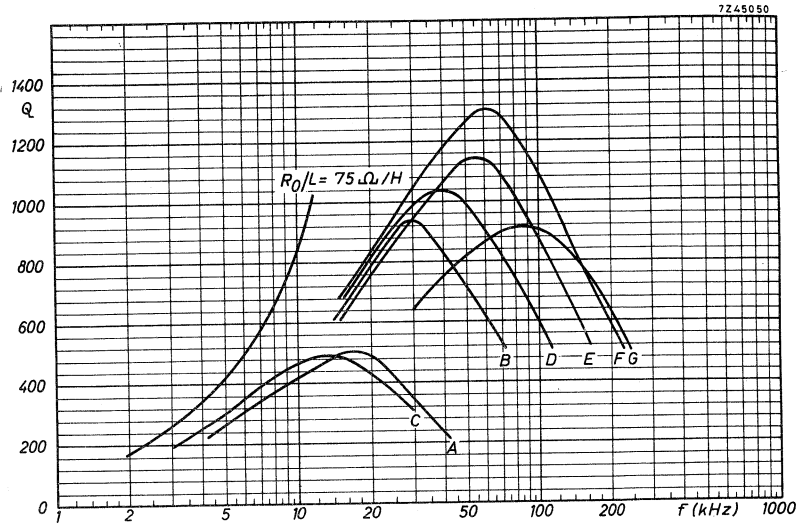
Single-section coil former.



FXC 3H1  
 $\mu_e = 100$

Single-section coil former.

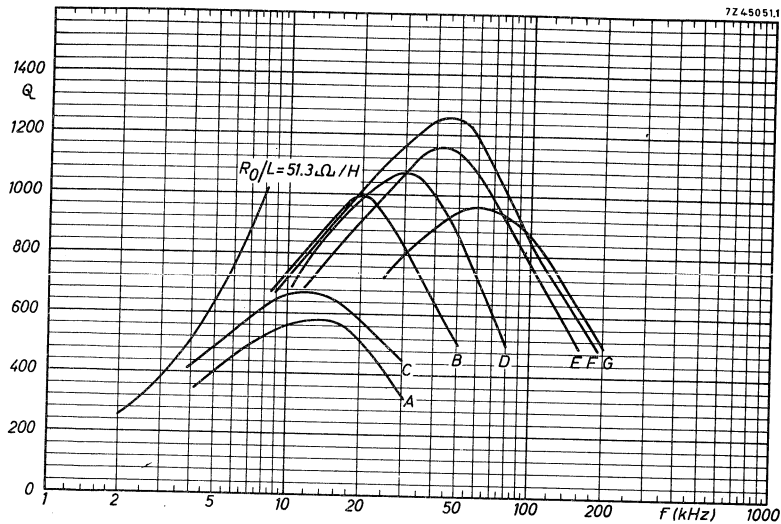
curve	L (mH)	number of turns	wire	$R_0/L$ ( $\Omega/H$ )
A	96.0	552	0.22 E.E.	139
B	28.4	301	45 × 0.04 E.S.	180
C	13.9	210	70 × 0.04 E.S.	168
D	4.24	116	100 × 0.04 E.S.S.	195
E	1.63	72	200 × 0.04 E.S.S.	160
F	0.23	27	315 × 0.04 E.S.S.	280



FXC 3H1  
 $\mu_e = 150$

Single-section coil former.

curve	L (mH)	number of turns	wire	$R_0/L$ ( $\Omega/H$ )
A	143	552	0.22 E.E.	93
B	42.6	301	45 × 0.04 E.S.	120
C	35.7	275	0.35 E	75
D	20.8	210	70 × 0.04 E.S.	110
E	6.34	116	100 × 0.04 E.S.S.	130
F	2.45	72	200 × 0.04 E.S.S.	106
G	0.34	27	315 × 0.04 E.S.S.	187

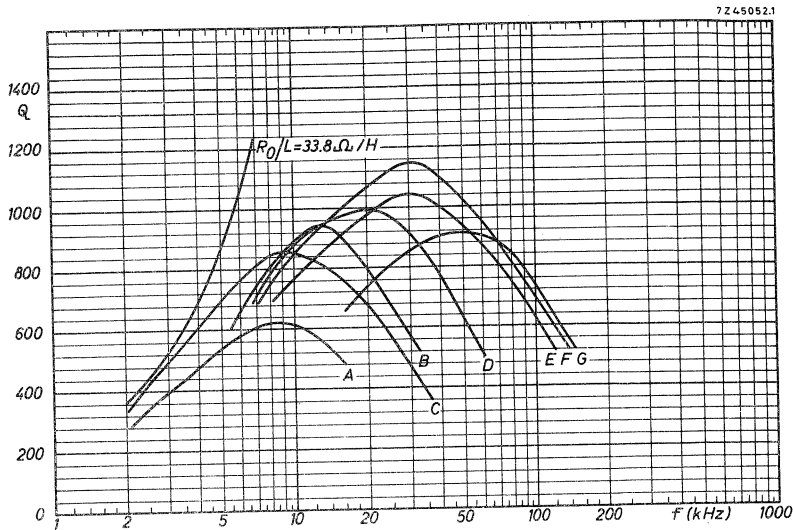


FXC 3H1  
 $\mu_e = 220$

Single-section coil former.

curve	L (mH)	number of turns	wire	$R_0/L$ ( $\Omega/H$ )
A	211	552	0.22 E.E.	63.0
B	62.4	301	45 x 0.04 E.S.	82.0
C	52.1	275	0.35 E	51.3
D	30.5	210	70 x 0.04 E.S.	75.0
E	9.30	116	100 x 0.04 E.S.S.	88.5
F	3.59	72	200 x 0.04 E.S.S.	72.5
G	0.50	27	315 x 0.04 E.S.S.	12.9





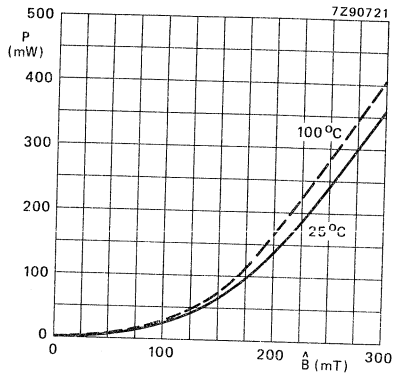
FXC 3H1  
 $\mu_e = 330$

Single-section coil former.

curve	L (mH)	number of turns	wire	$R_0/L$ ( $\Omega/H$ )
A	315	552	0.22 E.E.	42.2
B	94.1	301	45 × 0.04 E.S.	54.2
C	19.0	275	0.35 E	33.8
D	45.9	210	70 × 0.04 E.S.	50.0
E	11.4	116	100 × 0.04 E.S.S.	72.3
F	5.40	72	200 × 0.04 E.S.S.	48.2
G	0.76	27	315 × 0.04 E.S.S.	84.8

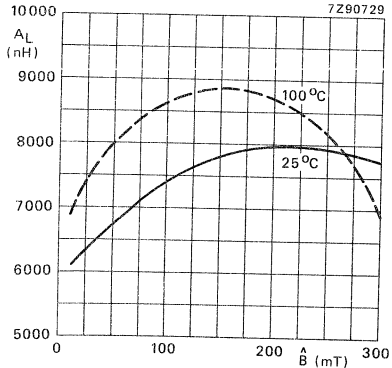
P AS A FUNCTION OF  $\hat{B}$  AT 16 kHz

3B8



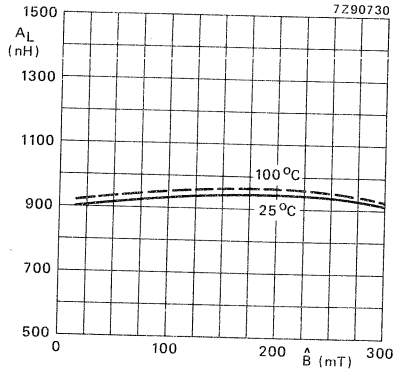
$A_L$  AS A FUNCTION OF  $\hat{B}$  AT 16 kHz

3B8



without air gap.

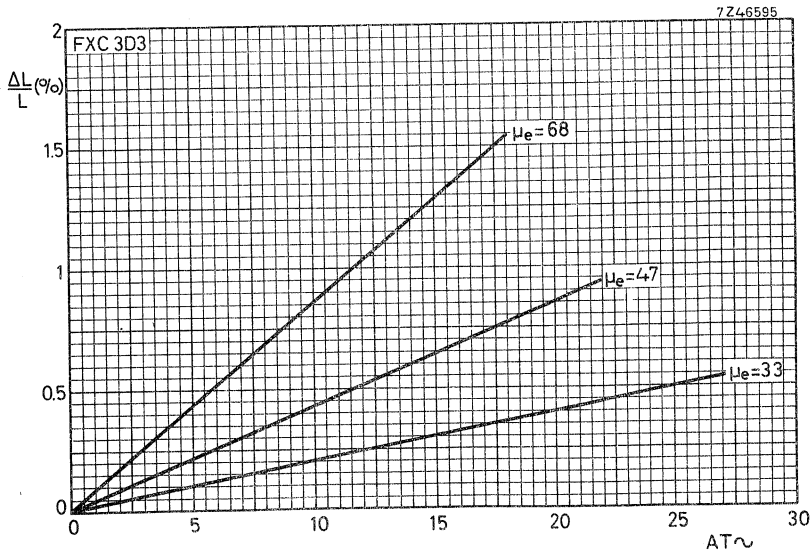
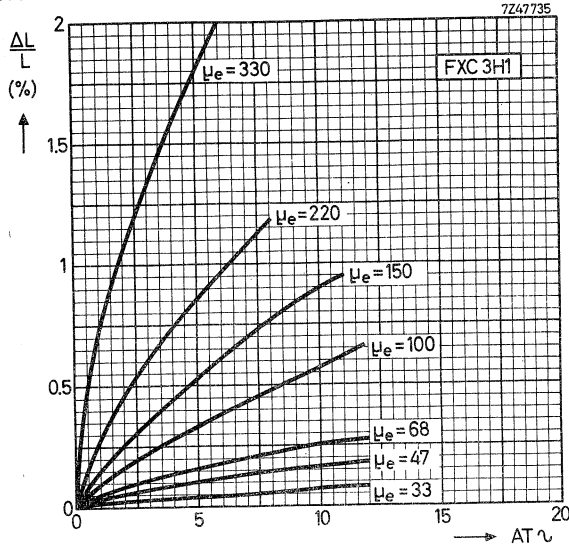
3B8

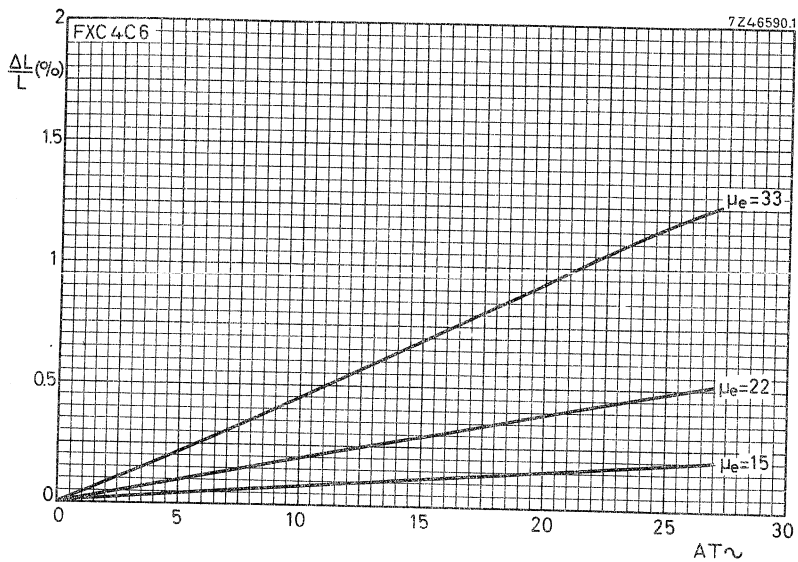


with air gap.

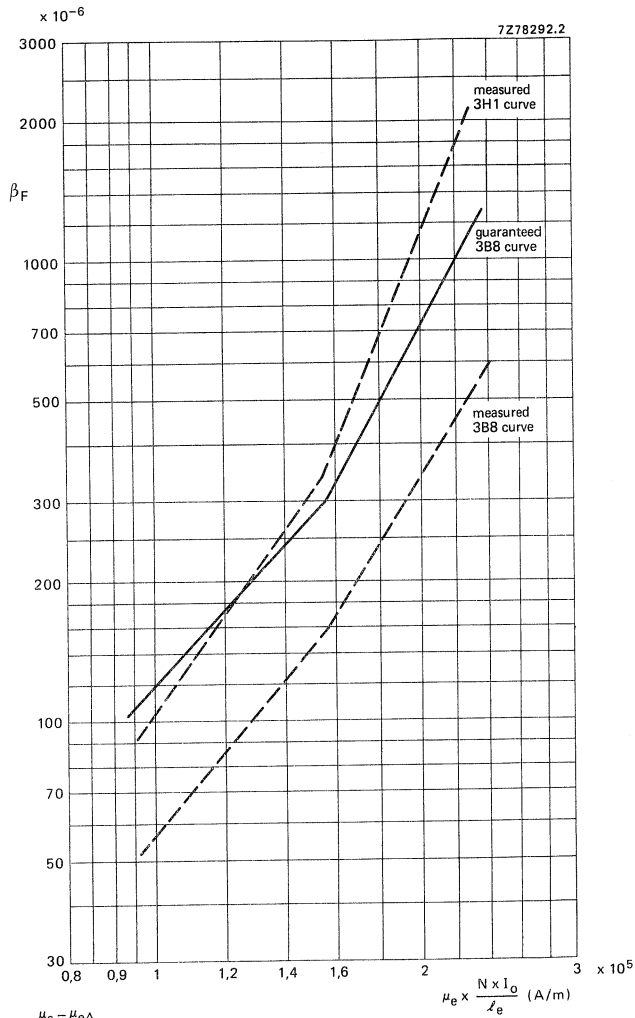
$\hat{B}$  calculated with  $A_{CPmin} = 76,5 \text{ mm}^2$

INDUCTANCE VARIATION AS A FUNCTION OF  $AT \sim$





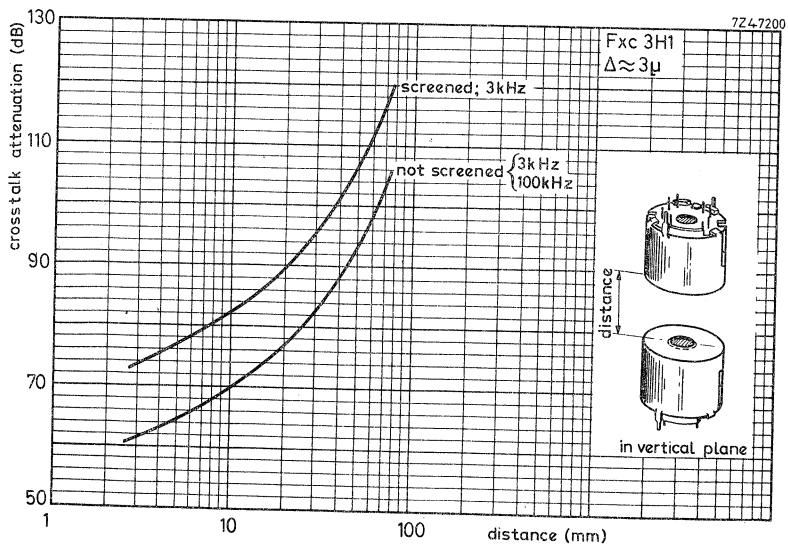
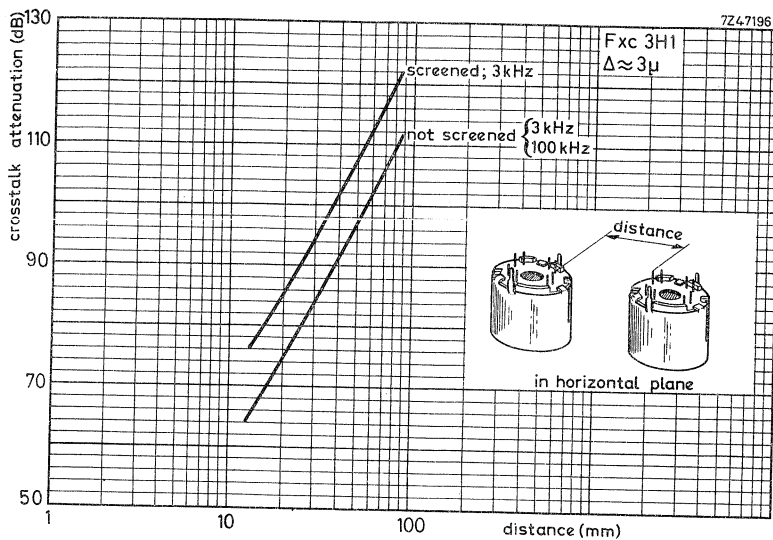
D.C. SENSITIVITY AT 25 °C

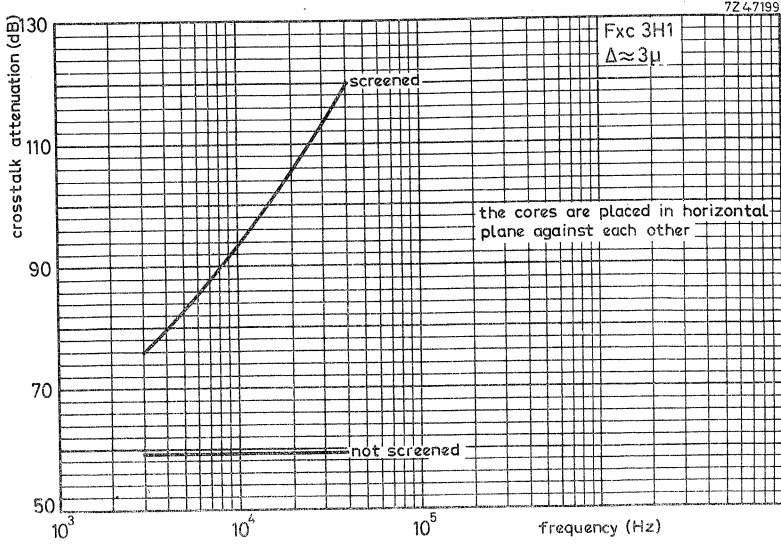


$$\beta_F = \frac{\mu_e - \mu_{e\Delta}}{\mu_e \times \mu_{e\Delta}}$$

Inductance variation as a function of d.c. polarization.

CROSSTALK ATTENUATION









## POTCORES

Three types of core can be supplied:

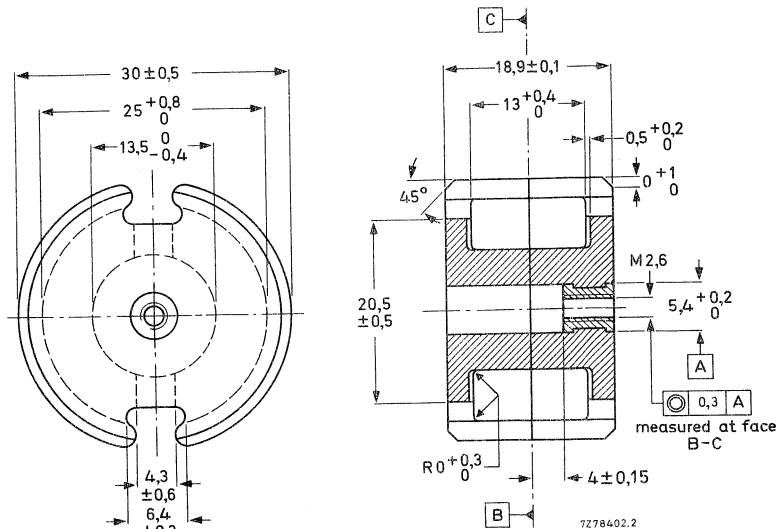
- CORE SETS provided with a nut for an adjuster and pre-adjusted on an inductance factor  $A_L$  or on a relative effective permeability value  $\mu_e$ .
- CORE SETS without nut and pre-adjusted on an  $A_L$  or a  $\mu_e$  value.
- CORE HALVES without air gap.

The potcores are in accordance with the following specifications: IEC 133 (international), NCF 83311 (France), DIN41293 (Germany) and BS4061 range 2 (Great Britain).

Potcores and associated parts are ordered by their 12-digit catalogue number. Quantity: a primary pack contains 20 core sets or 40 core halves; a storage pack contains 100 core sets or 200 core halves. Please order in multiples of these quantities.

### MECHANICAL DATA

Dimensions in mm



The polyamide nut is moulded-in, except for the 3D3 version in which it is cemented.

Pulling-out force of the nut  $\geq 50$  N

Torque of the screw thread  $\leq 10$  mNm

Extraction force of the adjuster from nut  $\geq 40$  N

## MECHANICAL DATA (continued)

Dimensional quantities according to IEC 205:

$$C_1 = \Sigma \frac{l_e}{A_e} = 0,330 \text{ mm}^{-1}; C_2 = \Sigma \frac{l_e}{A_e^2} = 0,00241 \text{ mm}^{-3}; V_e = 6190 \text{ mm}^3; l_e = 45,2 \text{ mm}; A_e = 137 \text{ mm}^2;$$

$$A_{CPmin} = 115 \text{ mm}^2.$$

Mass of core set: 34 g.

## ELECTRICAL DATA

The combination of two potcore halves without air gap, randomly chosen from a batch, has the following guaranteed properties. A measuring coil as described in the General section 'Potcores, square cores and cross cores' is inserted; the halves are pressed together with a force of 250 N. The values are valid 5 minutes or more after clamping.

	freq. kHz	$\hat{B}$ mT	temp. °C	grade		
				3B8	3D3	3H1
$A_L \pm 25\%$	4	$\leq 0,1$	$25 \pm 1$	7500	2800	7500
$\mu_e \pm 25\%$	4	$\leq 0,1$	$25 \pm 1$	1985	740	1985
$\alpha$	4	$\leq 0,1$	$25 \pm 1$	$\leq 13,3$	$\leq 21,7$	$\leq 13,3$
$\frac{\tan \delta}{\mu_i} \times 10^6$	4	$\leq 0,1$	$25 \pm 1$			$\leq 1,2$
	100	$\leq 0,1$	$25 \pm 1$		$\leq 8,0$	$\leq 6,0$
	500	$\leq 0,1$	$25 \pm 1$		$\leq 20$	
	1000	$\leq 0,1$	$25 \pm 1$		$\leq 45$	
P (W)	25	200*	$25 \pm 1$	$\leq 1,0$		
			$100 \pm 1$	$\leq 1,2$		
$\eta_B \times 10^3$	4	1,5 to 3,0	$25 \pm 1$			$\leq 0,62$
	100	0,3 to 1,2	$25 \pm 1$		$\leq 1,8$	
$\alpha_F \times 10^6/K$	$\leq 100$	$\leq 0,1$	5 to 25			+ 0,5 to 1,5
	$\leq 100$	$\leq 0,1$	25 to 55			+ 0,5 to 1,5
	$\leq 100$	$\leq 0,1$	25 to 70		0 to + 2	
$D_F \times 10^6$ (10-100 min)	$\leq 100$	$\leq 0,1$	$25 \pm 0,1$		$\leq 12$	$\leq 4,3$
$\beta_F \times 10^6$ , measured on sets with $\mu_e = 300 \pm 10\%$ and $25 \pm 1$ °C:						
at $\mu_e \times \frac{N \times I_0}{l_e} = 1,00 \times 10^5$ A/m				$\leq 110$		
= $1,60 \times 10^5$ A/m				$\leq 300$		
= $2,30 \times 10^5$ A/m				$\leq 1100$		

\*  $\hat{B}$  is calculated with  $A_{CPmin} = 115 \text{ mm}^2$ .

Core sets with nut and pre-adjusted on  $A_L$ .

$A_L$	corresponding $\mu_e$ -value	catalogue number 4322 022 . . . . .			
		3B8	3D3	3H1	
100 ± 1%	26,2		31440		
160 ± 1%	42		● 31450		
250 ± 1%	65,5		31460	31260	
315 ± 1,5%	83				
400 ± 1,5%	105			● 31280	
630 ± 2%	165	● 11870		● 31300	
1000 ± 3%	263			31310	
1600 ± 3%	420			31320	
2500 ± 3%	655			31330	

Core sets with nut and pre-adjusted on  $\mu_e$ .

$\mu_e$	$\alpha$	catalogue number 4322 022 . . . . .			
			3D3	3H1	
33 ± 1%	89,2		30430	30230	
47 ± 1%	74,7		30440		
68 ± 1%	62,1		30450	30250	
100 ± 1,5%	51,3			30260	
150 ± 2%	41,8			30270	
220 ± 3%	34,6			30280	
330 ± 3%	28,2			30290	
740 ± 25%	18,9		10400		
1990 ± 25%	11,5			10200	

Core sets without nut: replace the eighth digit of the catalogue number (3) by 1.

Cores with  $A_L \leq 400$ , or  $\mu_e \leq 100$  have a symmetrical air gap.Cores with  $A_L \geq 630$ , or  $\mu_e \geq 150$  have an asymmetrical air gap.

Core halves without air gap, without nut:

Ferroxcube grade	catalogue number
3B8	4322 020 22390
3D3	4322 020 22270
3H1	4322 020 22260

## COIL FORMERS

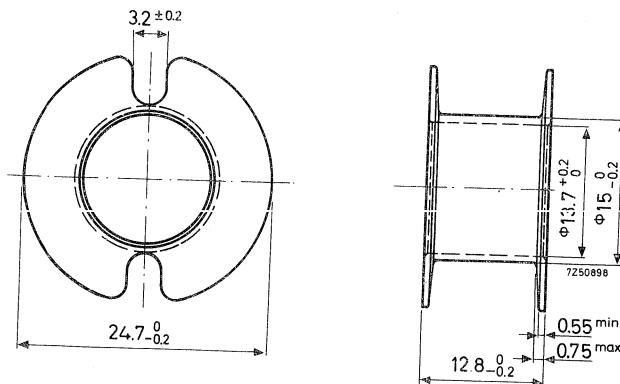
Three types of coil former can be supplied:

- with one section;
- with two sections;
- with three sections.

The dimensions conform with the following specifications: IEC 133 (international), NCF 83311 (France), DIN 41294 (Germany) and BS 4061 range 2 (Great Britain).

### SINGLE-SECTION COIL FORMER

Dimensions in mm



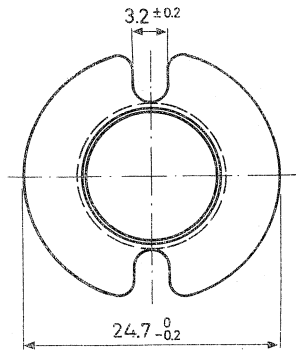
Catalogue number	4322 021 30360
Material	polycarbonate
Window area	55 mm <sup>2</sup>
Mean length of turn	62 mm
Max. temperature	130 °C

D.C. losses

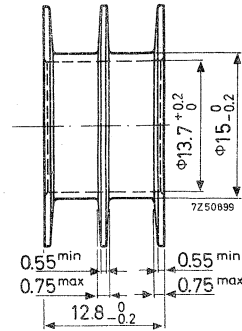
$$\frac{R_O}{L} = \frac{1}{\mu_e} \times \frac{1}{f_{cu}} \times 5,07 \times 10^3 \Omega/H$$

Mass 0,75 g

## TWO-SECTION COIL FORMER



Catalogue number	4322 021 30370
Material	polycarbonate
Window area	2 x 26 mm <sup>2</sup>
Mean length of turn	62 mm
Max. temperature	130 °C

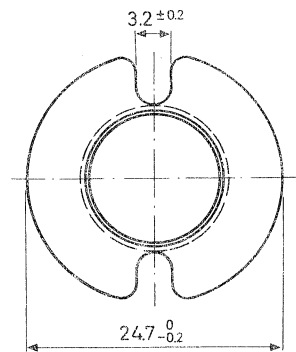


D.C. losses

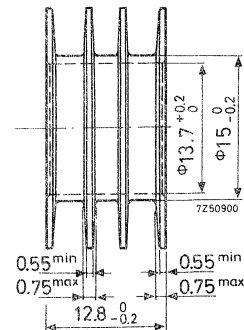
$$\frac{R_0}{L} = \frac{1}{\mu_e} \times \frac{1}{f_{cu}} \times 5,38 \times 10^3 \Omega/H$$

Mass 1,0 g

## THREE-SECTION COIL FORMER



Catalogue number	4322 021 30380
Material	polycarbonate
Window area	3 x 16 mm <sup>2</sup>
Mean length of turn	62 mm
Max. temperature	130 °C

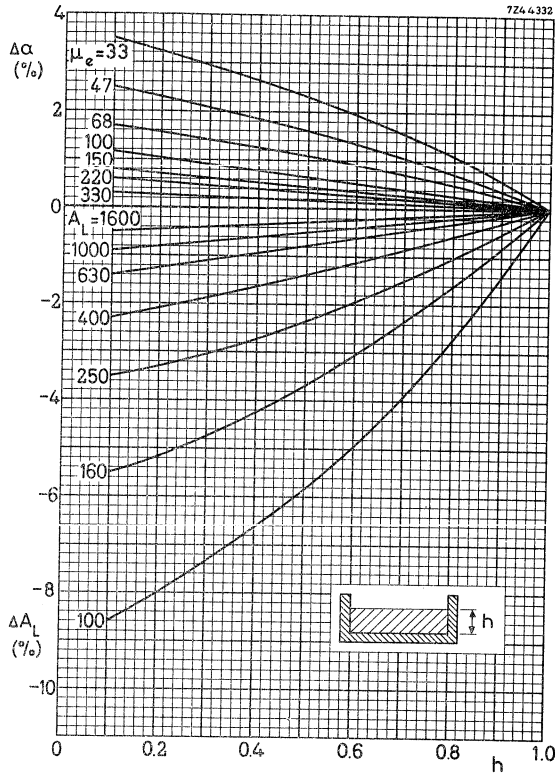


D.C. losses

$$\frac{R_0}{L} = \frac{1}{\mu_e} \times \frac{1}{f_{cu}} \times 5,74 \times 10^3 \Omega/H$$

Mass 1,2 g

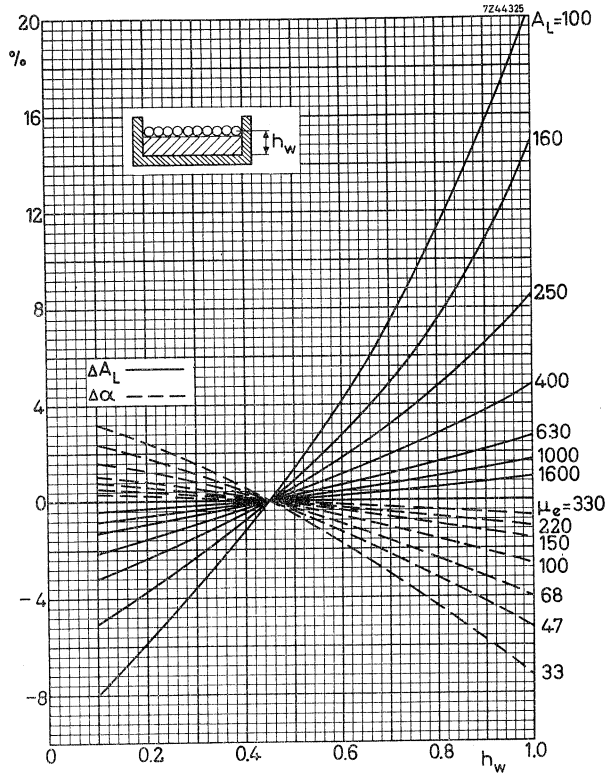
DATA FOR PARTLY FILLED COIL FORMER



Increase of the  $\alpha$  and decrease of the  $A_L$  factor for different  $\mu_e$  values and  $A_L$  factors as a function of the relative winding height on a single-section coil former. Valid for Ferroxcube 3H1 and 3D3.

Example:

On a single-section coil former only 0,4 part of the available height is used. A potcore with  $\mu_e = 68$  in that case obtains an  $\alpha$  factor of  $62,1 + 1,25\%$ .



Variation of the  $\alpha$  and  $A_L$  factors for a coupling winding of one layer as a function of its winding height  $h_w$  on a single-section coil former. Valid for Ferroxcube 3H1 and 3D3.

Example:

On a single-section coil former a coupling winding is laid on 0,7 of the available height. A potcore with  $\mu_e = 68$  obtains for that winding an  $\alpha$  factor of 62,1 - 1,6%.





## INDUCTANCE ADJUSTERS

(old types)

## CONTINUOUS ADJUSTERS

Dimensions in mm

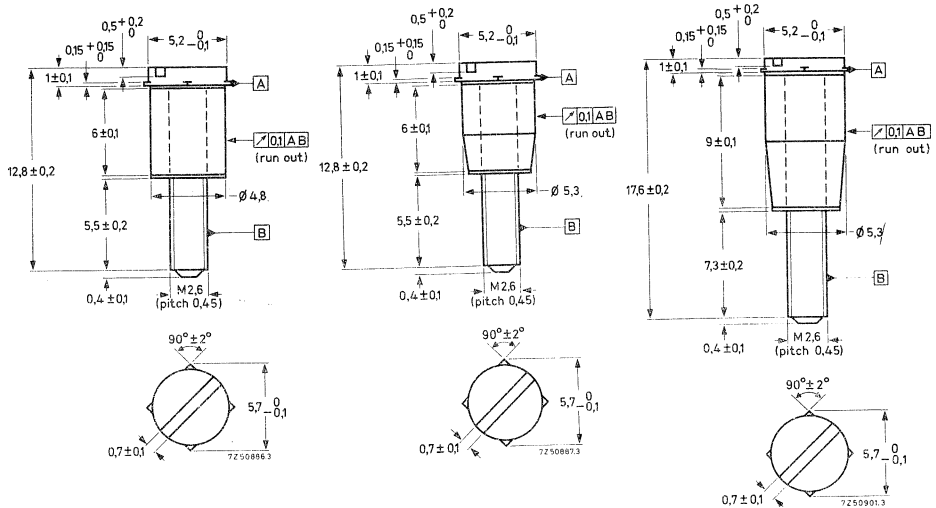


Fig. A.

Fig. B.

Fig. C.

The tolerances on inductance of the pre-adjusted potcores (without adjuster) are given under Potcores. After inserting a coil (impregnated or not) in an electrical circuit, its inductance can be adjusted to the required value with an accuracy  $< 0,03\%$  by means of a continuous inductance adjuster. Such an adjuster increases the inductance of the coil, see following pages.

The adjuster is screwed through the potcore into the nut and is held in position by the four protrusions near the top of the adjuster. For special requirements a bigger or smaller adjustment range may be obtained by using an adjuster belonging to the next higher or lower effective permeability.

The influence of the adjusters on the variability of the inductance is negligible. The maximum permissible temperature is  $110^\circ\text{C}$ .

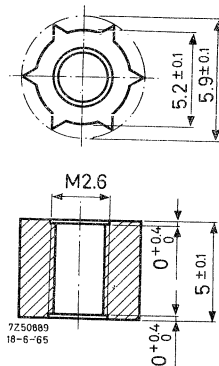
Types of adjuster and recommended applications.

Fig.	colour	catalogue number 4322 021 .....	potcore	
			$\mu_e$	$A_L$
A	green	30780	33	100
A	red	30800	47	160
B	white	30980	68	250
B	white	30980	100	400
A	brown	30810	150	630
B	grey	31090	220	1000
C	black	31120	330	1600

The adjusters are packed in plastic bags of 100. Please order in multiples of this quantity.

#### Nut for adjuster

These data are given for those manufacturers who prefer to insert the nut themselves.



Catalogue number

4322 021 30160

Material

polycarbonate

Max. impregnation temperature for 24 hours

120 °C

Recommended distance from mating surface to nut

for  $A_L \leq 1000$  resp.  $\mu_e \leq 220$

$3,35 \pm 0,15$  mm or

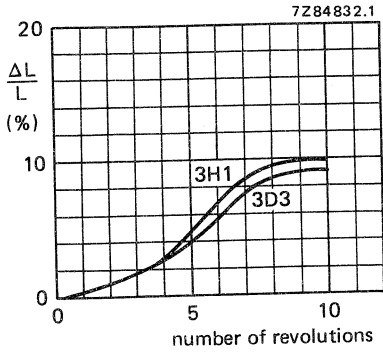
for  $A_L \geq 1600$  resp.  $\mu_e \geq 330$

$4,35 \pm 0,15$  mm

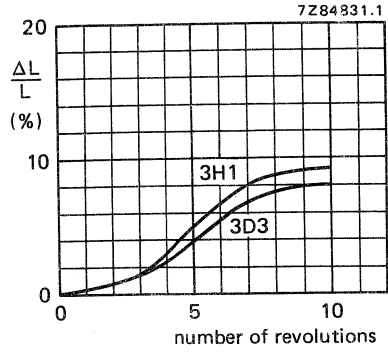
For more information see Potcores General, Mounting data.

The nuts are packed in plastic bags of 100. Please order in multiples of this quantity.

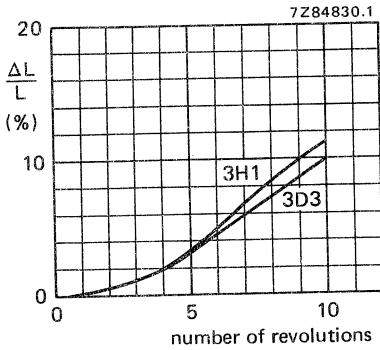
Adjustment curves



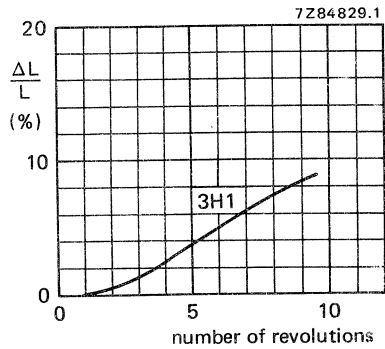
$\mu_e = 33$   
Adjuster 4322 021 30780



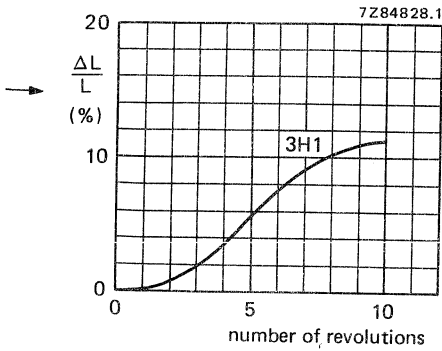
$\mu_e = 47$   
Adjuster 4322 021 30800



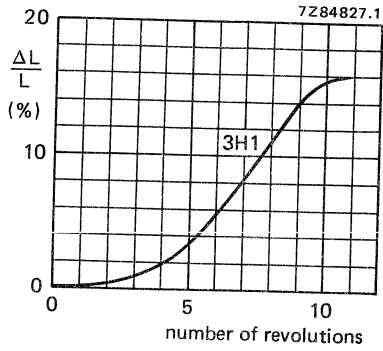
$\mu_e = 68$   
Adjuster 4322 021 30980



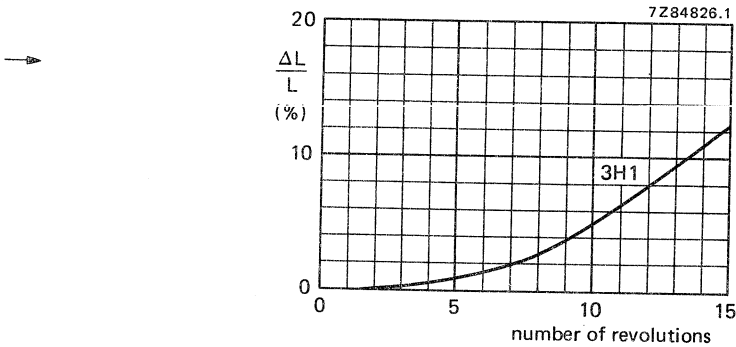
$\mu_e = 100$   
Adjuster 4322 021 30980



$\mu_e = 150$   
Adjuster 4322 021 30810



$\mu_e = 220$   
Adjuster 4322 021 31090



$\mu_e = 330$   
Adjuster 4322 021 31120

## INDUCTANCE ADJUSTERS

(new types)

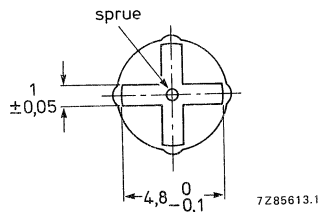
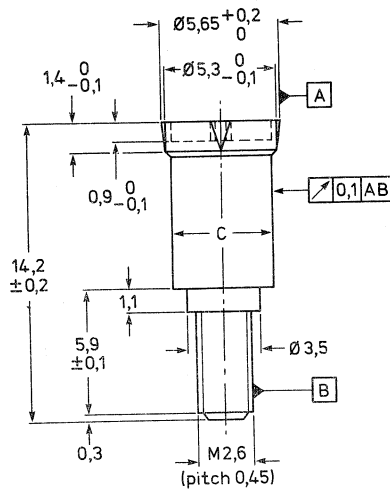


Fig. 1.

Material: polypropylene, reinforced with glass fibre.

The tolerances on inductance factor of the pre-adjusted cores without adjuster are given in the table of pre-adjusted cores with standard  $A_L$  values. The inductance of the pre-adjusted core can be increased to the required value — with a setting accuracy  $< 0,03\%$  — by means of a continuous adjuster.

The adjuster is screwed through the centre hole of the core into the nut and is held in position by the four cones near the top of the adjuster.

The combination of the polyamide moulded-in nut and the polypropylene adjuster — both reinforced with glass fibre — gives an excellent stability with temperature, shocks and vibrations. Besides this, the combination has a very smooth adjustment curve due to the excellent concentricity of the moulded-in nut and the adjuster.

The maximum permissible temperature of the adjustment combination is:  $150^\circ\text{C}$ , during 8 h. The maximum working temperature is  $110^\circ\text{C}$ .

The tables below show the available types and which adjuster is recommended for typical  $A_L$  values.

Table 1 Colour code of adjusters

catalogue number	colour	dia. C (Fig. 1) mm	material
4322 021 38380	white	4,40	FXC
38390	grey	5,10	FXC

Table 2 Catalogue numbers of recommended adjusters for typical  $A_L$  values

$A_L$	3H1/3B7	3D3
160	to be fixed	
250		
315		
400		
630		
1000	4322 021 38380	
	38390	
	38390	

**PACKAGING**

The adjusters are packed in plastic bags of 100. Please order in multiples of this quantity.

**ADJUSTING TOOL**

An adjusting tool combination for M2 and M2, 6 is available, catalogue number 4322 058 03270.

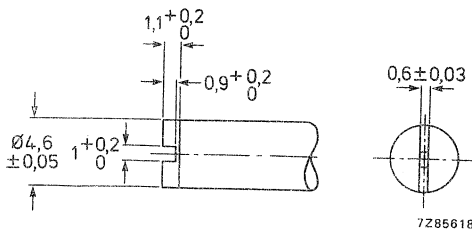
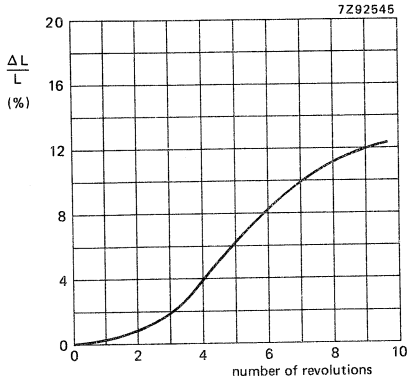


Fig. 2.

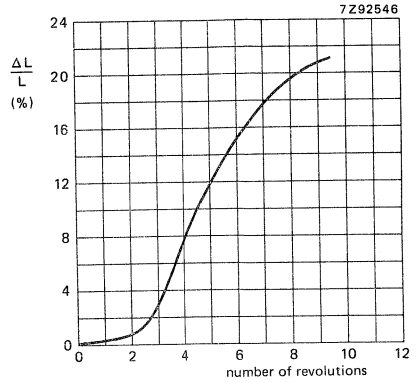
For customers who wish to make the screwdriver themselves the outlines of the essential part are given in Fig. 2.

**ADJUSTEMENT CURVES**

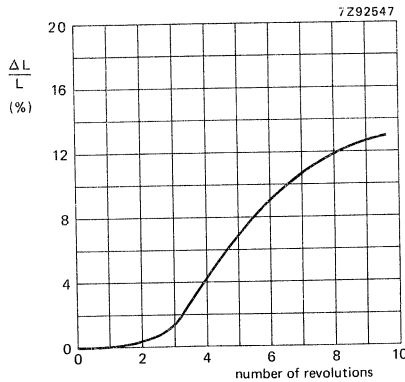
Characteristic curves



$A_L = 400$ ; FXC 3H1



$A_L = 630$ ; FXC 3H1

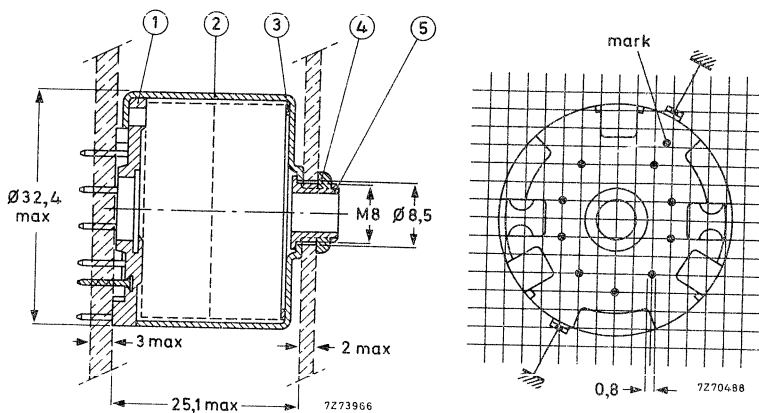


$A_L = 1000$ ; FXC 3H1

Note: 0 revolutions corresponds to at least one turn of interaction.

## MOUNTING PARTS

## MOUNTING



- |                     |                |
|---------------------|----------------|
| (1) tag plate       | 4322 021 30480 |
| (2) brass container | 4322 021 30560 |
| (3) spring          | 4322 021 30670 |

- |                 |                |
|-----------------|----------------|
| (4) nut         | 4322 021 30710 |
| (5) fixing bush | 4322 021 30720 |

The core is suitable for mounting on printed-wiring boards and on conventional panels.

The parts 1, 2, 3 (and 6) are sufficient to construct an assembly for use in combination with printed wiring.

The nine soldering pins are arranged to fit a grid of 2,54 mm (0,1 inch).

The pin length is sufficient for a board thickness of up to 3 mm. The board should be provided with holes of  $1,3 \pm 0,1$  mm diameter.

\* There is another mark in a similar position on the top of the container.



If one-hole mounting preferred, the parts 4 and 5 should be added. The coil assembly may then be mounted on panels having a thickness of up to 2 mm. The panel should be provided with a hole of 8,5 diameter.

It is recommended that the spring (3) be placed in the position indicated to obtain the best stability against shock and vibration.

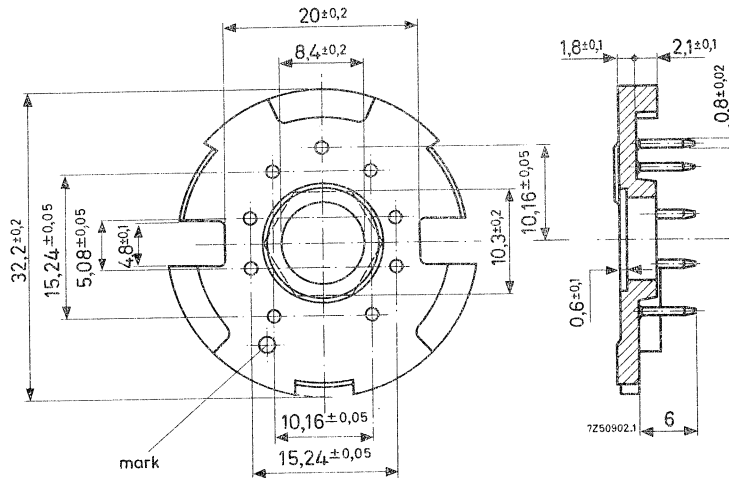
Before bending the lips of the container, pressure should be exerted evenly on the rim of the tag plate until it meets the container. The force which is required is approximately 250 Newton. After bending the lips the spring will have the correct tension.

**PART DRAWINGS** (dimensions in mm)

(1) **Tag plate 4322 021 30480**

PLate: polyester reinforced with glass fibre, resistant against dip-soldering at 400 °C for 2 s.

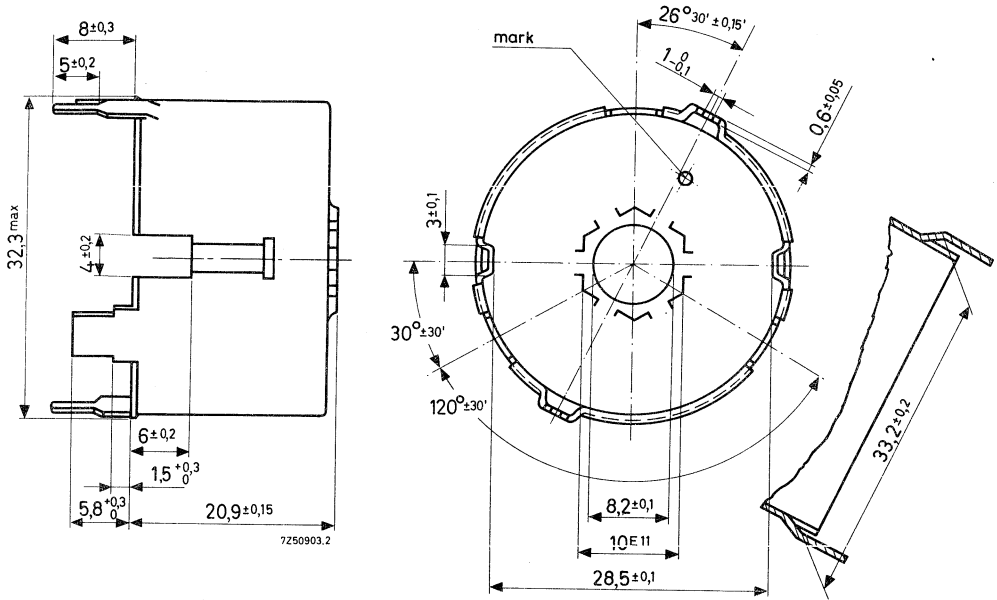
Pins: phosphor bronze, dip-soldered



The tag plates are packed in units of 30 pieces on a polystyrene plate, and with 200 pieces in a cardboard box. Please order in multiples of these quantities.

(2) Container 4322 021 30560

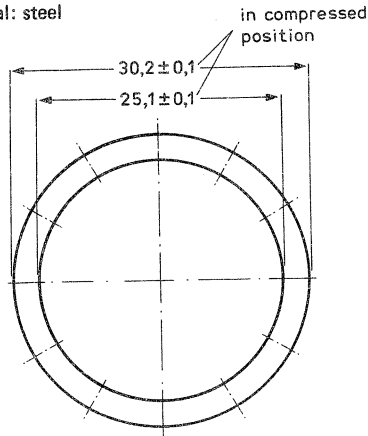
Material: brass, nickel plated; thereafter tin plated



→ The containers are packed with 20 pieces in a primary pack, and 100 pieces in a storage pack. Please order in multiples of these quantities.

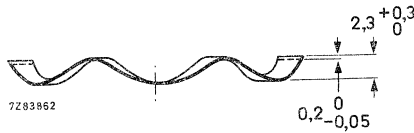
(3) Spring 4322 021 30670

Material: steel



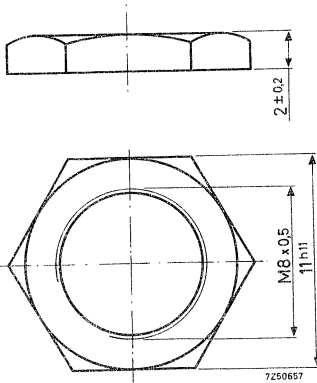
A force of 169 to 281 N is required to compress the spring to 0,45 mm.

The springs are supplied in quantities of 250. Please order in multiples of this quantity.



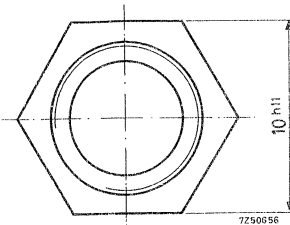
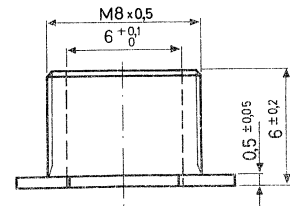
(4) Nut 4322 021 30710

Material: brass, nickel plated



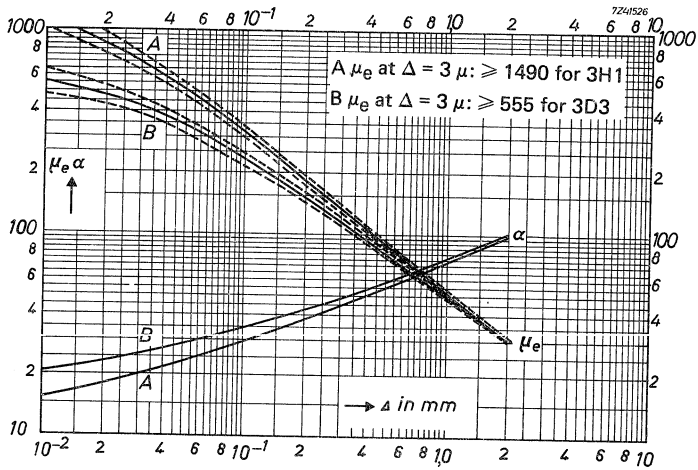
(5) Fixing bush 4322 021 30720

Material: brass, nickel plated



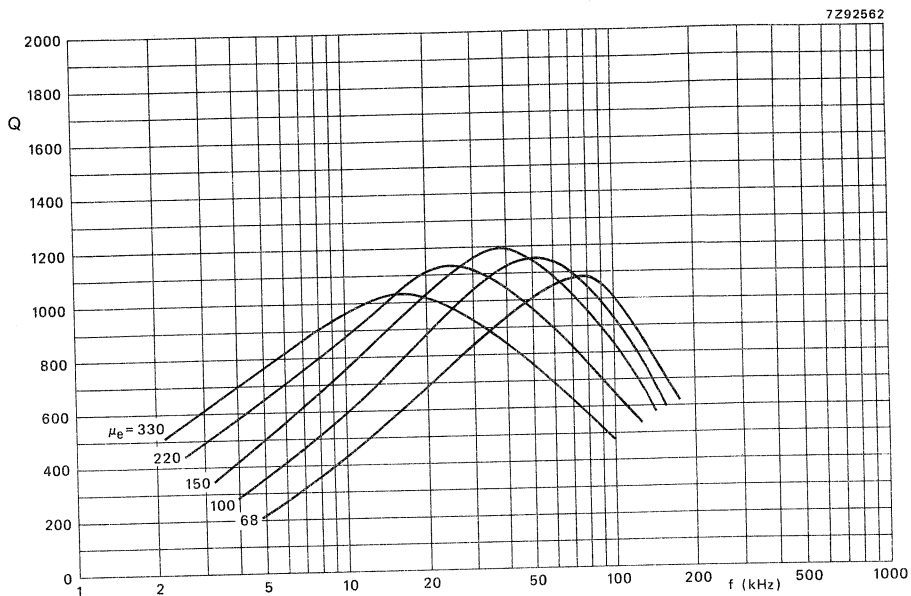
# CHARACTERISTIC CURVES

$\mu_e - \alpha$  CURVES



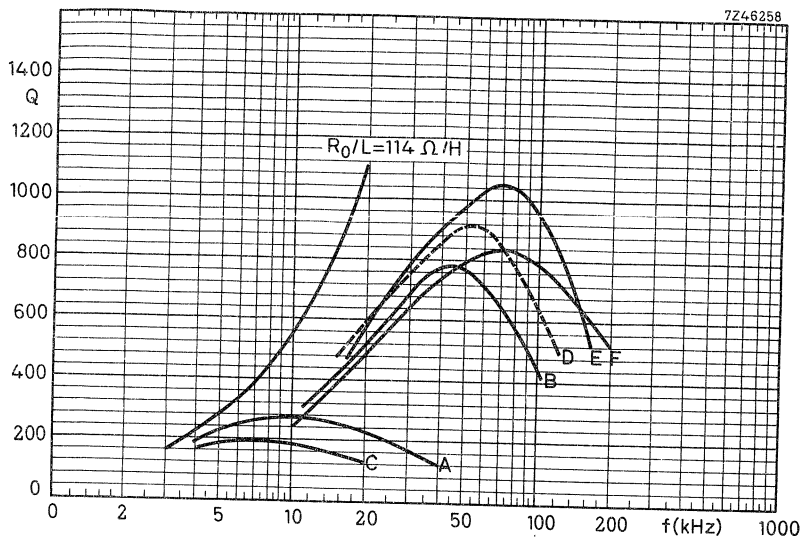
Relative effective permeability and turn factor for 1 mH as a function of the air gap length.

TYPICAL Q-CURVES for FXC 3H1



Enveloping curves.

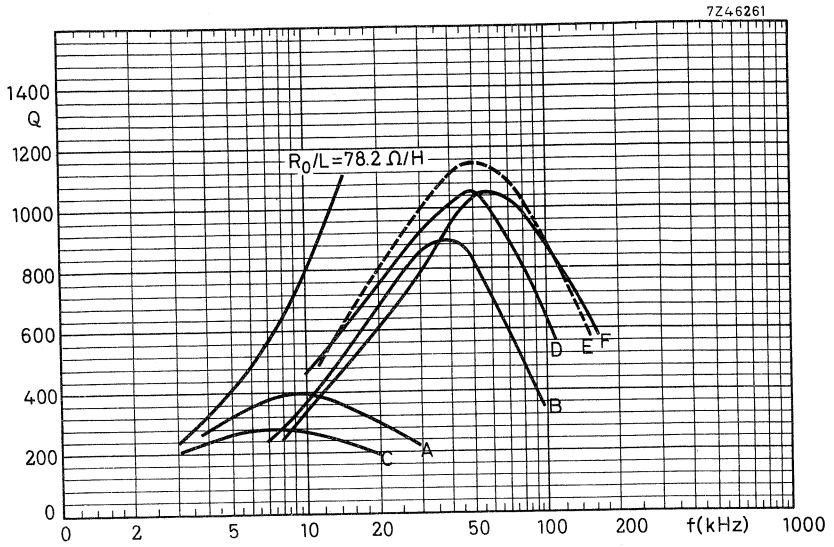
Single-section coil former.



FXC 3H1  
 $\mu_e = 68$

Single-section coil former.

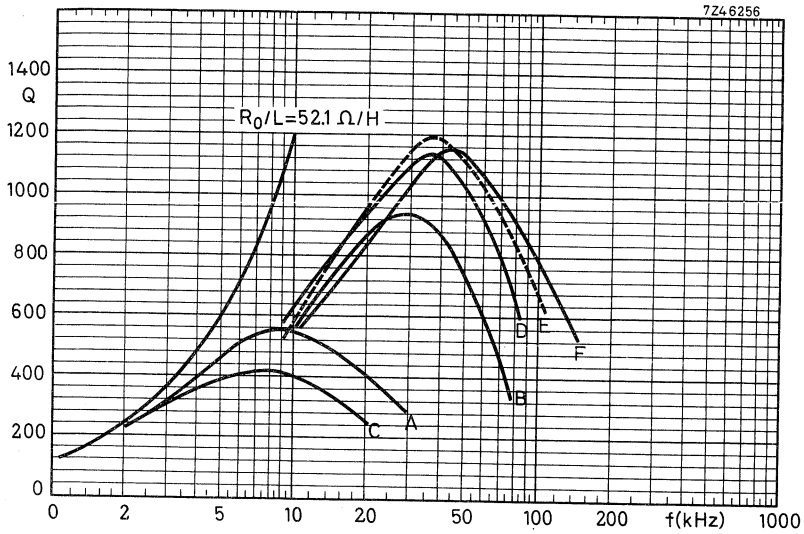
curve	L (mH)	number of turns	wire	$R_0/L$ ( $\Omega/H$ )
A	35.7	371	0.35 E.E.	114
B	19.9	277	70 x 0.04 E.S.	215
C	10.3	199	0.50 E.E.	108
D	5.68	148	40 x 0.07 E.S.	175
E	2.10	90	200 x 0.04 E.S.S.	182
F	1.74	82	70 x 0.07 E.S.S.	212



FXC 3H1  
 $\mu_e = 100$

Single-section coil former.

curve	L (mH)	number of turns	wire	$R_0/L$ ( $\Omega/H$ )
A	52.3	371	0.35 E.E.	78.2
B	29.1	277	70 x 0.04 E.S.	147
C	15.0	199	0.50 E.E.	74.0
D	8.32	148	40 x 0.07 E.S.	120
E	3.08	90	200 x 0.04 E.S.S.	124
F	2.55	82	70 x 0.07 E.S.S.	145

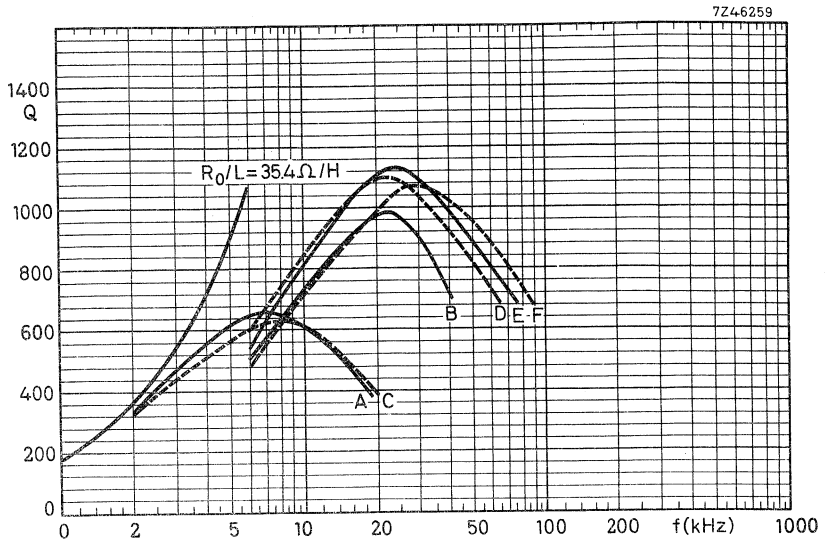


FXC 3H1  
 $\mu_e = 150$

Single-section coil former.

curve	L (mH)	number of turns	wire	$R_0/L$ ( $\Omega/H$ )
A	78.5	371	0.35 E. E.	52.1
B	44.0	277	70 x 0.04 E. S.	97.4
C	22.5	199	0.50 E. E.	49.2
D	12.5	148	40 x 0.07 E. S.	80.0
E	4.62	90	200 x 0.04 E. S. S.	83.1
F	3.84	82	70 x 0.07 E. S. S.	95.8



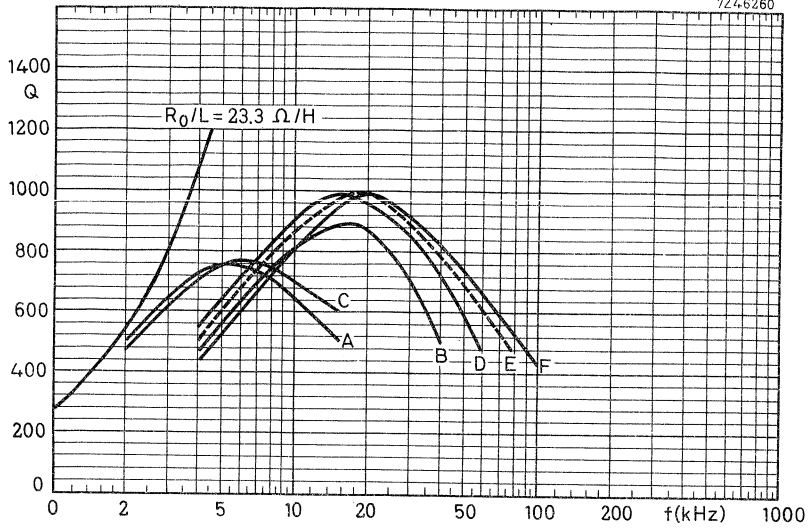


FXC 3H1  
 $\mu_e = 220$

Single-section coil former.

curve	L (mH)	number of turns	wire	$R_0/L$ ( $\Omega/H$ )
A	115	371	0.35 E.E.	35.4
B	64.1	277	70 × 0.04 E.S.	66.8
C	33.1	199	0.50 E.E.	33.7
D	18.3	148	40 × 0.07 E.S.	54.6
E	6.75	90	200 × 0.04 E.S.S.	56.5
F	5.59	82	70 × 0.07 E.S.S.	65.9

7Z4.6260

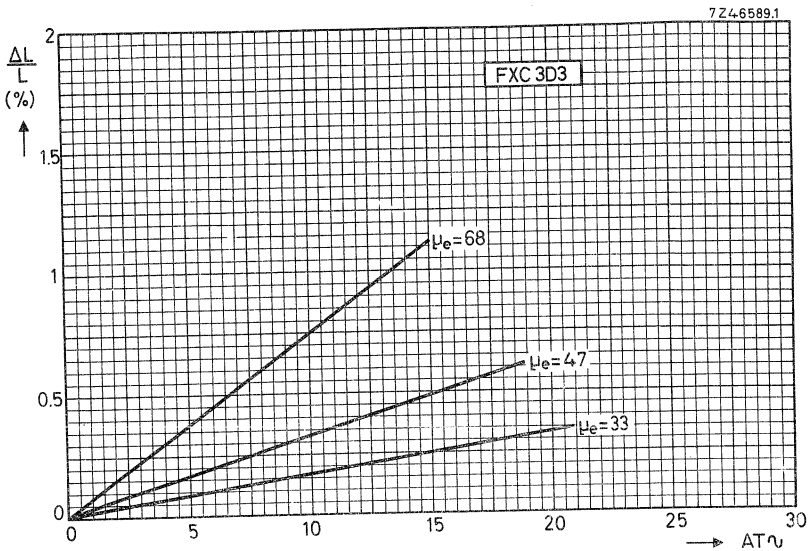


FXC 3H1  
 $\mu_e = 330$

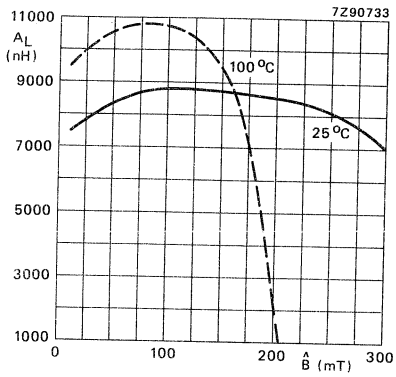
Single-section coil former.

curve	L (mH)	number of turns	wire	$R_0/L$ ( $\Omega/H$ )
A	175	371	0.35 E.E.	23.3
B	97.6	277	70 x 0.04 E.S.S.	43.9
C	50.2	199	0.50 E.E.	22.1
D	27.4	148	40 x 0.07 E.S.S.	36.5
E	10.3	90	200 x 0.04 E.S.S.S.	37.1
F	8.41	82	70 x 0.07 E.S.S.	43.8

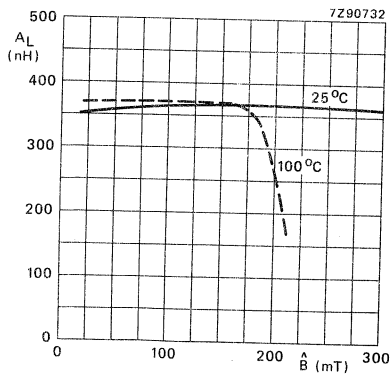
INDUCTANCE VARIATION AS A FUNCTION OF AT ~



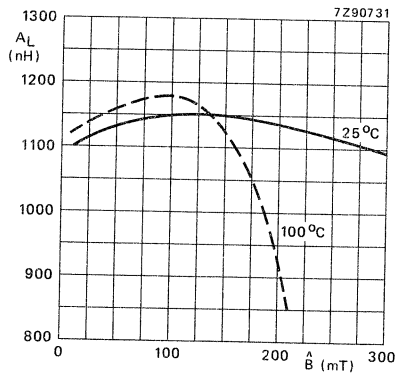
$A_L$  AS A FUNCTION OF  $\hat{B}$   
 FXC 3H1



Without airgap.

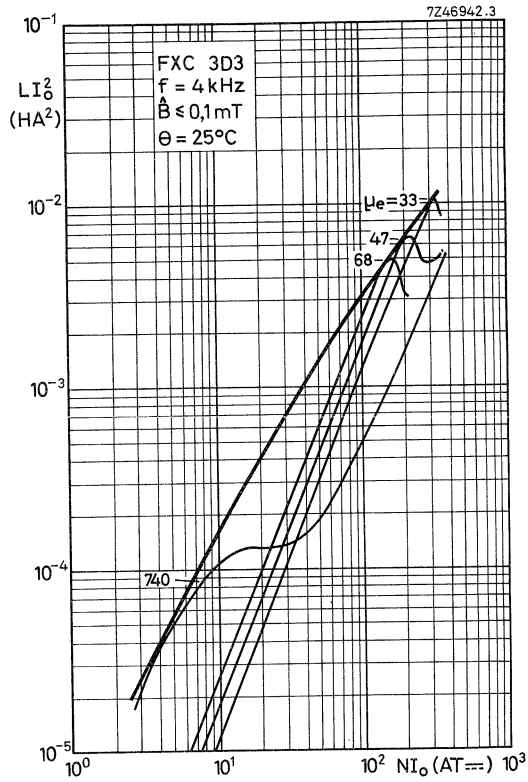


$\mu_e = 100$ .

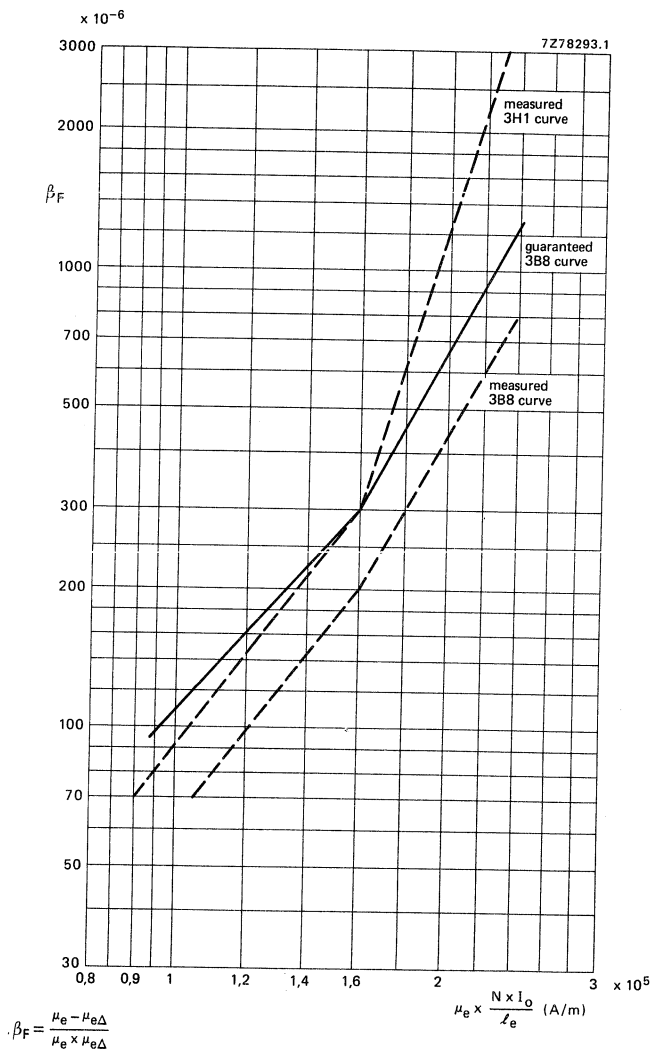


$\mu_e = 300$ .

$\hat{B}$  calculated with  $A_{CP \min} = 115 \text{ mm}^2$ .



D.C. SENSITIVITY AT 25 °C



Inductance variation as a function of d.c. polarization.

## POTCORES

Three types of core can be supplied:

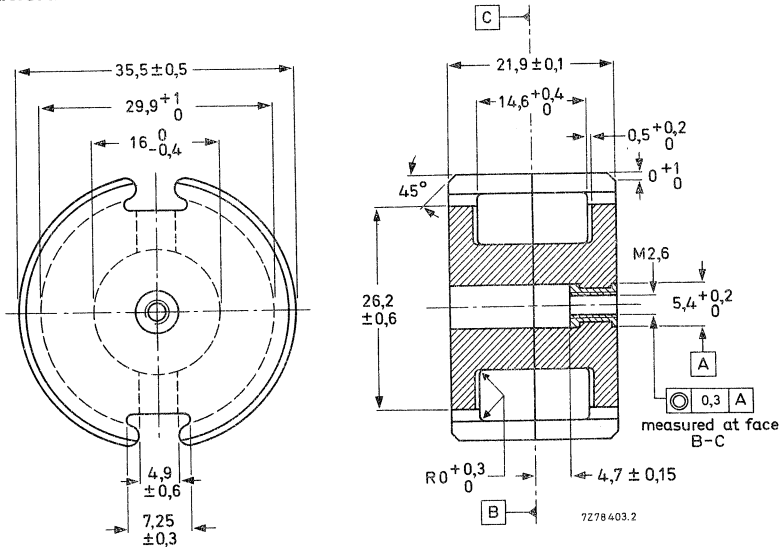
- CORE SETS provided with a nut for an adjuster and pre-adjusted on an inductance factor  $A_L$  or on a relative effective permeability value  $\mu_e$ .
- CORE SETS without nut and pre-adjusted on an  $A_L$  or a  $\mu_e$  value.
- CORE HALVES without air gap.

The potcores are in accordance with the following specifications: IEC 133 (international), NCF 83311 (France), DIN41293 (Germany) and BS4061 range 2 (Great Britain).

Potcores and associated parts are ordered by their 12-digit catalogue number. Quantity: a primary pack contains 20 core sets or 40 core halves; a storage pack contains 80 core sets or 160 core halves. Please order in multiples of these quantities.

### MECHANICAL DATA

Dimensions in mm



Pulling-out force of the nut  
Torque of the screw thread  
Extraction force of the adjuster from the nut  
Dimensional quantities according to IEC 205:

$\geq 50$  N.  
 $\leq 10$  mNm.  
 $\geq 40$  N.

The polyamide nut is moulded-in, except for the 3D3 version, in which it is cemented.

$$C_1 = \Sigma \frac{l_e}{A_e} = 0,264 \text{ mm}^{-1}; C_2 = \Sigma \frac{l_e}{A_e^2} = 0,00131 \text{ mm}^{-3}; V_e = 10700 \text{ mm}^3; l_e = 53,2 \text{ mm}; A_e = 202 \text{ mm}^2;$$

$ACP_{\min} = 172 \text{ mm}^2$ .

Mass of core set: 54 g.

**ELECTRICAL DATA**

The combination of two potcore halves without air gap, randomly chosen from a batch, has the following guaranteed properties. A measuring coil as described in the General section 'Potcores, square cores and cross cores', is inserted; the halves are pressed together with a force of 350 N. The values are valid 5 minutes or more after clamping.

	freq. kHz	$\hat{B}$ mT	temp. °C	grade		
				3B8	3D3	3H1
$A_L \pm 25\%$	4	$\leq 0,1$	$25 \pm 1$	9500	3550	9500
$\mu_e \pm 25\%$	4	$\leq 0,1$	$25 \pm 1$	2025	745	2025
$\alpha$	4	$\leq 0,1$	$25 \pm 1$	$\leq 11,7$	$\leq 19,3$	$\leq 11,7$
$\frac{\tan \delta}{\mu_i} \times 10^6$	4	$\leq 0,1$	$25 \pm 1$			$\leq 1,2$
	100	$\leq 0,1$	$25 \pm 1$		$\leq 8,0$	$\leq 6,0$
	500	$\leq 0,1$	$25 \pm 1$		$\leq 22$	
P (W)	1000	$\leq 0,1$	$25 \pm 1$		$\leq 50$	
	25	200*	$25 \pm 1$	$\leq 1,5$		
$\eta_B \times 10^3$			$100 \pm 1$	$\leq 1,9$		
	4	1,5 to 3,0	$25 \pm 1$			$\leq 0,62$
$\alpha_F \times 10^6/K$	100	0,3 to 1,2	$25 \pm 1$		$\leq 1,8$	
	$\leq 100$	$\leq 0,1$	5 to 25			+ 0,5 to 1,5
	$\leq 100$	$\leq 0,1$	25 to 55			+ 0,5 to 1,5
$D_F \times 10^6$ (10 100 min)	$\leq 100$	$\leq 0,1$	25 to 70		0 to + 2	
	$\leq 100$	$\leq 0,1$	$25 \pm 0,1$		$\leq 12$	$\leq 4,3$
$\beta_F \times 10^6$ , measured on sets with $\mu_e = 300 \pm 10\%$ and $25 \pm 1$ °C:						
at $\mu_e \times \frac{N \times I_0}{I_e} = 1,00 \times 10^5$ A/m				$\leq 110$		
= $1,60 \times 10^5$ A/m				$\leq 300$		
= $2,30 \times 10^5$ A/m				$\leq 1050$		

\*  $\hat{B}$  is calculated with  $A_{CPmin} = 172 \text{ mm}^2$ .



Core sets with nuts and pre-adjusted on  $A_L$ .

$A_L$	corre- sponding $\mu_e$ -value	catalogue number 4322 022 . . . . .			3H1, without nut
		3B8	3D3	3H1	
40 ± 1%	8,39				4322 021 13220 ←
100 ± 1%	21			33240	
160 ± 1%	33,6	● 13800	33450	33250	
250 ± 1%	52,5	13810	● 33460	33260	
315 ± 1,5%	66,2	13820			
400 ± 1,5%	84	● 13830	33480	● 33280	
630 ± 2%	132			● 33300	
1000 ± 3%	210			33310	
1250 ± 3%	262			33980	
1600 ± 3%	336	13870		33320 ←	
2500 ± 5%	525			33290	

Core sets with nut and pre-adjusted on  $\mu_e$ .

$\mu_e$	$\alpha$	catalogue number 4322 022 . . . . .			
			3D3	3H1	
33 ± 1%	79,7		32430		
47 ± 1%	66,8		32440		
68 ± 1%	55,6		32450	32250	
100 ± 1,5%	45,8			32260	
150 ± 2%	37,4			32270	
220 ± 3%	30,9			32280	
330 ± 3%	25,2			32290	
750 ± 25%	16,7		12400		
2030 ± 25%	10,2			12200	

Core sets without nut: replace the eighth digit of the catalogue number (3) by 1.

Cores with  $A_L \leq 630$ , or  $\mu_e \leq 150$ , have a symmetrical air gap.

Cores with  $A_L \geq 1000$ , or  $\mu_e \geq 220$ , and all 3B8 cores have an asymmetrical air gap.

Core halves without air gap, without nut:

Ferroxcube grade	catalogue number
3B8	4322 020 22610
3D3	4322 020 22520
3H1	4322 020 22510

● Preferred type.



## COIL FORMERS

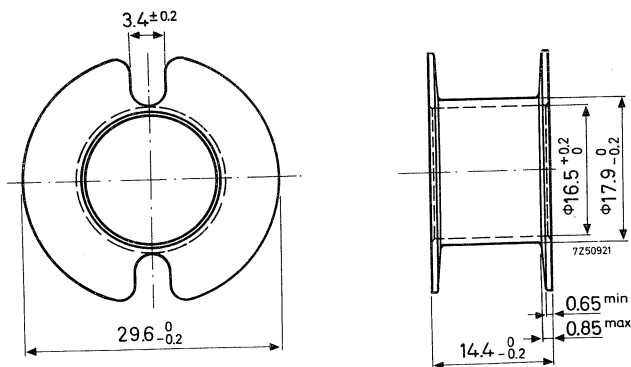
Three types of coil former can be supplied:

- with one section;
- with two sections;
- with three sections.

The dimensions conform with the following specifications: IEC 133 (international), NCF 83311 (France), DIN 41294 (Germany) and BS4061 range 2 (Great Britain).

### SINGLE-SECTION COIL FORMER

Dimensions in mm



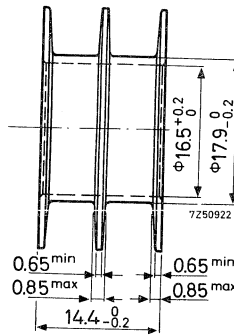
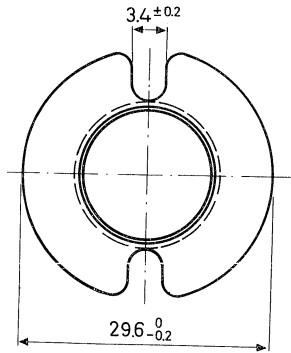
Catalogue number	4322 021 30390
Material	polycarbonate
Window area	75 mm <sup>2</sup>
Mean length of turn	74 mm
Maximum temperature	130 °C

D.C. losses

$$\frac{R_o}{L} = \frac{1}{\mu_e} \times \frac{1}{f_{cu}} = 3,59 \times 10^3 \Omega/H$$

Mass 1,3 g

**TWO-SECTION COIL FORMER**



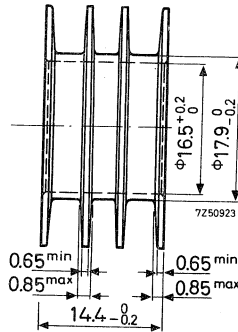
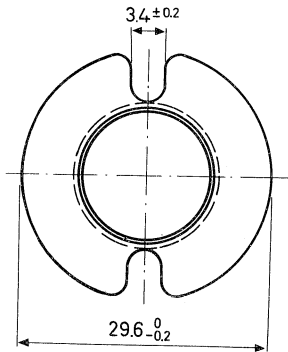
Catalogue number 4322 021 30400  
 Material polycarbonate  
 Window area  $2 \times 35 \text{ mm}^2$   
 Mean length of turn 74 mm  
 Maximum temperature 130 °C

D.C. losses

$$\frac{R_0}{L} = \frac{1}{\mu_e} \times \frac{1}{f_{cu}} \times 3,81 \times 10^3 \Omega/\text{H}$$

Mass 1,55 g

**THREE-SECTION COIL FORMER**



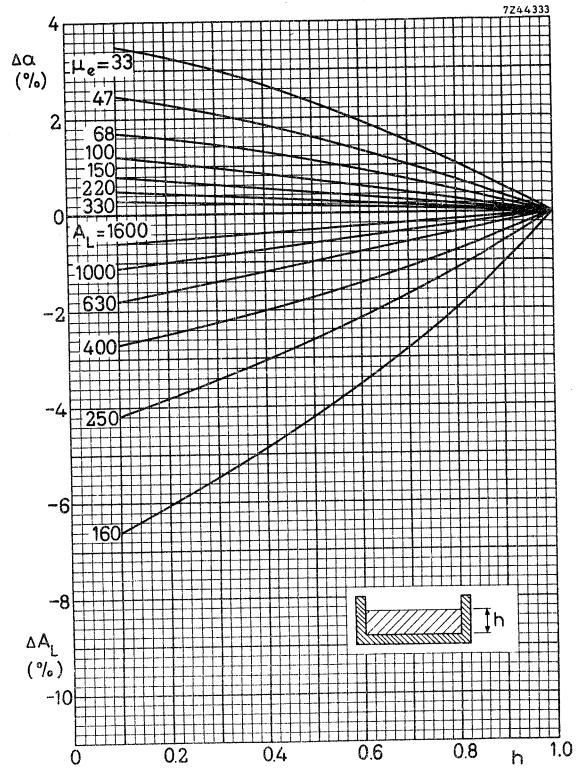
Catalogue number 4322 021 30410  
 Material polycarbonate  
 Window area  $3 \times 22 \text{ mm}^2$   
 Mean length of turn 74 mm  
 Maximum temperature 130 °C

D.C. losses

$$\frac{R_0}{L} = \frac{1}{\mu_e} \times \frac{1}{f_{cu}} \times 4,06 \times 10^3 \Omega/\text{H}$$

Mass

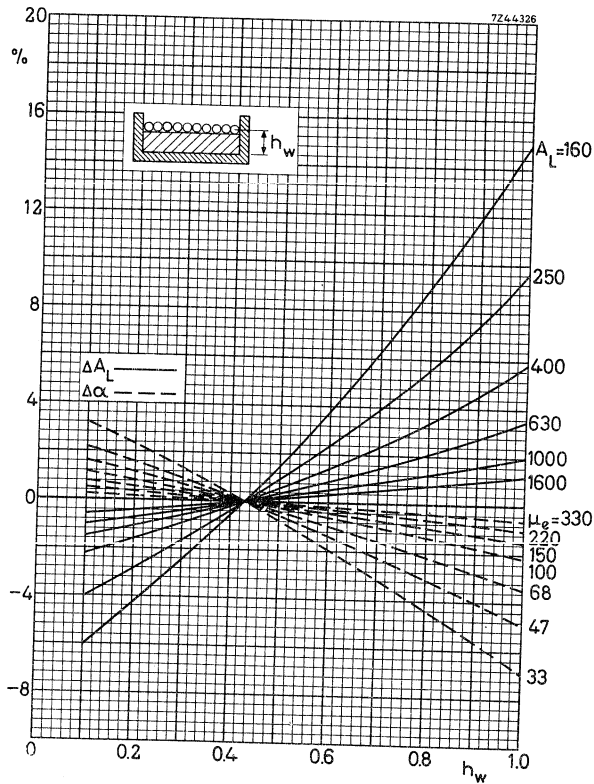
## DATA FOR PARTLY FILLED COIL FORMER



Increase of the  $\alpha$  and decrease of the  $A_L$  factor for different  $\mu_e$  values and  $A_L$  factors as a function of the relative winding height on a single-section coil former. Valid for Ferroxcube 3H1 and 3D3.

Example:

On a single-section coil former only 0,4 part of the available height is used. A potcore with  $\mu_e = 68$  in that case obtains an  $\alpha$  factor of  $55,6 + 1,2\%$ .



Variation of the  $\alpha$  and  $A_L$  factors for a coupling winding of one layer as a function of its winding height  $h_w$  on a single-section coil former. Valid for Ferroxcube 3H1 and 3D3.

Example:

On a single-section coil former a coupling winding is laid on 0,7 of the available height. A potcore with  $\mu_e = 68$  obtains for that winding an  $\alpha$  factor of 55,6 - 1,6%.

# INDUCTANCE ADJUSTERS

(old types)

## CONTINUOUS ADJUSTERS

The tolerances on inductance of the pre-adjusted potcores (without adjuster) are given under Potcores. After inserting a coil (impregnated or not) in an electrical circuit, its inductance can be adjusted to the required value with an accuracy  $< 0,03\%$  by means of an continuous inductance adjuster. Such an adjuster increases the inductance of the coil, see following pages.

The adjuster is screwed through the potcore into the nut and is held in position by the four protrusions near the top of the adjuster. For special requirements a bigger or smaller adjustment range may be obtained by using an adjuster belonging to the next higher or lower effective permeability.

The influence of the adjusters on the variability of the inductance is negligible. The maximum permissible temperature is  $110\text{ }^{\circ}\text{C}$ .

Table 2 shows the type of adjuster recommended for different potcores.

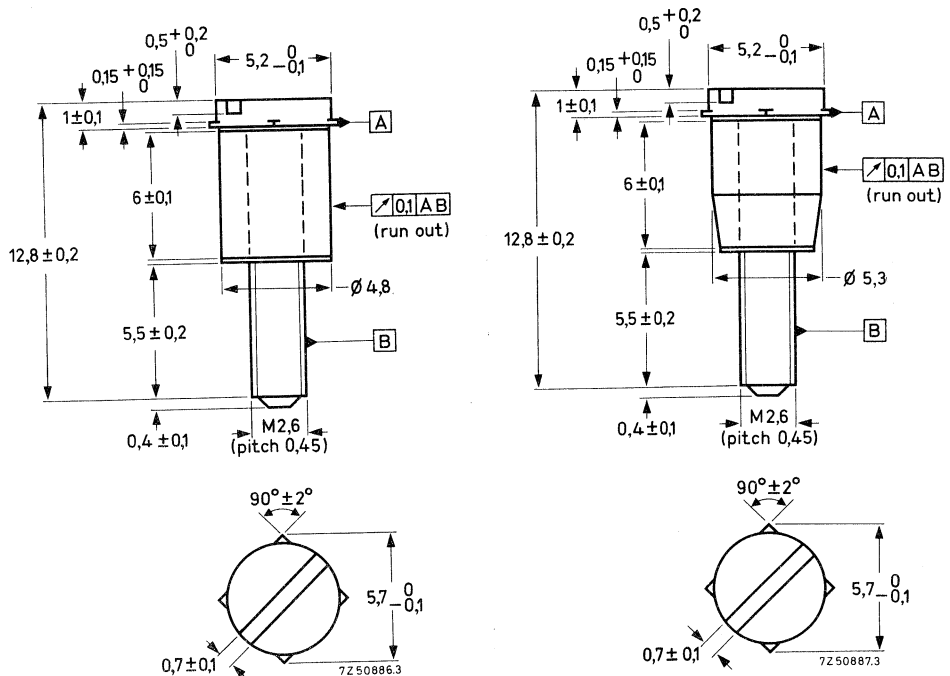


Fig. A.

Fig. B.

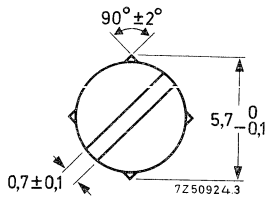
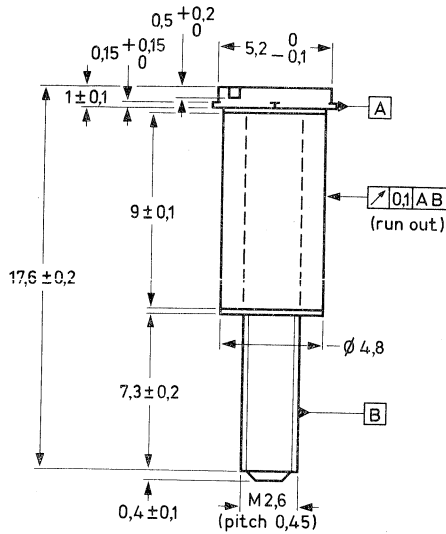


Fig. C.

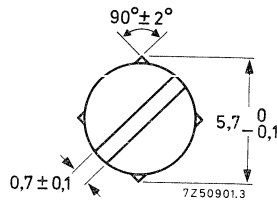
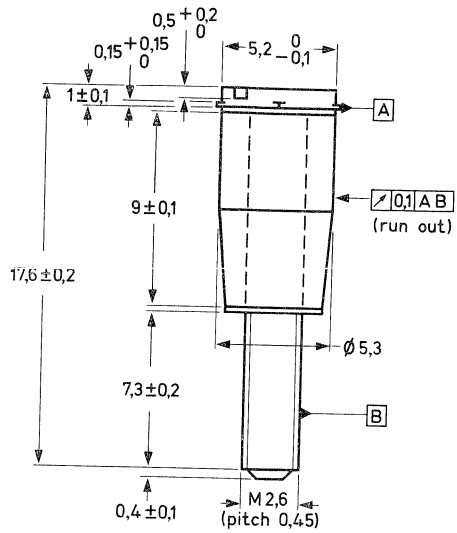


Fig. D.

→ Types of adjuster and recommended applications for potcores with grade 3H1 and 3D3:

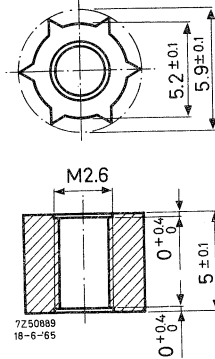
Fig.	colour	catalogue number 4322 021 . . . . .	potcore	
			$\mu_e$	$A_L$
A	yellow	30790	33	160
B	white	30980	47	250
B	white	30980	68	
A	brown	30810	100	400
A	brown	30810		630
C	grey	31110	150	
B	grey	31090	220	1000
D	black	31120	330	1600

The adjusters are packed in plastic bags of 100. Please order in multiples of this quantity.



**Nut for adjuster**

These data are given for those manufacturers who prefer to insert the nut themselves.



Catalogue number

4322 021 30160

Material

polycarbonate

Max. impregnation temperature for 24 hours

120 °C

Recommended distance from mating surface to nut

for  $A_L \geq 1000$ ,  $\mu_e \leq 100$  and  $\mu_e = 220$

$2,85 \pm 0,15$  mm or

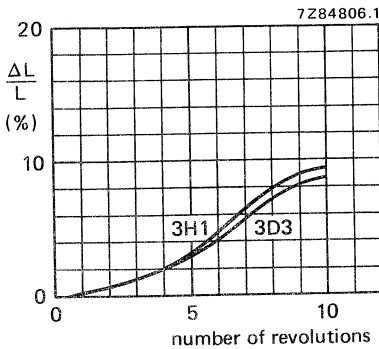
for  $A_L = 1600$ ,  $\mu_e = 150$  and  $\mu_e = 330$

$4,95 \pm 0,15$  mm

The nuts are packed in plastic bags of 100. Please order in multiples of this quantity.

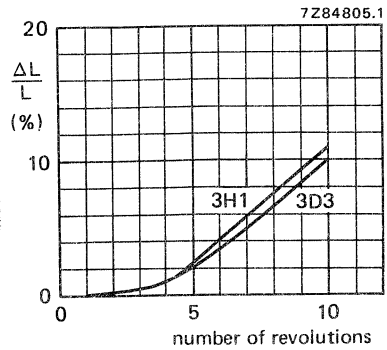
For more information see Potcores General, Mounting data.

**Adjustment curves**



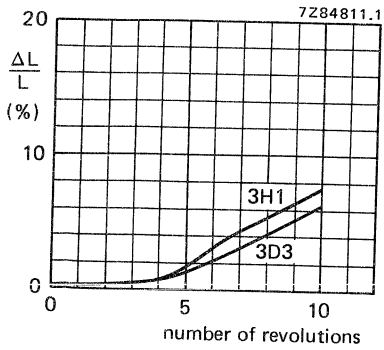
$\mu_e = 33$

Adjuster 4322 021 30790

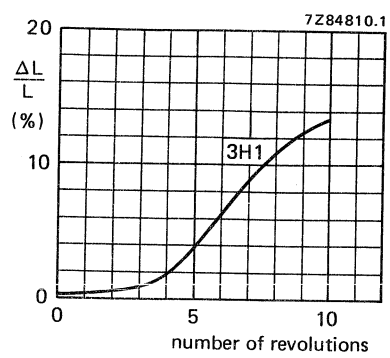


$\mu_e = 47$

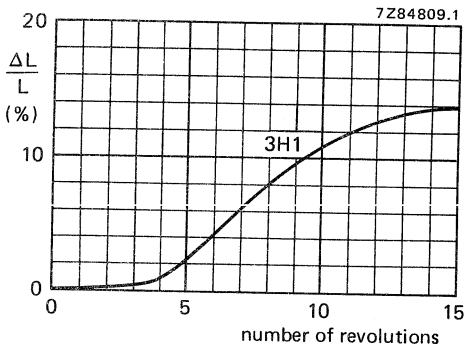
Adjuster 4322 021 30980



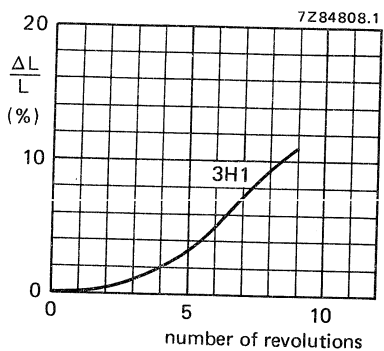
$\mu_e = 68$   
Adjuster 4322 021 30980



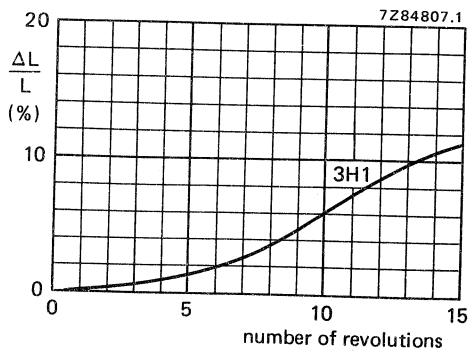
$\mu_e = 100$   
Adjuster 4322 021 30810



$\mu_e = 150$   
Adjuster 4322 021 31110



$\mu_e = 220$   
Adjuster 4322 021 31090



$\mu_e = 330$   
Adjuster 4322 021 31120

## INDUCTANCE ADJUSTERS

(new types)

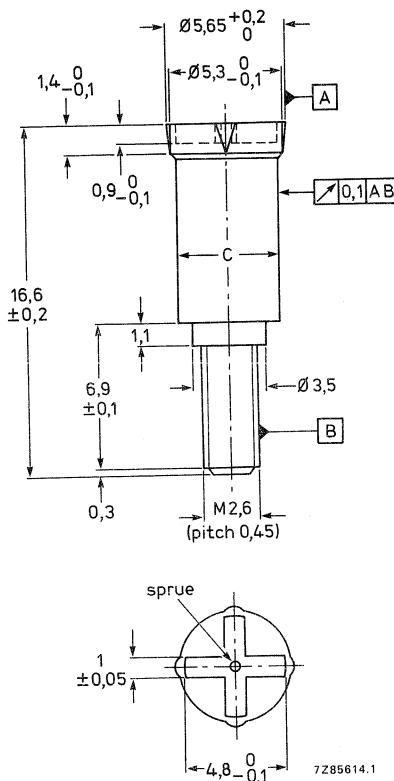


Fig. 1.

Material: polypropylene, reinforced with glass fibre.

The tolerances on inductance factor of the pre-adjusted cores without adjuster are given in the table of pre-adjusted cores with standard  $A_L$  values. The inductance of the pre-adjusted core can be increased to the required value — with a setting accuracy  $< 0,03\%$  — by means of a continuous adjuster.

The adjuster is screwed through the centre hole of the core into the nut and is held in position by the four cones near the top of the adjuster.

The combination of the polyamide moulded-in nut and the polypropylene adjuster — both reinforced with glass fibre — gives an excellent stability with temperature, shocks and vibrations. Besides this, the combination has a very smooth adjustment curve due to the excellent concentricity of the moulded-in nut and the adjuster.

The maximum permissible temperature of the adjustment combination is:  $150\text{ }^{\circ}\text{C}$ , during 8 h. The maximum working temperature is  $110\text{ }^{\circ}\text{C}$ .

The tables below show the available types and which adjuster is recommended for typical  $A_L$  values.

Table 1 Colour code of adjusters

catalogue number	colour	dia. C (Fig. 1) mm	material
4322 021 39290	grey	5,20	FXC

Table 2 Catalogue numbers of recommended adjusters for typical  $A_L$  values

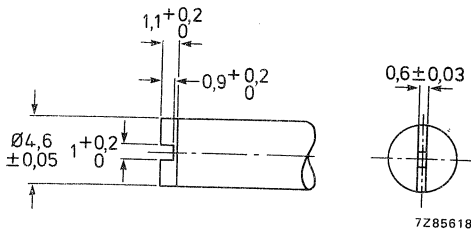
$A_L$	3H1	3D3
250		
315		
400		
630		
1000	4322 021 39290	
1250	39290	
1600	39290	

**PACKAGING**

The adjusters are packed in plastic bags of 100. Please order in multiples of this quantity.

**ADJUSTING TOOL**

An adjusting tool combination for M2 and M2,6 is available, catalogue number 4322 058 03270.

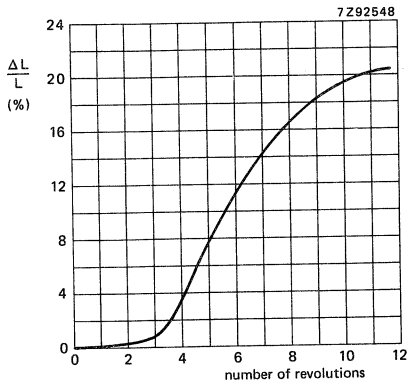


For customers who wish to make the screwdriver themselves the outlines of the essential part are given in Fig. 2.

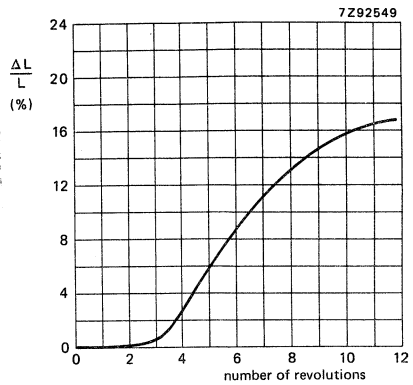
Fig. 2.

ADJUSTMENT CURVES

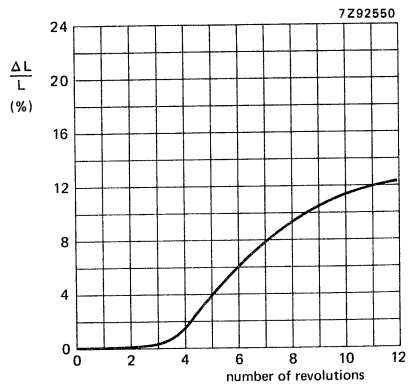
Characteristic curves



$A_L = 1000$ ; FXC 3H1



$A_L = 1250$ ; FXC 3H1

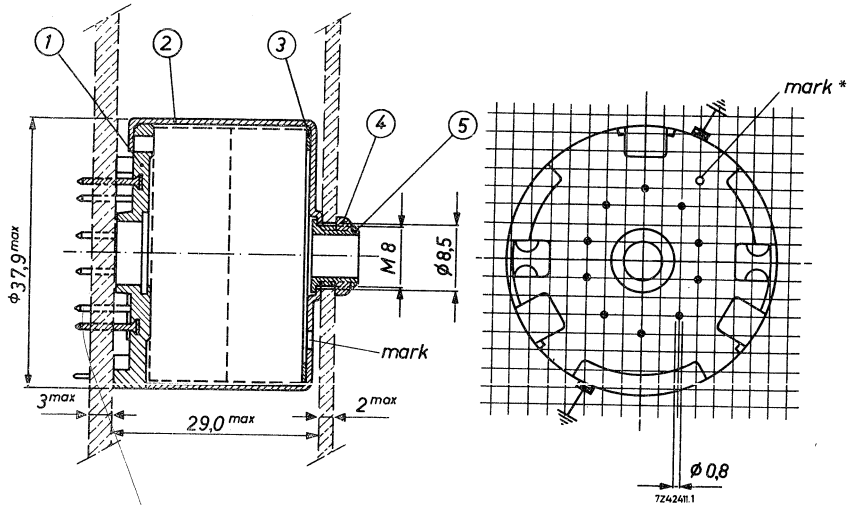


$A_L = 1600$ ; FXC 3H1

Note: 0 revolutions corresponds to at least one turn of interaction.

## MOUNTING PARTS

### MOUNTING



- |                     |                |                 |                |
|---------------------|----------------|-----------------|----------------|
| (1) tag plate       | 4322 021 30490 | (4) nut         | 4322 021 30710 |
| (2) brass container | 4322 021 30570 | (5) fixing bush | 4322 021 30720 |
| (3) spring          | 4322 021 30680 |                 |                |

The core is suitable for mounting on printed-wiring boards and on conventional panels.

The parts 1, 2, 3 are sufficient to construct an assembly for use in combination with printed wiring.

The ten soldering pins are arranged to fit a grid of 2,54 mm (0,1 inch).

The pin length is sufficient for a board thickness of up to 3 mm. The board should be provided with holes of  $1,3 \pm 0,1$  mm diameter.

\* There is another mark in a similar position on the top of the container.

If one-hole mounting is preferred, the parts 4 and 5 should be added. The coil assembly may then be mounted on panels having a thickness of up to 2 mm. The panel should be provided with a hole of 8,5 mm diameter.

It is recommended that the spring (3) be placed in the position indicated to obtain the best stability against shock and vibration.

Before bending the lips of the container, pressure should be exerted evenly on the rim of the tag plate until it meets the container. The force which is required is approximately 350 Newton. After bending the lips the spring will have the correct tension.

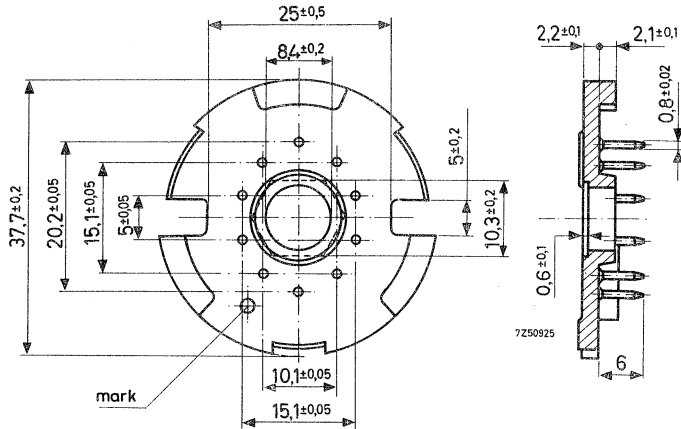
**PART DRAWINGS**

Dimensions in mm

(1) Tag plate 4322 021 30490

Plate: polyester reinforced with glass fibre, resistant against dip-soldering at 400 °C for 2 s.

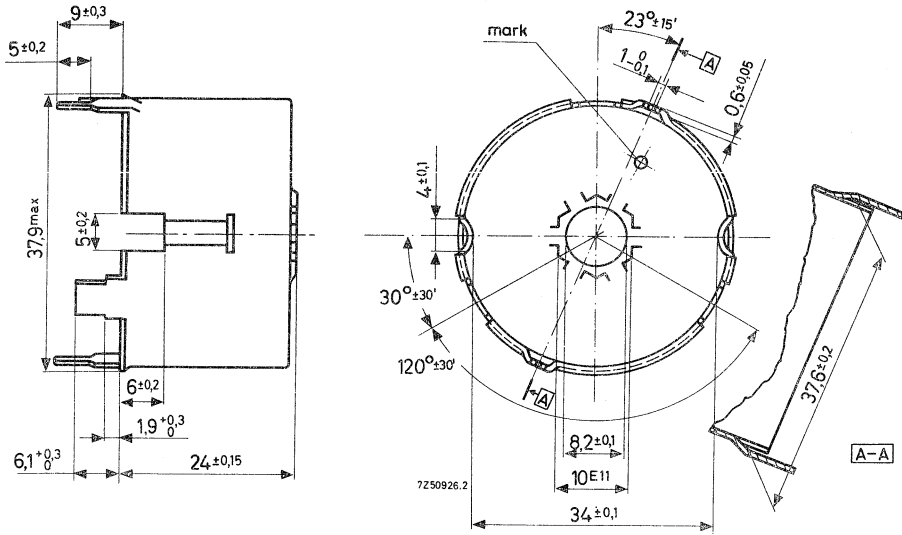
Pins : phosphor bronze, dip-soldered.



The tag plates are packed in units of 24 pieces on a polystyrene plate, and with 150 pieces in a cardboard box. Please order in multiples of these quantities.

(2) Container 4322 021 30570

Material: brass, nickel plated; thereafter tin plated.



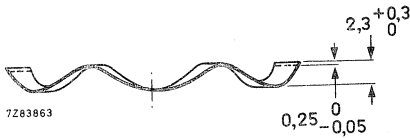
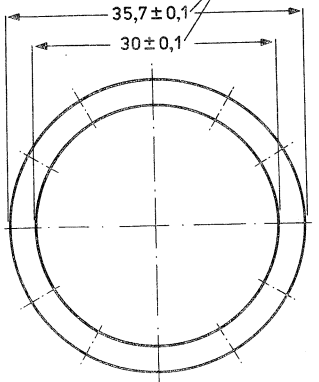
→ The containers are packed with 20 pieces in a primary pack, and 100 pieces in a storage pack. Please order in multiples of these quantities.



(3) Spring 4322 021 30680

Material: steel

in compressed position

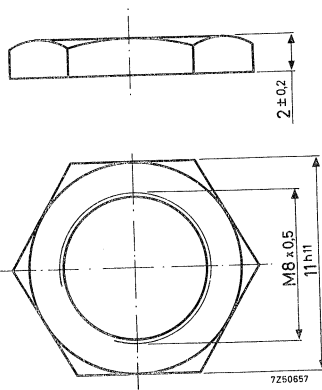


A force of 255 to 425 N is required to compress the spring to 0,55 mm.

The springs are supplied in quantities of 200. Please order in multiples of this quantity.

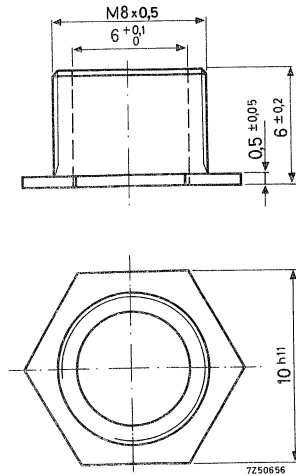
(4) Nut 4322 021 30710

Material: brass, nickel plated



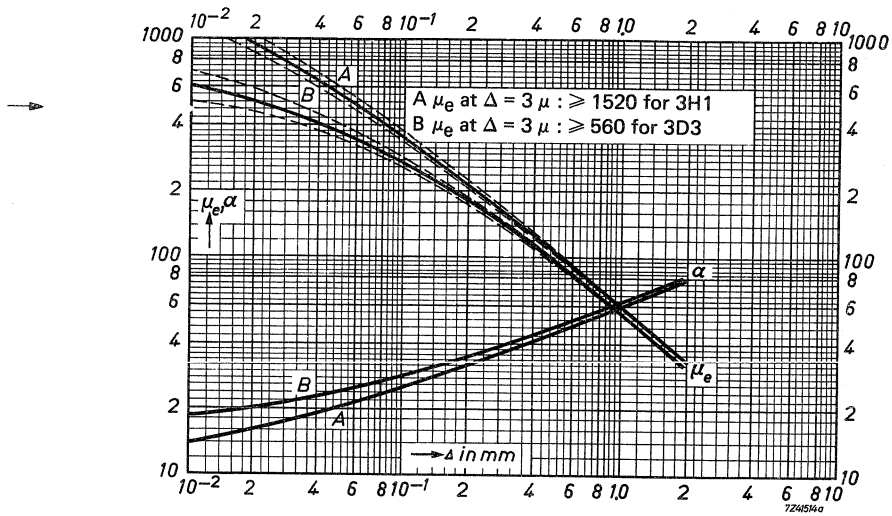
(5) Fixing bush 4322 021 30720

Material: brass, nickel plated



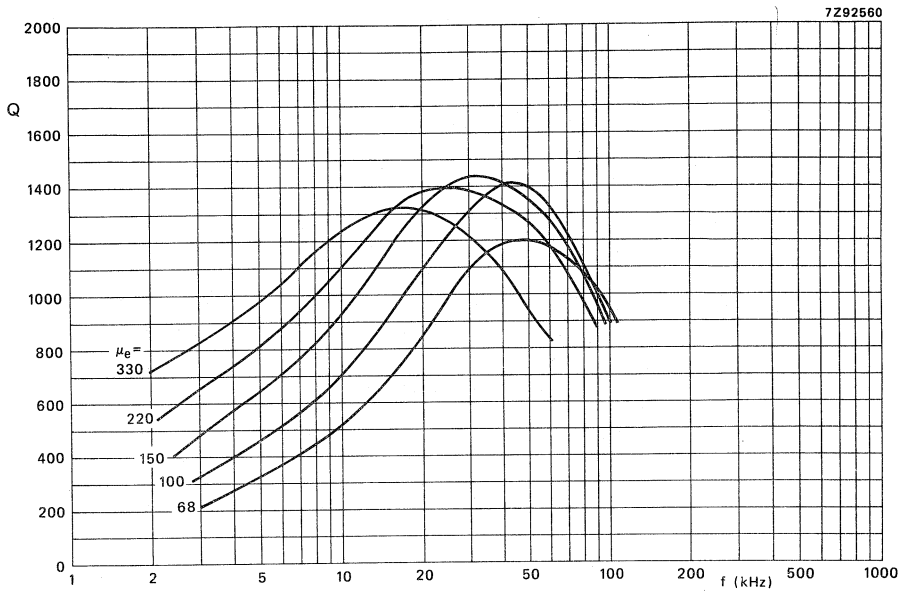
### CHARACTERISTIC CURVES

$\mu_e$ - $\alpha$  CURVES



Relative effective permeability and turn factor for 1 mH as a function of the air gap length.

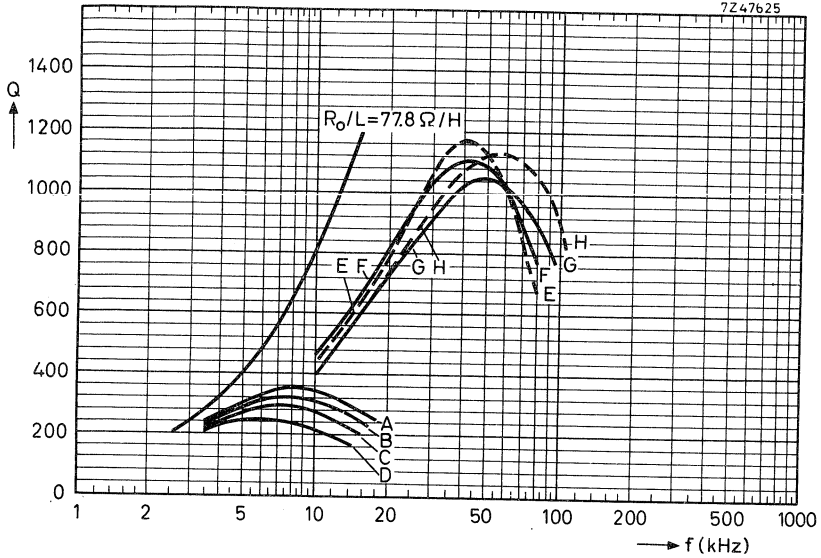
→ TYPICAL Q-CURVES FOR FXC 3H1



Enveloping curves.

Coil former 4322 021 30390.

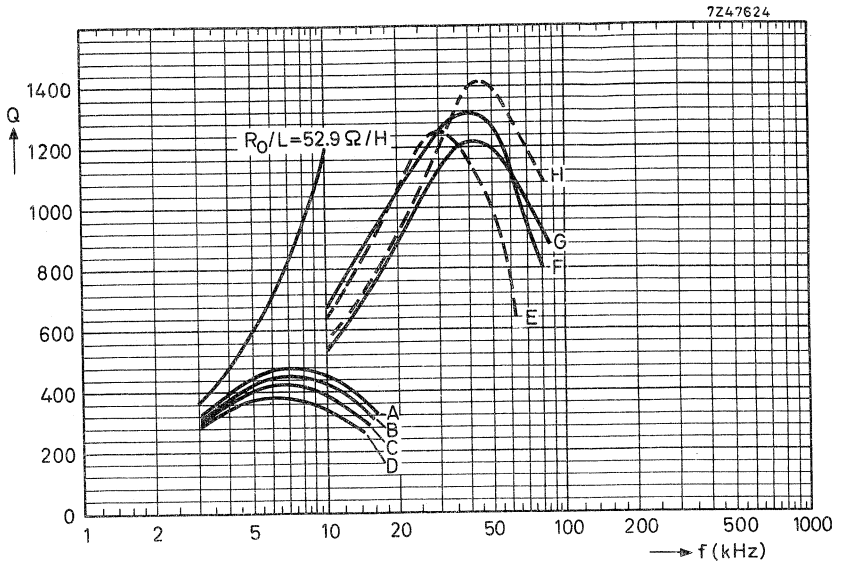
7247625



FXC 3H1  
 $\mu_e = 68$

Single-section coil former.

curve	L (mH)	number of turns	wire	$R_0/L$ ( $\Omega/H$ )
A	87.0	518	0.35 E. E.	77.8
B	48.5	387	0.40 E. E.	79.0
C	34.1	325	0.45 E. E.	77.0
D	23.6	270	0.50 E. E.	75.6
E	18.1	237	100 x 0.04 E. S.	129
F	5.30	128	200 x 0.04 E. S. S.	130
G	4.50	118	70 x 0.07 E. S. S.	137
H	2.07	80	100 x 0.07 E. S. S.	131

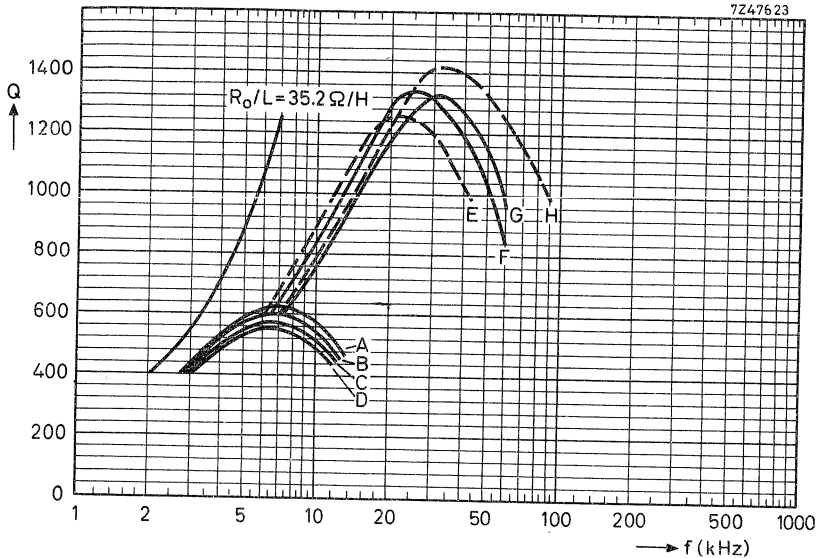


FXC 3H1  
 $\mu_e = 100$

Single-section coil former. ←

curve	L (mH)	number of turns	wire	$R_0/L$ ( $\Omega/H$ )
A	128	518	0.35 E.E.	52.9
B	71.4	387	0.40 E.E.	53.6
C	50.0	325	0.45 E.E.	52.2
D	34.7	270	0.50 E.E.	51.5
E	26.7	237	100 × 0.04 E.S.	88.0
F	7.83	128	200 × 0.04 E.S.S.	87.5
G	6.64	118	70 × 0.07 E.S.S.	94.3
H	3.06	80	100 × 0.07 E.S.S.	89.2

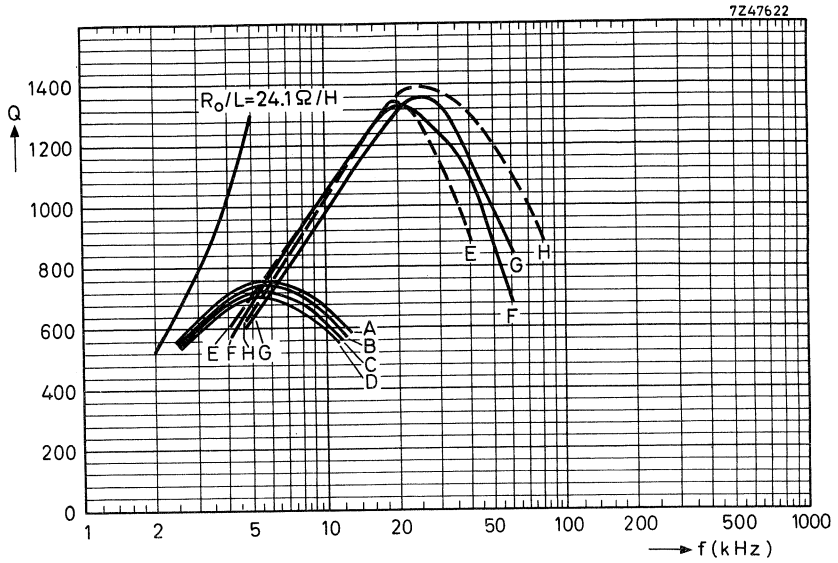
7247623



FXC 3H1  
 $\mu_e = 150$

Single-section coil former.

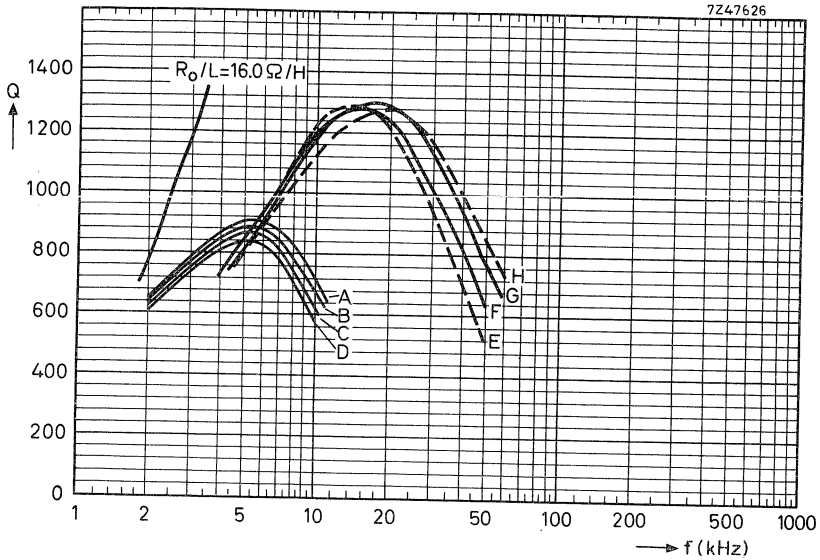
curve	L (mH)	number of turns	wire	$R_o/L$ ( $\Omega/H$ )
A	192	518	0.35 E.E.	35.2
B	107	387	0.40 E.E.	35.8
C	75.5	325	0.45 E.E.	34.8
D	52.3	270	0.50 E.E.	34.2
E	40.3	237	100 x 0.04 E.S.	58.3
F	11.7	128	200 x 0.04 E.S.S.	58.5
G	9.97	118	70 x 0.07 E.S.S.	62.7
H	4.59	80	100 x 0.07 E.S.S.	59.5



FXC 3H1  
 $\mu_e = 220$

Single-section coil former. ←

curve	L (mH)	number of turns	wire	$R_o/L$ ( $\Omega/H$ )
A	281	518	0.35 E.E.	24.1
B	157	387	0.40 E.E.	24.6
C	111	325	0.45 E.E.	23.8
D	76.4	270	0.50 E.E.	23.4
E	58.9	237	100 × 0.04 E.S.	39.9
F	17.1	128	200 × 0.04 E.S.S.	40.0
G	14.6	118	70 × 0.07 E.S.S.	42.8
H	6.70	80	100 × 0.07 E.S.S.	40.7



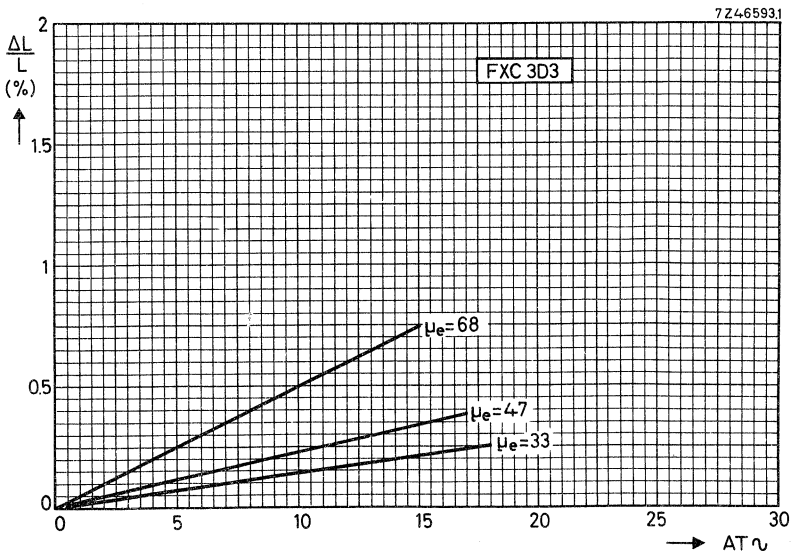
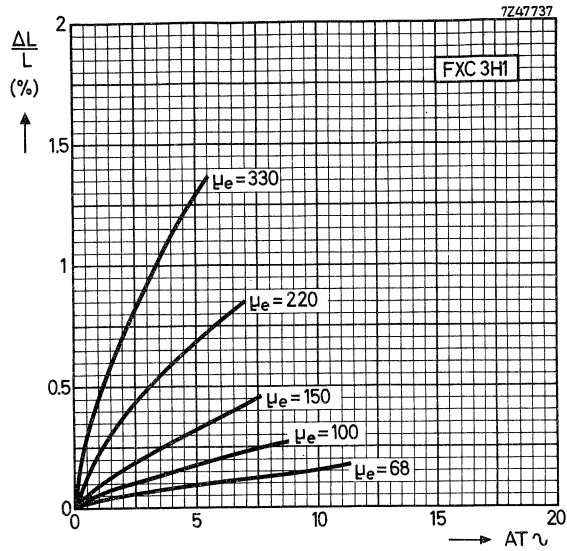
FXC 3H1  
 $\mu_e = 330$

Single-section coil former.

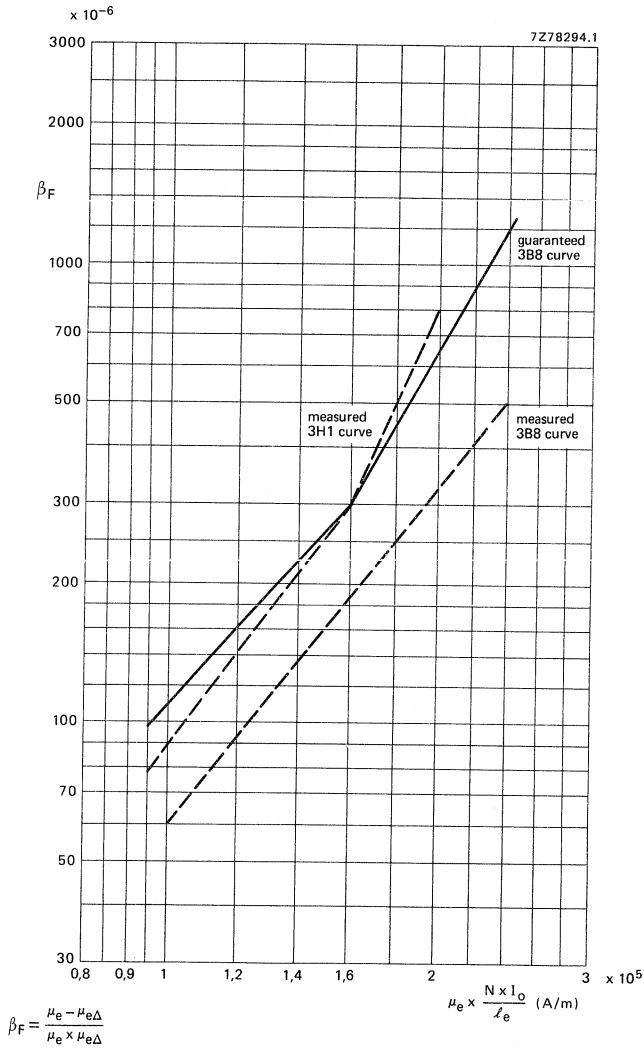
curve	L (mH)	number of turns	wire	$R_0/L$ ( $\Omega/H$ )
A	424	518	0.35 E.E.	16.0
B	236	387	0.40 E.E.	16.2
C	166	325	0.45 E.E.	15.9
D	108	270	0.50 E.E.	16.6
E	88.5	237	100 x 0.04 E.S.S.	26.6
F	25.8	128	200 x 0.04 E.S.S.	26.5
G	22.0	118	70 x 0.07 E.S.S.	28.4
H	10.1	80	100 x 0.07 E.S.S.	27.0



INDUCTANCE VARIATION AS A FUNCTION OF AT ~

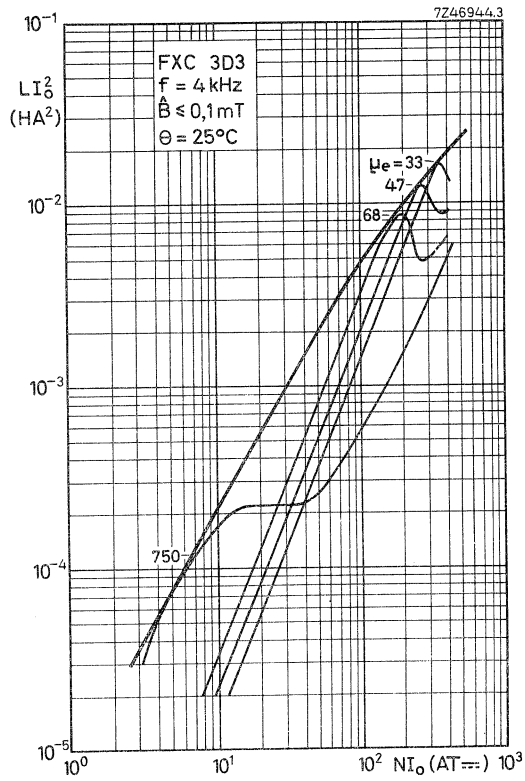


D.C. SENSITIVITY AT 25 °C



Inductance variation as a function of d.c. polarization.

Typical values





## POTCORES

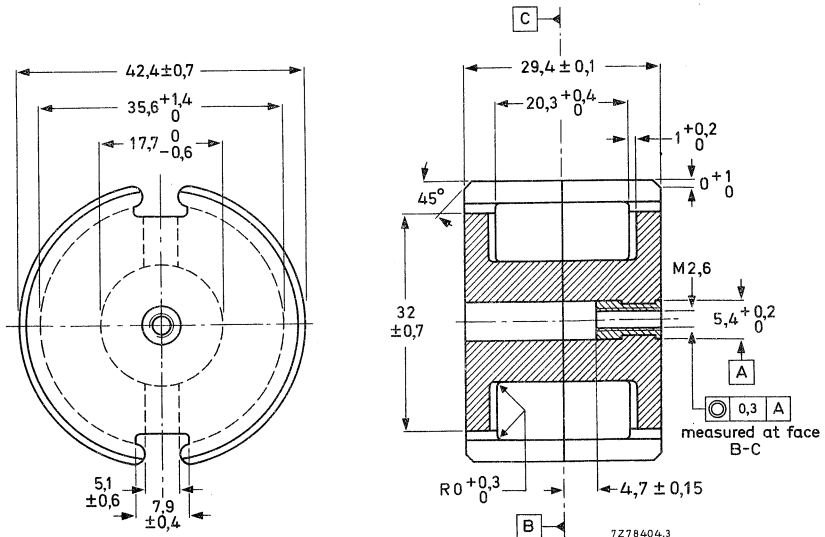
Three types of cores can be supplied:

- CORE SETS provided with a nut for an adjuster and pre-adjusted on an inductance factor  $A_L$  or on a relative effective permeability value  $\mu_e$ .
- CORE SETS without nut and pre-adjusted on an  $A_L$  or a  $\mu_e$  value.
- CORE HALVES without air gap.

Potcores and associated parts are ordered by their 12-digit catalogue number. Quantity: a primary pack contains 20 core sets or 40 core halves; a storage pack contains 80 core sets or 160 core halves. Please order in multiples of these quantities.

### MECHANICAL DATA

Dimensions in mm



Pulling-out force of the nut  $\geq 50$  N

Torque of the screw thread  $\leq 10$  mNm.

Extraction force of the adjuster from the nut  $\geq 40$  N

**MECHANICAL DATA** (continued)

Dimensional quantities according to IEC 205:

$$C_1 = \Sigma \frac{l}{A} = 0,259 \text{ mm}^{-1}; C_2 = \Sigma \frac{l}{A^2} = 0,000977 \text{ mm}^{-3}; V_e = 18\,200 \text{ mm}^3; l_e = 68,6 \text{ mm};$$

$$\rightarrow A_e = 265 \text{ mm}^2; A_{CP \text{ min}} = 214 \text{ mm}^2.$$

Mass of core set: 104 g.

**ELECTRICAL DATA**

The combination of two potcore halves without air gap, randomly chosen from a batch, has the following guaranteed properties. A measuring coil as described in the General section 'Potcores, square cores and cross cores', is inserted; the halves are pressed together with a force of 550 N. The values are valid 5 minutes or more after clamping.

	freq. kHz	$\hat{B}$ mT	temp. °C	grade	
				3H1	
$A_L \pm 25\%$	4	$\leq 0,1$	$25 \pm 1$	10 250	
$\mu_e \pm 25\%$	4	$\leq 0,1$	$25 \pm 1$	2100	
$\alpha$	4	$\leq 0,1$	$25 \pm 1$	$\leq 11,4$	
$\frac{\tan \delta}{\mu_i} \times 10^6$	4	$\leq 0,1$	$25 \pm 1$	$\leq 1,2$	
	100	$\leq 0,1$	$25 \pm 1$	$\leq 8$	
$\bar{\eta}_B \times 10^3$	4	1,5 to 3,0	$25 \pm 1$	$\leq 0,62$	
$\alpha_F \times 10^6/K$	$\leq 100$	$\leq 0,1$	5 to 25	+ 0,5 to 1,5	
	$\leq 100$	$\leq 0,1$	25 to 55	+ 0,5 to 1,5	
$D_F \times 10^6$	$\leq 100$	$\leq 0,1$	25 to 70		
(10-100 min)	$\leq 100$	$\leq 0,1$	$25 \pm 0,1$	$\leq 4,3$	

Core sets with nut and pre-adjusted on  $A_L$ .

$A_L$	corre- sponding $\mu_e$ -value	catalogue number 4322 022 . . . . .
		3H1
100 ± 1%	20,5	35240
250 ± 1%	51	35260
400 ± 1%	81	● 35280
630 ± 2%	130	35300
1000 ± 3%	205	● 35310
1600 ± 3%	325	35320
2500 ± 10%	510	—

Core sets with nut and pre-adjusted on  $\mu_e$ .

$\mu_e$	$\alpha$	catalogue number 4322 022 . . . . .
		3H1
68 ± 1%	55,0	34250
100 ± 1,5%	45,0	34260
150 ± 2%	36,8	34270
220 ± 3%	30,4	34280
330 ± 3%	24,8	34290
2120 ± 25%	9,85	14200

Core sets without nut: replace the eighth digit of the catalogue number (3) by 1.  
 Cores with  $A_L \leq 630$ , or  $\mu_e \leq 150$  have a symmetrical air gap.  
 Cores with  $A_L \geq 1000$ , or  $\mu_e \geq 220$  have an asymmetrical air gap.

Core halves without air gap, without nut.

Ferroxcube grade	catalogue number
3H1	4322 020 22760

● Preferred type.

## COIL FORMERS

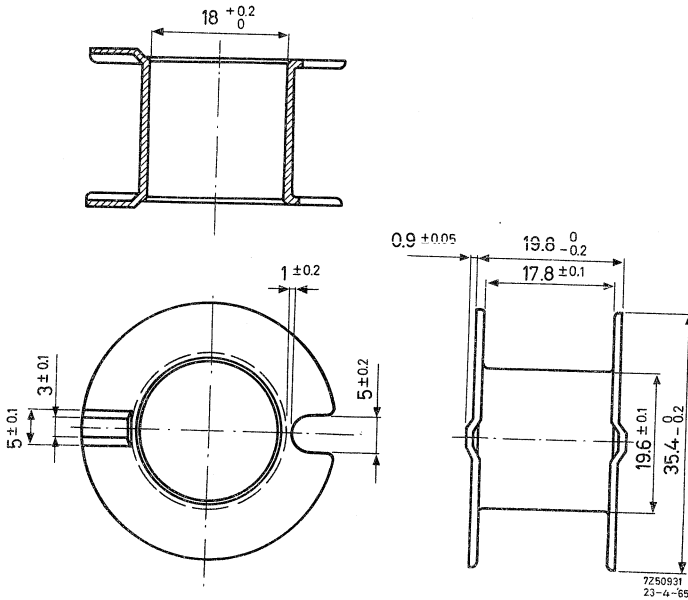
### GENERAL

Two types of coil former can be supplied:

- with one section;
- with two sections.

The dimensions conform with the following specifications: IEC 133 (international), NCF 83311 (France) and BS 4061 range 2 (Great Britain).

### SINGLE-SECTION COIL FORMER



Catalogue number	4322 021 30420
Material	polycarbonate
Window area	140 mm <sup>2</sup>
Mean length of turn	86 mm
Max. temperature	130 °C

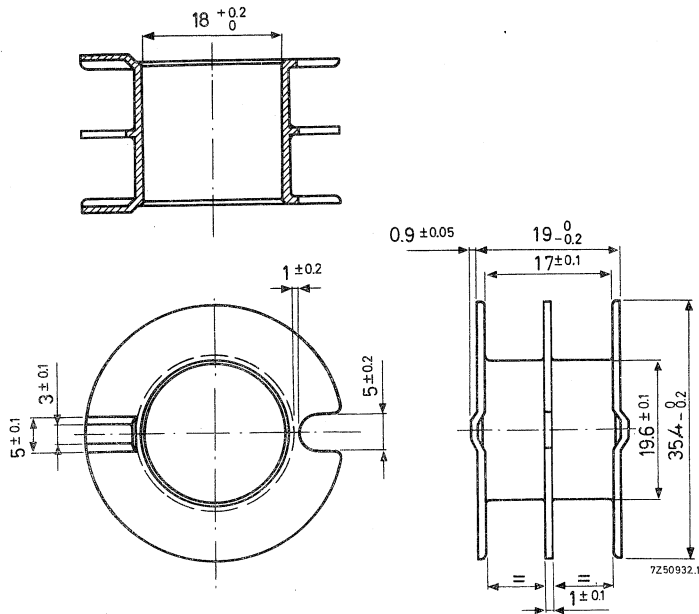
D.C. losses

$$\frac{R_o}{L} = \frac{1}{\mu_e} \times \frac{1}{f_{cu}} \times 2,16 \times 10^3 \Omega/H$$

Mass 2,4 g



## TWO-SECTION COIL FORMER



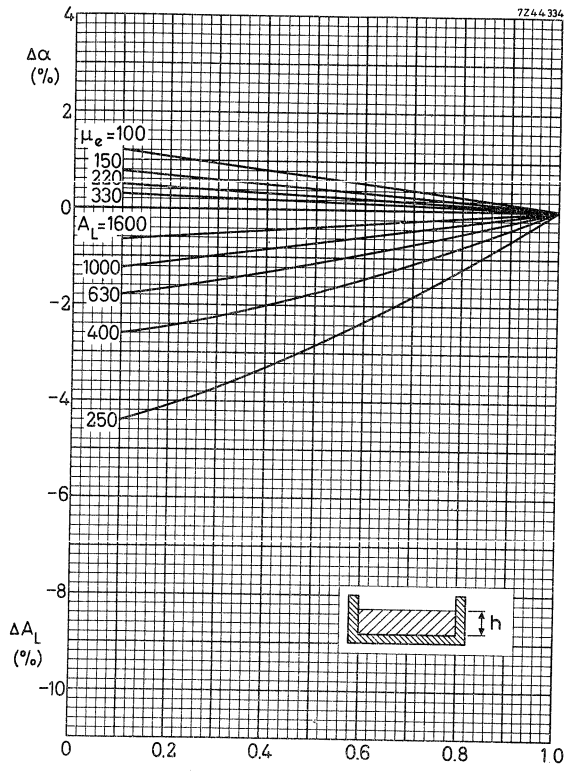
Catalogue number	4322 021 30430
Material	polycarbonate
Window area	2 x 63 mm <sup>2</sup>
Mean length of turn	86 mm
Max. temperature	130 °C

D.C. losses

$$\frac{R_o}{L} = \frac{1}{\mu_e} \times \frac{1}{f_{cu}} \times 2,40 \times 10^3 \Omega/H$$

Mass 3,0 g

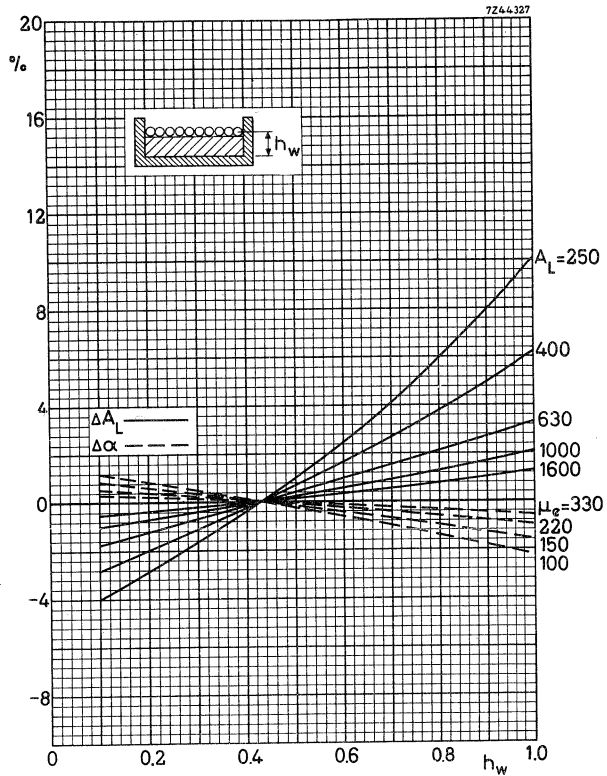
DATA FOR WHEN THE COIL FORMER IS PARTLY FILLED



Increase of the  $\alpha$  and decrease of the  $A_L$  factor for different  $\mu_e$  values and  $A_L$  factors as a function of the relative winding height on a single-section coil former. Valid for Ferroxcube 3H1.

Example:

On a single-section coil former only 0,4 part of the available height is used. A potcore with  $\mu_e = 100$  in that case obtains a  $\alpha$  factor of 45,0 + 0,75 %.



Variation of the  $\alpha$  and  $A_L$  factors for a coupling winding of one layer as a function of its winding height  $h_w$  on a single-section coil former. Valid for Ferroxcube 3H1.

Example:

On a single-section coil former a coupling winding is laid on 0,7 of the available height. A potcore with  $\mu_e = 100$  obtains for that winding an  $\alpha$  factor of 45,0 - 1,0 %.

# INDUCTANCE ADJUSTERS

(old types)

## CONTINUOUS ADJUSTERS

Dimensions in mm

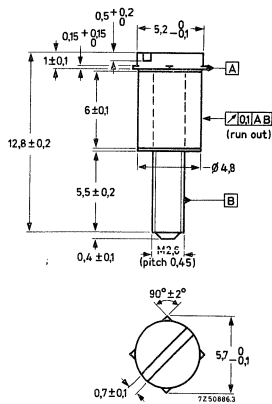


Fig. A.

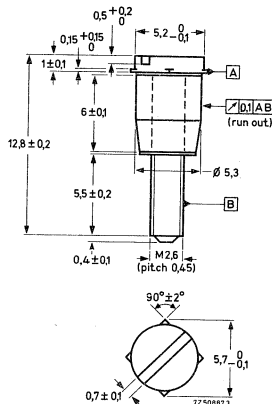


Fig. B.

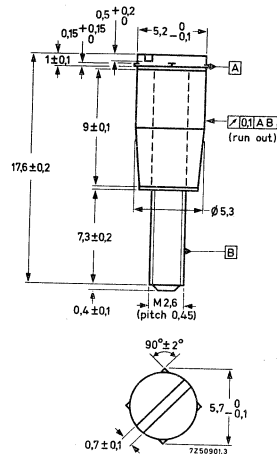


Fig. C.

The tolerances on inductance of the pre-adjusted potcores (without adjuster) are given under Potcores. After inserting a coil (impregnated or not) in an electrical circuit, its inductance can be adjusted to the required value with an accuracy  $< 0,03\%$  by means of a continuous inductance adjuster. Such an adjuster increases the inductance of the coil, see following pages.

The adjuster is screwed through the potcore into the nut and is held in position by the four protrusions near the top of the adjuster. For special requirements a bigger or smaller adjustment range may be obtained by using an adjuster belonging to the next higher or lower effective permeability.

The influence of the adjusters on the variability of the inductance is negligible. The maximum permissible temperature is  $110\text{ }^{\circ}\text{C}$ .

The table on the next page shows the type of adjuster recommended for different potcores.

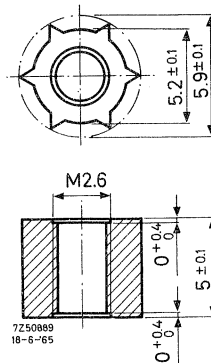
Types of adjuster and recommended applications

Fig.	colour	catalogue number 4322 021 . . . . .	potcore	
			$\mu_e$	$A_L$
B	white	30980	68	250
A	brown	30810	100	400
A	brown	30810		630
B	grey	31090	150	1000
B	grey	31090	220	
C	black	31120	330	1600

The adjusters are packed in plastic bags of 100. Please order in multiples of this quantity.

Nut for adjuster

These data are given for those manufacturers who prefer to insert the nut themselves.



Catalogue number

4322 021 30160

Material

polycarbonate

Max. impregnation temperature for 24 hours

120 °C

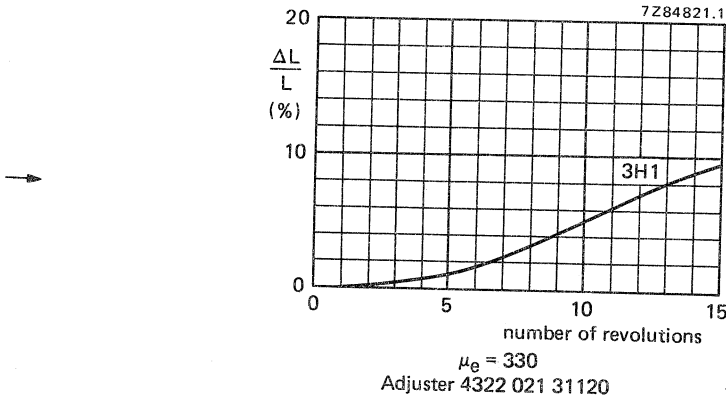
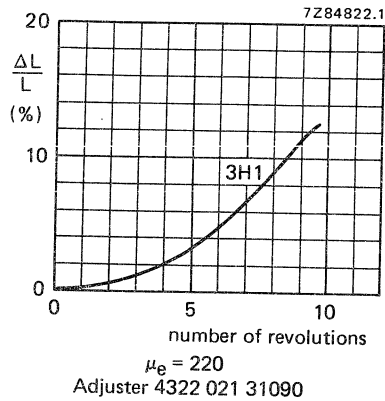
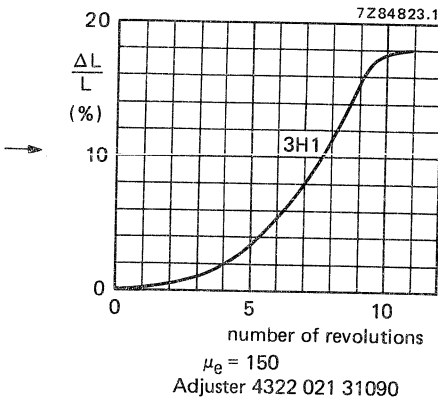
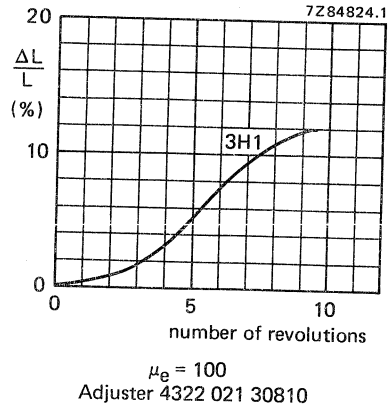
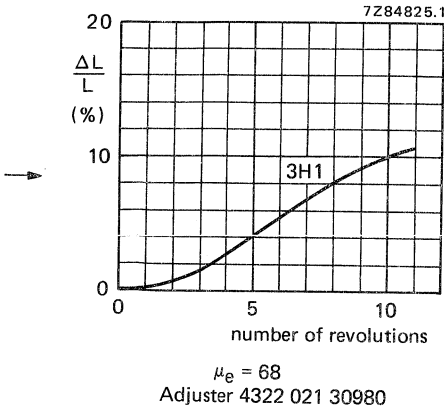
Recommended distance from mating surface to nut

4,7 ± 0,15

The nuts are packed in plastic bags of 100. Please order in multiples of this quantity.

For more information see Potcores General, Mounting Data.

Adjustment curves



## INDUCTANCE ADJUSTERS

(new types)

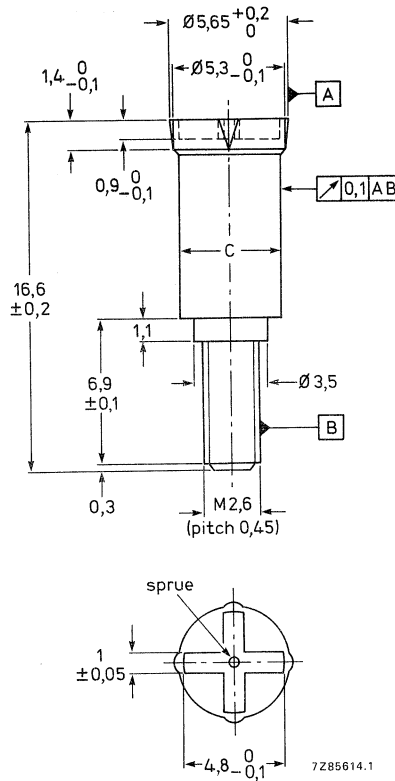


Fig. 1.

Material: polypropylene, reinforced with glass fibre.

The tolerances on inductance factor of the pre-adjusted cores without adjuster are given in the table of pre-adjusted cores with standard  $A_L$  values. The inductance of the pre-adjusted core can be increased to the required value – with a setting accuracy  $< 0,03\%$  – by means of a continuous adjuster.

The adjuster is screwed through the centre hole of the core into the nut and is held in position by the four cones near the top of the adjuster.

The combination of the polyamide moulded-in nut and the polypropylene adjuster – both reinforced with glass fibre – gives an excellent stability with temperature, shocks and vibrations. Besides this, the combination has a very smooth adjustment curve due to the excellent concentricity of the moulded-in nut and the adjuster.

The maximum permissible temperature of the adjustment combination is: 150 °C, during 8 h. The maximum working temperature is 110 °C.

The tables below show the available types and which adjuster is recommended for typical  $A_L$  values.

Table 1 Colour code of adjusters

catalogue number	colour	dia. C (Fig. 1) mm	material
4322 021 39290	grey	5,20	FXC

Table 2 Catalogue numbers of recommended adjusters for typical  $A_L$  values

$A_L$	3111
250	4322 021 39290 39290
400	
630	
1000	
1600	

**PACKAGING**

The adjusters are packed in plastic bags of 100. Please order in multiples of this quantity.

**ADJUSTING TOOL**

An adjusting tool combination for M2 and M2,6 is available, catalogue number 4322 058 03270.

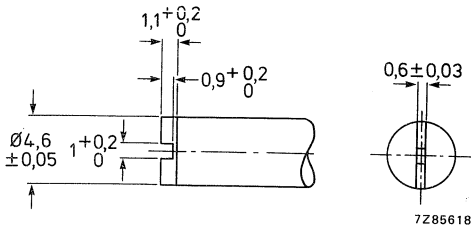


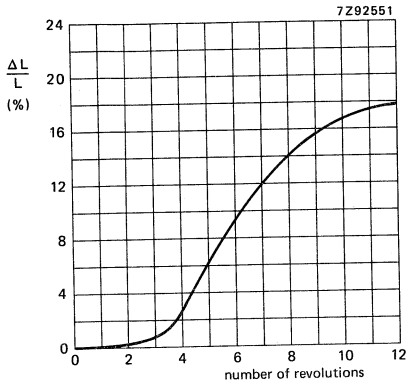
Fig. 2.

For customers who wish to make the screwdriver themselves the outlines of the essential part are given in Fig. 2.

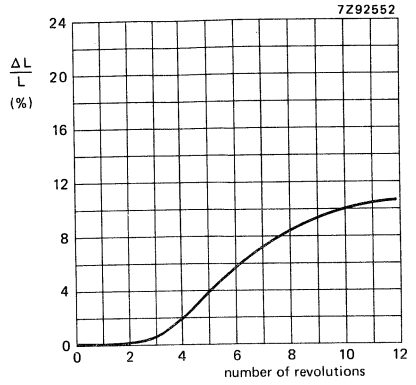


**ADJUSTMENT CURVES**

Characteristic curves



$A_L = 1000$ ; FXC 3H1

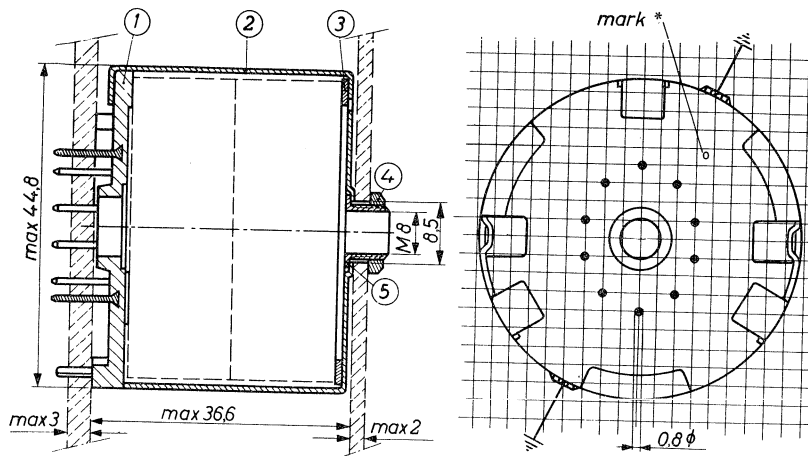


$A_L = 1600$ ; FXC 3H1

Note: 0 revolutions corresponds to at least one turn of interaction.

## MOUNTING PARTS

## MOUNTING



- (1) tag plate 4322 021 30500  
 (2) brass container 4322 021 30580  
 (3) spring 4322 021 30690

- (4) nut 4322 021 30710  
 (5) fixing bush 4322 021 30720

The core is suitable for mounting on printed-wiring boards and on conventional panels.

The parts 1, 2 and 3 are sufficient to construct an assembly for use in combination with printed wiring.

The ten soldering pins are arranged to fit a grid of 2,54 mm (0,1 inch).

The pin length is sufficient for a board thickness of up to 3 mm. The board should be provided with holes of  $1,3 \pm 0,1$  mm diameter.

\* There is another mark in a similar position on the top of the container.

If one-hole mounting is preferred, the parts 4 and 5 should be added. The coil assembly may then be mounted on panels having a thickness of up to 2 mm. The panel should be provided with a hole of 8,5 mm diameter.

It is recommended that the spring (3) be placed in the position indicated to obtain the best stability against shock and vibration.

Before bending the lips of the container, pressure should be exerted evenly on the rim of the tag plate until it meets the container. The force which is required is approximately 550 Newton. After bending the lips the spring will have the correct tension.

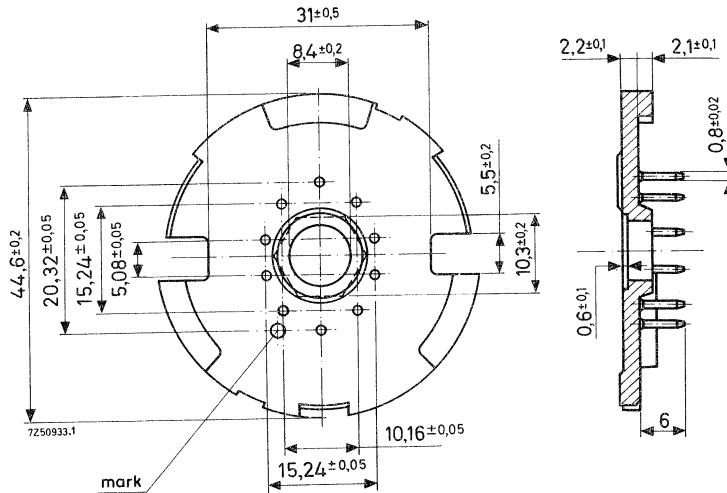
**PART DRAWINGS**

Dimensions in mm

(1) **Tag plate 4322 021 30500**

Plate: polyester reinforced with glass fibre, resistant against dip-soldering at 400 °C for 2 s

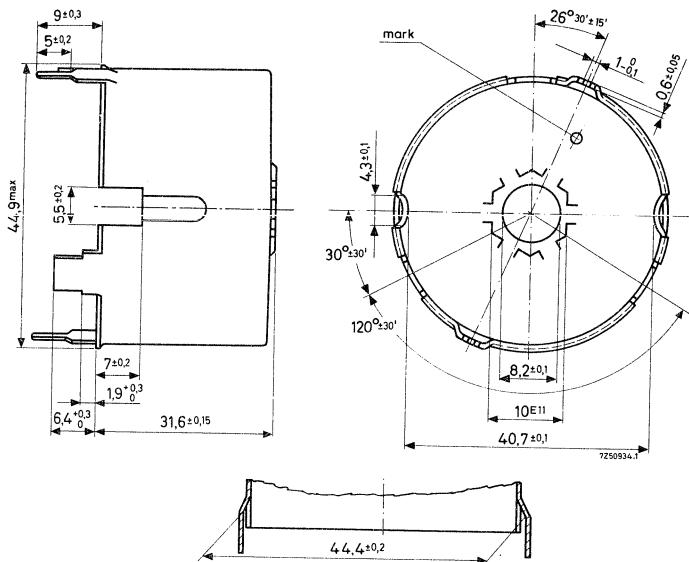
Pins: phosphor bronze, dip-soldered.



The tag plates are packed in units of 15 pieces on a polystyrene plate, and with 100 pieces in a cardboard box. Please order in multiples of these quantities.

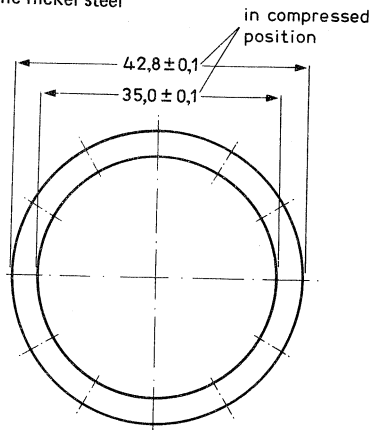
(2) Container 4322 021 30580

Material: brass, nickel plated; thereafter tin plated



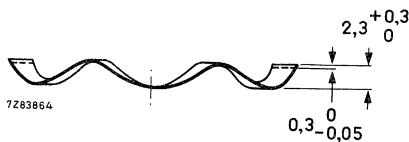
(b) Spring 4322 021 30690

Material: chrome-nickel steel



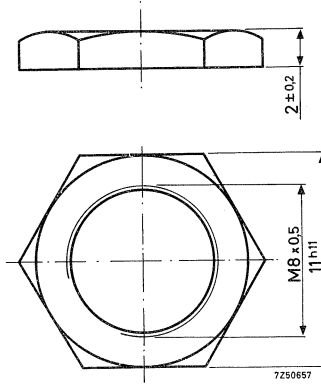
A force of 383 to 638 N is required to compress the spring to 0,67 mm.

The springs are supplied in quantities of 100. Please order in multiples of this quantity.



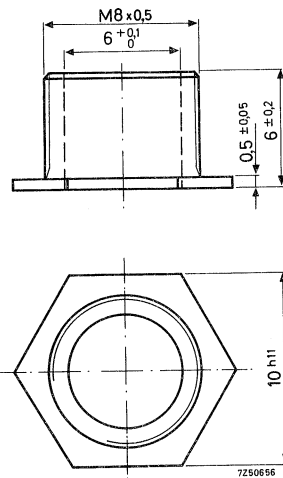
(4) Nut 4322 021 30710

Material: brass, nickel plated



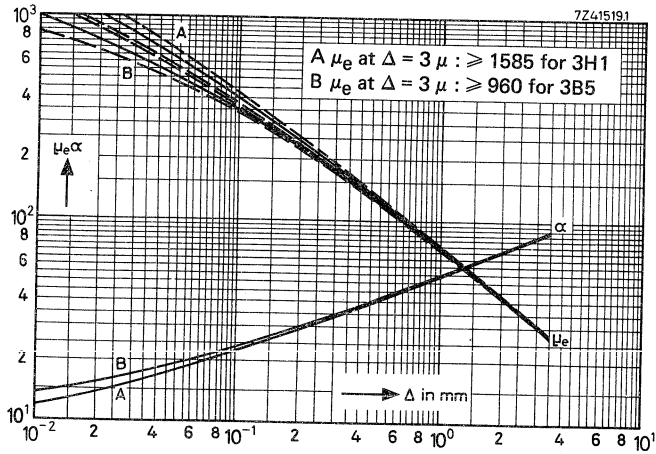
(5) Fixing bush 4322 021 30720

Material: brass, nickel plated



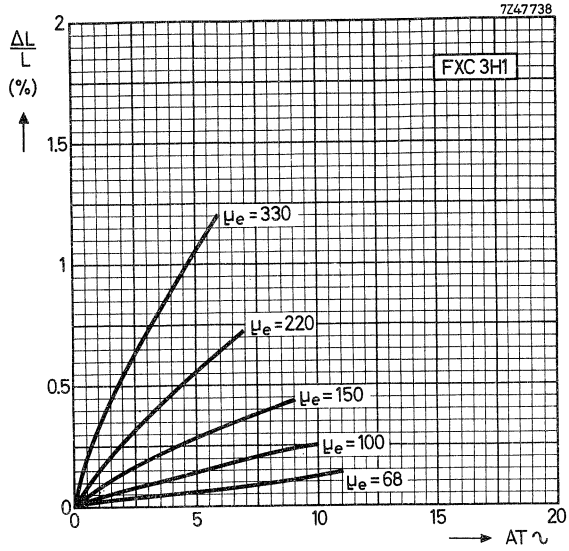
# CHARACTERISTIC CURVES

## $\mu_e$ - $\alpha$ CURVES



Relative effective permeability and turn factor for 1 mH as a function of the air gap length.

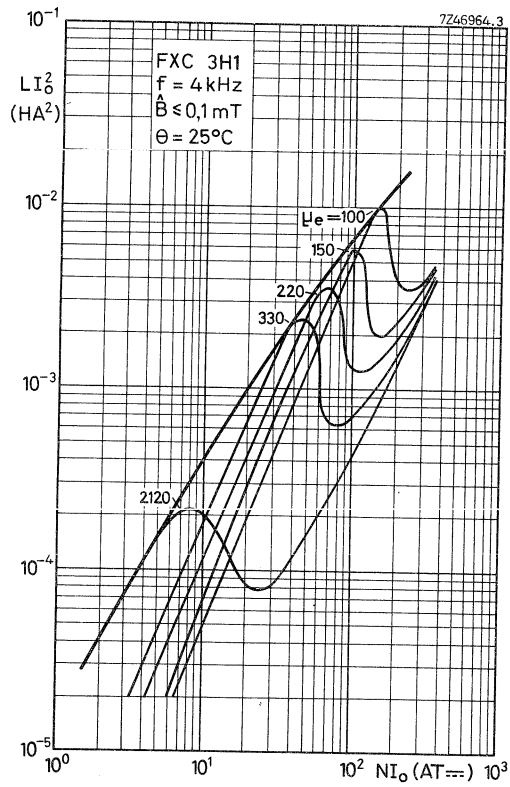
INDUCTANCE VARIATION AS A FUNCTION OF  $AT \sim$



**HANNA CURVE**

Indicating the optimum inductance for a certain  $\mu_e$ -value and direct current.

Typical values





## POTCORES

### INTRODUCTION

Two types of core can be supplied:

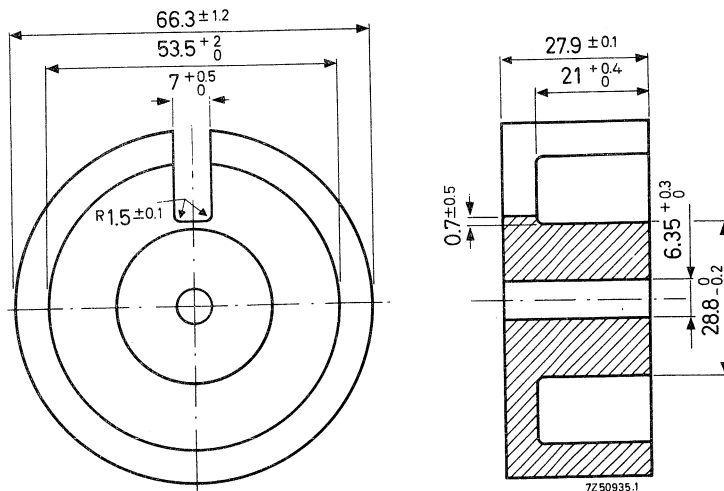
- Separate core halves, air gap to be ground by the user himself.
- Pre-adjusted potcores, available to special order. The  $\mu_e$  values can be chosen from the E6 standard series of values, the  $A_L$  values from the R5 series.

Potcores and associated parts are ordered by their 12-digit catalogue number.

Quantity: a storage pack contains 12 halves each packed in corrugated fibre cardboard, catalogue number 4322 020 23000, grade 3E1.

### MECHANICAL DATA

Dimensions in mm



Dimensional quantities according to IEC 205:

$$C_1 = \Sigma \frac{l}{A} = 0,172 \text{ mm}^{-1}; C_2 = \Sigma \frac{l}{A^2} = 0,000240 \text{ mm}^{-3}; V_e = 88300 \text{ mm}^3; l_e = 123 \text{ mm};$$

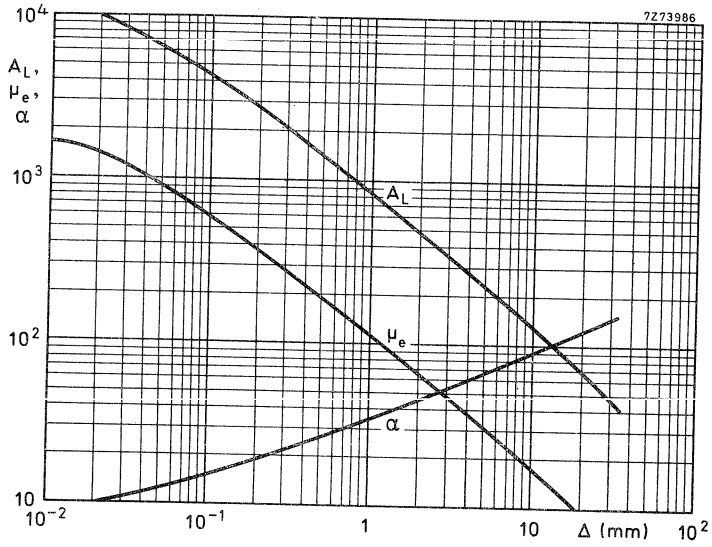
$$A_e = 717 \text{ mm}^2; A_{CP \text{ min}} = 590 \text{ mm}^2.$$

Mass of core set: 550 g.

For the combination of two potcore halves randomly chosen from a batch and pressed together with a force of 1700 N, the values below are guaranteed at  $25 \pm 10 \text{ }^\circ\text{C}$ .

	$\hat{B}$ mT	freq. kHz	3E1 grade
$\mu_e$	$\leq 0,1$	4	$\geq 1970$
$\alpha$	$\leq 0,1$	4	$\leq 8,25$

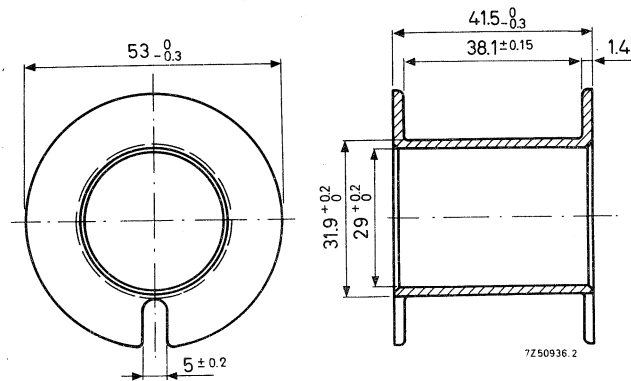
### CHARACTERISTIC CURVES



Inductance factor, relative effective permeability and turns factor as a function of the air gap length.

## COIL FORMER

## SINGLE-SECTION COIL FORMER



Catalogue number	4322 021 31320
Material	polycarbonate
Window area	400 mm <sup>2</sup>
Mean length of turn	130 mm
Max. temperature	130 °C

D.C. losses

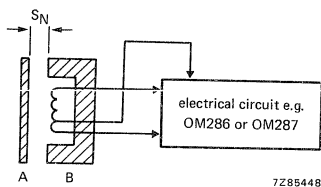
$$\frac{R_o}{L} = \frac{1}{\mu_e} \times \frac{1}{f_{cu}} \times 0,80 \times 10^3 \Omega/H$$

Mass 11,8 g



**POTCORE HALVES AND COIL FORMERS  
FOR INDUCTIVE PROXIMITY DETECTORS**

## INTRODUCTION



An inductive proximity detector operates as follows. A metal object A approaches — or recedes from — an open potcore half with coil B. The change in the Q of the oscillator is used to generate an electrical signal that can be used to drive an electromechanical relay, an audible alarm or similar devices.

Potcore halves with diameters up to 9,4 mm are manufactured in Ferroxcube grade 3D3 and potcore halves with diameters 14 mm and larger in Ferroxcube grade 3H1, because the operating frequency of oscillators with small potcore halves is higher than that of oscillators with large potcore halves.

Suitable coil formers are available for all potcore halves. The polycarbonate material of the coil former limits the maximum potting temperature to 110 °C. The potting material should be somewhat flexible to avoid high mechanical stresses on the Ferroxcube potcore halves.

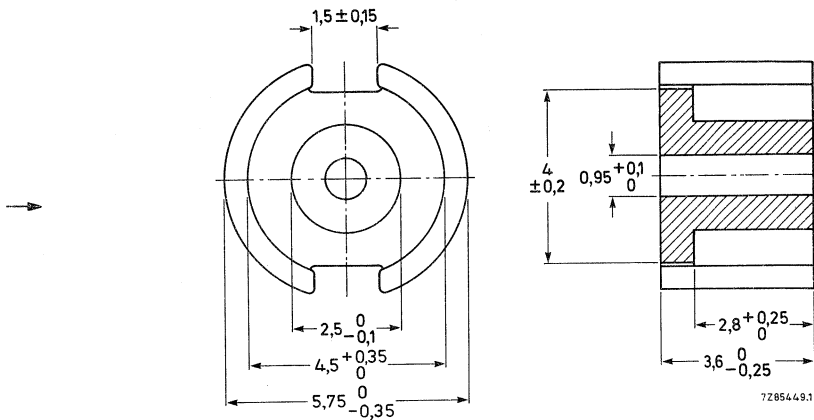
### SURVEY OF TYPES

Ferroxcube potcore half	grade	catalogue number	coil former
5,6 x 3,6	3D3	4322 020 54210	4322 021 33540 ←
7,4 x 3,9	3D3	4322 020 54510	4322 021 32990
9,4 x 4,8	3D3	4322 020 54710	4322 021 31700
14 x 7,5	3H1	4322 020 54800	4322 021 30250
26 x 9,2	3H1	4322 020 54900	4322 021 33700

## POTCORE HALF

Non-ground potcore half, intended for use in proximity detectors.

## MECHANICAL DATA



Material grade: 3D3

Initial permeability, toroidally measured:  $\mu_i = 750 \pm 20\%$

Mass of one potcore half: 0,25 g

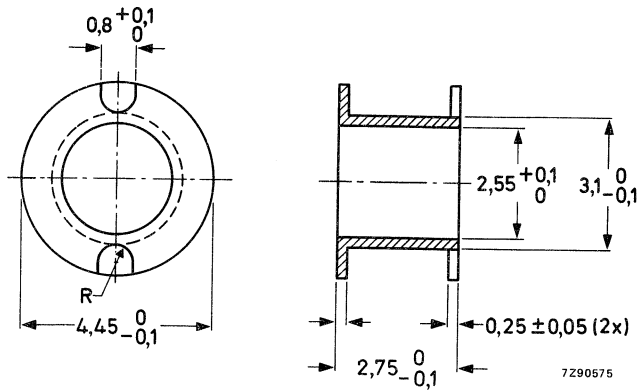
Catalogue number: 4322 020 54210

Quantities: a primary pack contains 100 core halves, a storage pack contains 500 core halves. Please order in multiples of these quantities.

5,6 x 3,6

## COIL FORMER

Dimensions in mm



Catalogue number	4322 021 33540
Material	polyamide
Window area	1,9 mm <sup>2</sup>
Mean length of turn	11,7 mm
Maximum temperature	130 °C
A <sub>R</sub> value*	221 μΩ
Mass	0,03 g

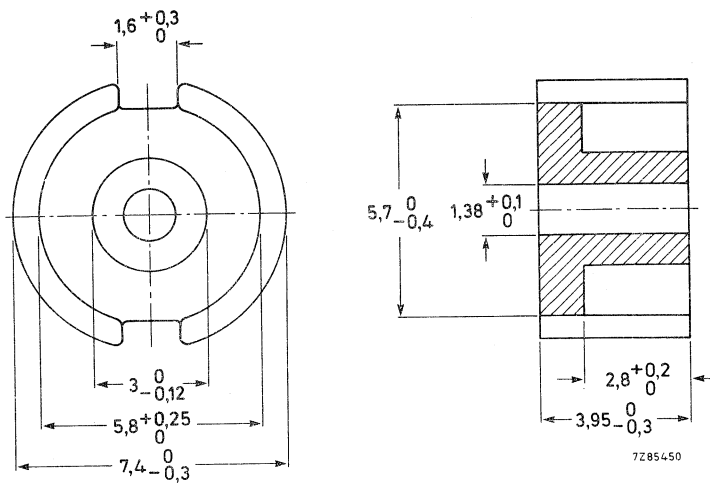
\* D.C. resistance =  $A_R \cdot (\text{number of turns})^2$  or  $R_0 = A_R \cdot N^2$ .



## POTCORE HALF

Non-ground potcore half, intended for the use in proximity detectors.

## MECHANICAL DATA



Material grade: 3D3

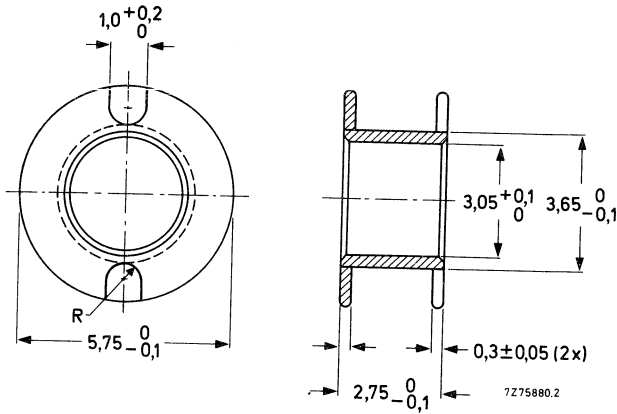
Initial permeability, toroidally measured:  $\mu_i = 750 \pm 20\%$

Mass of one potcore half: 0,3 g

Catalogue number: 4322 020 54510

Quantities: A primary pack contains 100 core halves; a storage pack contains 500 core halves. Please order in multiples of these quantities.

## COIL FORMER



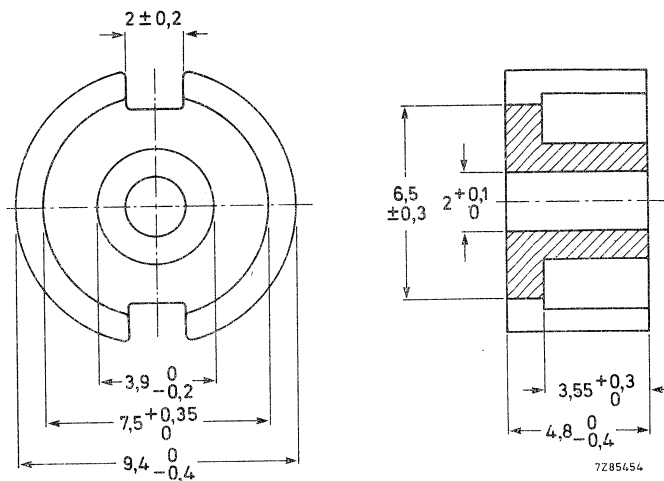
Catalogue number	4322 021 32990
Material	polyamide
Window area	2,2 mm <sup>2</sup>
Mean length of turn	14,6 mm
Maximum temperature	130 °C
A <sub>R</sub> value*	230 μΩ
Mass	0,04 g

\* D.C. resistance =  $A_R \cdot (\text{number of turns})^2$  or:  $R_0 = A_R \cdot N^2$ .

## POTCORE HALF

Non-ground potcore half, intended for use in proximity detectors.

## MECHANICAL DATA



Material grade: 3D3

Initial permeability, toroidally measured:  $\mu_i = 750 \pm 20\%$

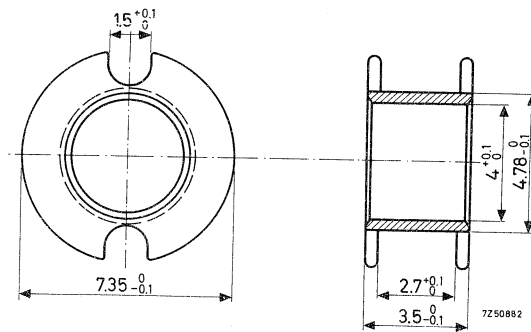
Mass of one potcore half: 1,6 g

Catalogue number: 4322 020 54710

Quantities: a primary pack contains 50 core halves, a storage pack contains 400 core halves. Please order in multiples of these quantities.

## COIL FORMER

This coil former is identical to the single-section coil former for potcore P9/5.



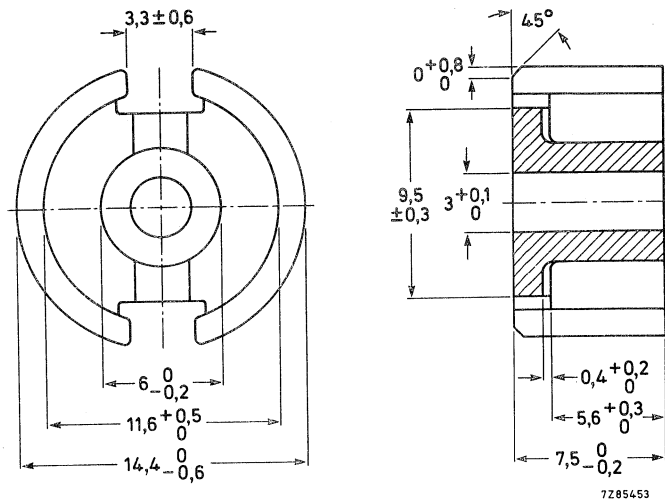
Catalogue number	4322 021 31700
Material	polycarbonate
Window area	3,4 mm <sup>2</sup>
Mean length of turn	19 mm
Maximum temperature	130 °C
A <sub>R</sub> value*	200 μΩ
Mass	0,07 g

\* D.C. resistance =  $A_R \cdot (\text{number of turns})^2$  or:  $R_0 = A_R \cdot N^2$ .

## POTCORE HALF

Non-ground potcore half, intended for use in proximity detectors.

## MECHANICAL DATA



Material grade: 3H1

Initial permeability, toroidally measured:  $\mu_i = 2300 \pm 20\%$

Mass of one potcore half: 2,0 g

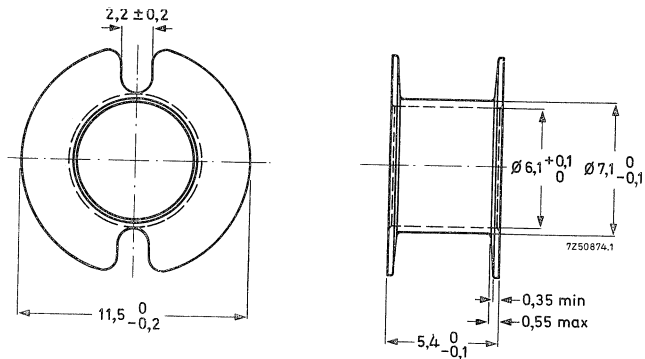
Catalogue number: 4322 020 54800

Quantities: a primary pack contains 40 core halves; a storage pack contains 200 core halves. Please order in multiples of these quantities.

→ 14 x 7,5

## COIL FORMER

This coil former is identical to the single-section coil former for potcore P14/B.



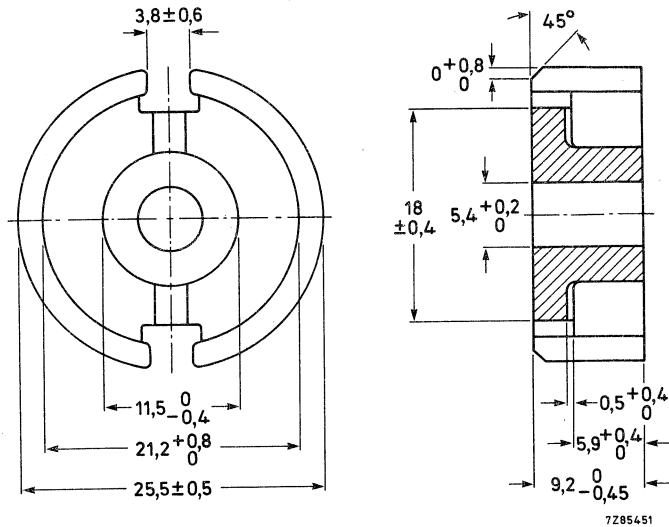
Catalogue number	4322 021 30250
Material	polycarbonate
Window area	9,7 mm <sup>2</sup>
Mean length of turn	29 mm
Maximum temperature	130 °C
A <sub>R</sub> value*	110 μΩ
Mass	0,15 g

\* D.C. resistance = A<sub>R</sub> · (number of turns)<sup>2</sup> or: R<sub>0</sub> = A<sub>R</sub> · N<sup>2</sup>.

## POTCORE HALF

Non-ground potcore half, intended for use in proximity detectors.

## MECHANICAL DATA



Material grade: 3H1

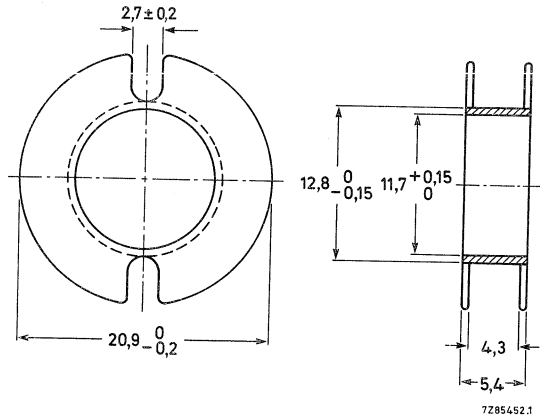
Initial permeability, toroidally measured:  $\mu_i = 2300 \pm 20\%$

Mass of one potcore half: 11 g

Catalogue number: 4322 020 54900

Quantities: a primary pack contains 40 core halves, a storage pack contains 200 core halves. Please order in multiples of these quantities.

### COIL FORMER |



Catalogue number:

Material

Window area

Mean length of turn

Maximum temperature

$A_R$  value\*

Mass

4322 021 33700

polycarbonate

22 mm<sup>2</sup>

14,6 mm

130 °C

90  $\mu\Omega$

0,4 g

\* D.C. resistance =  $A_R \cdot (\text{number of turns})^2$  or:  $R_0 = A_R \cdot N^2$ .



**SQUARE CORES AND ACCESSORIES**



## SQUARE CORES

These types of core can be supplied:

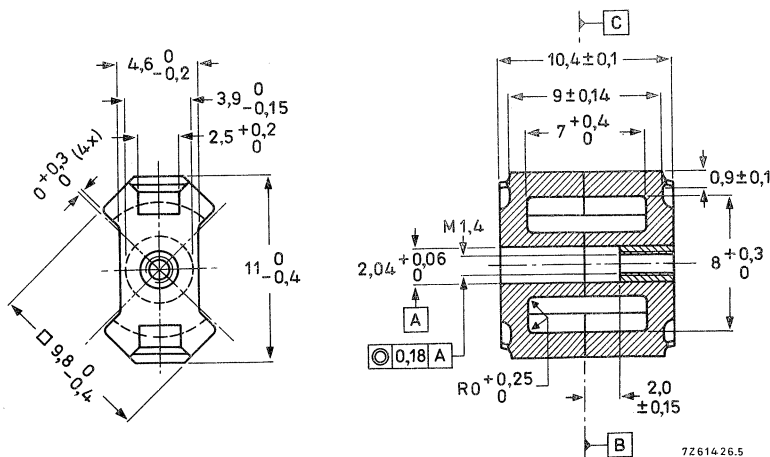
- CORE SETS provided with a nut for an adjuster and pre-adjusted on an inductance factor  $A_L$ .
- CORE SETS without nut and pre-adjusted on an  $A_L$  value.
- CORE HALVES without air gap.

The square cores are in accordance with the following specifications: IEC431 (international), UTE83-300 (France), DIN 41980 (Germany).

Square cores and associated parts are ordered by their 12-digit catalogue number. Quantity: a primary pack contains 20 core sets or 40 core halves; a storage pack contains 100 core sets or 200 core halves. Please order in multiples of these quantities.

### MECHANICAL DATA

Dimensions in mm



Pulling-out force of the nut	≥ 20 N (at ambient temperature)
Torque of the screw thread	≤ 4 mNm
Extraction force of adjuster from nut	≥ 10 N

**MECHANICAL DATA (continued)**

Dimensional quantities according to IEC 205:

a. Version with centre hole:

$$C_1 = \Sigma \frac{l}{A} = 1,94 \text{ mm}^{-1}; C_2 = \Sigma \frac{l}{A^2} = 0,176 \text{ mm}^{-3}; V_e = 230 \text{ mm}^3; l_e = 21,3 \text{ mm}; A_e = 11,0 \text{ mm}^2.$$

Mass of a core set: 2,5 g.

b. Version without centre hole:

$$C_1 = \Sigma \frac{l}{A} = 1,69 \text{ mm}^{-1}; C_2 = \Sigma \frac{l}{A^2} = 0,123 \text{ mm}^{-3}; V_e = 322 \text{ mm}^3; l_e = 23,3 \text{ mm}; A_e = 13,8 \text{ mm}^2.$$

Mass of a core set: 2,8 g.

## ELECTRICAL DATA

The combination of two square core halves without air gap, randomly chosen from a batch, has the following guaranteed properties. A measuring coil as described in the General section 'Potcores, square cores and cross cores', is inserted; the halves are pressed together with a force of 25 N. The values are valid 5 minutes or more after clamping.

	freq. kHz	$\hat{B}$ mT	temp. °C	grade	
				3E4	3H1
$A_L \pm 25\%$	4	$\leq 0,1$	$25 \pm 1$		1040
$\mu_e \pm 25\%$	4	$\leq 0,1$	$25 \pm 1$		1600
$\alpha$	4	$\leq 0,1$	$25 \pm 1$		$\leq 35,8$
$\frac{\tan \delta}{\mu_i} \times 10^6$	4	$\leq 0,1$	$25 \pm 1$	$\leq 2,5$	
	30	$\leq 0,1$	$25 \pm 1$		$\leq 3,0$
	100	$\leq 0,1$	$25 \pm 1$	$\leq 20$	$\leq 6,0$
	500	$\leq 0,1$	$25 \pm 1$	$\leq 200$	
$\eta_B \times 10^3$	4	1,5 to 3,0	$25 \pm 1$	$\leq 1,1$	$\leq 1,1$
$\alpha_F \times 10^6 / K$	$\leq 100$	$\leq 0,1$	5 to 25	0 to +2	+0,5 to +1,5
	$\leq 100$	$\leq 0,1$	25 to 55	0 to +2	+0,5 to +1,5
	$\leq 100$	$\leq 0,1$	25 to 70	0 to +2	
$D_F \times 10^6$ (10 – 100 min)	$\leq 100$	$\leq 0,1$	$25 \pm 0,1$	$\leq 4,3$	$\leq 4,3$

Core sets with nut and pre-adjusted on  $A_L$ .

$A_L$	corresponding $\mu_e$ -value	tol. on inductance (%)	cat. no. 4322 022 .....	
			3E4	3H1
40	62	$\pm 1$		77220
63	96	$\pm 1,5$		77230
100	152	$\pm 2$		● 77240
160	242	$\pm 5$		77250
250	380	$\pm 10$		77260
2790	3760	$\pm 25$	● 57900*	

Inductance  $L = N^2 A_L$  (in  $10^{-9}$  H).

Core sets without nut: replace the eighth digit of the catalogue number (7) by 5.

Cores with  $A_L \leq 40$  have a symmetrical air gap.

Cores with  $A_L \geq 63$  have an asymmetrical air gap.

→ Types marked\* are without centre hole.

In order to obtain better performance, type 4322 022 57900 is made without centre hole.

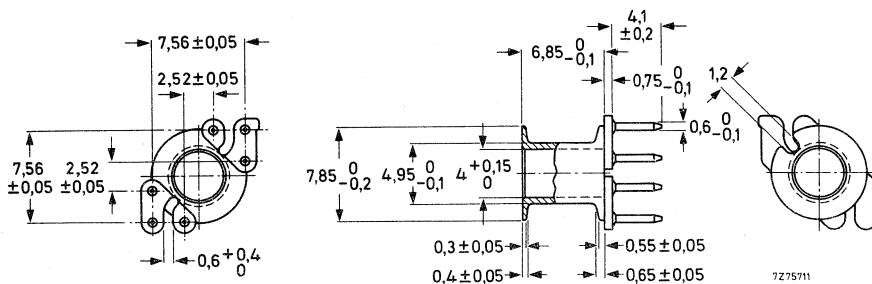
Core halves without air gap, without nut.

Ferroxcube grade	catalogue number
3H1	4322 020 26510

→ ● Preferred type.

## COIL FORMER

## SINGLE-SECTION, 6-PIN COIL FORMER



Catalogue number

4322 021 32210

Material

phenol formaldehyde reinforced with glass fibre,  
dip-soldered pins

Window area

8,8 mm<sup>2</sup>

Mean length of turn

20 mm

Max. temperature

180 °C

Solderability

resistant against dip-soldering at 400 °C for 2 s

D.C. losses

$$\frac{R_0}{L} = \frac{1}{\mu_e} \times \frac{1}{f_{Cu}} \times 55,7 \times 10^3 \Omega/H$$

Inflammability

UL94, class V-0

Mass

0,16 g

The coil formers are supplied in packs of 200 on a polystyrene plate. Please order in multiples of this quantity.

## INDUCTANCE ADJUSTERS

(old types)

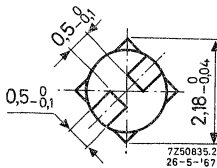
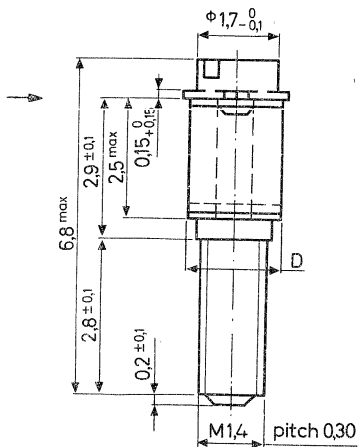
### ADJUSTERS

The tolerances on inductance of the pre-adjusted cores (without adjuster) are given in the table of pre-adjusted cores with standard  $A_L$  values. After inserting a coil (impregnated or not) in an electrical circuit, its inductance can be adjusted to the required value with an accuracy  $< 0,03\%$  by means of a continuous inductance adjuster. Such an adjuster increases the inductance of the coil (see following pages).

The adjuster is screwed through the core into the nut and is held in position by the lips of the adjuster head. For special requirements a larger or smaller adjustment range may be obtained by using an adjuster belonging to the next higher or lower  $A_L$  value.

The influence of the adjuster on the variability of the inductance is negligible. The maximum permissible temperature is  $110\text{ }^\circ\text{C}$ .

The table shows the type of adjuster recommended for different square cores.

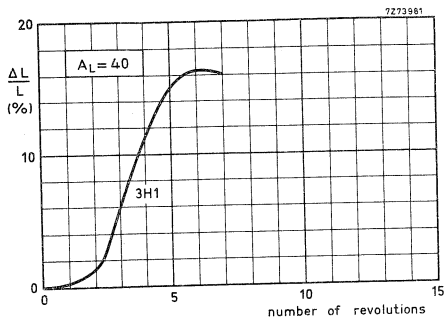


D	$A_L$ of core in 3H1	recommended adjuster	
		catalogue number	colour
1,85	40	4322 021 31250	natural
1,85	63	4322 021 31260	red
1,85	100	4322 021 31270	yellow
1,76	160	4322 021 31540	brown
1,85	250	4322 021 31280	grey

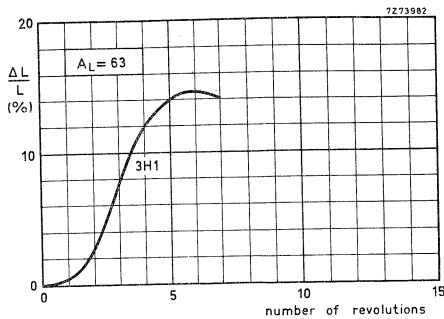
The adjusters are packed in plastic bags of 100. Please order in multiples of 100.



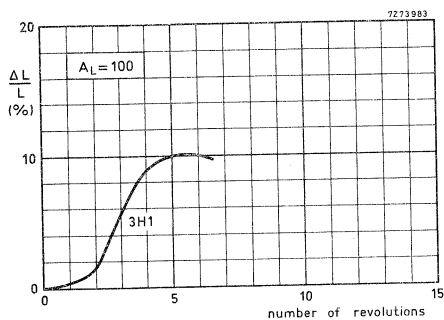
ADJUSTMENT CURVES



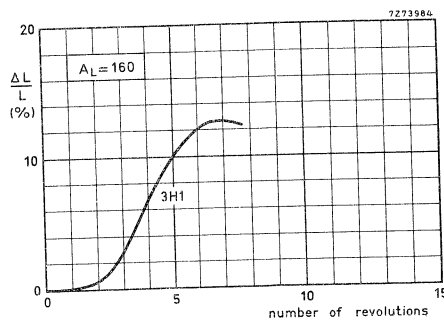
Adjuster 4322 021 31250.



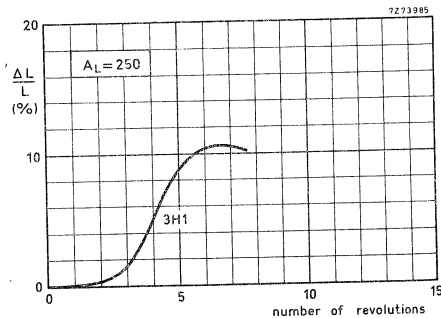
Adjuster 4322 021 31260.



Adjuster 4322 021 31270.



Adjuster 4322 021 31540.



Adjuster 4322 021 31280.



## INDUCTANCE ADJUSTERS

(new types)

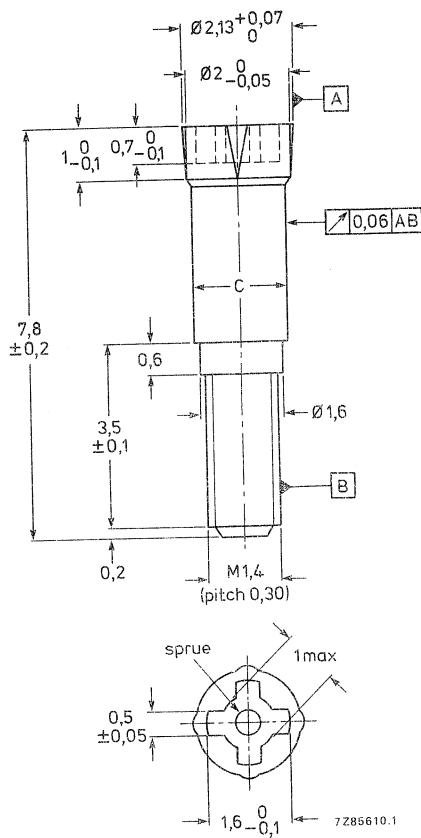


Fig. 1.

Material: polypropylene, reinforced with glass fibre.

The tolerances on inductance factor of the pre-adjusted cores without adjuster are given in the table of pre-adjusted cores with standard  $A_L$  values. The inductance of the pre-adjusted core can be increased to the required value — with a setting accuracy  $< 0,03\%$  — by means of a continuous adjuster.

The adjuster is screwed through the centre hole of the core into the nut and is held in position by the four cones near the top of the adjuster.

The combination of the polyamide moulded-in nut and the polypropylene adjuster — both reinforced with glass fibre — gives an excellent stability with temperature, shocks and vibrations. Besides this, the combination has a very smooth adjustment curve due to the excellent concentricity of the moulded-in nut and the adjuster.

The maximum permissible temperature of the adjustment combination is: 150 °C, during 8 h. The maximum working temperature is 110 °C.

The tables below show the available types and which adjuster is recommended for typical  $A_L$  values.

Table 1 Colour code of adjusters

catalogue number	colour	dia. C (Fig. 1) mm	material
4322 021 38700	black	1,93	FXC
38710	brown	1,70	FXC

Table 2 Catalogue numbers of recommended adjusters for typical  $A_L$  values

$A_L$	3H1
40	
63	
100	
160	4322 021 38710
250	38700

**PACKAGING**

The adjusters are packed in bags of 100. Please order in multiples.

**ADJUSTING TOOL**

An adjusting tool combination for M1,4 and M1,7 is available, catalogue number 4322 058 03260.

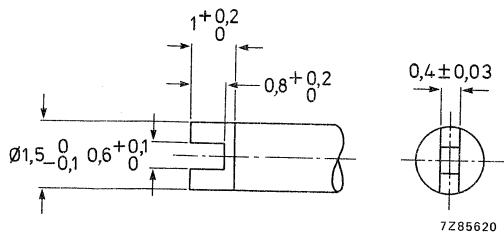
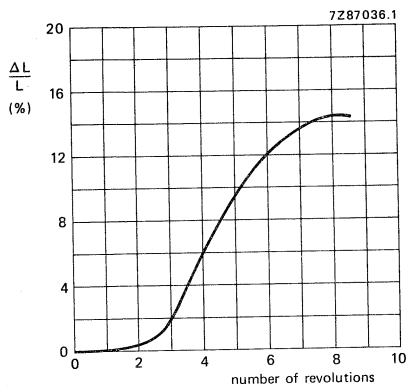


Fig. 2.

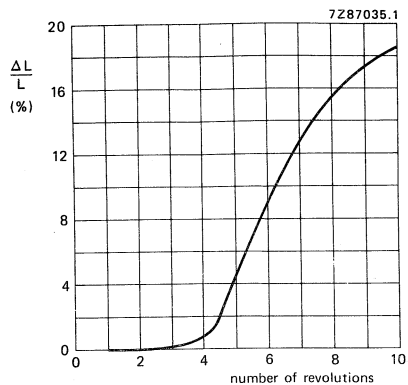
For customers who wish to make the screwdriver themselves the outlines of the essential part are given in Fig. 2.

ADJUSTMENT CURVES

Characteristic curves



$A_L = 160$ ; FXC 3H1

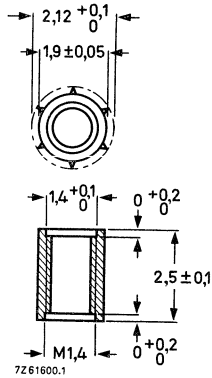


$A_L = 250$ ; FXC 3H1

Note: 0 revolutions corresponds to at least one turn of interaction.

**NUT FOR ADJUSTER**

These data are given for those manufacturers who prefer to insert the nut themselves.



Catalogue number

4322 021 31850

Material

polycarbonate

Maximum impregnation temperature for 24 hours

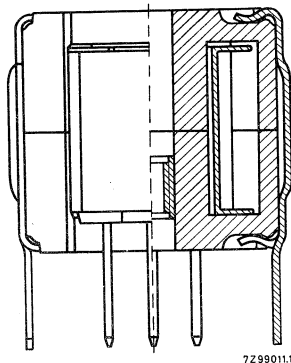
120 °C

Recommended distance from mating surface to nut

$2,0 \pm 0,15$  mm

The nuts are packed in bags of 100. Please order in multiples of 100.

## ASSEMBLING AND MOUNTING



### ASSEMBLING

The core halves are clamped together by means of two clips, type 4322 021 31900. As can be seen in the drawing, the hooked ends of each clip fit into recesses made in the core halves.

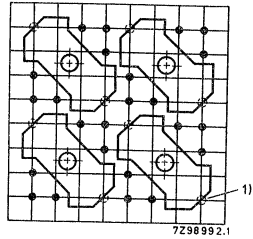
For a stable inductance we recommend that an adhesive be applied between the coil former flange and the lower core half. We also recommend that a tool be used for assembling. (Drawings of a simple tool are available under number 4322 058 00180.)

### MOUNTING

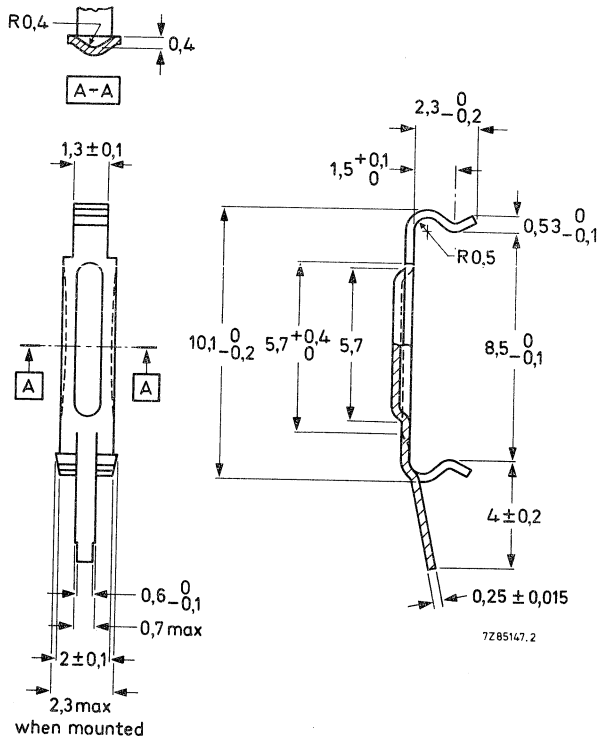
The two retaining clips are also used for mounting the assembled core on a printed-wiring board: the pins are simply soldered into the holes in the board. If so desired, one of the pins can also be used for earthing the core.

The soldering pins of coil formers and clips are so arranged that they will fit printed-wiring boards with a 0,1 in grid as well as those with a 2,50 mm grid. The pin length is sufficient for a board thickness of up to 2,4 mm. The recommended hole diameter in the board is  $1 \pm 0,1$  mm (according to IEC publication 97).

Hole pattern for an assembly of 4 cores.



PART DRAWING (dimensions in mm)



Clip 4322 021 31900

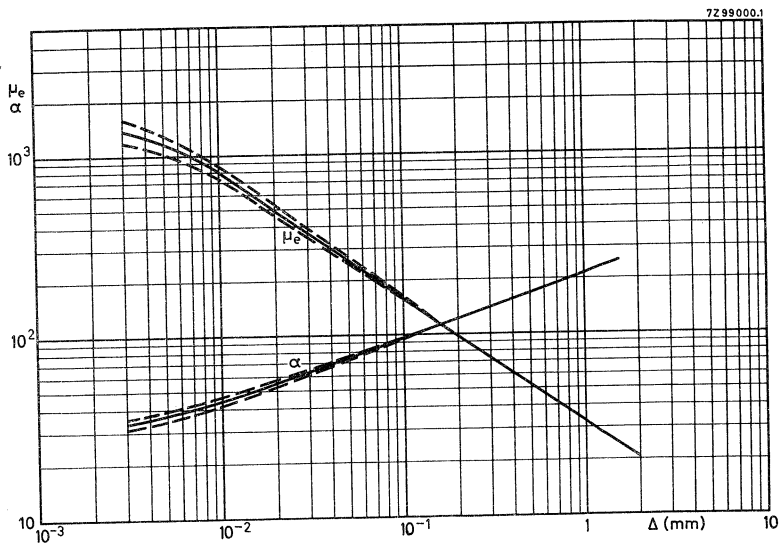
Material: steel; nickel plated thereafter silver plated and finally passivated.

Packaging quantity: 10 000

(1) Holes for tag on clip 4322 021 31900 (earth points).

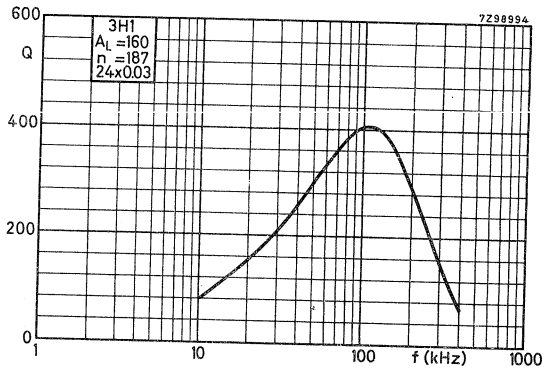
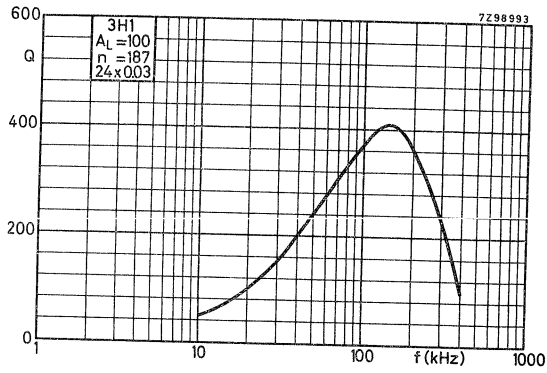


## CHARACTERISTIC CURVES

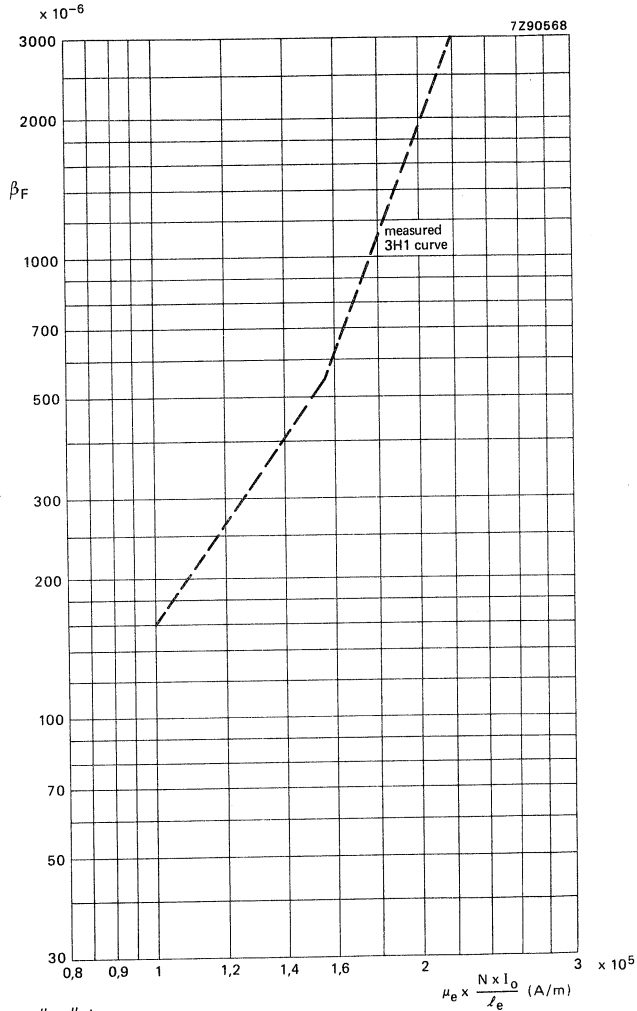
 $\mu_e - \alpha$  CURVES

Relative effective permeability and turns factor for 1 mH as a function of the air gap length.  $\mu_e \geq 1200$  at  $\Delta = 3 \mu\text{m}$  for 3H1.

Q-CURVES



D.C. SENSITIVITY AT 25 °C



$$\beta_F = \frac{\mu_e - \mu_{e\Delta}}{\mu_e \times \mu_{e\Delta}}$$

Inductance variation as a function of d.c. polarization.



## SQUARE CORES

Three types of core can be supplied:

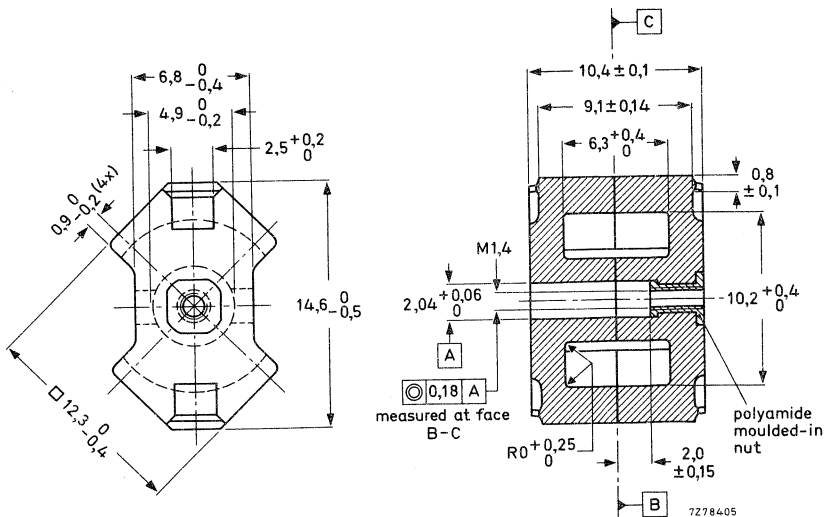
- CORE SETS provided with an injection-moulded nut for an adjuster and pre-adjusted on an inductance factor  $A_L$ .
- CORE SETS without nut and pre-adjusted on an  $A_L$  value.
- CORE HALVES without air gap.

The square cores are in accordance with the following specifications: IEC 431 (international), UTE83-300 (France), DIN 41980 (Germany).

Square cores and associated parts are ordered by their 12-digit catalogue number. Quantity: a primary pack contains 20 core sets or 40 core halves; a storage pack contains 100 core sets or 200 core halves. Please order in multiples of these quantities.

### MECHANICAL DATA

Dimensions in mm



- Pulling-out force of the nut  $\geq 20$  N (at ambient temperature)
- Torque of the screw thread  $\leq 4$  mNm
- Extraction force of adjuster from nut  $\geq 10$  N

**MECHANICAL DATA (continued)**

Dimensional quantities according to IEC 205:

a. Version with centre hole:

$$C_1 = \Sigma \frac{l}{A} = 1,01 \text{ mm}^{-1}; C_2 = \Sigma \frac{l}{A^2} = 0,0479 \text{ mm}^{-3}; V_e = 450 \text{ mm}^3; l_e = 21,4 \text{ mm}; A_e = 21,2 \text{ mm}^2;$$
$$A_{CPmin} = 14,7 \text{ mm}^2.$$

Mass of a core set: 3,0 g.

b. Version without centre hole:

$$C_1 = \Sigma \frac{l}{A} = 0,935 \text{ mm}^{-1}; C_2 = \Sigma \frac{l}{A^2} = 0,0378 \text{ mm}^{-3}; V_e = 574 \text{ mm}^3; l_e = 23,2 \text{ mm}; A_e = 24,8 \text{ mm}^2;$$
$$A_{CPmin} = 18,1 \text{ mm}^2.$$

Mass of a core set: 3,2 g.

**ELECTRICAL DATA**

The combination of two square core halves without air gap, randomly chosen from a batch, has the following guaranteed properties. A measuring coil as described in the General section 'Potcores, square cores and cross cores', is inserted; the halves are pressed together with a force of 35 N. The values are valid 5 minutes or more after clamping.

	freq. kHz	$\hat{B}$ mT	temp. °C	grade					
				3B8	3D3	3E4	3H1	3H3	4C6
$A_L \pm 25\%$	4	$\leq 0,1$	$25 \pm 1$	1960	840		1960	1680	150
$\mu_e \pm 25\%$	4	$\leq 0,1$	$25 \pm 1$	1590	670		1590	1350	124
$\alpha$	4	$\leq 0,1$	$25 \pm 1$	$\leq 26,0$	$\leq 39,7$		$\leq 26,0$	$\leq 27,2$	$\leq 92,6$
$\frac{\tan \delta}{\mu_i} \times 10^6$	4	$\leq 0,1$	$25 \pm 1$			$\leq 2,5$			
	30	$\leq 0,1$	$25 \pm 1$				$\leq 2,5$	$\leq 1,8$	
	100	$\leq 0,1$	$25 \pm 1$		$\leq 8$	$\leq 20$	$\leq 5,0$	$\leq 2,8$	
	500	$\leq 0,1$	$25 \pm 1$		$\leq 14$	$\leq 200$			
	1000	$\leq 0,1$	$25 \pm 1$		$\leq 30$				
	2000	$\leq 0,1$	$25 \pm 1$						$\leq 40$
$\eta_B \times 10^3$	10 000	$\leq 0,1$	$25 \pm 1$						$\leq 100$
	4	1,5 to 3,0	$25 \pm 1$			$\leq 1,1$	$\leq 0,86$		
	30	1,5 to 3,0	$25 \pm 1$					$\leq 0,85$	
$\alpha_F \times 10^6/K$	100	0,3 to 1,2	$25 \pm 1$		$\leq 1,8$				$\leq 9,2$
	$\leq 100$	$\leq 0,1$	5 to 25			0 to +2	+0,5 to 1,5	+0,7 $\pm$ 0,3	-2 to +4
	$\leq 100$	$\leq 0,1$	25 to 55			0 to +2	+0,5 to 1,5	+0,7 $\pm$ 0,3	0 to +6
$D_F \times 10^6$ (10-100...in)	$\leq 100$	$\leq 0,1$	25 to 70		0 to +2	0 to +2	+0,5 to 1,5	+0,7 $\pm$ 0,3	
	$\leq 100$	$\leq 0,1$	$25 \pm 0,1$		$\leq 12$	$\leq 4,3$	$\leq 4,3$	$\leq 3,0^*$	$\leq 10$
$\beta_F \times 10^6$ measured on sets with $\mu_e = 300 \pm 10\%$ and $25 \pm 1$ °C:									
at $\mu_e \times \frac{N \times I_0}{l_e} = 0,90 \times 10^5$ A/m $= 1,40 \times 10^5$ A/m $= 2,00 \times 10^5$ A/m				$\leq 120$	$\leq 300$	$\leq 1100$			

\* This value is valid within the temperature range of 25 to 70 °C.

Core sets with nut and pre-adjusted on  $A_L$ .

$A_L$	corresponding $\mu_e$ -value	tol. on inductance (%)	catalogue number 4322 022 . . . . .					
			3B8	3D3	3E4	3H1	3H3	4C6
16	13	± 1						
25	20	± 1		● 79410				79800
40	33	± 1		79420				● 79810
63	51	± 1		● 79430				● 79820
100	82	± 1	● 59470*	79440		79230	79530	79830
160	130	± 2				● 79240	● 79540	
250	200	± 3				● 79250	● 79550	
315	250	± 5				● 79260	● 79560	
400	330	± 5				79270	79570	
3450	2570	± 25				79280	79580	
4975	3700	± 25			● 59990*			

Inductance  $L = N^2 A_L$  (in  $10^{-9}$  H).

Core sets without nut: replace the eighth digit of the catalogue number (7) by 5.

Cores with  $A_L \leq 100$  have a symmetrical air gap, except the 3B8 core.

Cores with  $A_L \geq 160$  and the 3B8 core have an asymmetrical air gap.

Core halves without air gap, without nut.

Ferroxcube grade	catalogue number
3B8	4322 020 27080*
3D3	4322 020 26770
3H1	4322 020 26760
3H3	4322 020 26790
4C6	4322 020 26780

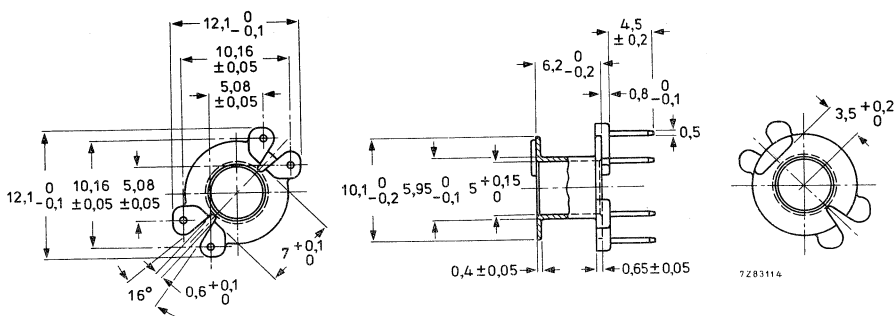
\* Have no centre hole.

● Preferred type.



## COIL FORMERS

## SINGLE-SECTION 4-PIN COIL FORMER



Catalogue number	4322 021 32830
Material	phenolformaldehyde reinforced with glass fibre, dip-soldered pins
Minimum window area	9,5 mm <sup>2</sup>
Mean length of turn	25 mm
Max. temperature	180 °C
Inflammability	UL94, class V-0

D.C. losses

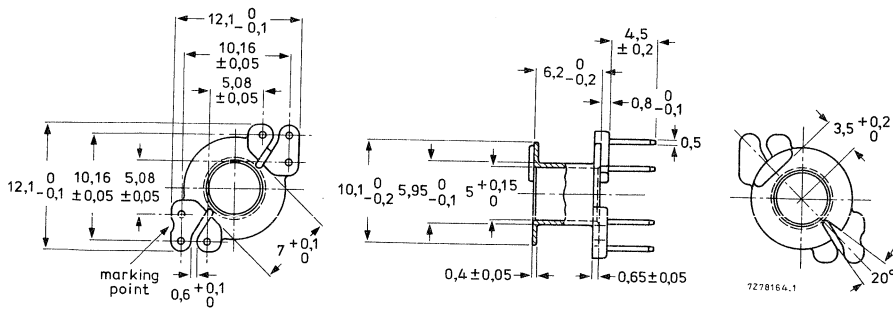
$$\frac{R_O}{L} = \frac{l}{\mu_e} \times \frac{l}{f_{cu}} \times 34 \times 10^3 \Omega/H$$

Solderability: resistant against  
dip-soldering at 400 °C for 2 s

Mass 0,28 g

The coil formers are supplied in packs of 150 on a polystyrene plate, and in cardboard boxes containing 5 such plates (750 pieces). Please order in multiples of these quantities.

SINGLE-SECTION 6-PIN COIL FORMER



Catalogue number	4322 021 32840	D.C. losses
Material	phenolformaldehyde reinforced with glass fibre, dip-soldered pins	$\frac{R_o}{L} = \frac{1}{\mu_e} \times \frac{1}{f_{Cu}} \times 34 \times 10^3 \Omega/H$
Minimum window area	9,5 mm <sup>2</sup>	Solderability: resistant against dip-soldering at 400 °C for 2 s
Mean length of turn	25 mm	Mass
Max. temperature	180 °C	0,28 g
→ Inflammability	UL94, class V-0	

The coil formers are supplied in packs of 150 on a polystyrene plate, and in cardboard boxes containing 5 such plates (750 pieces). Please order in multiples of these quantities.

# INDUCTANCE ADJUSTERS

(old types)

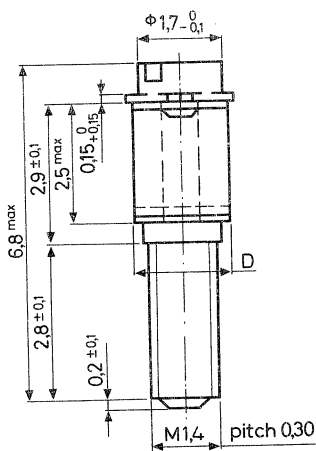
## ADJUSTERS

The tolerances on inductance of the pre-adjusted cores (without adjuster) are given in the table of pre-adjusted cores with standard  $A_L$  values. After inserting a coil (impregnated or not) in an electrical circuit, its inductance can be adjusted to the required value with an accuracy  $< 0,03\%$  by means of a continuous inductance adjuster. Such an adjuster increases the inductance of the coil (see following pages).

The adjuster is screwed through the centre hole of the core into the nut and is held in position by the four protrusions near the top of the adjuster. For special requirements a larger or smaller adjustment range may be obtained by using an adjuster belonging to the next higher or lower  $A_L$  value.

The influence of the adjuster on the variability of the inductance is negligible. The maximum permissible temperature is  $110^\circ\text{C}$ .

The table shows the type of adjuster recommended for different square cores.

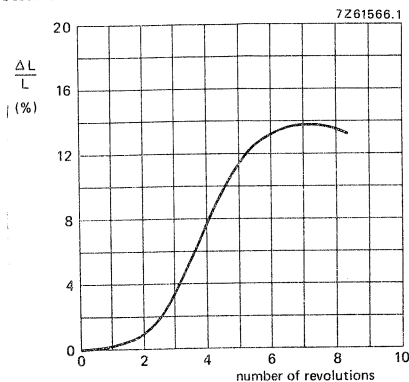


D	$A_L$ of core in 3H1/3D3	recommended adjuster	
		catalogue number	colour
1,85	40	4322 021 31250	natural
1,85	63	4322 021 31260	red
1,85	100	4322 021 31270	yellow
1,76	160	4322 021 31540	brown
1,85	250	4322 021 31280	grey
1,88	315	4322 021 32720	black
1,90	400	4322 021 32710	white

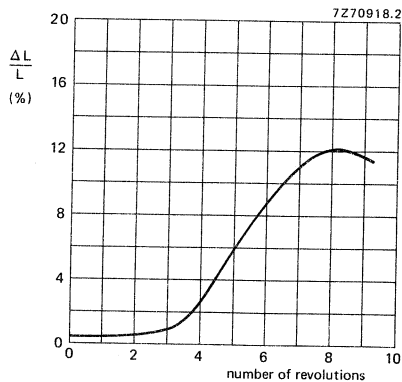
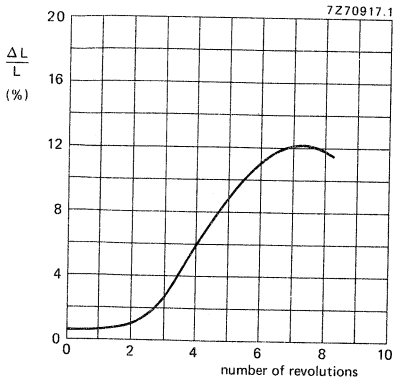
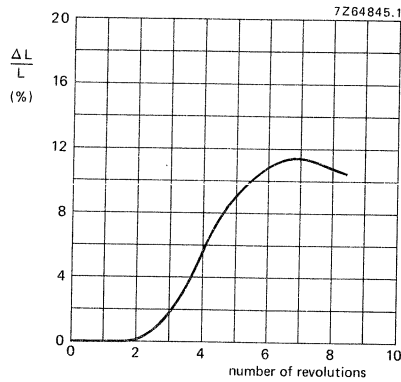
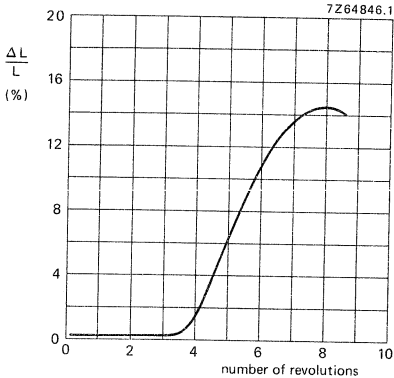
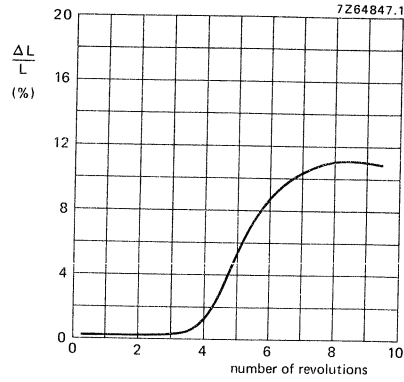
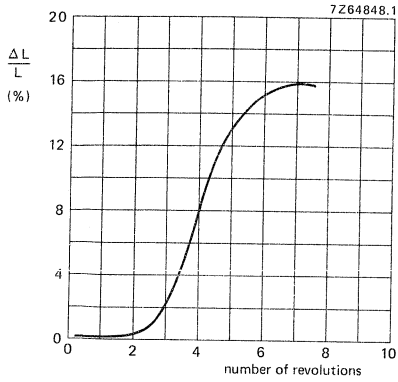
The adjusters are packed in bags of 100.  
Please order in multiples of 100.

## ADJUSTMENT CURVES

Characteristic curve.



$A_L = 40$ ; FXC 3D3/3H1.  
Adjuster 4322 021 31250.



## INDUCTANCE ADJUSTERS

(new types)

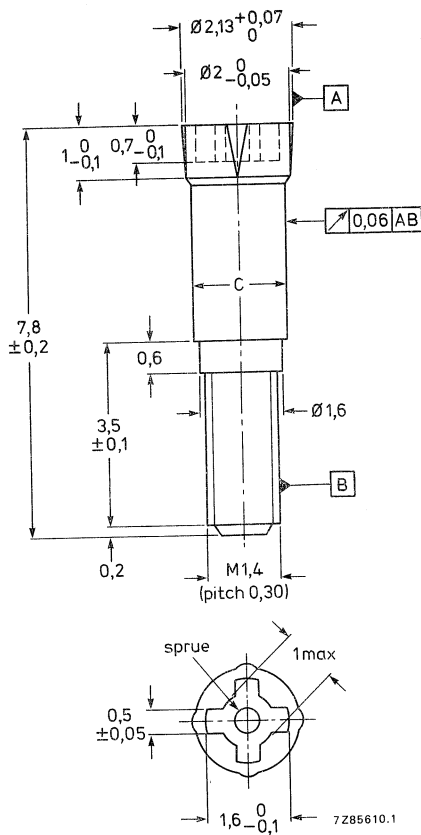


Fig. 1.

Material: polypropylene, reinforced with glass fibre.

The tolerances on inductance factor of the pre-adjusted cores without adjuster are given in the table of pre-adjusted cores with standard  $A_L$  values. The inductance of the pre-adjusted core can be increased to the required value — with a setting accuracy  $< 0,03\%$  — by means of a continuous adjuster.

The adjuster is screwed through the centre hole of the core into the nut and is held in position by the four cones near the top of the adjuster.

The combination of the polyamide moulded-in nut and the polypropylene adjuster — both reinforced with glass fibre — gives an excellent stability with temperature, shocks and vibrations. Besides this, the combination has a very smooth adjustment curve due to the excellent concentricity of the moulded-in nut and the adjuster.

The maximum permissible temperature of the adjustment combination is: 150 °C, during 8 h. The maximum working temperature is 110 °C.

The tables below show the available types and which adjuster is recommended for typical  $A_L$  values.

Table 1 Colour code of adjusters

catalogue number	colour	dia. C (Fig. 1) mm	material
4322 021 38700	black	1,93	FXC
38710	brown	1,70	FXC
38780	white	1,97	FXC
38790	grey	1,87	FXC

Table 2 Catalogue numbers of recommended adjusters for typical  $A_L$  values

$A_L$	3H1/3H3/3B7	3D3	4C6
16			
25			
40			
63			
100			
160	4322 021 38710		
250	38790		
315	38700		
400	38780		

**PACKAGING**

The adjusters are packed in bags of 100. Please order in multiples.

**ADJUSTING TOOL**

An adjusting tool combination for M1,4 and M1,7 is available, catalogue number 4322 058 03260.

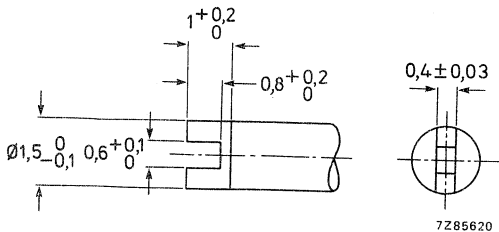
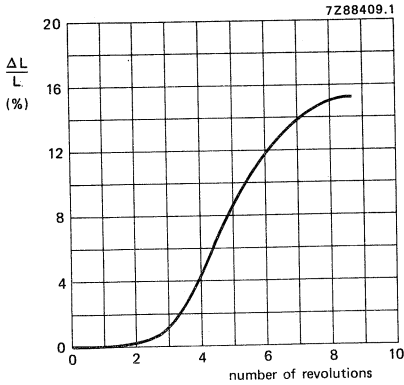


Fig. 2.

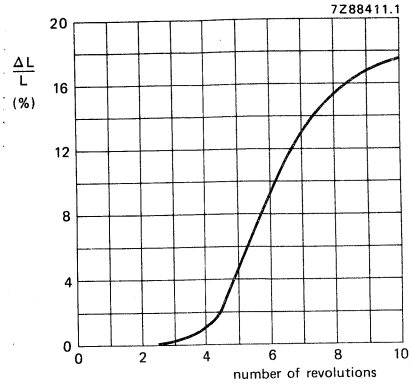
For customers who wish to make the screwdriver themselves the outlines of the essential part are given in Fig. 2.

ADJUSTMENT CURVES

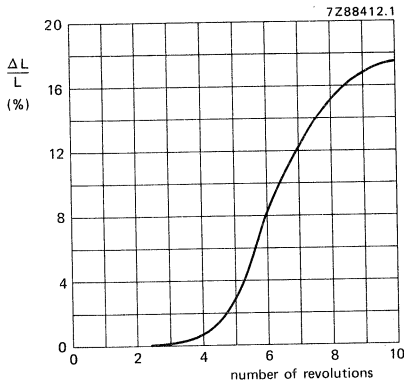
Characteristic curves



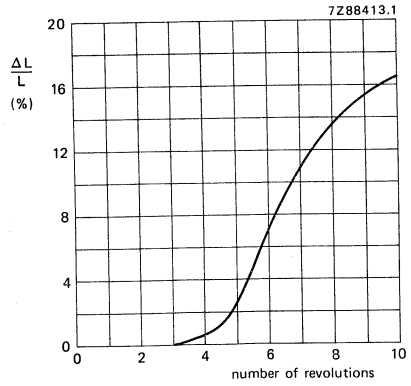
$A_L = 160$ ; FXC 3H1



$A_L = 250$ ; FXC 3H1



$A_L = 315$ ; FXC 3H1



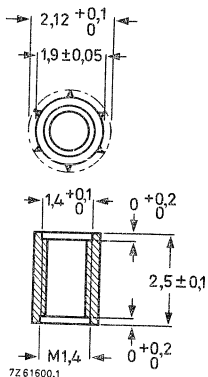
$A_L = 400$ ; FXC 3H1

Note: 0 revolutions corresponds with at least one turn of interaction.

RM5

### NUT FOR ADJUSTER

These data are given for those manufacturers who prefer to insert the nut.



Catalogue number

4322 021 31850

Material

polycarbonate

Max. impregnation temperature for 24 hours

120 °C

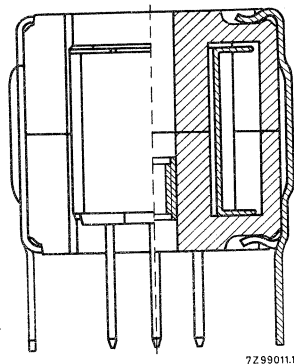
Recommended distance from mating surface to nut

$2,0 \pm 0,15$  mm

The nuts are packed in bags of 100. Please order in multiples of 100.



## ASSEMBLING AND MOUNTING



### ASSEMBLING

The core halves are clamped together by means of two clips, type 4322 021 31900. As can be seen in the drawing, the hooked ends of each clip fit into recesses made in the core halves.

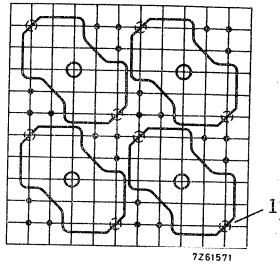
For a stable inductance we recommend that an adhesive be applied between the coil former flange and the lower core half. We also recommend that a tool be used for assembling. (Drawings of a simple tool are available under number 4322 058 00170).

### MOUNTING

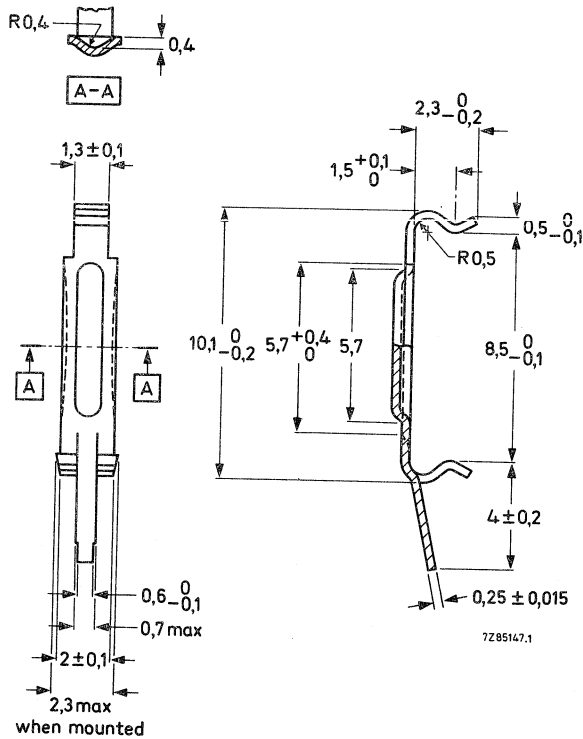
The two retaining clips are also used for mounting the assembled core on a printed-wiring board: the pins are simply soldered into the holes in the board. If so desired, one of the pins can also be used for earthing the core.

The soldering pins of coil formers and clips are so arranged that they will fit printed-wiring boards with a 0,1-inch grid as well as those with a 2,50 mm grid. The pin length is sufficient for a board thickness of up to 2,4 mm. The recommended hole diameter in the board is  $1 \pm 0,1$  mm (according to IEC publication 97).

Hole pattern for an assembly of 4 cores.



PART DRAWING (dimensions in mm)



Clip 4322 021 31900

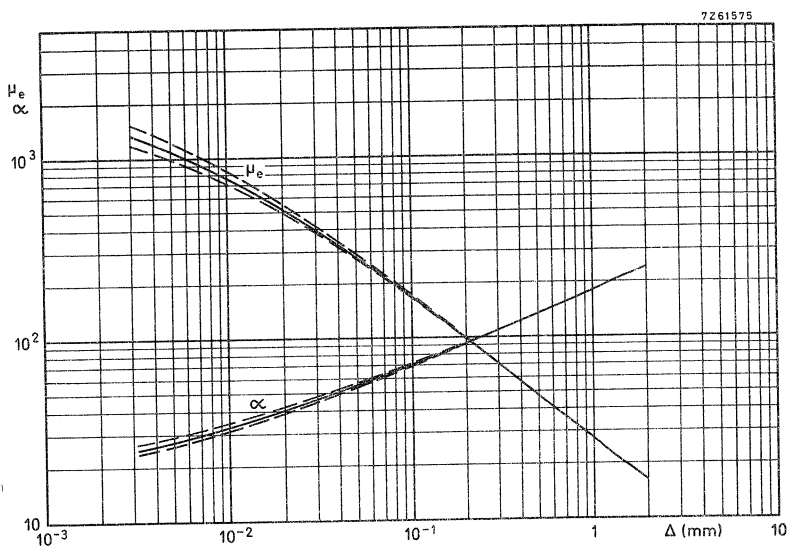
Material: steel; silver plated over nickel and passivated.

Packing quantity: 10 000 pieces.

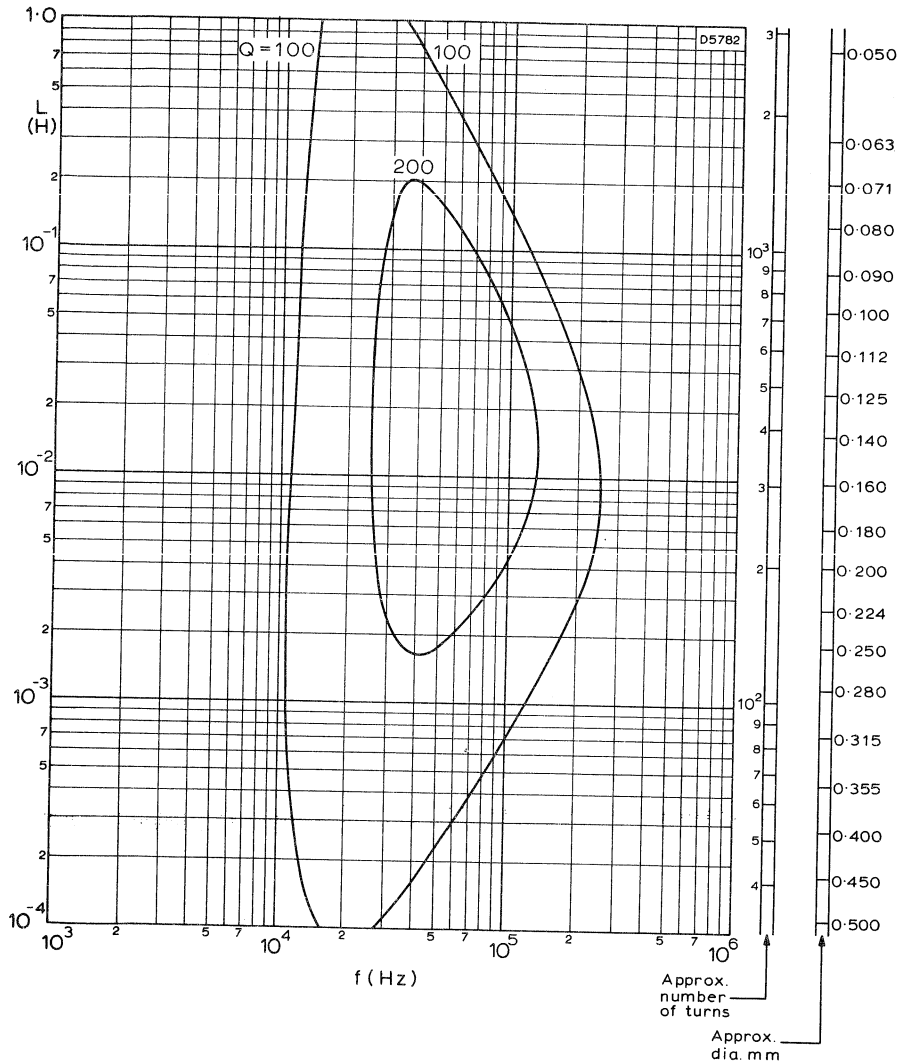
(1) Holes for tag on clip 4322 021 31900 (earth points).

## CHARACTERISTIC CURVES

### $\mu_e$ - $\alpha$ CURVES

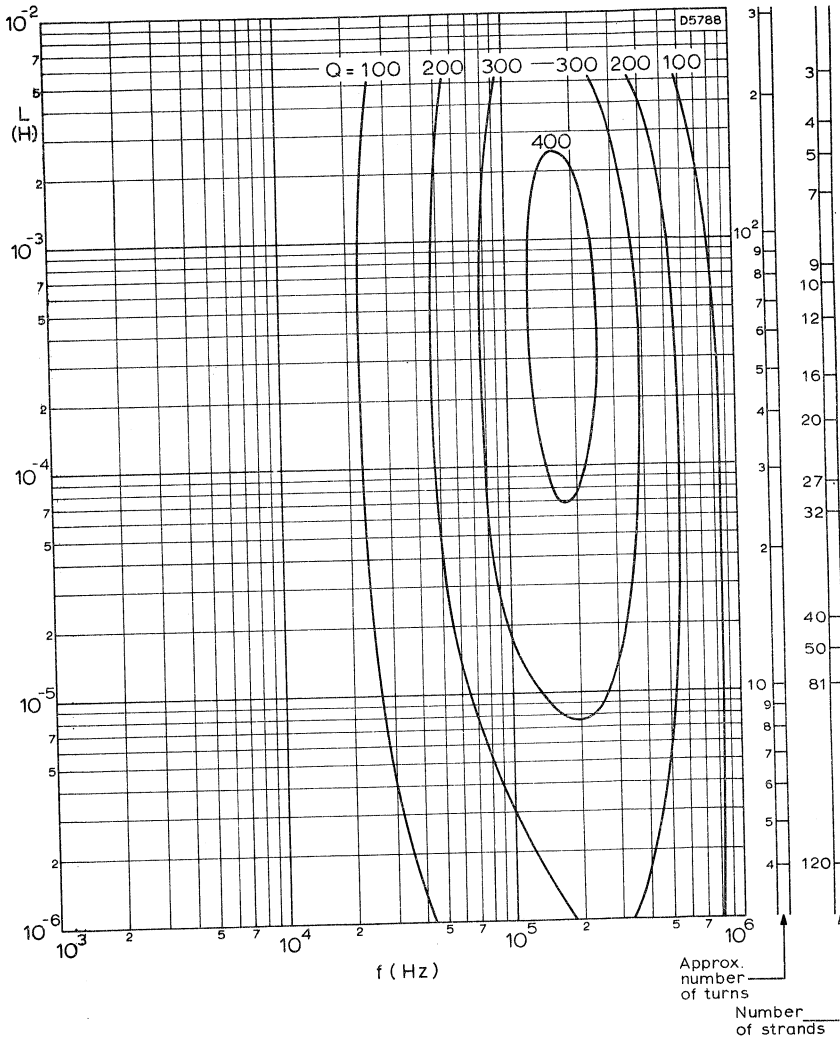


Relative effective permeability and turn factor for 1 mH as a function of the air gap length.  
 $\mu_e = 1590$  at  $\Delta = 3 \mu\text{m}$  for 3H1.



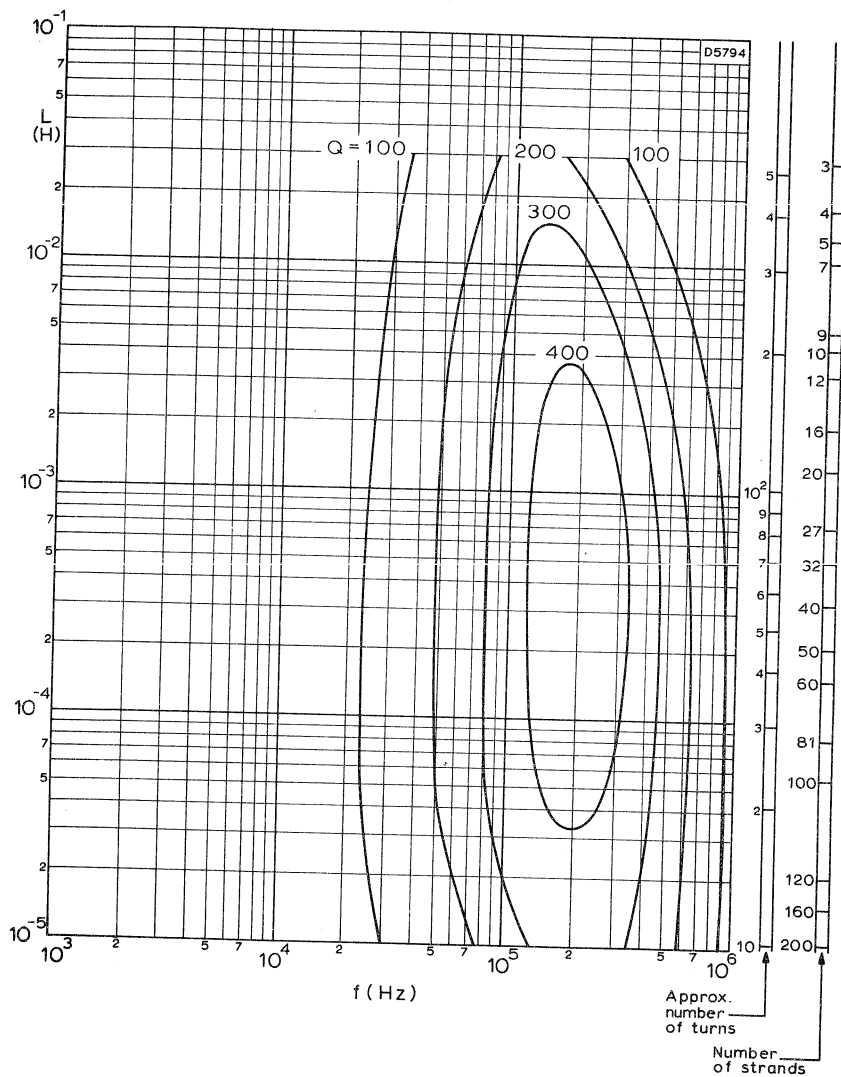
ISO - Q CURVES

These curves show Q-factors obtainable with full windings of enamelled copper wire on coil formers 4322 021 32830/32840. Material grade FXC 3H1, A<sub>L</sub> = 100.



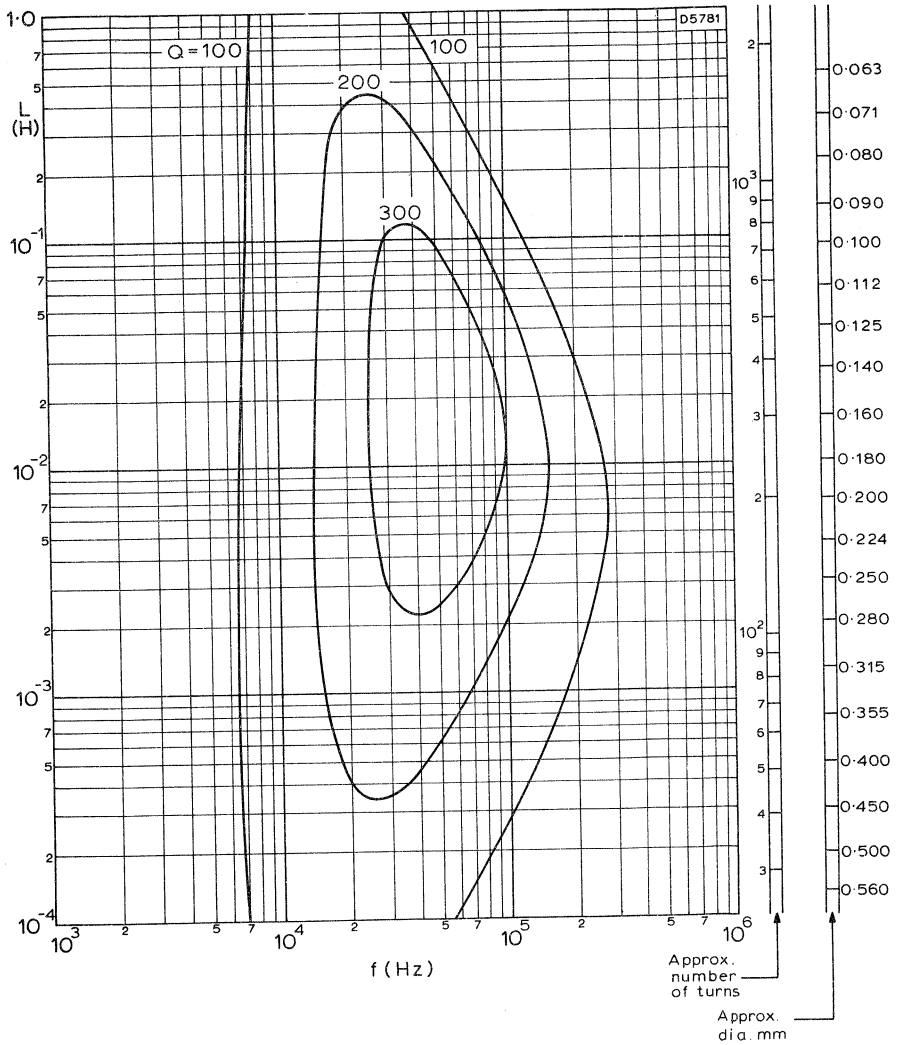
ISO - CURVES

These curves show Q-factors obtainable with full windings of 0,071 mm diameter bunched conductors on coil formers 4322 021 32830/32840. FXC grade 3H1,  $A_L = 100$ .



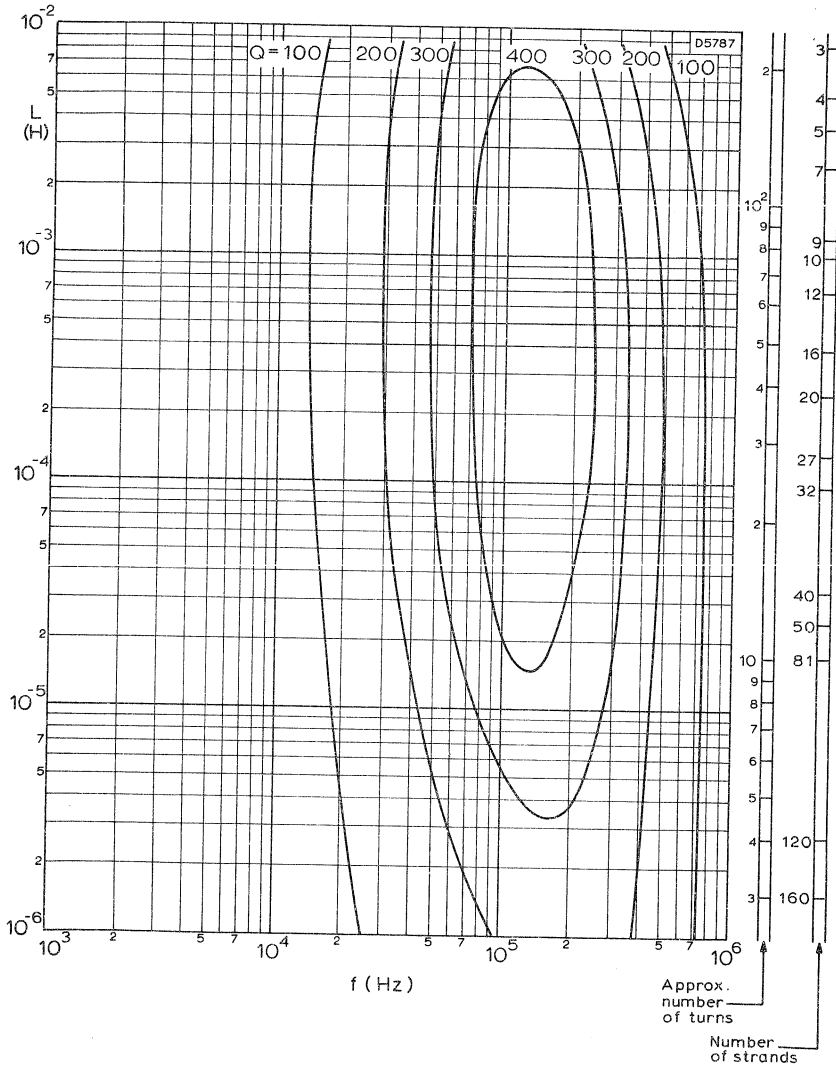
ISO - CURVES

These curves show Q-factors obtainable with full windings of 0,040 mm diameter bunched conductors on coil formers 4322 021 32830/32840. FXC grade 3H1,  $A_L = 100$ .



ISO - Q CURVES

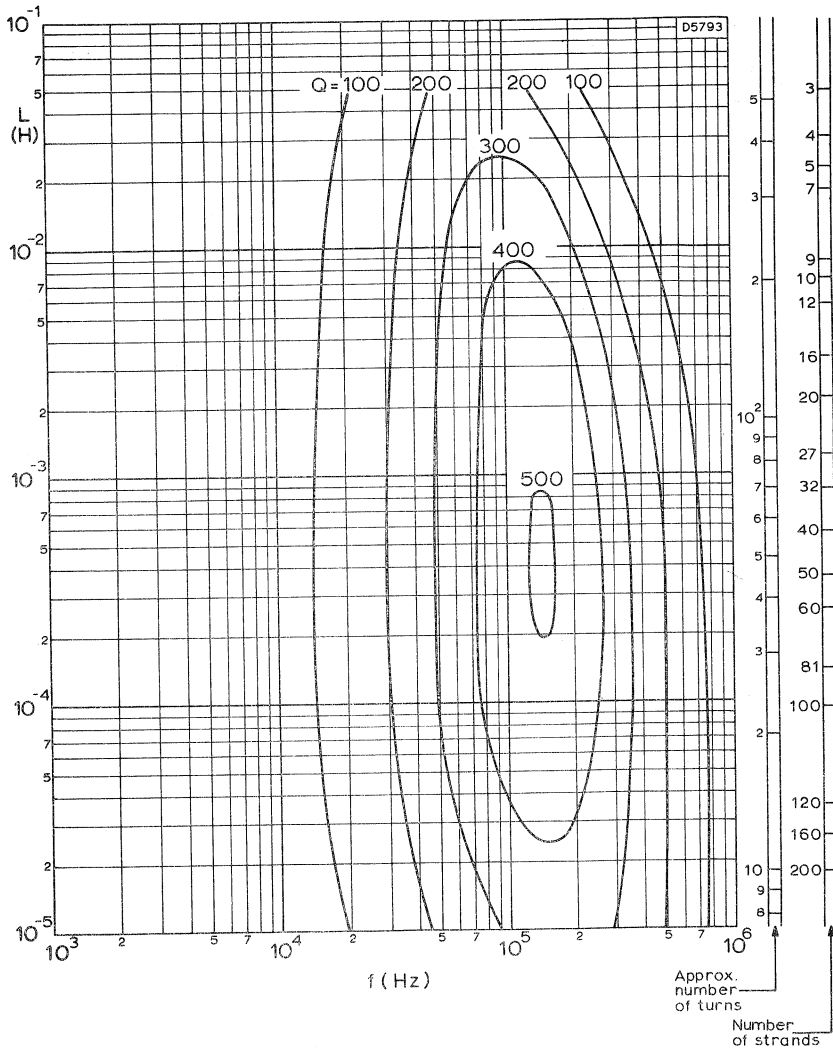
These curves show Q-factors obtainable with full windings of enamelled copper wire on coil formers 4322 021 32830/32840. Material grade FXC 3H1,  $A_L = 160$ .



ISO - CURVES

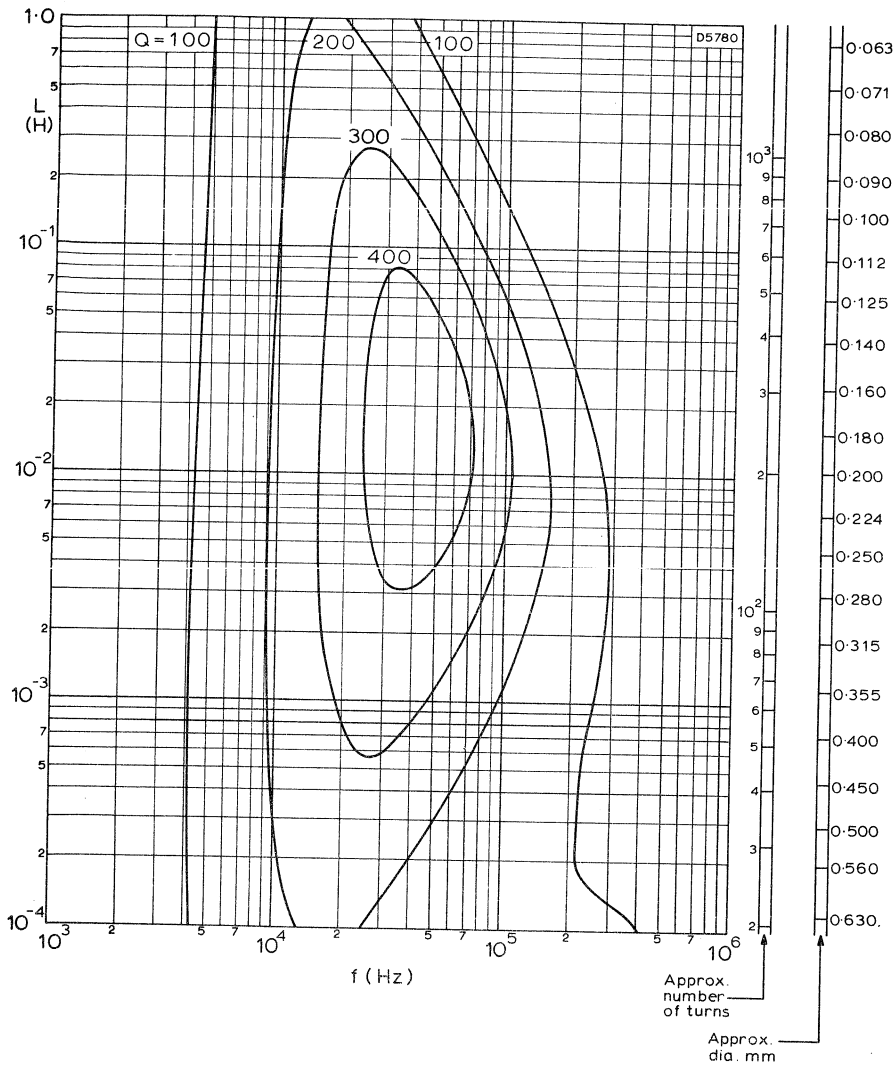
These curves show Q-factors obtainable with full windings of 0,071 mm diameter bunched conductors on coil formers 4322 021 32830/32840. FXC grade 3H1,  $A_L = 160$ .





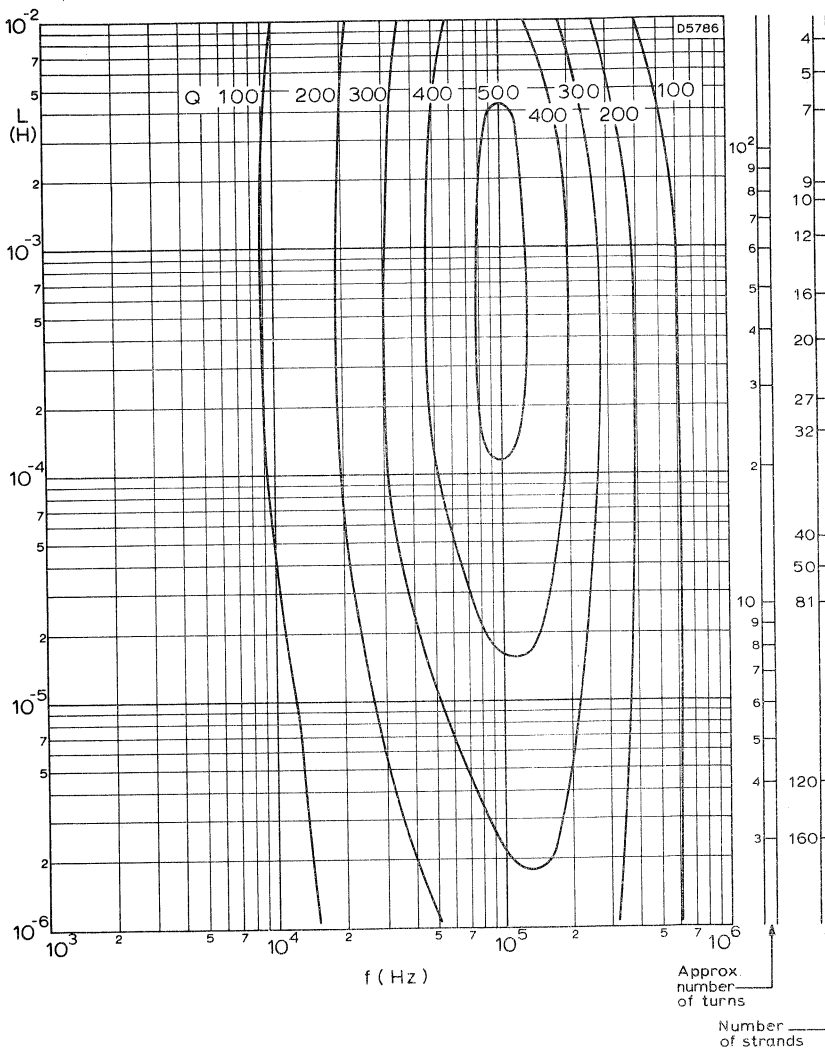
ISO - CURVES

These curves show Q-factors obtainable with full windings of 0,040 mm diameter bunched conductors on coil formers 4322 021 32830/32840. FXC grade 3H1,  $A_L = 160$ .



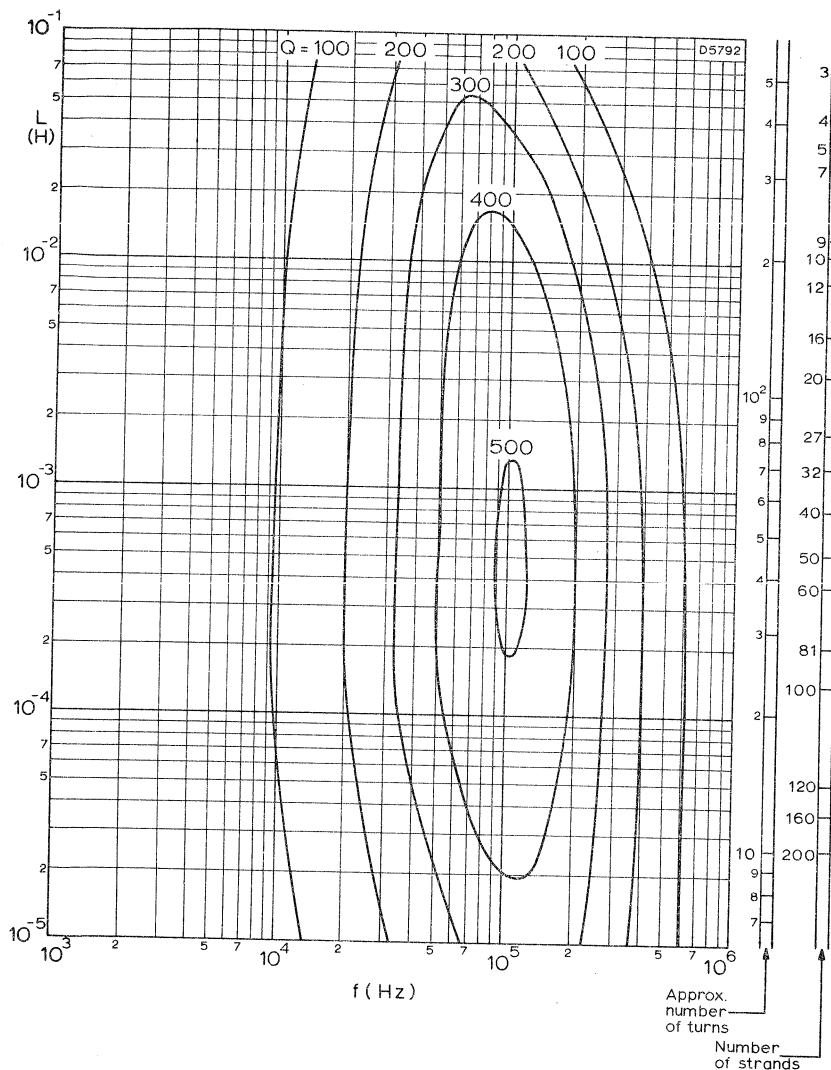
ISO - Q CURVES

These curves show Q-factors obtainable with full windings of enamelled copper wire on coil formers 4322 021 32830/32840. Material grade FXC 3H1,  $A_L = 250$ .



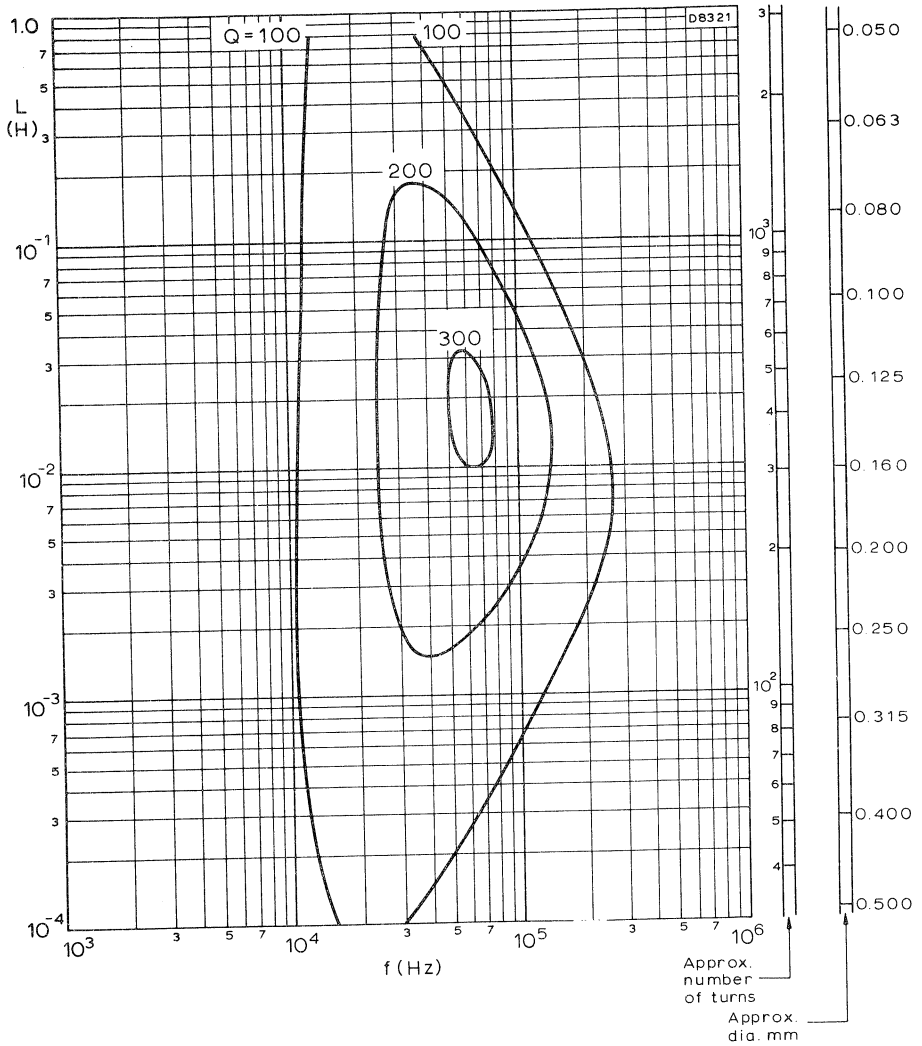
ISO - CURVES

These curves show Q-factors obtainable with full windings of 0,071 mm diameter bunched conductors on coil formers 4322 021 32830/32840. FXC grade 3H1,  $A_L = 250$ .



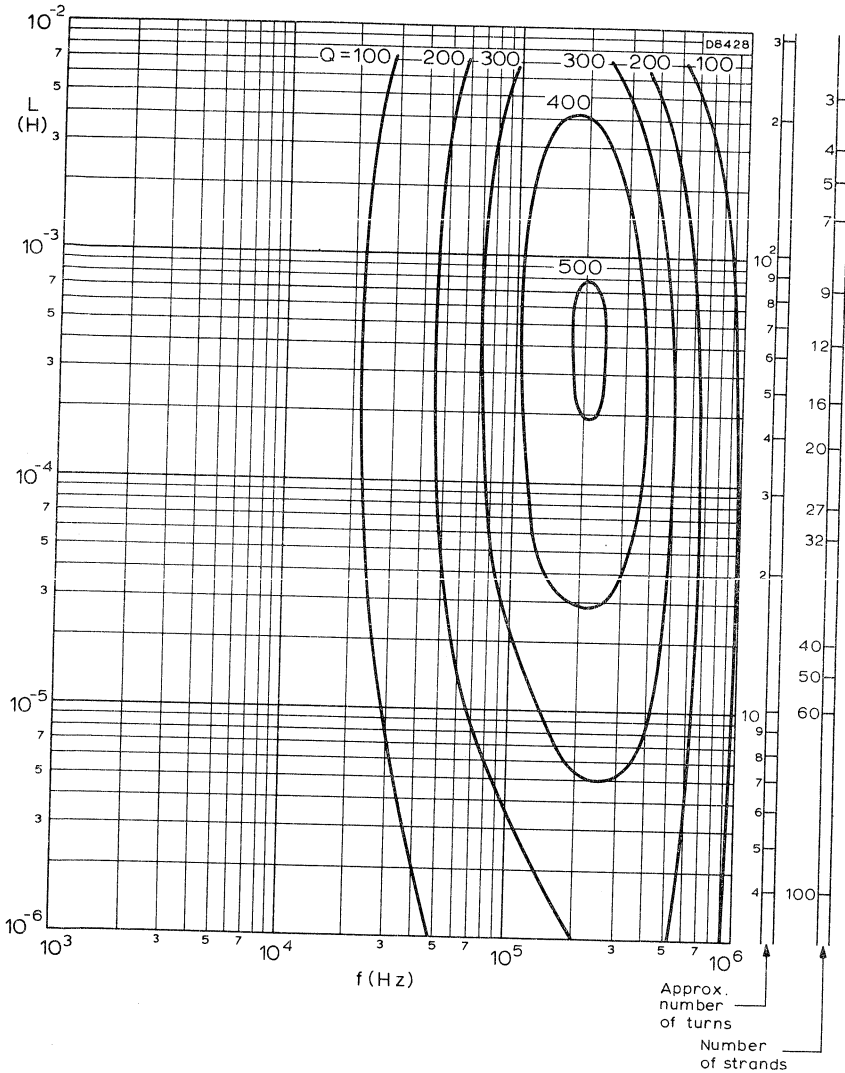
ISO - CURVES

These curves show Q-factors obtainable with full windings of 0,040 mm diameter bunched conductors on coil formers 4322 021 32830/32840. FXC grade 3H1,  $A_L = 250$ .



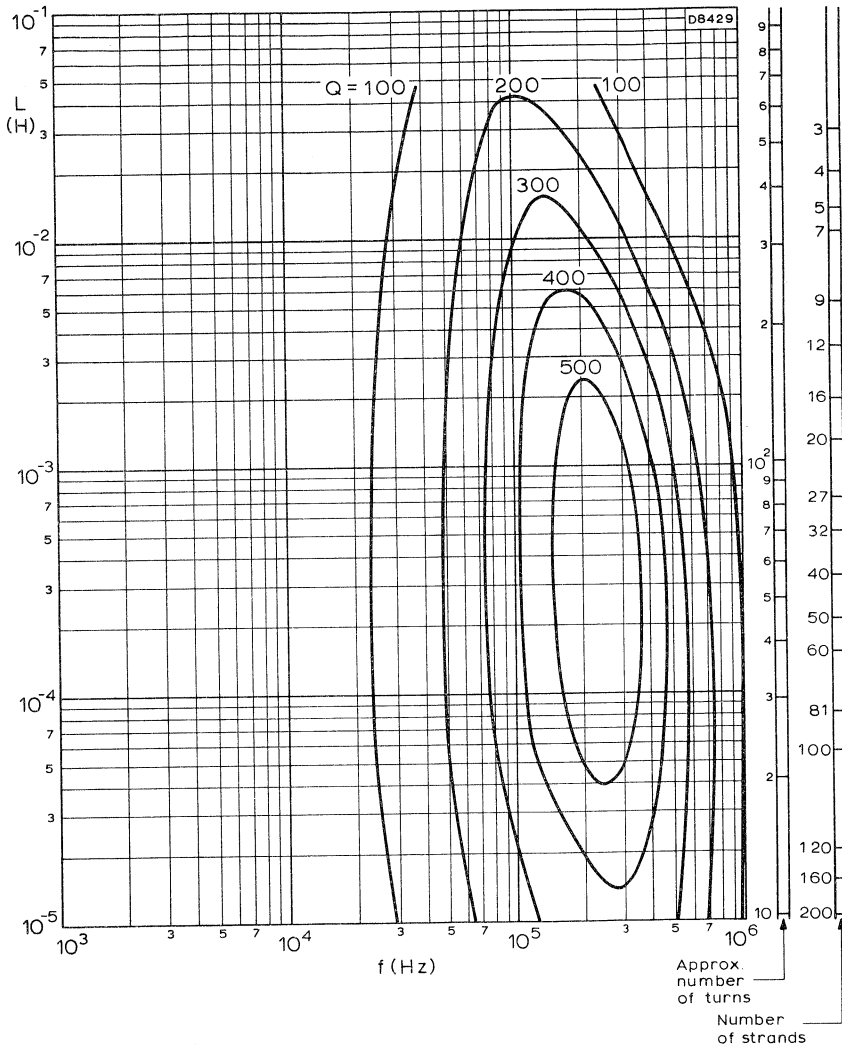
ISO - Q CURVES

These curves show Q-factors obtainable with full windings of enamelled copper wire on coil formers 4322 021 32830/32840. Material grade FXC 3H3,  $A_L = 100$ .



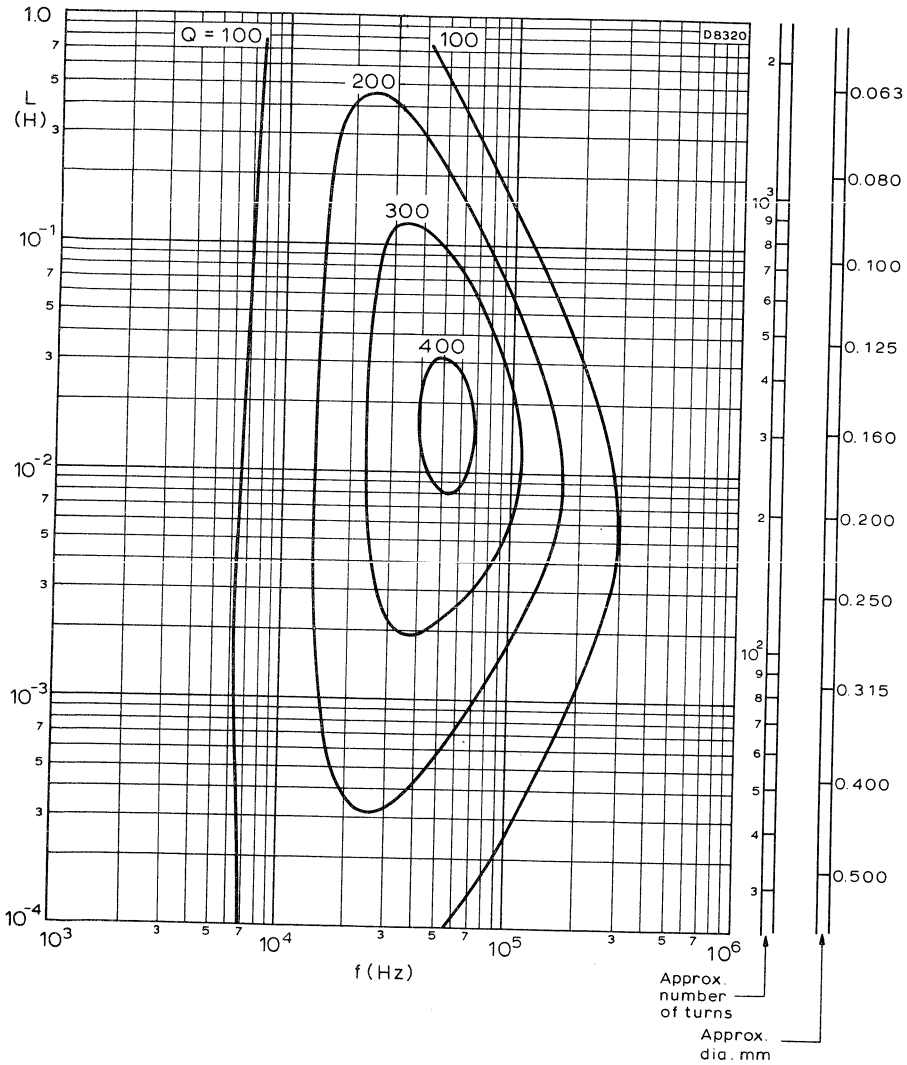
ISO - CURVES

These curves show Q-factors obtainable with full windings of 0,071 mm diameter bunched conductors on coil formers 4322 021 32830/32840. FXC grade 3H3,  $A_L = 100$ .



ISO - CURVES

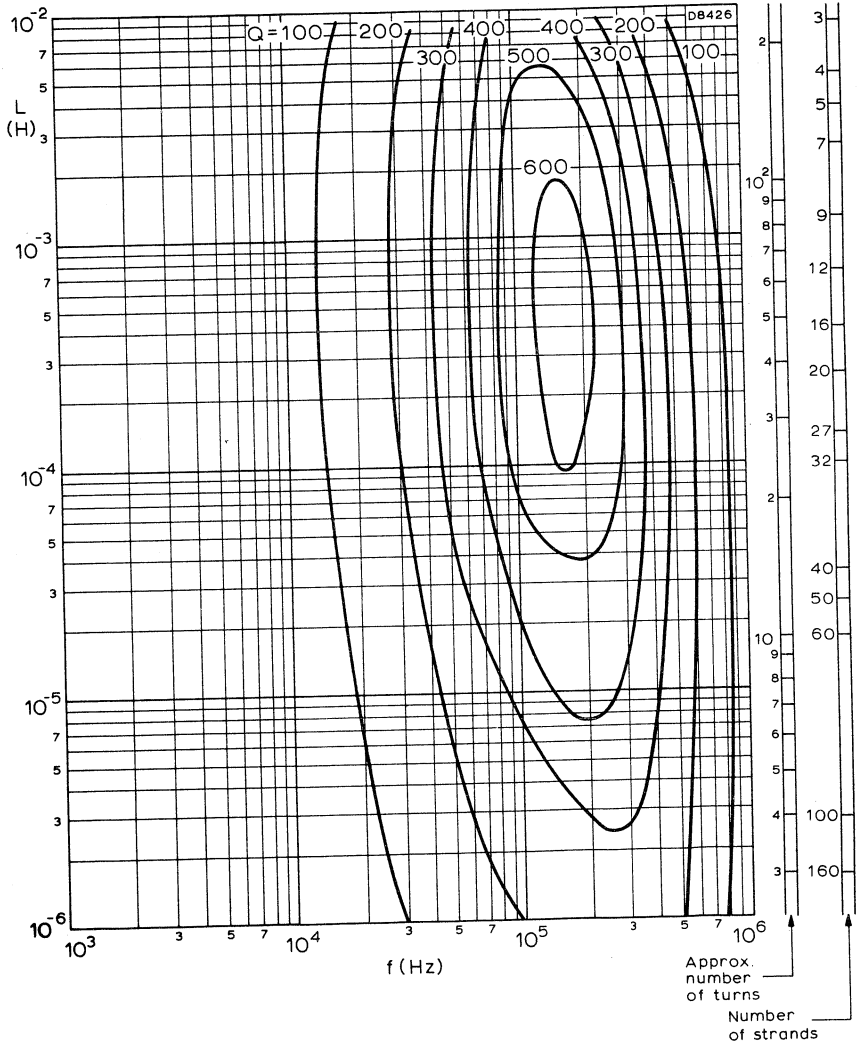
These curves show Q-factors obtainable with full windings of 0,040 mm diameter bunched conductors on coil formers 4322 021 32830/32840. FXC grade 3H3,  $A_L = 100$ .



ISO - Q CURVES

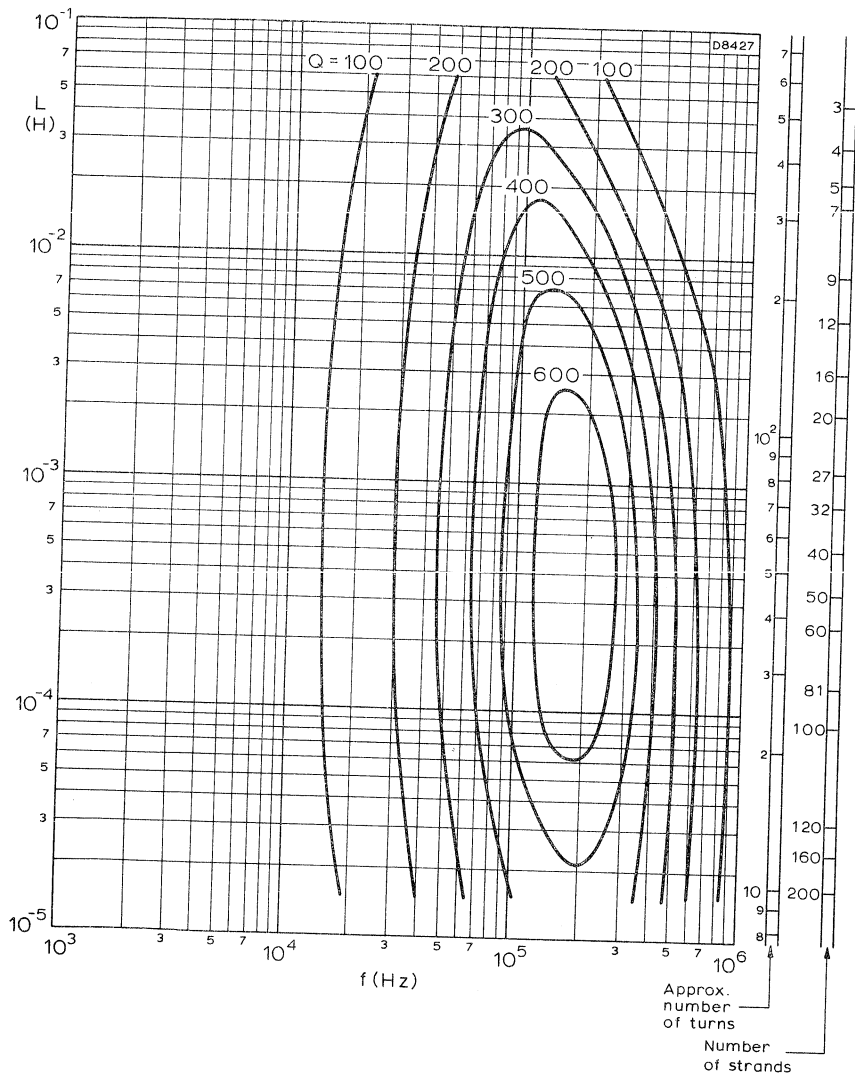
These curves show Q-factors obtainable with full windings of enamelled copper wire on coil formers 4322 021 32830/32840. Material grade FXC 3H3,  $A_L = 160$ .





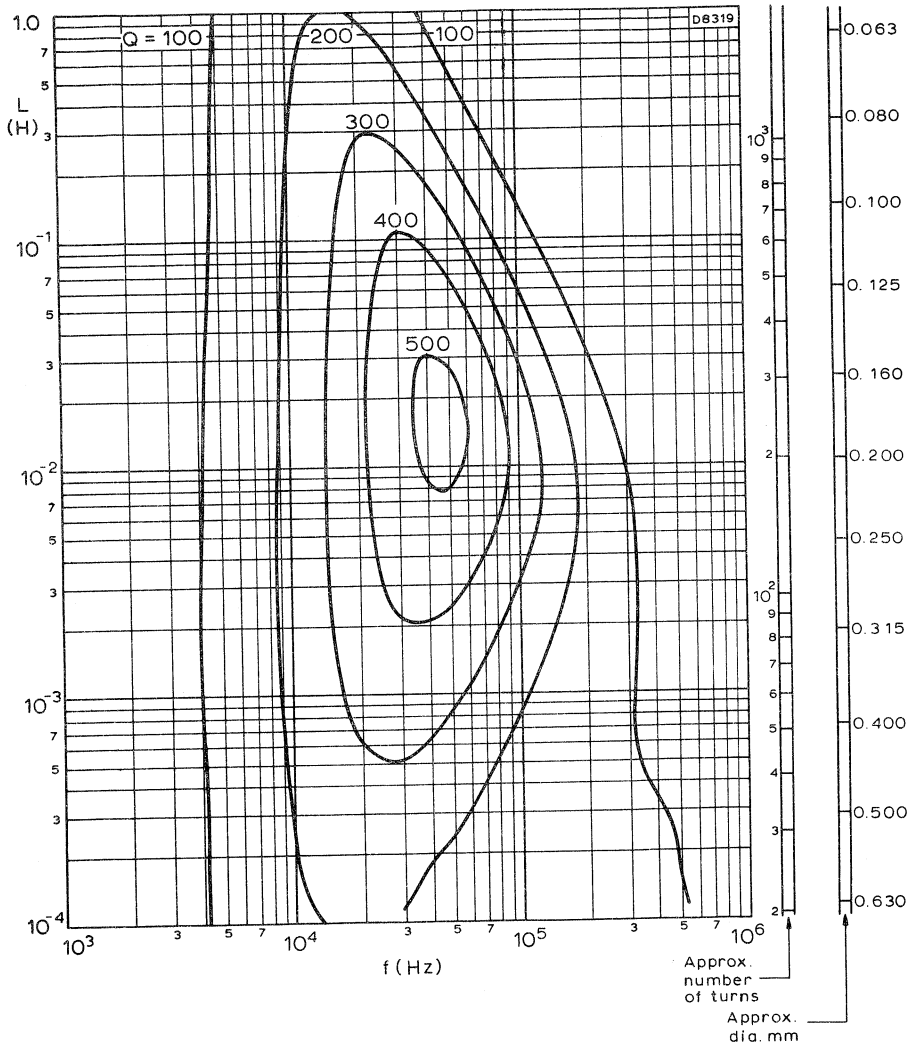
ISO - CURVES

These curves show Q-factors obtainable with full windings of 0,071 mm diameter bunched conductors on coil formers 4322 021 32830/32840. FXC grade 3H3,  $A_L = 160$ .



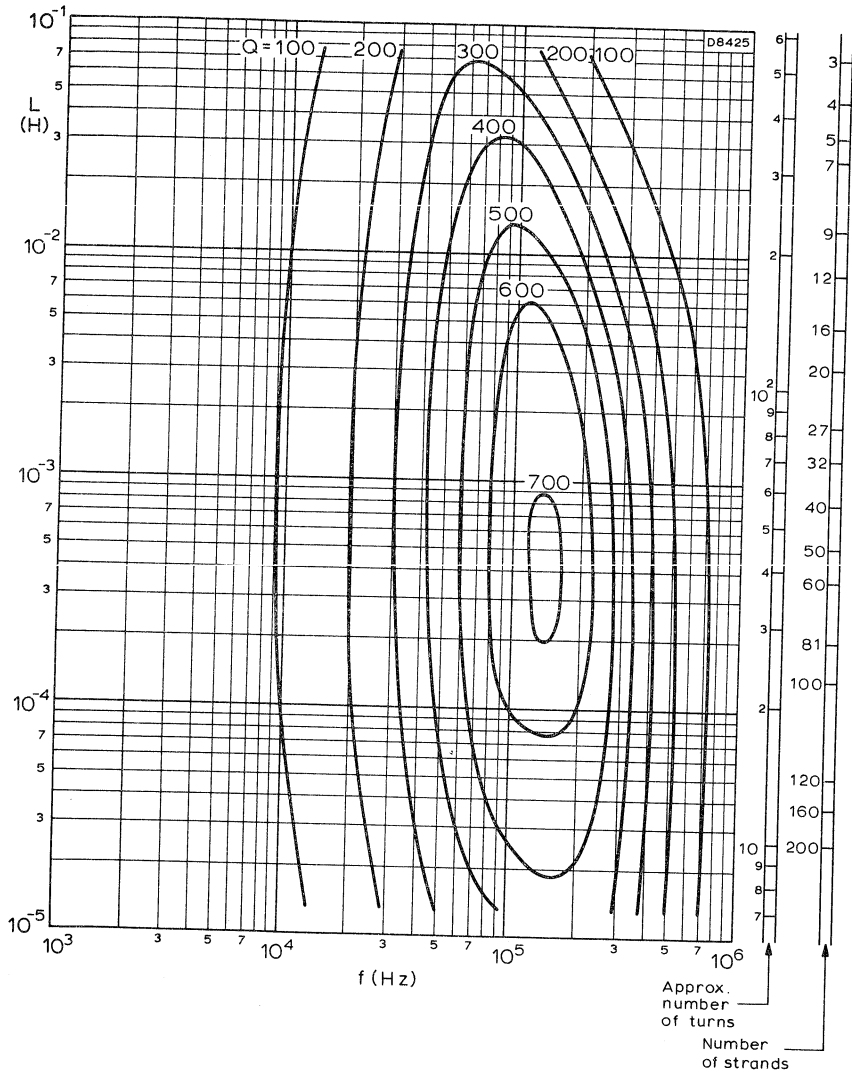
ISO - CURVES

These curves show  $Q$ -factors obtainable with full windings of 0,040 mm diameter bunched conductors on coil formers 4322 021 32830/32840. FXC grade 3H3,  $A_L = 160$ .



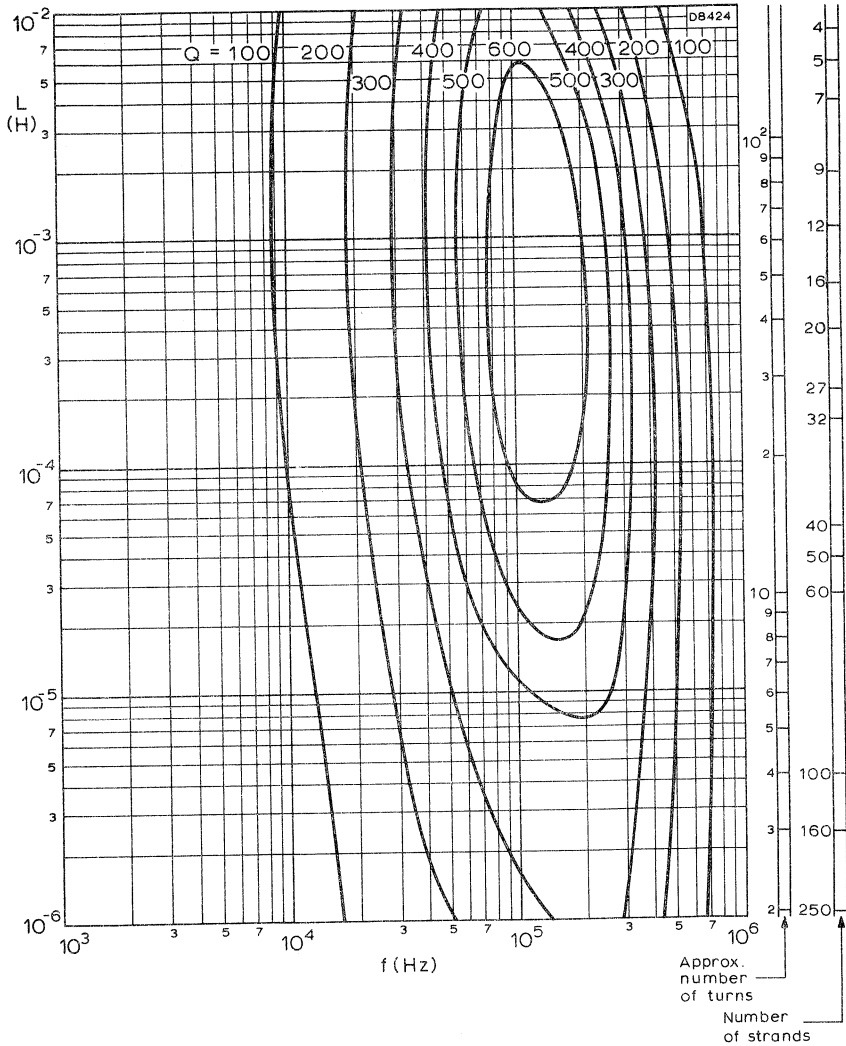
ISO - Q CURVES

These curves show Q-factors obtainable with full windings of enamelled copper wire on coil formers 4322 021 32830/32840. Material grade FXC 3H3,  $A_L = 250$ .



ISO - CURVES

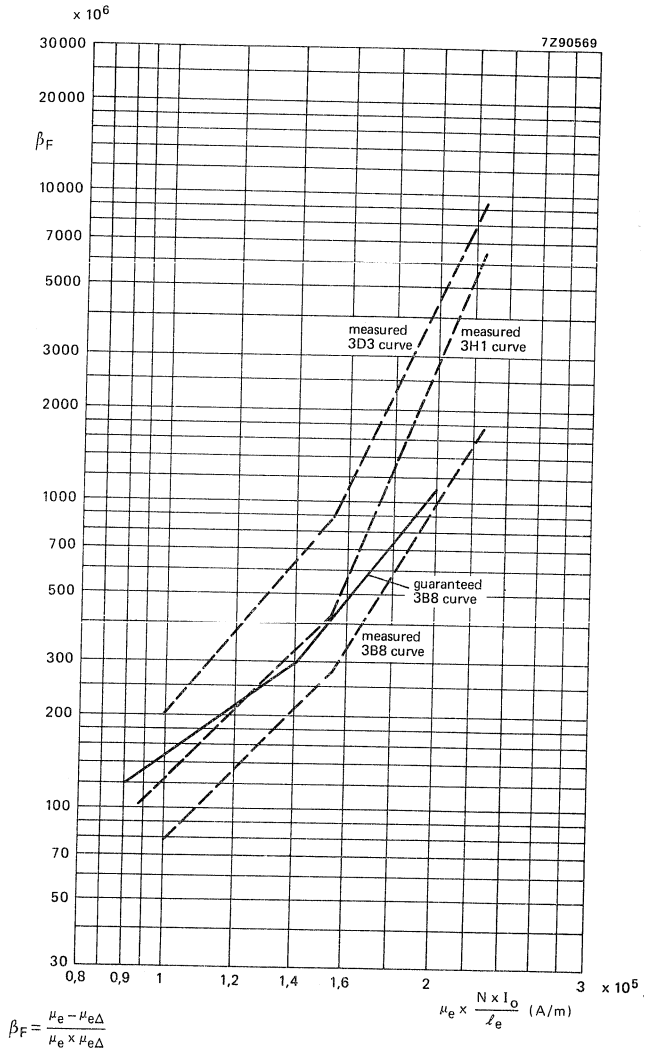
These curves show Q-factors obtainable with full windings of 0,071 mm diameter bunched conductors on coil formers 4322 021 32830/32840. FXC grade 3H3,  $A_L = 250$ .



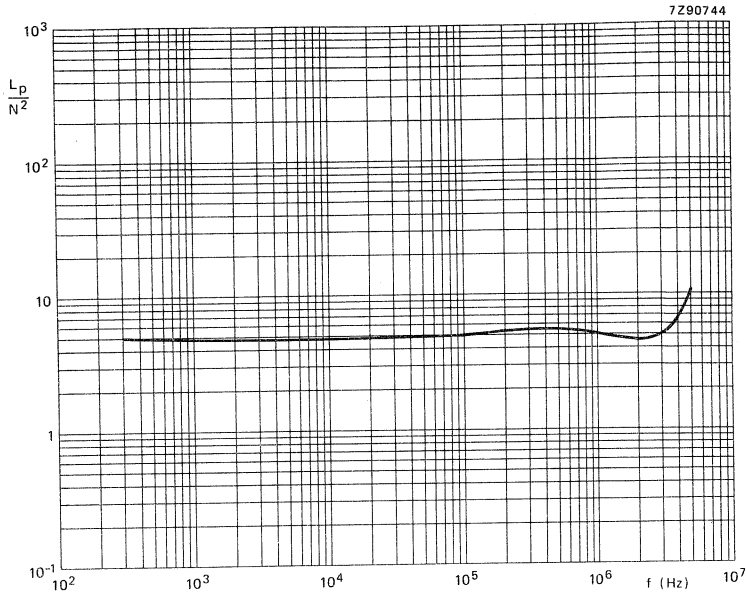
ISO - CURVES

These curves show Q-factors obtainable with full windings of 0,040 mm diameter bunched conductors on coil formers 4322 021 32830/32840. FXC grade 3H3,  $A_L = 250$ .

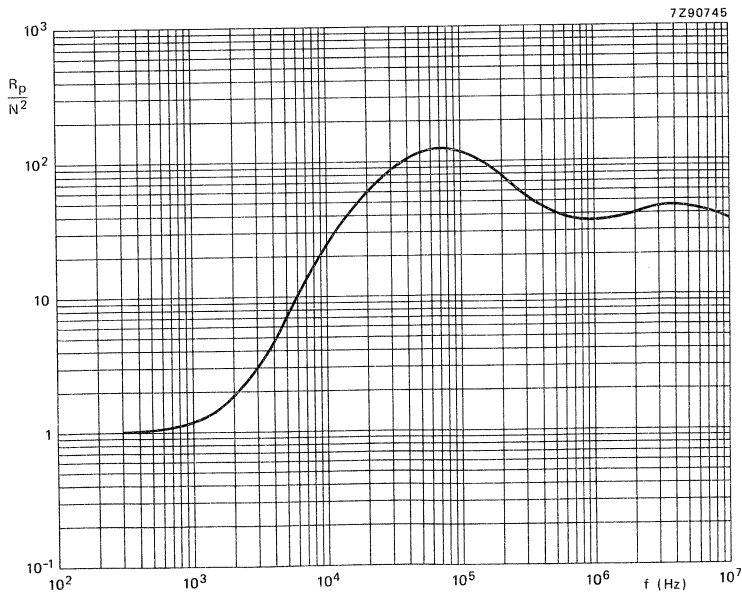
D.C. SENSITIVITY AT 25 °C



Inductance variation as a function of d.c. polarization.

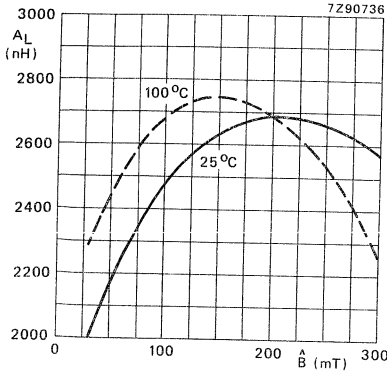


FXC 3E4. Inductance as a function of the frequency.

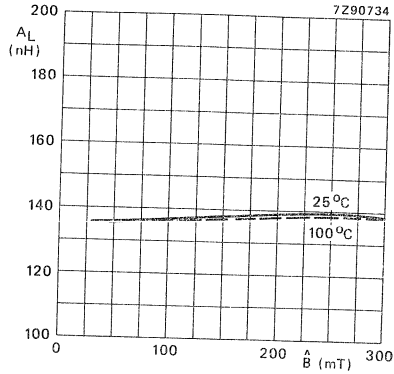


FXC 3E4. Losses as a function of the frequency at  $\hat{B} \approx 0,1$  mT.

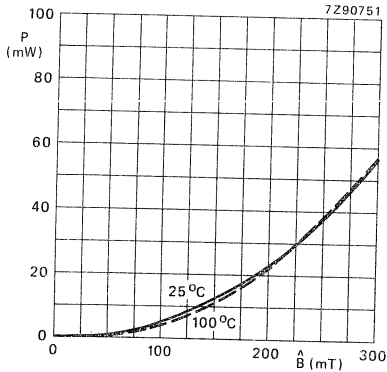
FXC 3B8



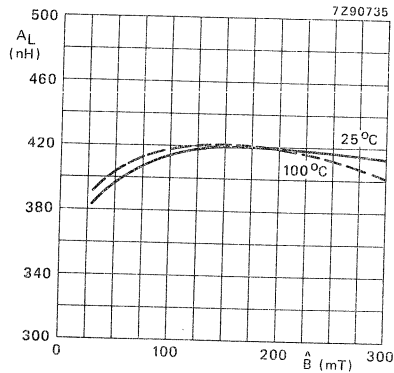
$A_L = f(\hat{B})$  at 16 kHz, and at 25 and 100 °C. No air gap.



$A_L = f(\hat{B})$  at 16 kHz, and at 25 and 100 °C, for  $\mu_e = 100$ .



$P = f(\hat{B})$  at 16 kHz, and at 25 and 100 °C. No air gap.



$A_L = f(\hat{B})$  at 16 kHz, and at 25 and 100 °C, for  $\mu_e = 300$ .

$\hat{B}$  is calculated with  $A_{CPmin} = 18,1 \text{ mm}^2$ .



## SQUARE CORES

Three types of core can be supplied:

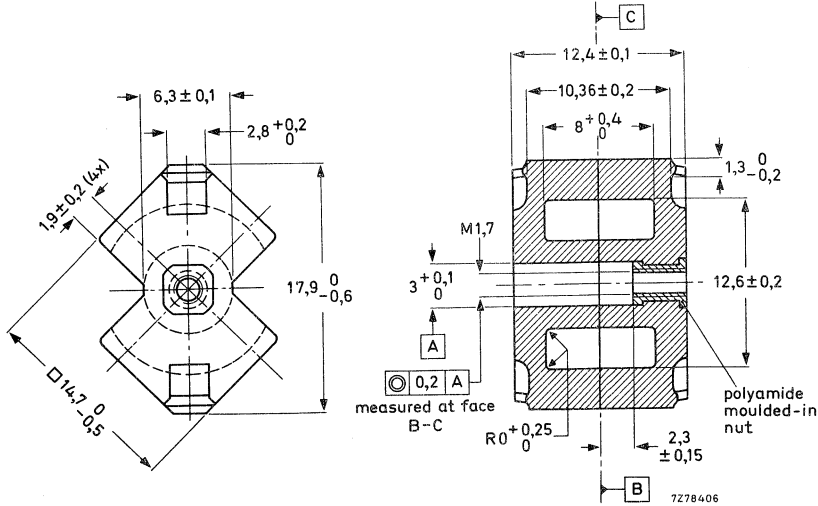
- CORE SETS provided with a nut for an adjuster and pre-adjusted on an inductance factor  $A_L$ .
- CORE SETS without nut and pre-adjusted on an  $A_L$  value.
- CORE HALVES without air gap.

The square cores are in accordance with the following specifications: IEC 431 (international), UTE83-300 (France), DIN 41980 (Germany)

Square cores and associated parts are ordered by their 12-digit catalogue number. Quantity: a primary pack contains 20 core sets or 40 core halves; a storage pack contains 100 core sets or 200 core halves. Please order in multiples of these quantities.

**MECHANICAL DATA**

Dimensions in mm



Note: 4C6 cores have a cemented nut.

- Pulling-out force of the nut  $\geq 30$  N (at ambient temperature)
- Torque of the screw thread  $\leq 8$  mNm
- Extraction force of adjuster from nut  $\geq 20$  N

**MECHANICAL DATA** (continued)

Dimensional quantities according to IEC 205:

a. Version with centre hole:

$$C_1 = \Sigma \frac{l}{A} = 0,810 \text{ mm}^{-1}; C_2 = \Sigma \frac{l}{A^2} = 0,0257 \text{ mm}^{-3}; V_e = 810 \text{ mm}^3; l_e = 25,6 \text{ mm}; A_e = 32,0 \text{ mm}^2;$$

$$\rightarrow A_{CPmin} = 23,9 \text{ mm}^2.$$

Mass of a core set: 4,5 g.

b. Version without centre hole:

$$C_1 = \Sigma \frac{l}{A} = 0,732 \text{ mm}^{-1}; C_2 = \Sigma \frac{l}{A^2} = 0,0194 \text{ mm}^{-3}; V_e = 1040 \text{ mm}^3; l_e = 27,5 \text{ mm}; A_e = 38,0 \text{ mm}^2;$$

$$\rightarrow A_{CPmin} = 31,2 \text{ mm}^2.$$

Mass of a core set: 4,7 g.

**ELECTRICAL DATA**

The combination of two square core halves without air gap, randomly chosen from a batch, has the following guaranteed properties. A measuring coil as described in the General section 'Potcores, square cores and cross cores', is inserted; the halves are pressed together with a force of 50 N. The values are valid 5 minutes or more after clamping.

	freq. kHz	$\overset{A}{B}$ mT	temp. °C	grade					
				3B8	3D3	3E4	3H1	3H3	4C6
$A_L \pm 25\%$	4	$\leq 0,1$	$25 \pm 1$	2400	1080		2640	2400	194
$\mu_e \pm 25\%$	4	$\leq 0,1$	$25 \pm 1$	1400	700		1700	1545	125
$\alpha$	4	$\leq 0,1$	$25 \pm 1$	$\leq 23,6$	$\leq 35,0$		$\leq 22,4$	$\leq 23,6$	$\leq 82,8$
$\frac{\tan \delta}{\mu_i} \times 10^6$	4	$\leq 0,1$	$25 \pm 1$			$\leq 2,5$			
	30	$\leq 0,1$	$25 \pm 1$				$\leq 2,5$	$\leq 1,8$	
	100	$\leq 0,1$	$25 \pm 1$		$\leq 3,5$	$\leq 20$	$\leq 5,0$	$\leq 2,6$	
	500 $\blacktriangle$	$\leq 0,1$	$25 \pm 1$		$\leq 6,5$	$\leq 200$			
	1000	$\leq 0,1$	$25 \pm 1$		$\leq 35$				
	2000	$\leq 0,1$	$25 \pm 1$						$\leq 40$
	10 000	$\leq 0,1$	$25 \pm 1$						$\leq 100$
P (W)	25	200*	$100 \pm 1$	$\leq 0,30$ $\leq 0,35$					
$\eta_B \times 10^3$	4	1,5 to 3,0	$25 \pm 1$		$\leq 0,8$	$\leq 1,1$	$\leq 0,86$		
	30	1,5 to 3,0	$25 \pm 1$					$\leq 0,65$	
	100	0,3 to 1,2	$25 \pm 1$						$\leq 9,2$
$\alpha_F \times 10^6/K$	$\leq 100$	$\leq 0,1$	5 to 25		$1 \pm 0,5$	0 to +2	+0,5 to 1,5	+0,7 $\pm$ 0,3	-2 to +4
	$\leq 100$	$\leq 0,1$	25 to 55		$1 \pm 0,5$	0 to +2	+0,5 to 1,5	+0,7 $\pm$ 0,3	0 to +6
	$\leq 100$	$\leq 0,1$	25 to 70		$1 \pm 0,5$	0 to +2	+0,5 to 1,5	+0,7 $\pm$ 0,3	
$D_F \times 10^5$ (10-100 min)	$\leq 100$	$\leq 0,1$	$25 \pm 0,1$		$\leq 8$	$\leq 4,3$	$\leq 4,3$	$\leq 3,0^{**}$	$\leq 10$
	$\beta_F \times 10^6$ measured on sets with $\mu_e = 300 \pm 10\%$ and $25 \pm 1$ °C: at $\mu_e \times \frac{N \times I_0}{l_e} = 1,00 \times 10^5$ A/m $= 1,55 \times 10^5$ A/m $= 2,25 \times 10^5$ A/m				$\leq 120$ $\leq 300$ $\leq 1100$				

$\blacktriangle$  3D3 at 700 kHz: 11.

\*  $\overset{A}{B}$  is calculated with  $A_{CPmin} = 31,2$  mm<sup>2</sup>.

\*\* This value is valid within the temperature range of 25 to 70 °C.

Core sets with nut and pre-adjusted on  $A_L$ .

$A_L$	corre- sponding $\mu_e$ -value	tol. on induct- ance (%)	catalogue number 4322 022 . . . . .					
			3B8	3D3	3E4	3H1	3H3	4C6
25	16,1	$\pm 1$						
40	25,8	$\pm 1$	55470*	● 75420		75220		75810
63	40,6	$\pm 1$	55480*	75430		75230		● 75820
100	64,5	$\pm 2$		● 75440		75240		● 75830
160	103	$\pm 2$	● 55500*	75450		● 75250		
200	129	$\pm 2$				● 75370	75550	
250	161	$\pm 2$	54900*			● 75260	● 75680	
315	203	$\pm 2$				75270	● 75560	
400	258	$\pm 2$	55510*			75280	75570	
630	406	$\pm 3$				75300	75580	
1000	645	$\pm 10$				75310	75600	
1250	806	$\pm 10$				75390		
4780	2780	$\pm 25$						
6710	3930	$\pm 25$			● 55900*			

Inductance  $L = N^2 A_L$  (in  $10^{-9}$  H)

Core sets without nut: replace the eighth digit of the catalogue number (7) by 5.

Cores with  $A_L \leq 100$  have a symmetrical air gap.

Cores with  $A_L \geq 160$  and both 3B8 cores have an asymmetrical air gap.

Core halves without air gap, without nut.

Ferroxcube grade	catalogue number
3B8	4322 020 27630*
3D3	4322 020 25140
3H1	4322 020 25130
3H3	4322 020 25190
4C6	4322 020 25150

\* These types have no centre hole.

● Preferred types.

## COIL FORMERS

## GENERAL

Four types of coil former can be supplied:

- with 1 section and 4 pins
- with 2 sections and 4 pins
- with 1 section and 6 pins
- with 2 sections and 6 pins.

The arrangement of the soldering pins is suitable for both 0,1 inch and 2,50 mm grid, see "Mounting".

The coil formers are supplied in packs of 100 on a polystyrene plate, and in cardboard boxes containing 5 such plates (500 pieces). Please order in multiples of these quantities.

## SINGLE-SECTION, 4-PIN COIL FORMER

Catalogue number	4322 021 32280	Solderability resistant against dipsoldering at 400 °C for 2 s
Material: phenolformaldehyde reinforced with glass fibre		D.C. losses:
Window area	17,3 mm <sup>2</sup>	$\frac{R_o}{L} = \frac{1}{\mu_e} \times \frac{1}{f_{cu}} \times 18,9 \times 10^3 \Omega/H$
Mean length of turn	30 mm	Mass
Maximum temperature	180 °C	0,4 g
Inflammability	UL94, class V-0	

## TWO-SECTION, 4-PIN COIL FORMER

Catalogue number	4322 021 32300	Solderability resistant against dipsoldering at 400 °C for 2 s
Material: phenolformaldehyde reinforced with glass fibre		D.C. losses:
Window area	2 x 8,2 mm <sup>2</sup>	$\frac{R_o}{L} = \frac{1}{\mu_e} \times \frac{1}{f_{cu}} \times 19,9 \times 10^3 \Omega/H$
Mean length of turn	30 mm	Mass
Max. temperature	180 °C	0,4 g
Inflammability	UL94, class V-0	

**SINGLE-SECTION, 6-PIN COIL FORMER**

Catalogue number 4322 021 32290  
 Material: phenolformaldehyde reinforced with glass fibre  
 Window area 17,3 mm<sup>2</sup>  
 Mean length of turn 30 mm  
 Max. temperature 180 °C  
 → Inflammability UL94, class V-0

Solderability resistant against dipsoldering at 400 °C for 2 s

D.C. losses:

$$\frac{R_o}{L} \times \frac{1}{\mu_e} \times \frac{1}{f_{cu}} \times 18,9 \times 10^3 \Omega/H$$

Mass 0,4 g

**TWO SECTION, 6-PIN COIL FORMER**

Catalogue number 4322 021 32310  
 Material: phenolformaldehyde reinforced with glass fibre  
 Window area 2 x 8,2 mm<sup>2</sup>  
 Mean length of turn 30 mm  
 Max. temperature 180 °C  
 → Inflammability UL94, class V-0

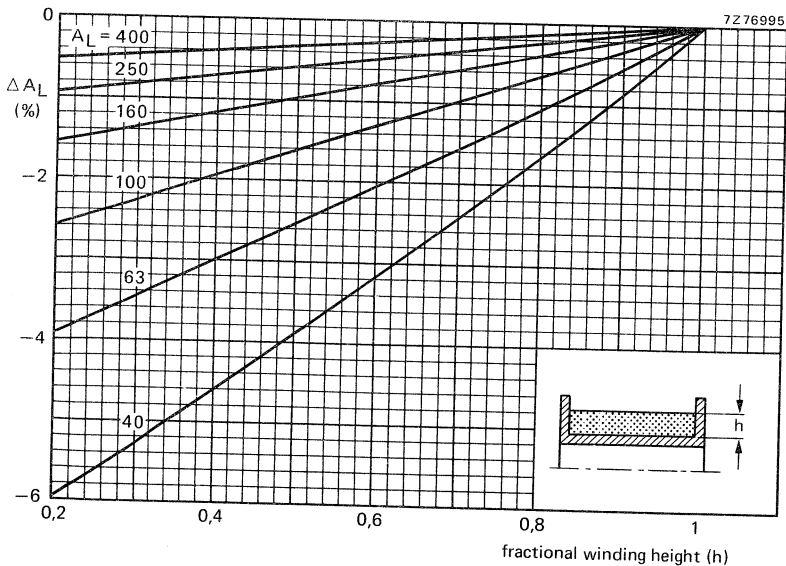
Solderability resistant against dip-soldering at 400 °C for 2 s

D.C. losses:

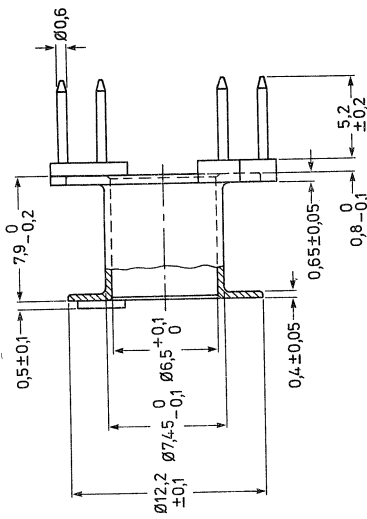
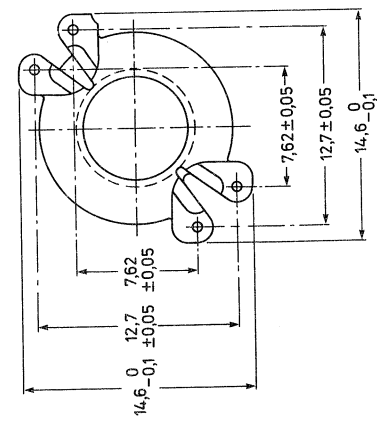
$$\frac{R_o}{L} \times \frac{1}{\mu_e} \times \frac{1}{f_{cu}} \times 19,9 \times 10^3 \Omega/H$$

Mass 0,4 g

Data for when the coil former is partly filled.

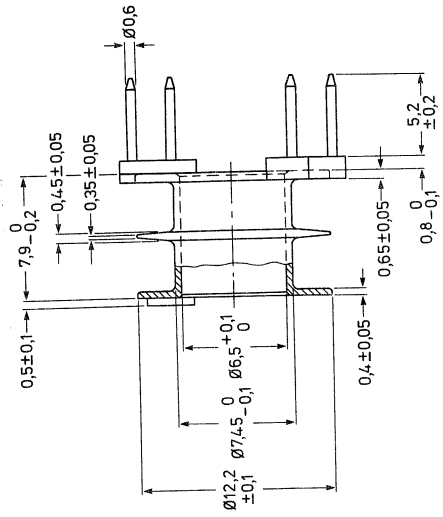
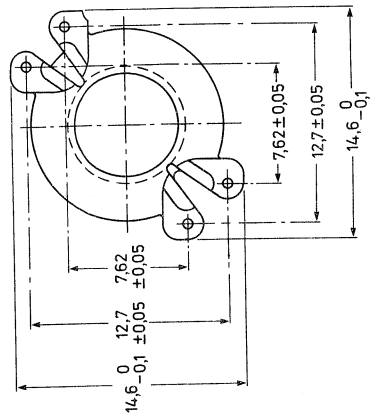


**DIMENSIONAL DIAGRAMS**



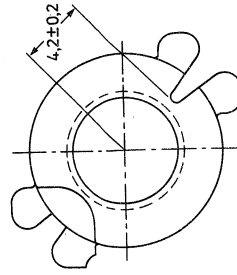
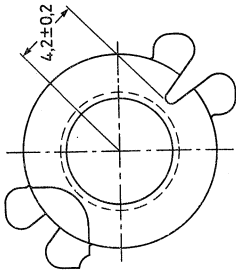
7268405.3

Single-section, 4-pin coil former.

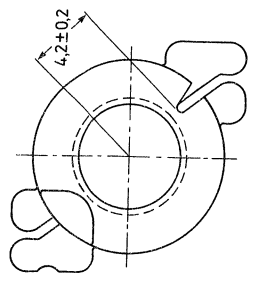
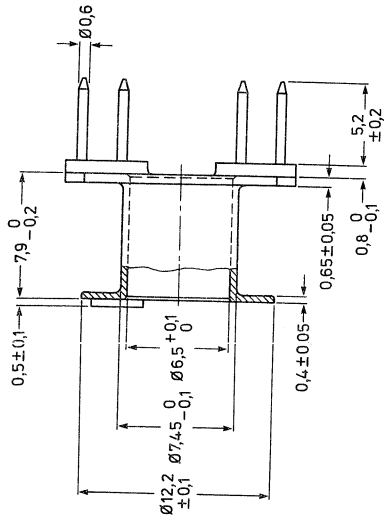
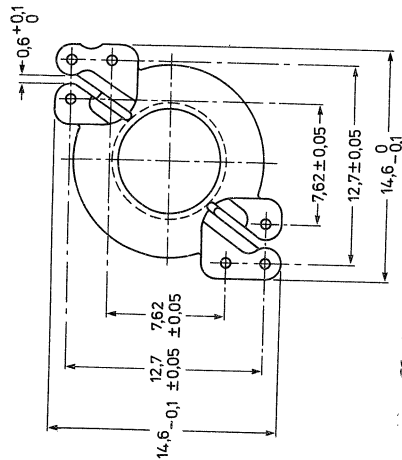


7268404.3

Two-section, 4-pin coil former.

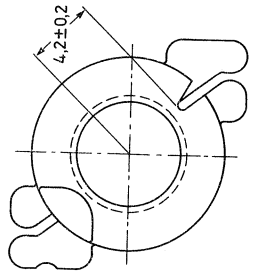
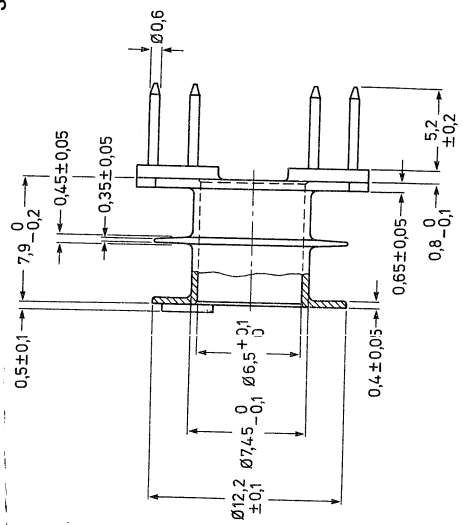
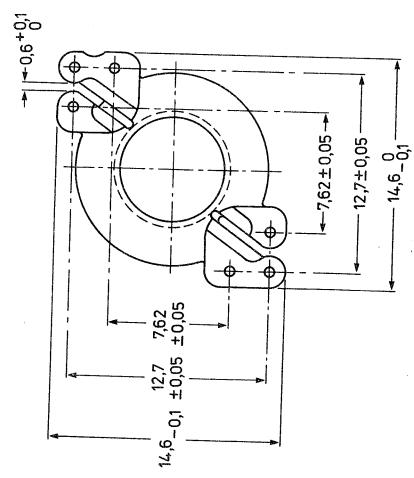


DIMENSIONAL DIAGRAMS (continued)



7Z68408.3

Single-section, 6-pin coil former.



7Z68403.2

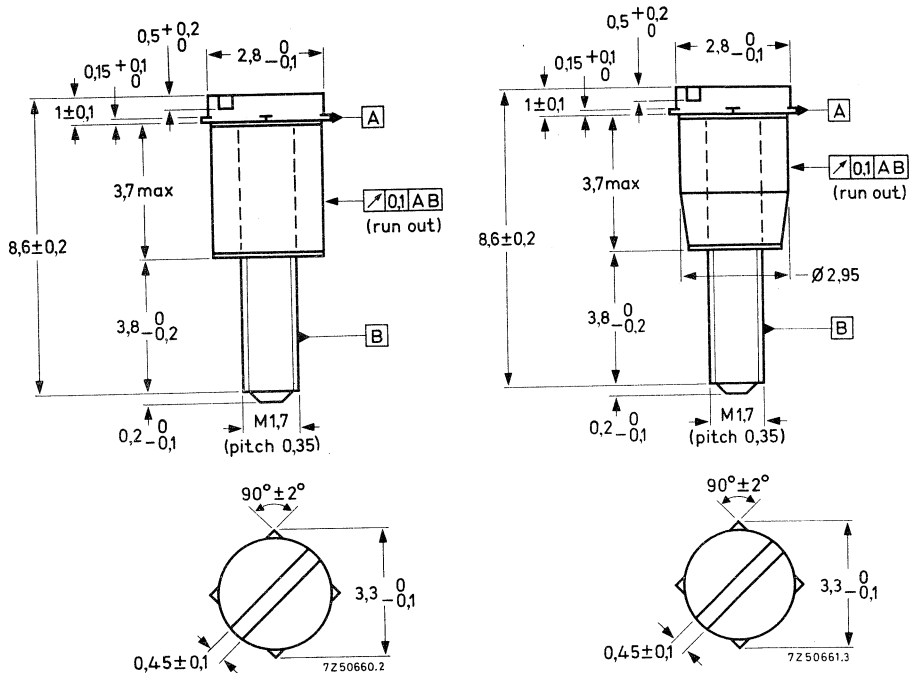
Two-section, 6-pin coil former.



## INDUCTANCE ADJUSTERS

(old types)

### ADJUSTERS



Version A, tube dia. 2,5 mm  
 Version B, tube dia. 2,7 mm  
 Version C, tube dia. 2,77 mm

Version D

The tolerances on inductance of the pre-adjusted cores (without adjuster) are given in the table of pre-adjusted cores with standard  $A_L$  values. After inserting a coil (impregnated or not) in an electrical circuit, its inductance can be adjusted to the required value with an accuracy  $< 0,03\%$  by means of a continuous inductance adjuster. Such an adjuster increases the inductance of the coil (see following pages).

The adjuster is screwed through the centre hole of the core into the nut and is held in position by the four protrusions near the top of the adjuster. For special requirements a larger or smaller adjustment range may be obtained by using an adjuster belonging to the next higher or lower  $A_L$  value.

The influence of the adjuster on the variability of the inductance is negligible. The maximum permissible temperature is 110 °C.

The table shows the type of adjuster recommended for different square cores.

Table I, available types

version	colour	catalogue number
A	white	4322 021 32130
B	brown	4322 021 32140
C	black	4322 021 32150
B	natural	4322 021 32160
B	red	4322 021 32170
D	grey	4322 021 32180

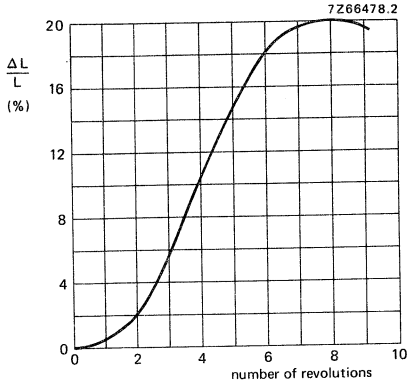
Table II, recommended application

A <sub>L</sub>	3H1/3D3
	catalogue number
40	4322 021 32160
63	4322 021 32160
100	4322 021 32170
160	4322 021 32130
200	4322 021 32130
250	4322 021 32130 or 4322 021 32140
315	4322 021 32140
400	4322 021 32150
630	4322 021 32180

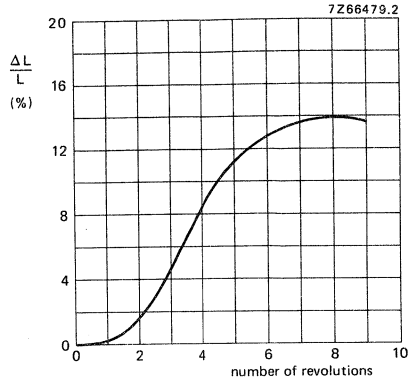
The adjusters are packed in bags of 100. Please order in multiples of 100.

ADJUSTMENT CURVES

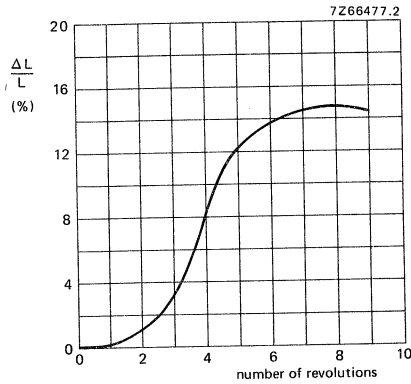
Distance between nut and mating surface = 2,3 mm for all  $A_L$  values.



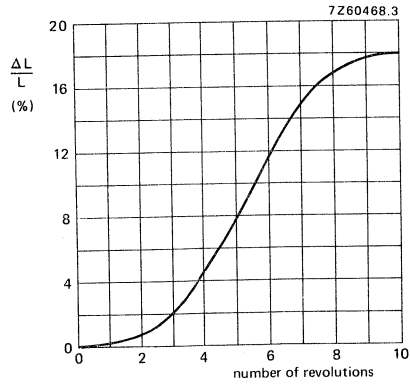
$A_L = 40$ ; FXC 3D3/3H1.



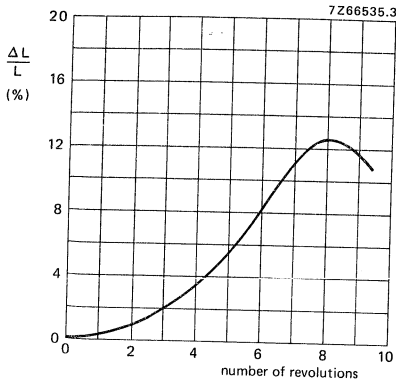
$A_L = 63$ ; FXC 3D3/3H1.



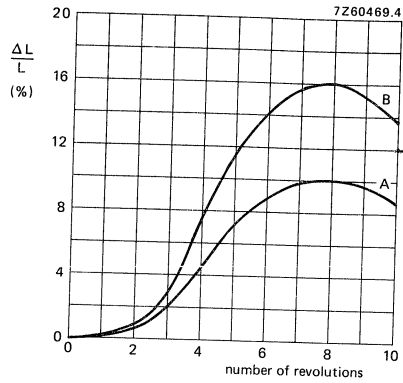
$A_L = 100$ ; FXC 3D3/3H1.



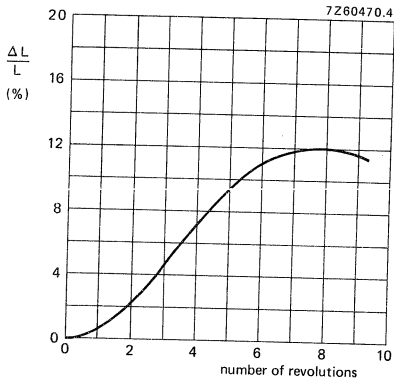
$A_L = 160$ ; FXC 3D3/3H1.



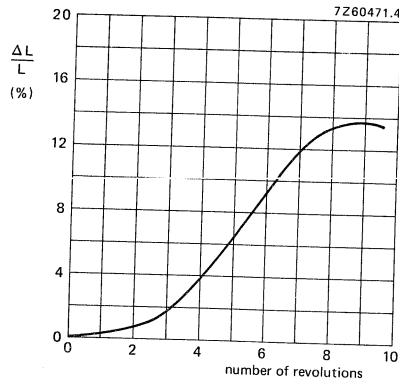
Adjuster 4322 021 32130.



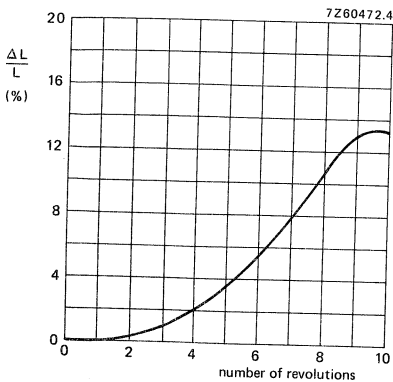
Curve A: adjuster 4322 021 32130.  
Curve B: adjuster 4322 021 32140.



Adjuster 4322 021 32140.



Adjuster 4322 021 32150.



Adjuster 4322 021 32180.

## INDUCTANCE ADJUSTERS

(new types)

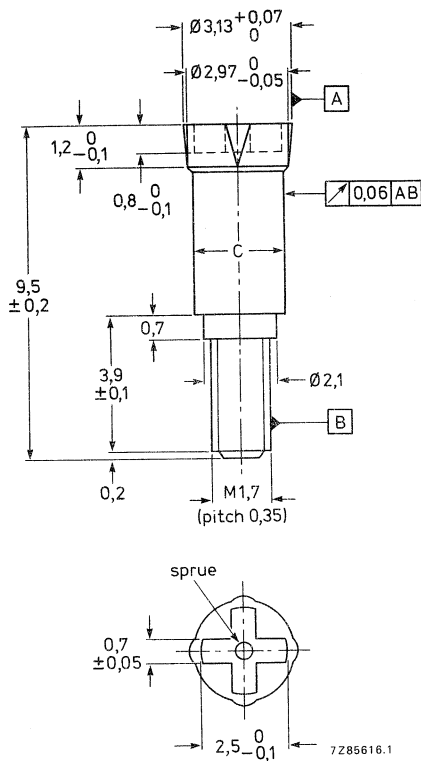


Fig. 1.

Material: polypropylene, reinforced with glass fibre.

The tolerances on inductance factor of the pre-adjusted cores without adjuster are given in the table of pre-adjusted cores with standard  $A_L$  values. The inductance of the pre-adjusted core can be increased to the required value – with a setting accuracy  $< 0,03\%$  – by means of a continuous adjuster.

The adjuster is screwed through the centre hole of the core into the nut and is held in position by the four cones near the top of the adjuster.

The combination of the polyamide moulded-in nut and the polypropylene adjuster – both reinforced with glass fibre – gives an excellent stability with temperature, shocks and vibrations. Besides this, the combination has a very smooth adjustment curve due to the excellent concentricity of the moulded-in nut and the adjuster.

The maximum permissible temperature of the adjustment combination is:  $150\text{ }^\circ\text{C}$ , during 8 h. The maximum working temperature is  $110\text{ }^\circ\text{C}$ .

The tables below show the available types and which adjuster is recommended for typical  $A_L$  values.

Table 1 Colour code of adjusters

catalogue number	colour	dia. C (Fig. 1) mm	material
4322 021 38600	black	2,83	FXC
38610	brown	2,70	FXC
38670	violet	2,58	FXC
38680	white	2,48	FXC
38690	grey	2,93	FXC

Table 2 Catalogue numbers of recommended adjusters for typical  $A_L$  values

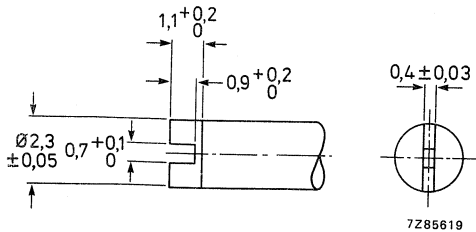
$A_L$	3H1/3H3/3B7	3D3	4C6
25			
40			
63			
100			
160			
200	4322 021 38680	4322 021 38680	
250	38670		
315	38610		
400	38600		
630	38690		

**PACKAGING**

The adjusters are packed in bags of 100. Please order in multiples.

**ADJUSTING TOOL**

An adjusting tool combination for M1,4 and M1,7 is available, catalogue number 4322 058 03260.

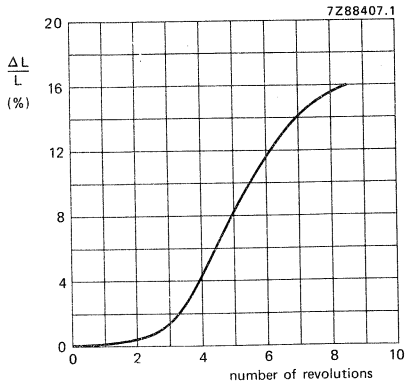


For customers who wish to make the screwdriver themselves the outlines of the essential part are given in Fig. 2.

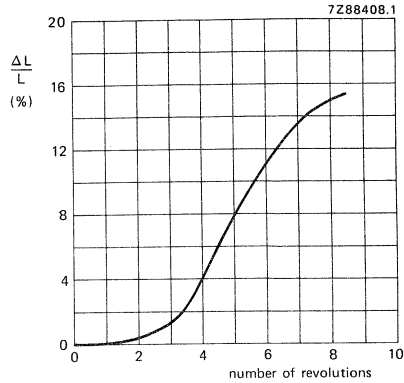
Fig. 2.

ADJUSTMENT CURVES

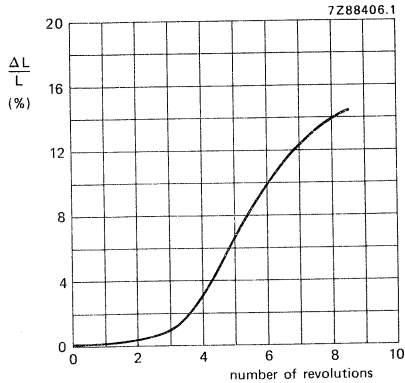
Characteristic curves



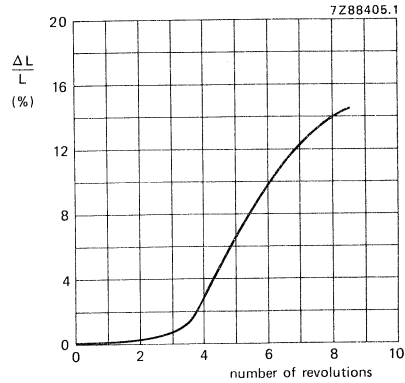
$A_L = 160$ ; FXC 3D3



$A_L = 200$ ; FXC 3H1

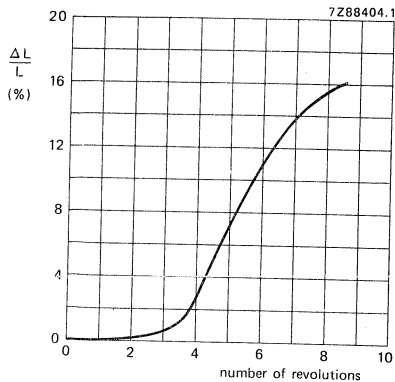


$A_L = 250$ ; FXC 3H1

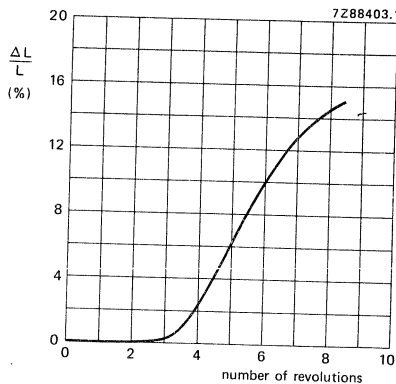


$A_L = 315$ ; FXC 3H1

Note on next page.



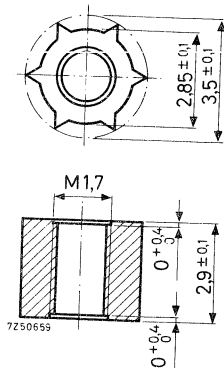
$A_L = 400$ ; FXC 3H1



$A_L = 630$ ; FXC 3H1

**NUT FOR ADJUSTER**

These data are given for those manufacturers who prefer to insert the nut themselves.



Catalogue number

4322 021 30140

Material

polycarbonate

Maximum impregnation temperature during 24 hours

120 °C

Recommended distance from mating surface to nut

$2,3 \pm 0,15$  mm

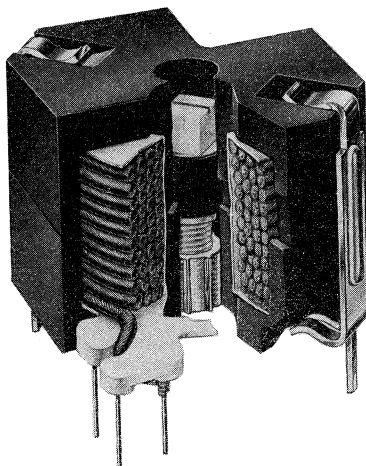
The nuts are packed in bags of 100. Please order in multiples of 100.

Note: 0 revolutions corresponds to at least one turn of interaction.



## ASSEMBLING AND MOUNTING

## ASSEMBLING

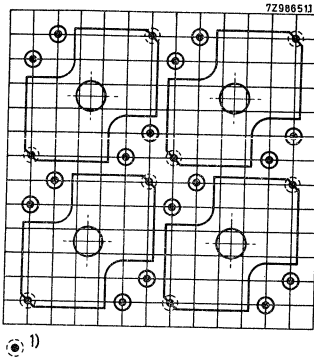


RZ25252

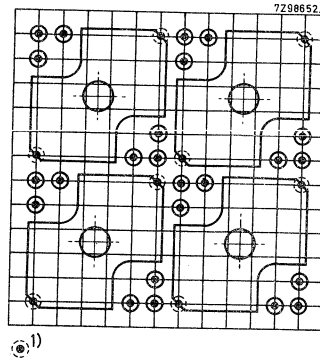
The illustration shows the simplicity of the assembly; the core halves are held together by two clips. The tags of the clips are used for mechanical fastening and/or for earthing. For a stable inductance we recommend that an adhesive be applied between the coil former flange and the lower core half. The use of a tool for attaching the clips is recommended. (Drawings of a simple tool for this purpose are available under number 4322 058 00150.)

**MOUNTING**

The soldering pins of coil formers and clips are so arranged that they will fit printed-wiring boards with a 0,1 inch grid as well as those with a 2,50 mm grid. The pin length is sufficient for a board thickness up to 2,4 mm. The recommended hole diameter in the board is  $1,0 \pm 0,1$  or  $1,3 \pm 0,1$  mm (according to IEC publication 97).

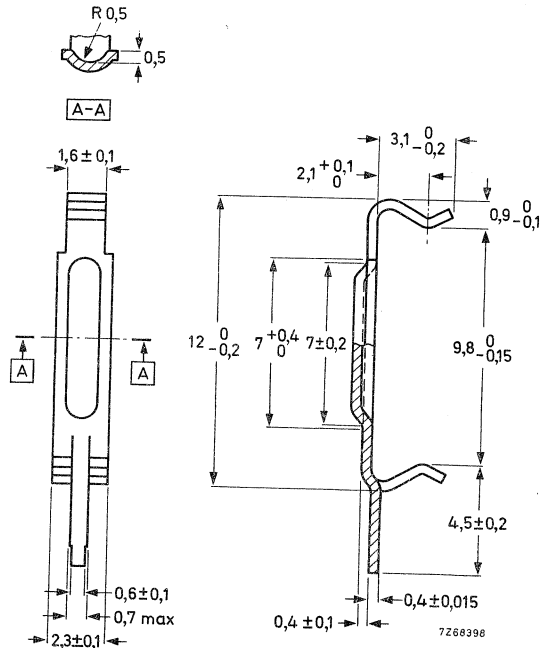


Hole pattern for an assembly of 4 cores, each fitted with a 4-pin coil.



Hole pattern for an assembly of 4 cores, each fitted with a 6-pin coil former.

**PART DRAWING (dimensions in mm)**



Clip 4322 021 31780

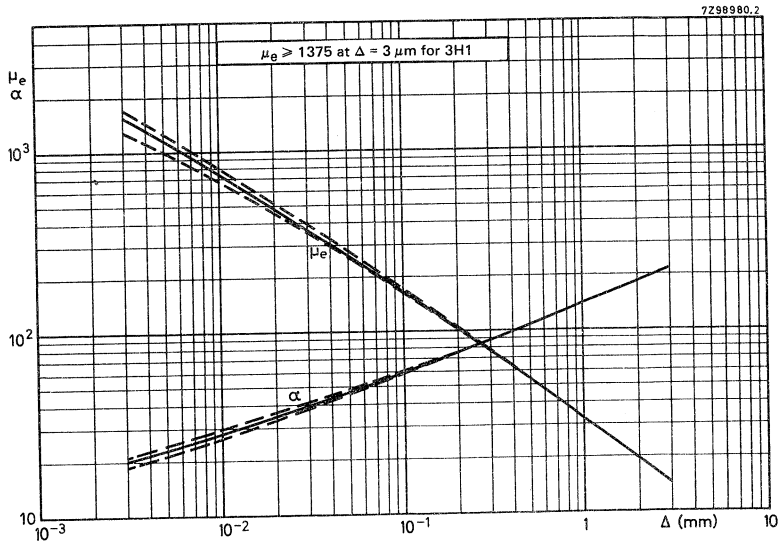
Material: steel; silver-plated over nickel, and then passivated.

Packaging quantity: 5000

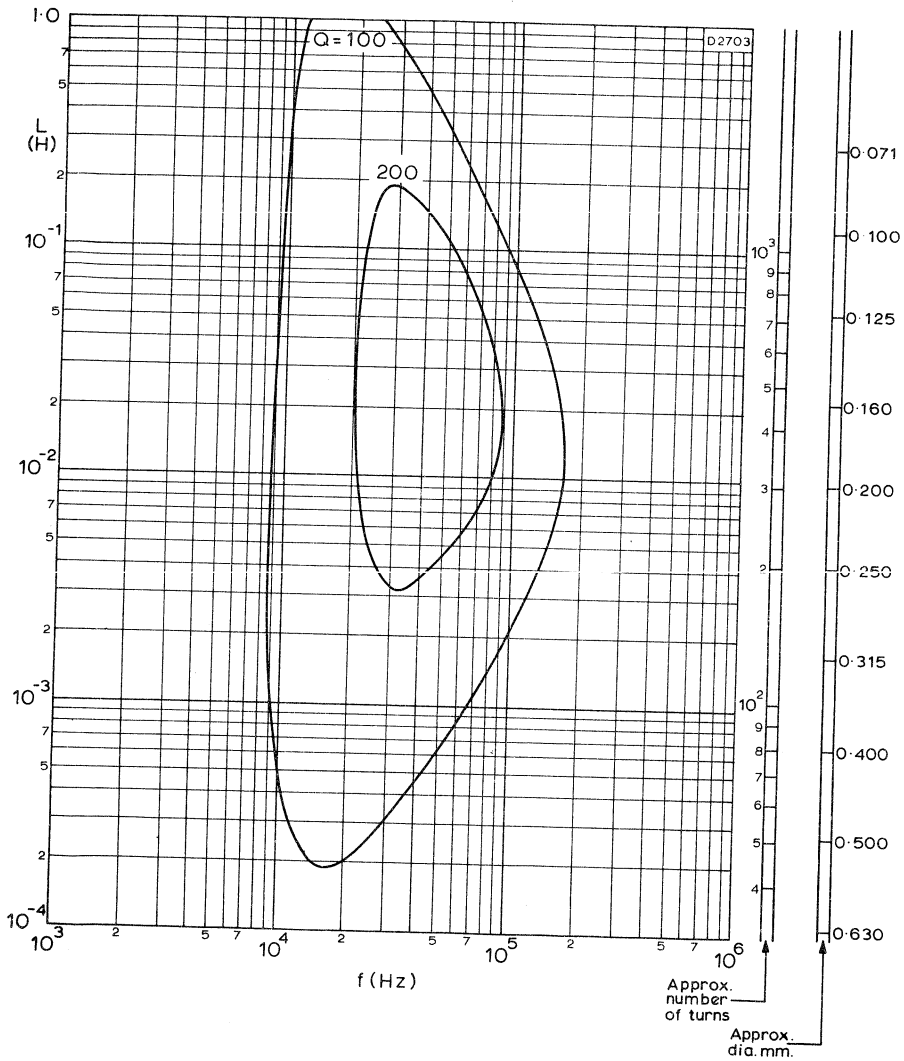
1) Holes for tag on clip 4322 021 31780 (earth points).

# CHARACTERISTIC CURVES

$\mu_e - \alpha$  CURVES

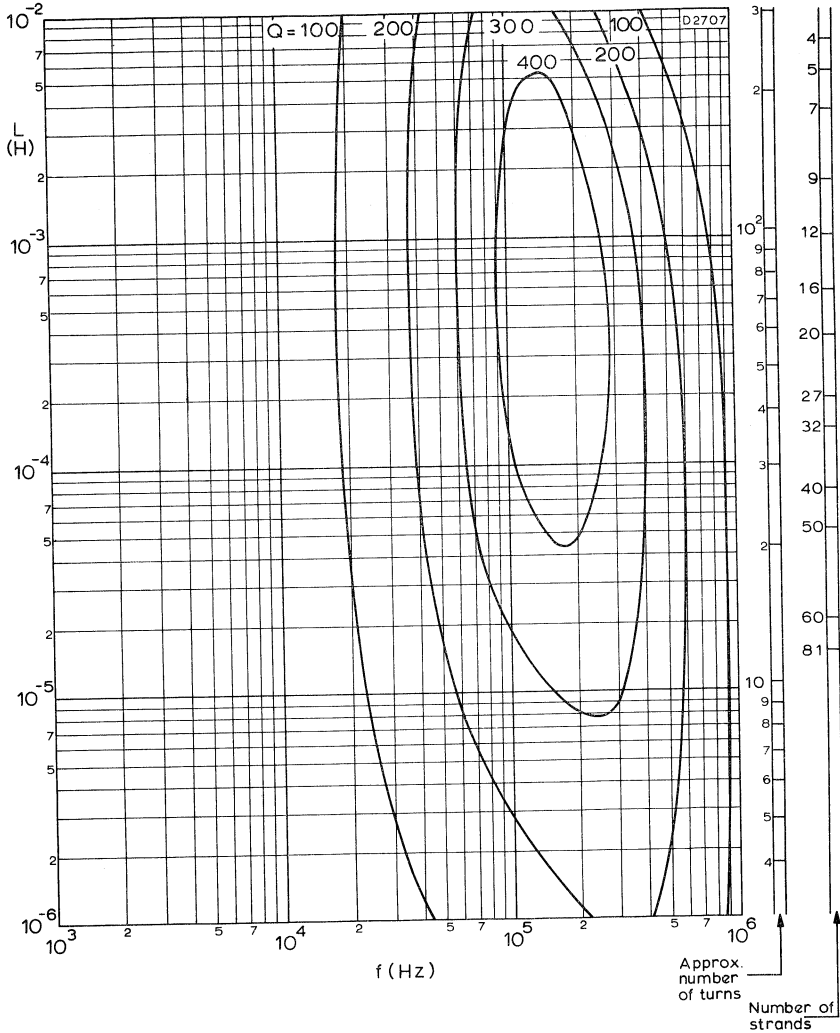


Relative effective permeability and turns factor for 1 mH as a function of the air gap length.



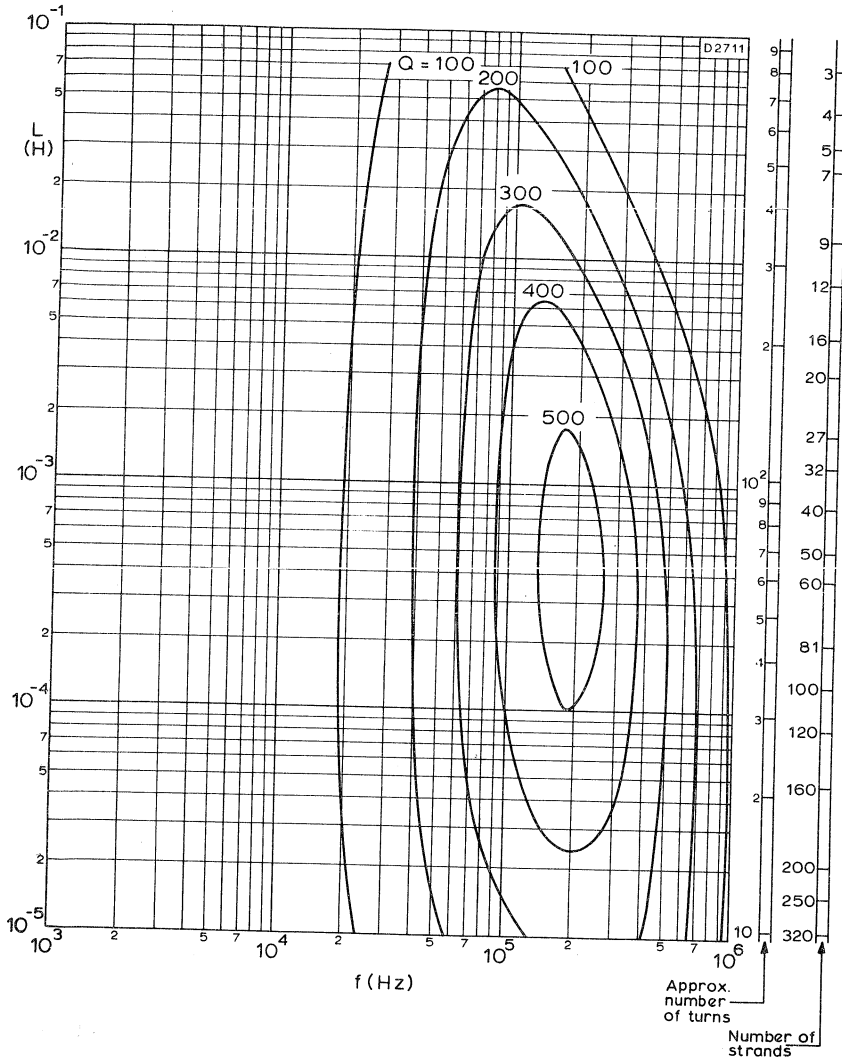
ISO - Q CURVES

These curves show typical Q-factors obtainable with full windings of enamelled copper wire on coil  
 → formers 4322 021 32280/32290. Material grade FXC 3H3,  $A_L = 100$ .



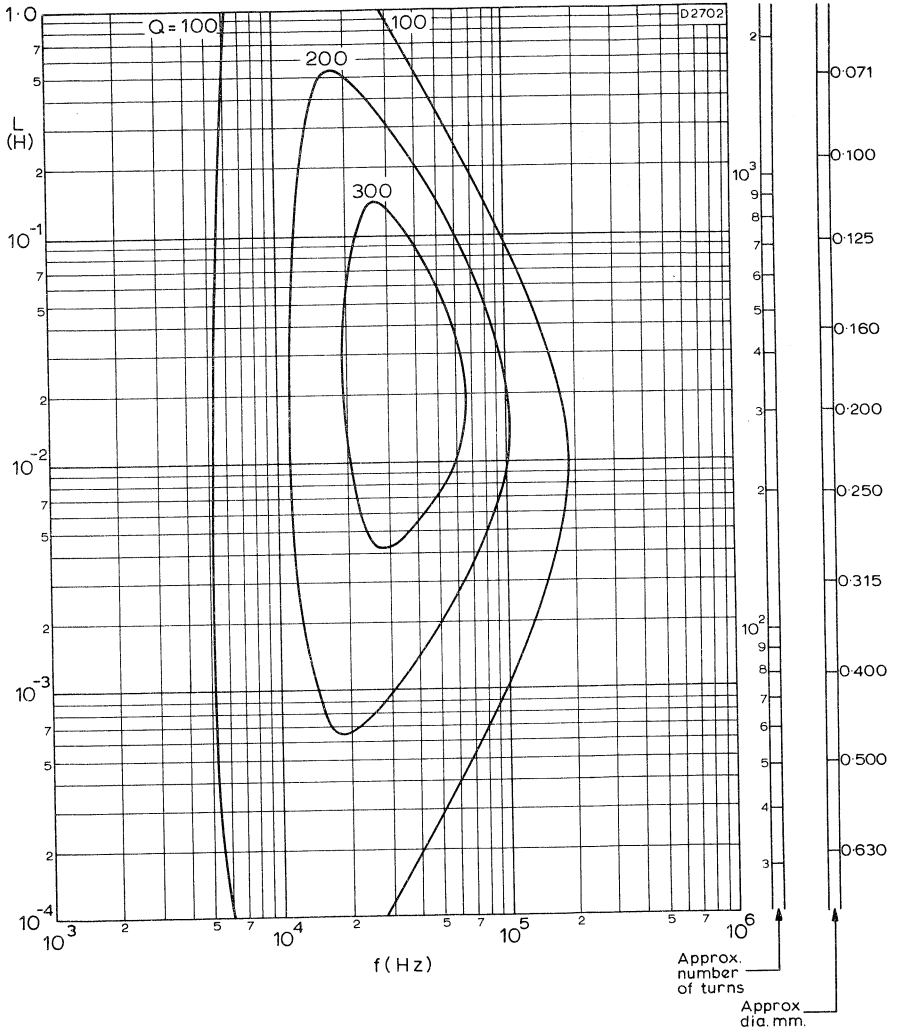
ISO - CURVES

These curves show typical Q-factors obtainable with full windings of 0,071 mm diameter bunched conductors on coil formers 4322 021 32280/32290. FXC grade 3H3,  $A_L = 100$ .



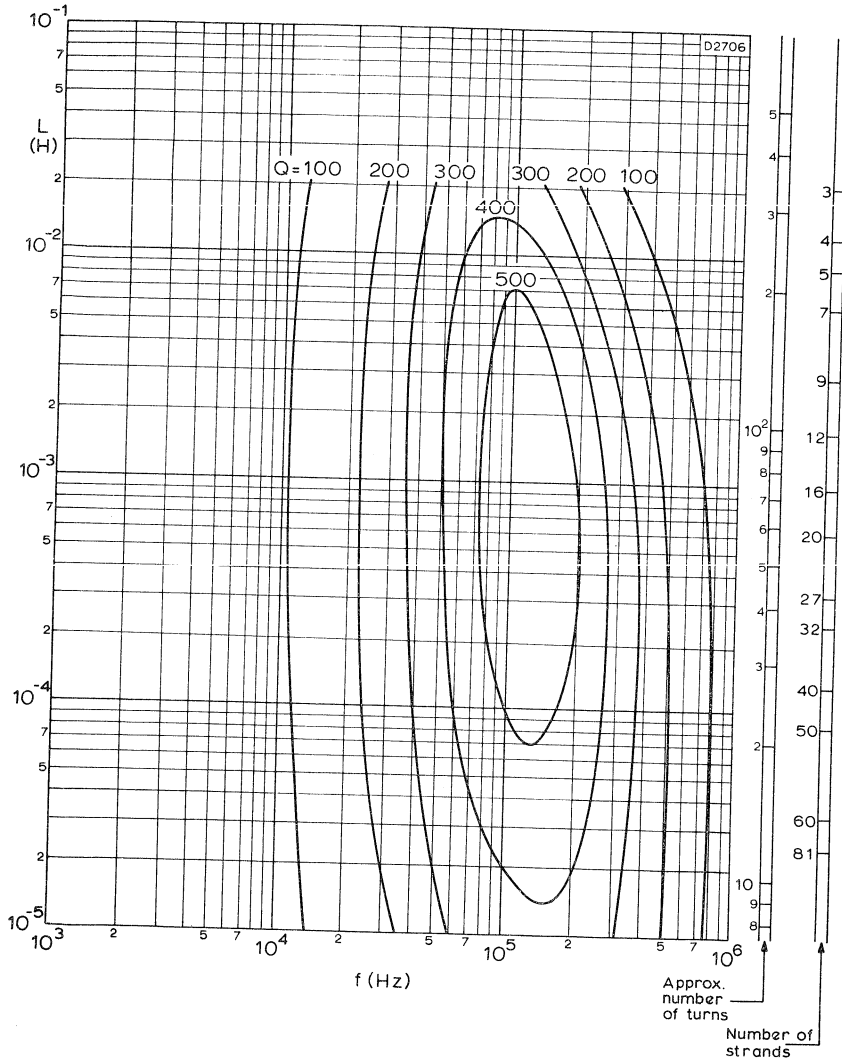
ISO - CURVES

These curves show typical Q-factors obtainable with full windings of 0,040 mm diameter bunched conductors on coil formers 4322 021 32280/32290. FXC grade 3H3,  $A_L = 100$ .



ISO - Q CURVES

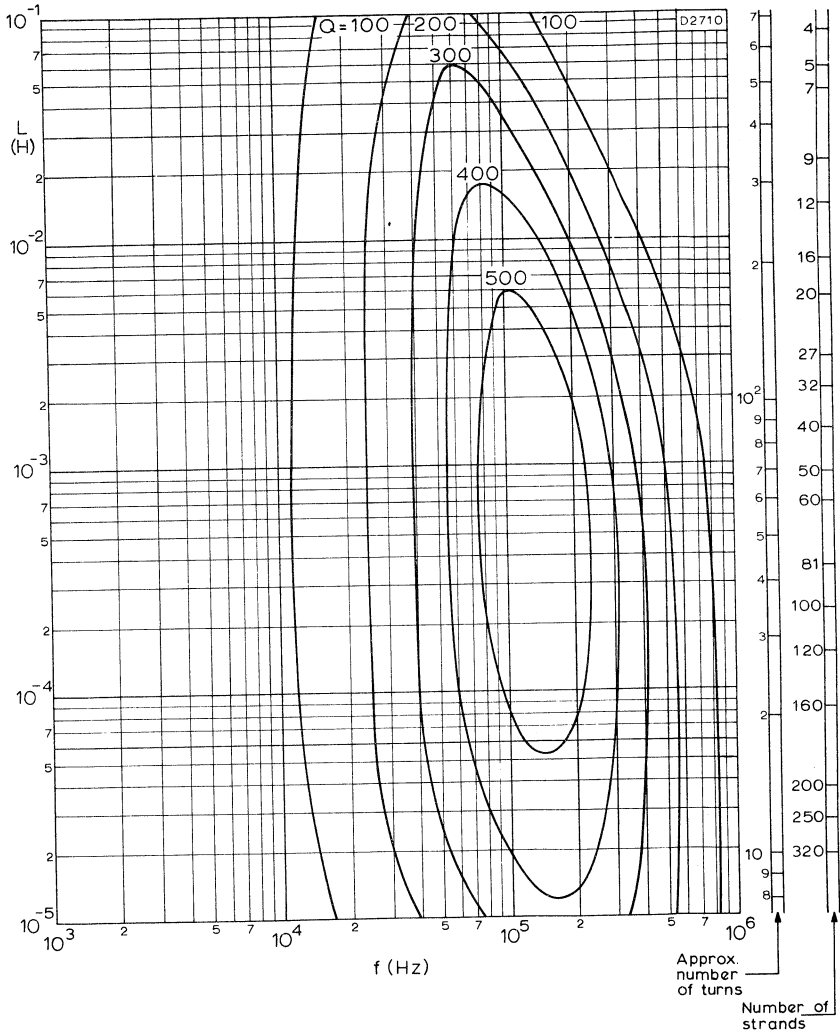
These curves show typical Q-factors obtainable with full windings of enamelled copper wire on coil formers 4322 021 32280/32290. Material grade FXC 3H3,  $A_L = 160$ .



ISO - CURVES

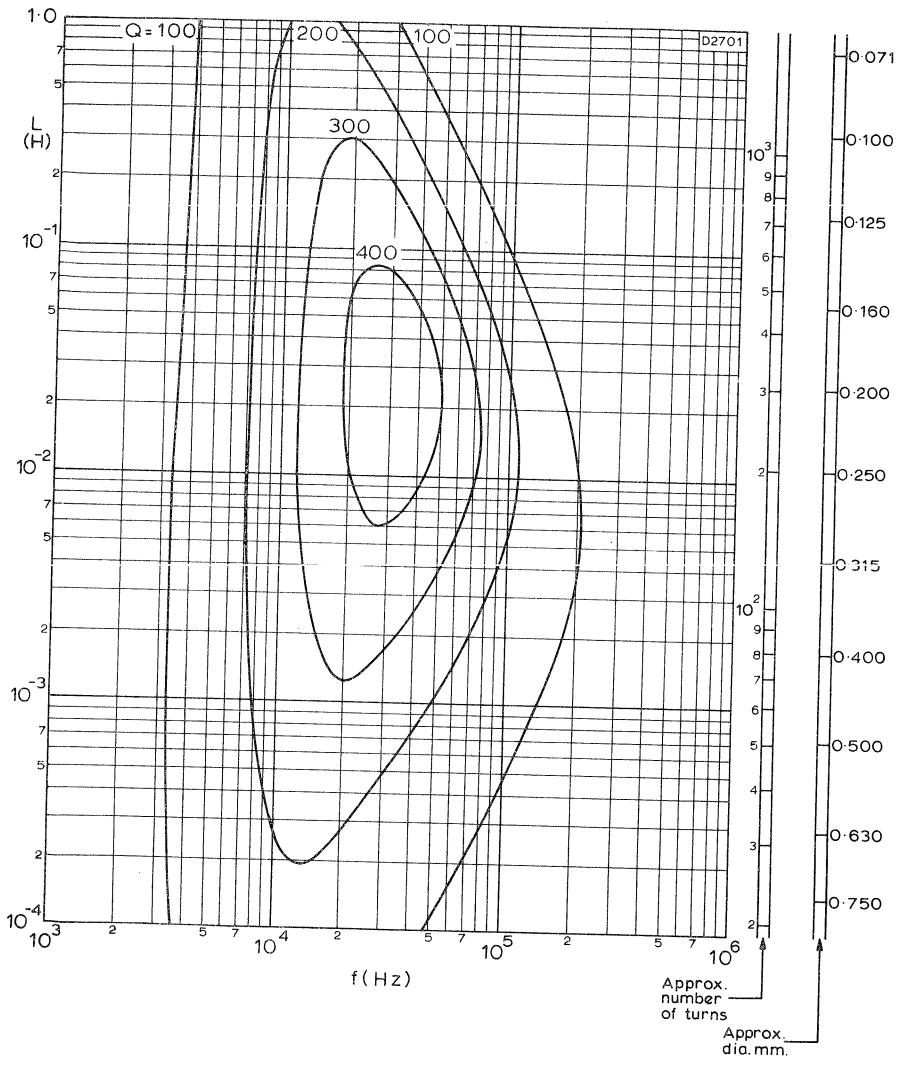
These curves show typical Q-factors obtainable with full windings of 0,071 mm diameter bunched  
 → conductors on coil formers 4322 021 32280/32290. FXC grade 3H3,  $A_L = 160$ .





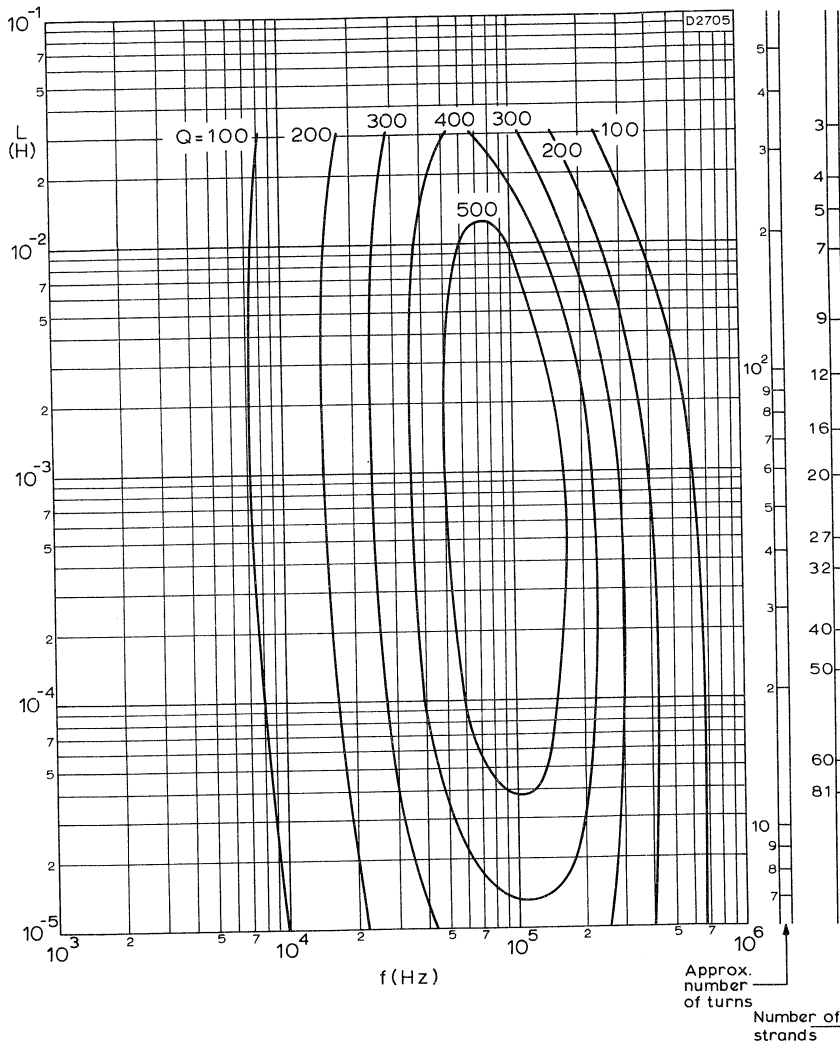
ISO - CURVES

These curves show typical Q-factors obtainable with full windings of 0,040 mm diameter bunched conductors on coil formers 4322 021 32280/32290. FXC grade 3H3,  $A_L = 160$ .



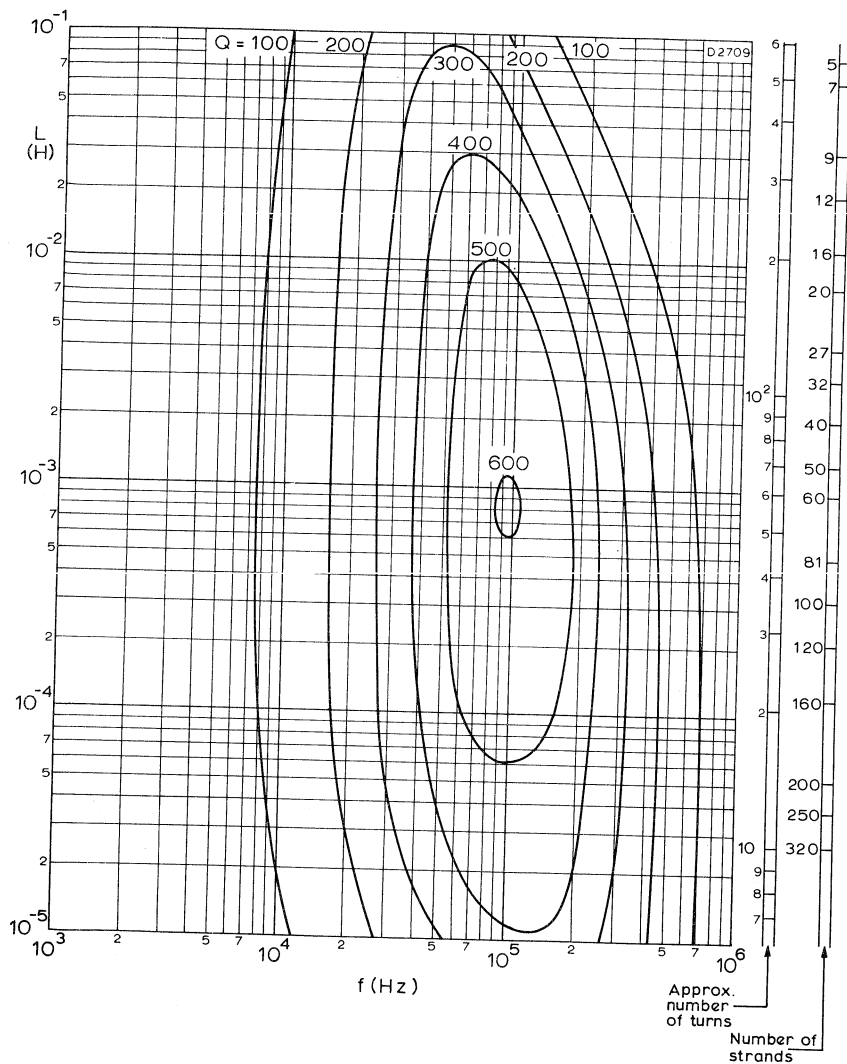
ISO - Q CURVES

These curves show typical Q-factors obtainable with full windings of enamelled copper wire on coil  
 → formers 4322 021 32280/32290. Material grade FXC 3H3,  $A_L = 250$ .



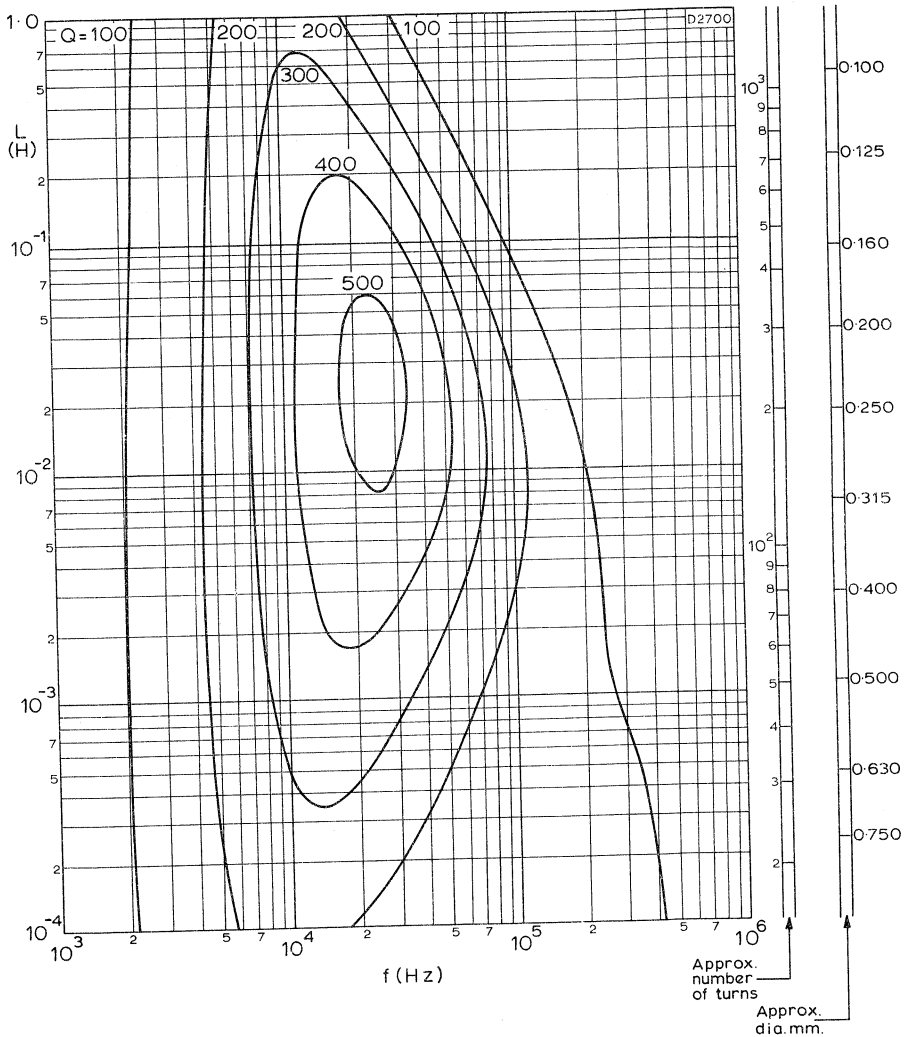
ISO - CURVES

These curves show typical Q-factors obtainable with full windings of 0,071 mm diameter bunched conductors on coil formers 4322 021 32280/32290. FXC grade 3H3,  $A_L = 250$ .



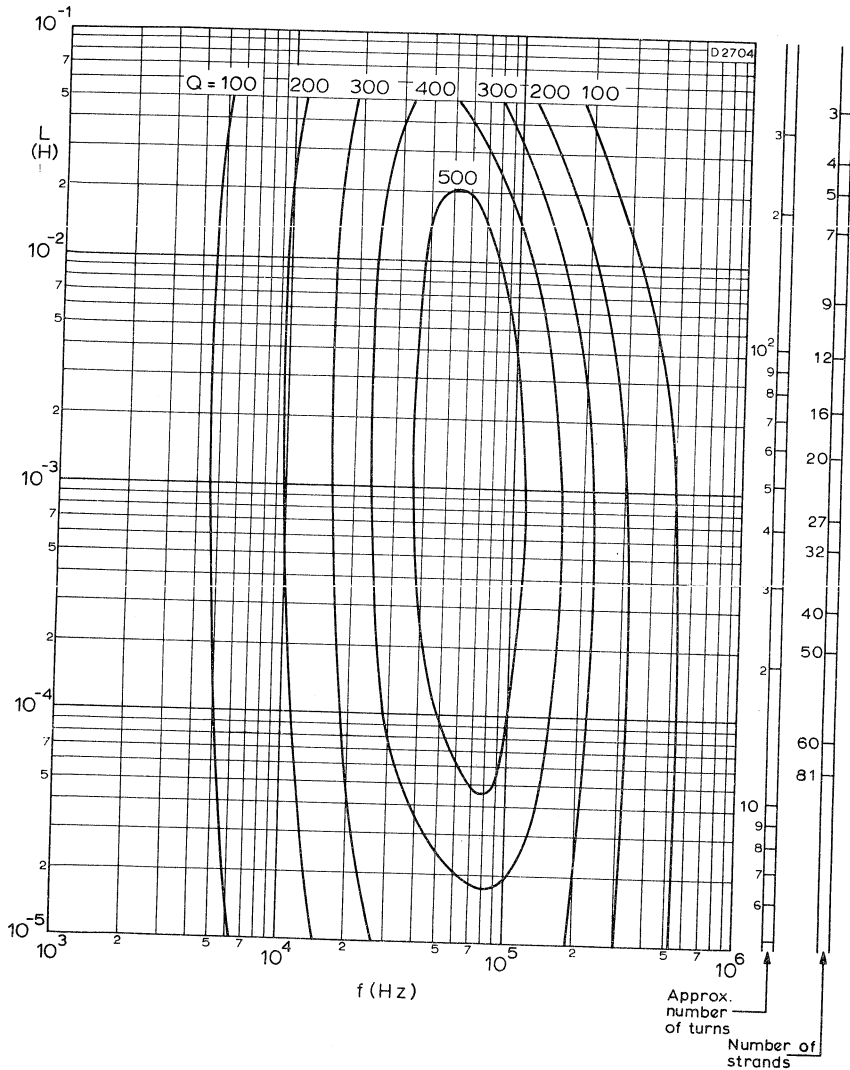
ISO - CURVES

These curves show typical Q-factors obtainable with full windings of 0,040 mm diameter bunched  
 → conductors on coil formers 4322 021 32280/32290. FXC grade 3H3,  $A_L = 250$ .



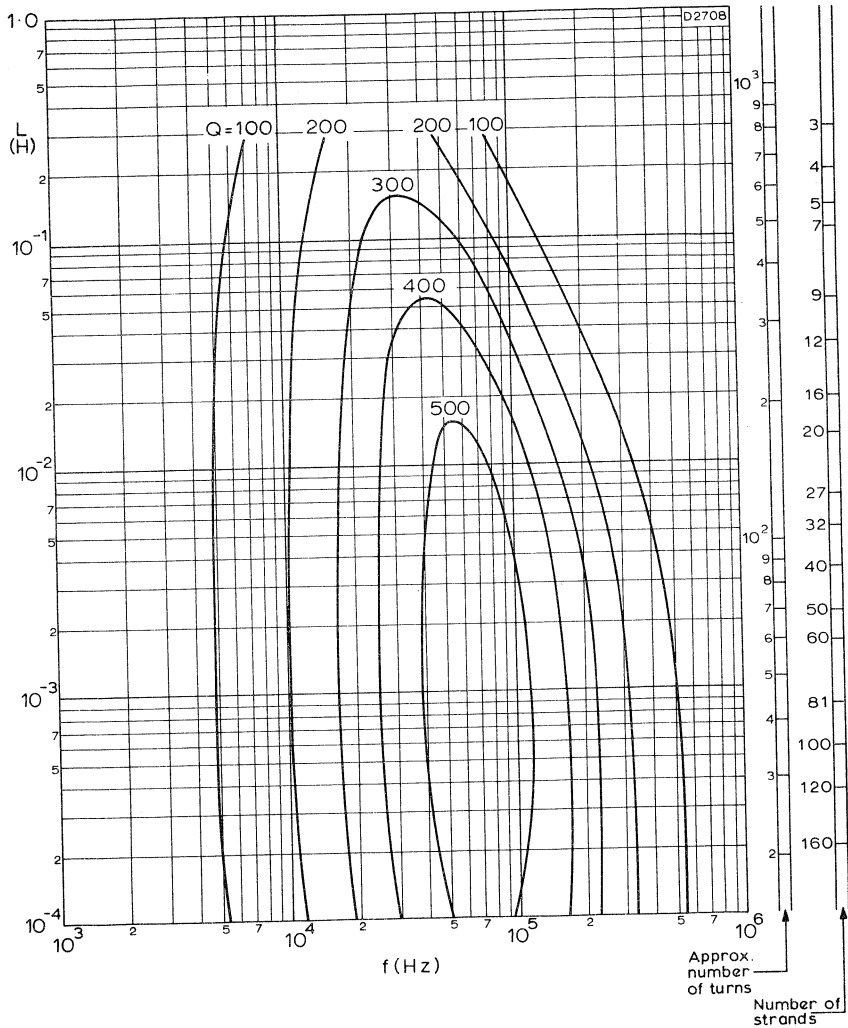
ISO - Q CURVES

These curves show typical Q-factors obtainable with full windings of enamelled copper wire on coil formers 4322 021 32280/32290. Material grade FXC 3H3,  $A_L = 400$ .



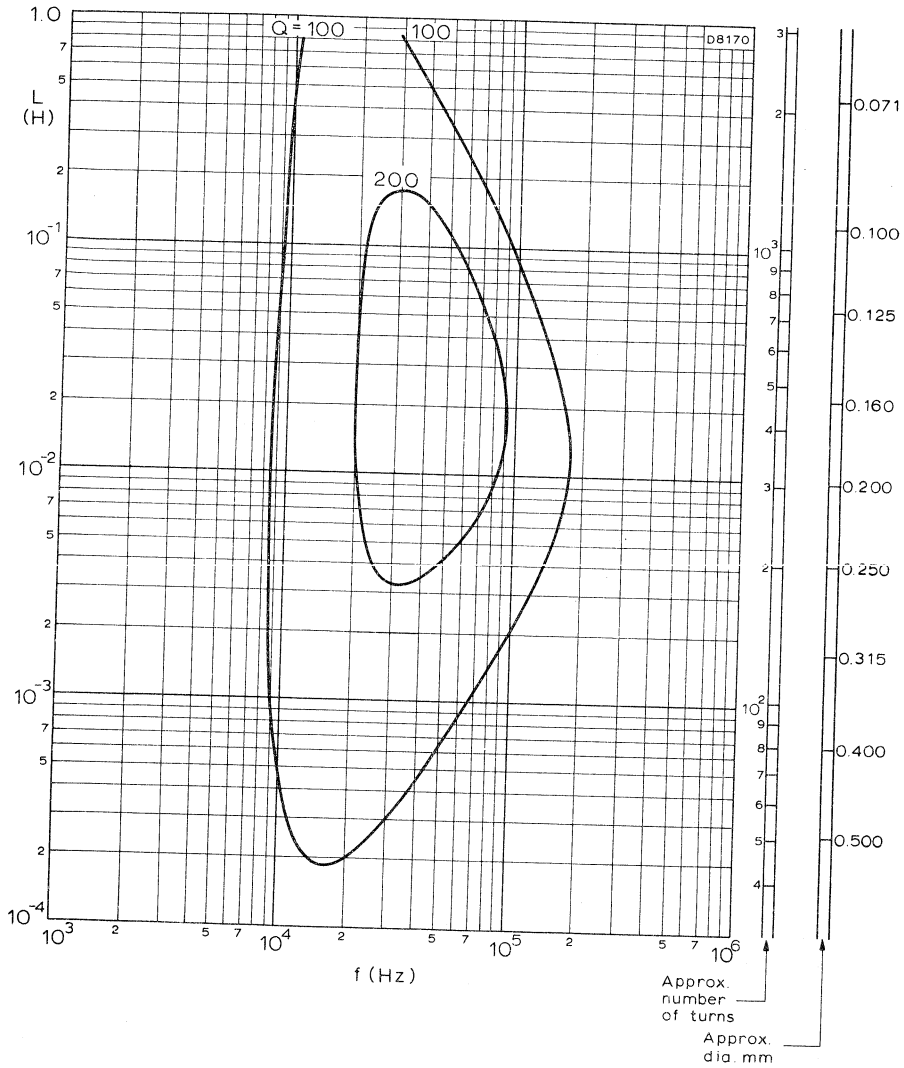
ISO - CURVES

These curves show typical Q-factors obtainable with full windings of 0,071 mm diameter bunched conductors on coil formers 4322 021 32280/32290. FXC grade 3H3,  $A_L = 400$ .



ISO - CURVES

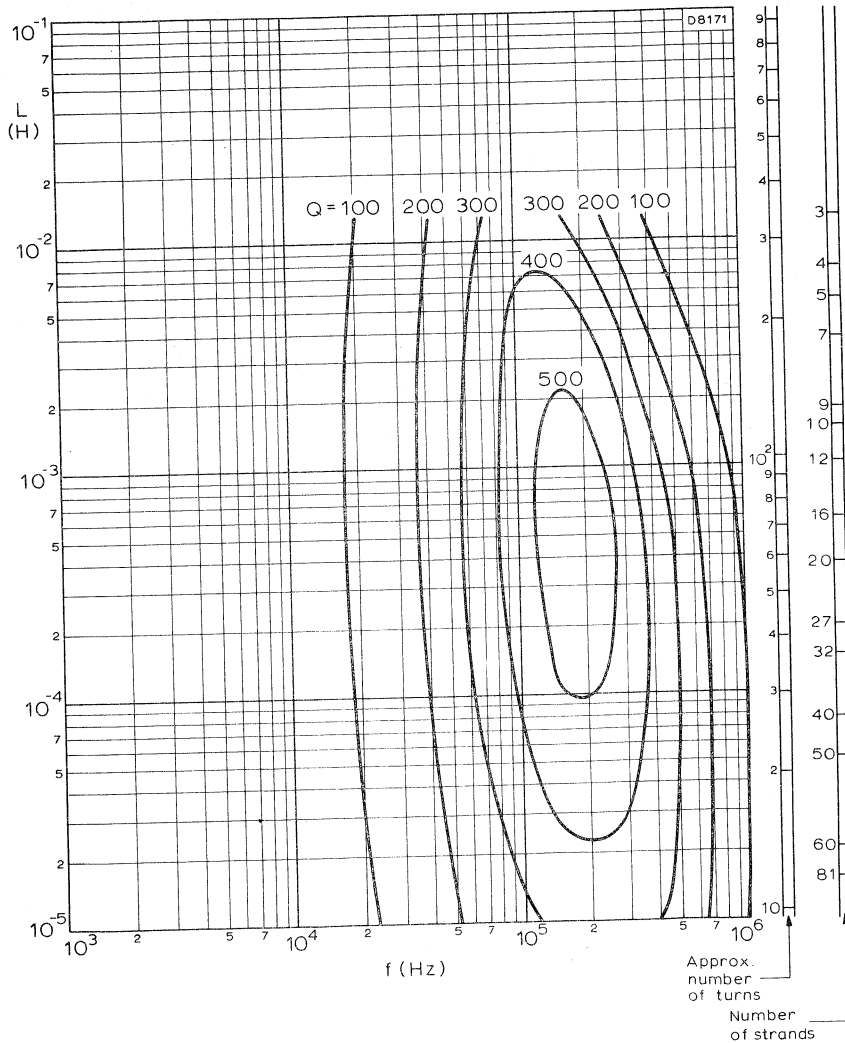
These curves show typical Q-factors obtainable with full windings of 0,040 mm diameter bunched conductors on coil formers 4322 021 32280/32290. FXC grade 3H3,  $A_L = 400$ .



ISO - Q CURVES

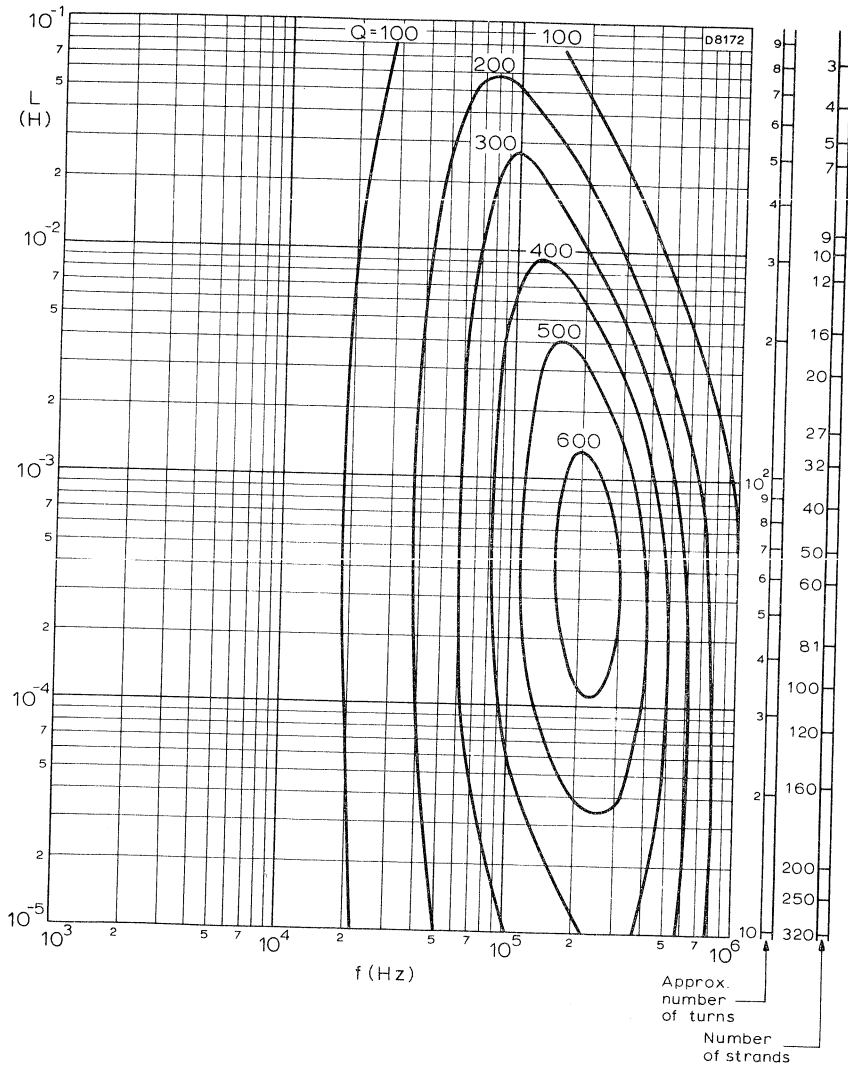
These curves show typical Q-factors obtainable with full windings of enamelled copper wire on coil  
 → formers 4322 021 32280/32290. Material grade FXC 3H1,  $A_L = 100$ .





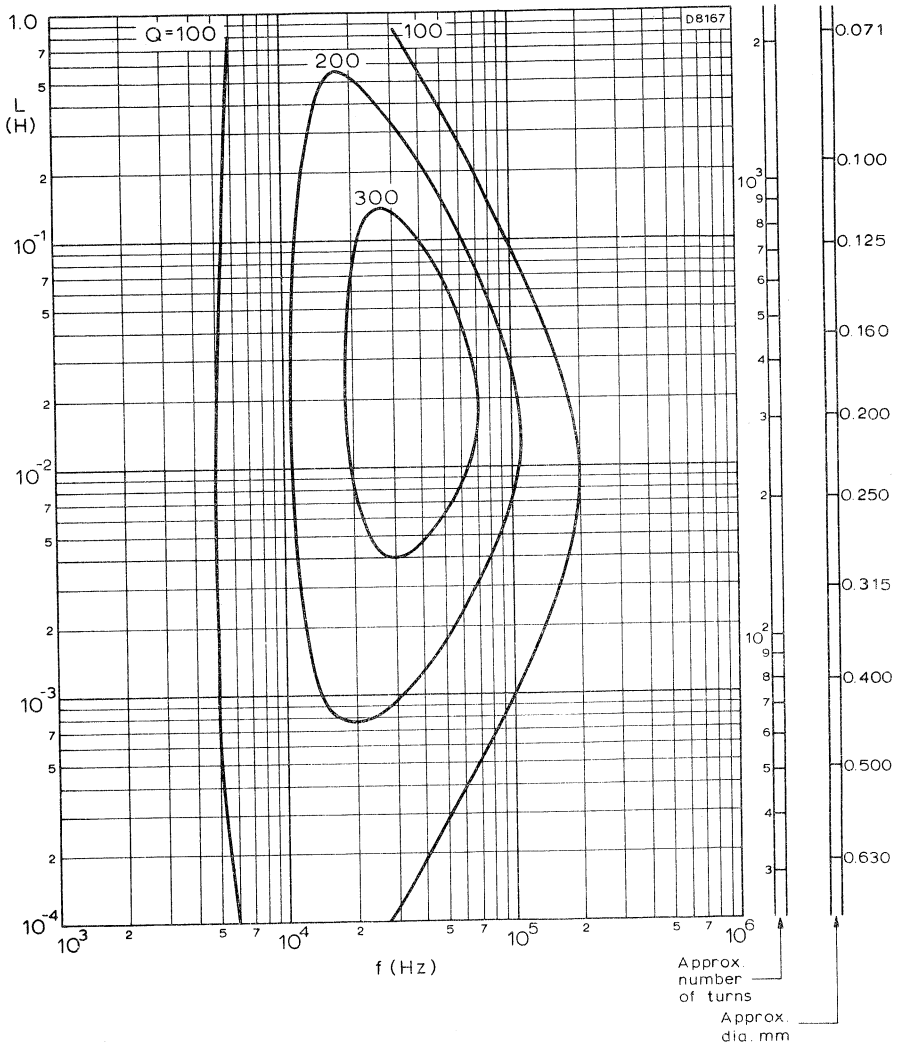
ISO - CURVES

These curves show typical  $Q$ -factors obtainable with full windings of 0,071 mm diameter bunched conductors on coil formers 4322 021 32280/32290. FXC grade 3H1,  $A_L = 100$ .



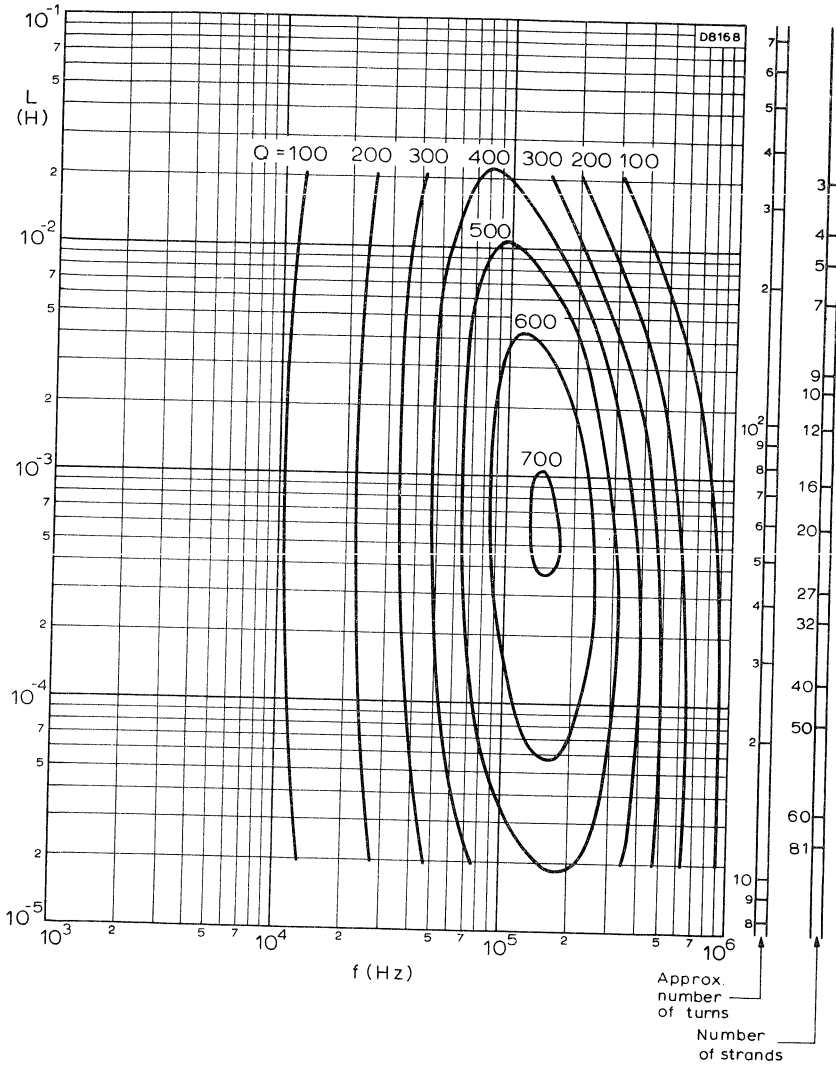
ISO - CURVES

These curves show typical Q-factors obtainable with full windings of 0,040 mm diameter bunched  
 → conductors on coil formers 4322 021 32280/32290. FXC grade 3H1,  $A_L = 100$ .



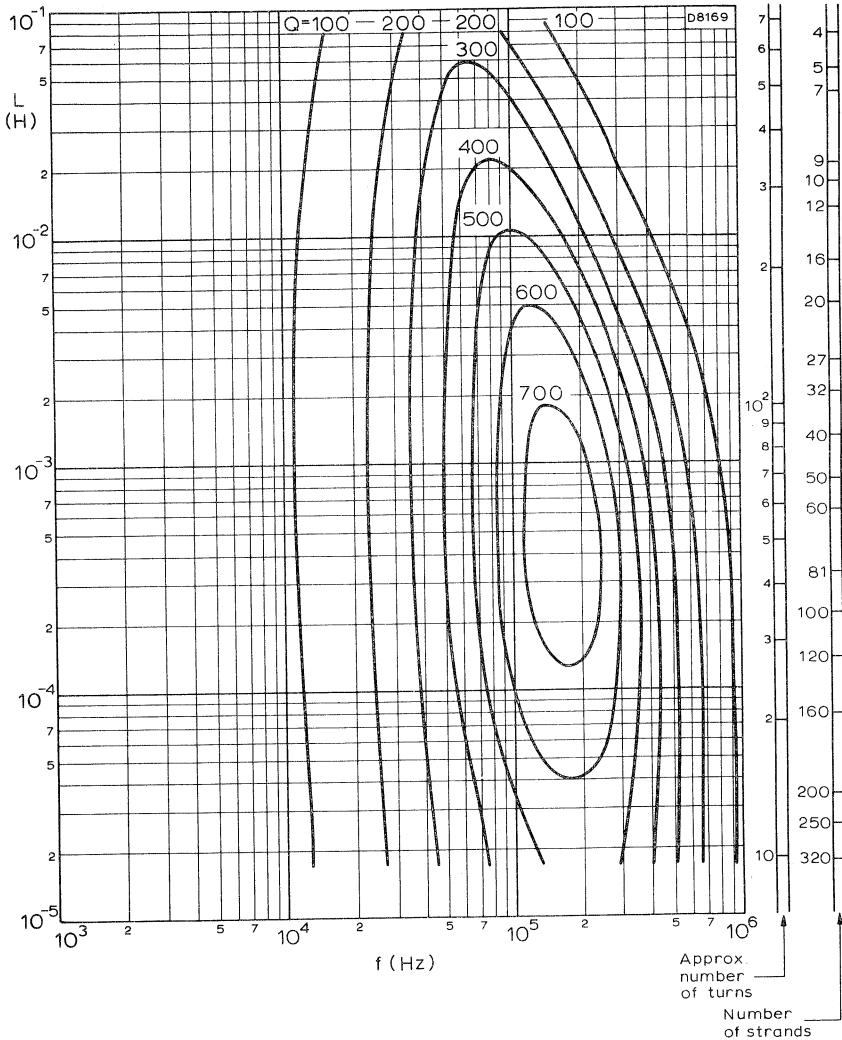
ISO - Q CURVES

These curves show typical Q-factors obtainable with full windings of enamelled copper wire on coil formers 4322 021 32280/32290. Material grade FXC 3H1,  $A_L = 160$ .



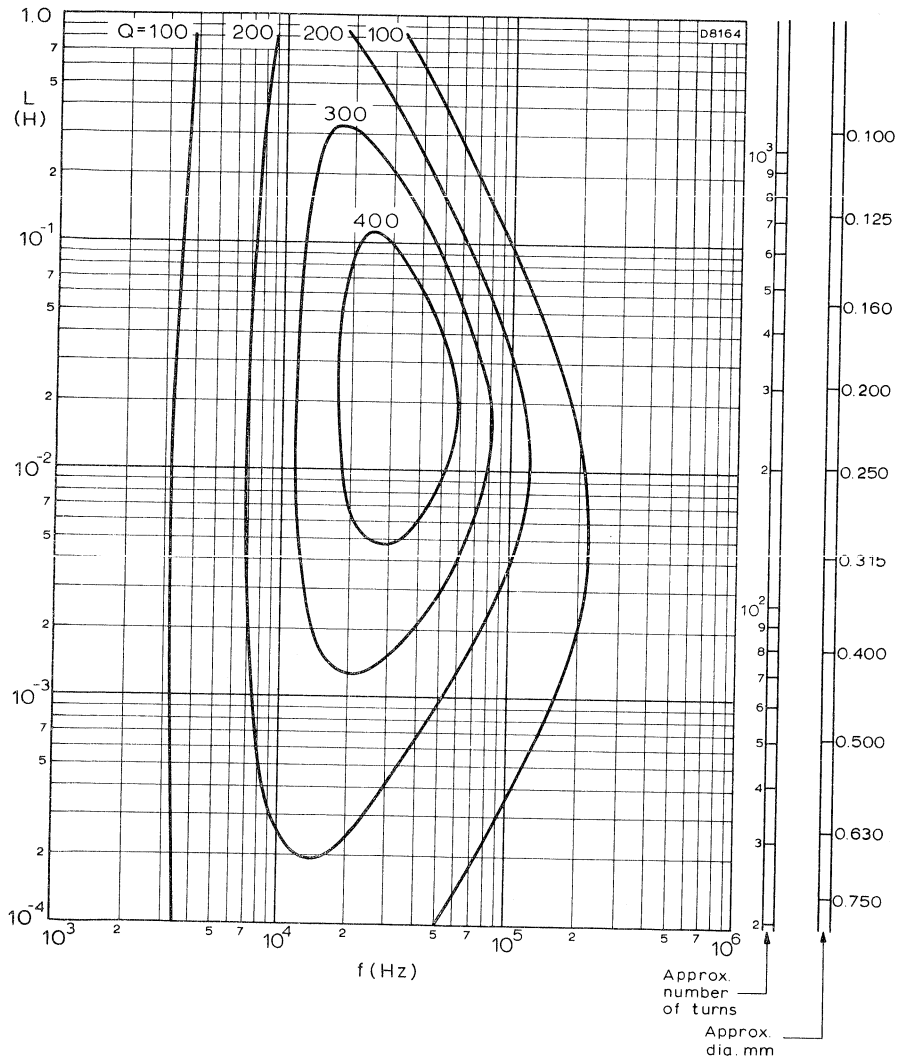
ISO - CURVES

These curves show typical Q-factors obtainable with full windings of 0,071 mm diameter bunched  
 → conductors on coil formers 4322 021 32280/32290. FXC grade 3H1,  $A_L = 160$ .



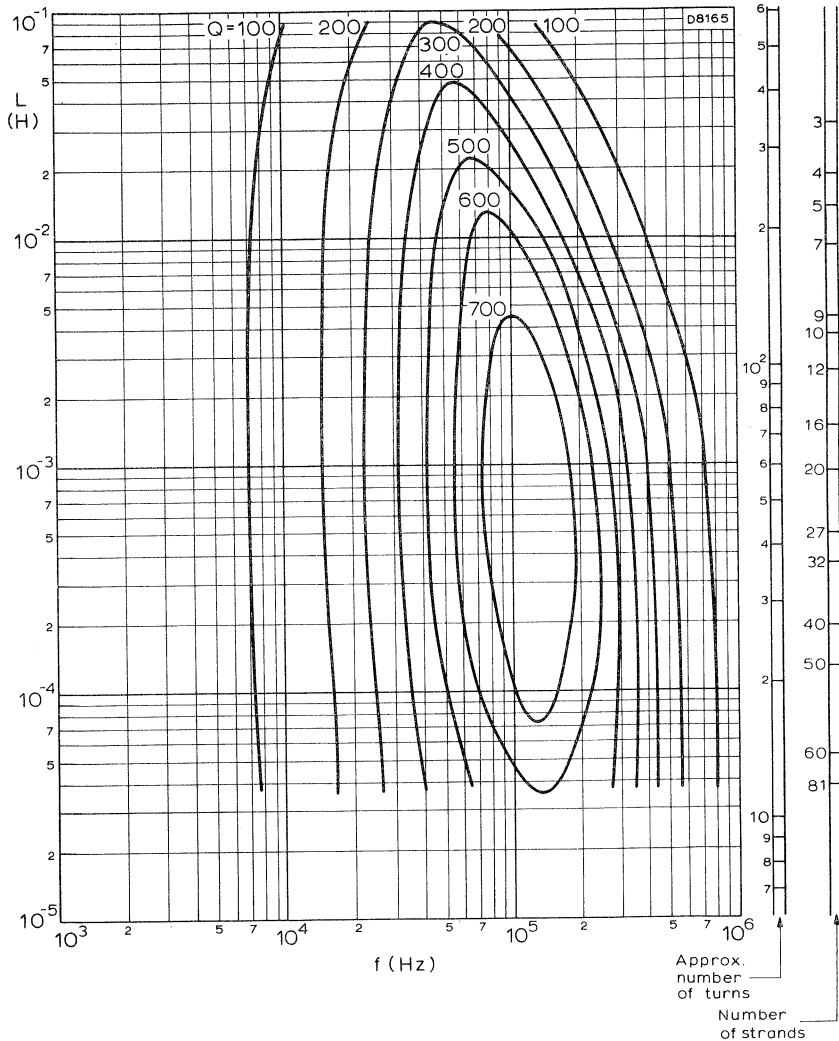
ISO - CURVES

These curves show typical Q-factors obtainable with full windings of 0,040 mm diameter bunched conductors on coil formers 4322 021 32280/32290. FXC grade 3H1,  $A_L = 160$ .



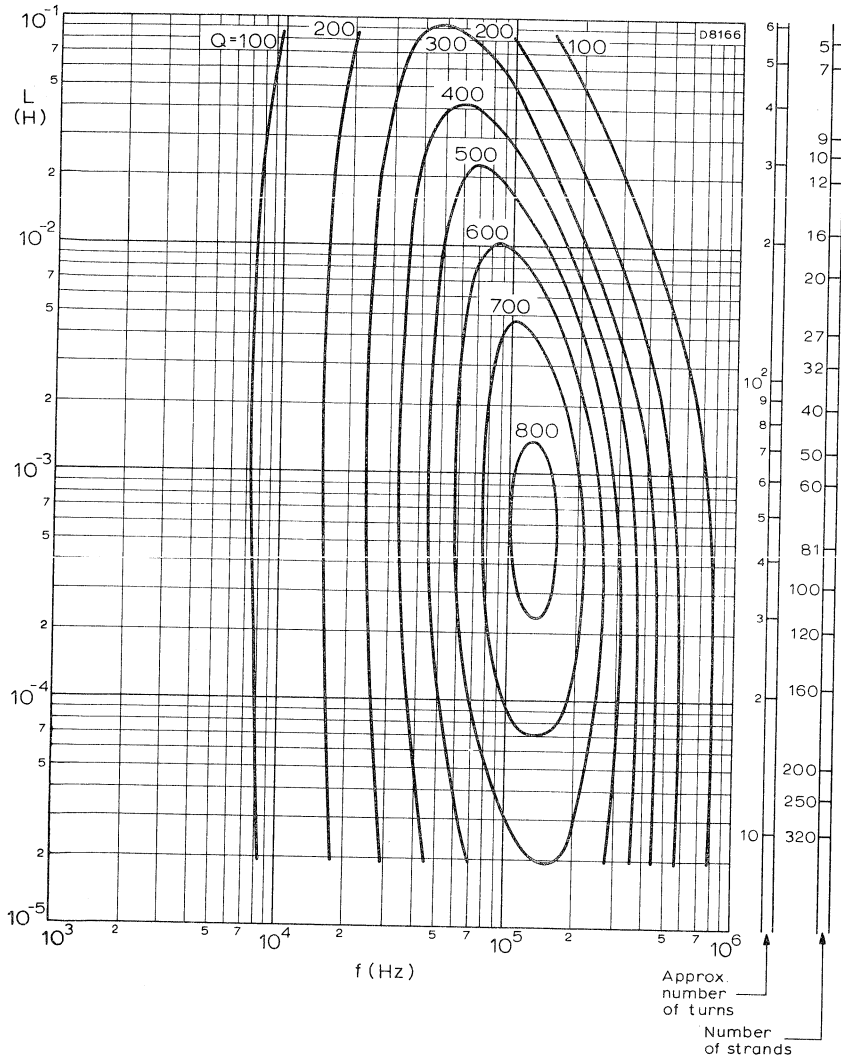
ISO - Q CURVES

These curves show typical Q-factors obtainable with full windings of enamelled copper wire on coil  
 → formers 4322 021 32280/32290. Material grade FXC 3H1,  $A_L = 250$ .



ISO - CURVES

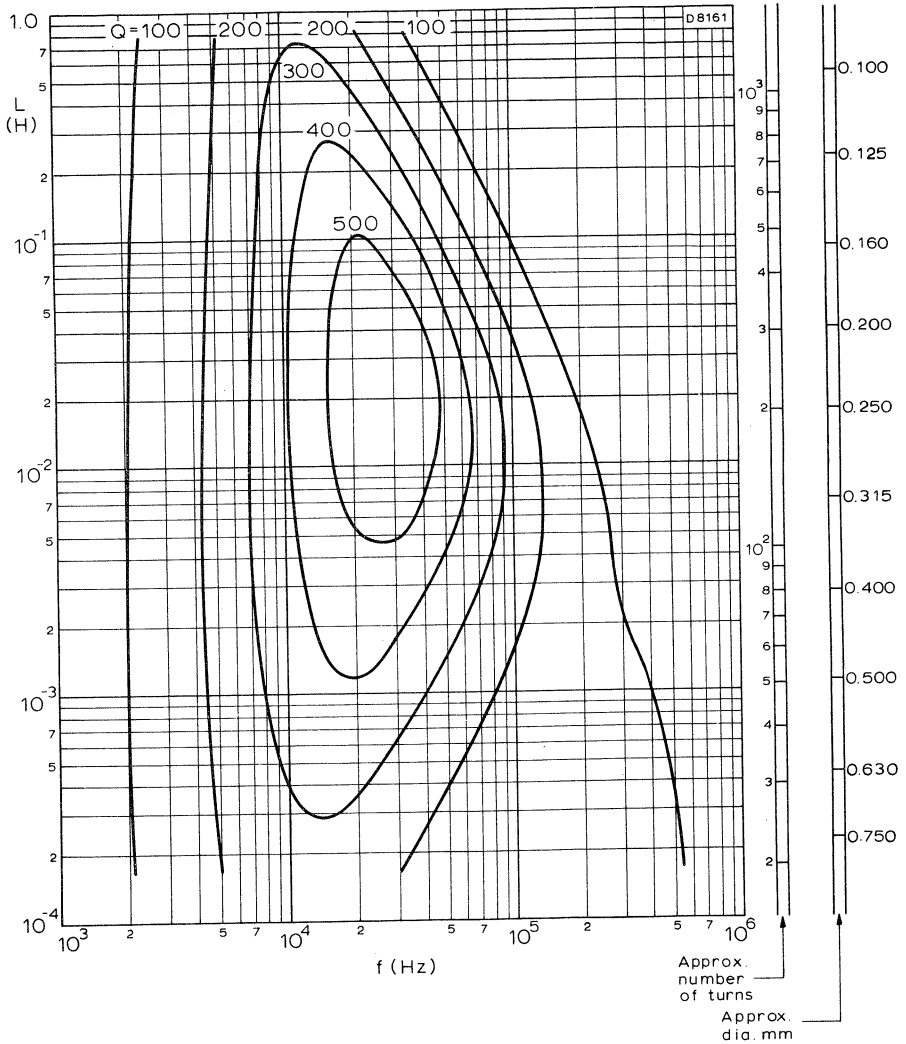
These curves show typical Q-factors obtainable with full windings of 0,071 mm diameter bunched conductors on coil formers 4322 021 32280/32290. FXC grade 3H1,  $A_L = 250$ .



ISO - CURVES

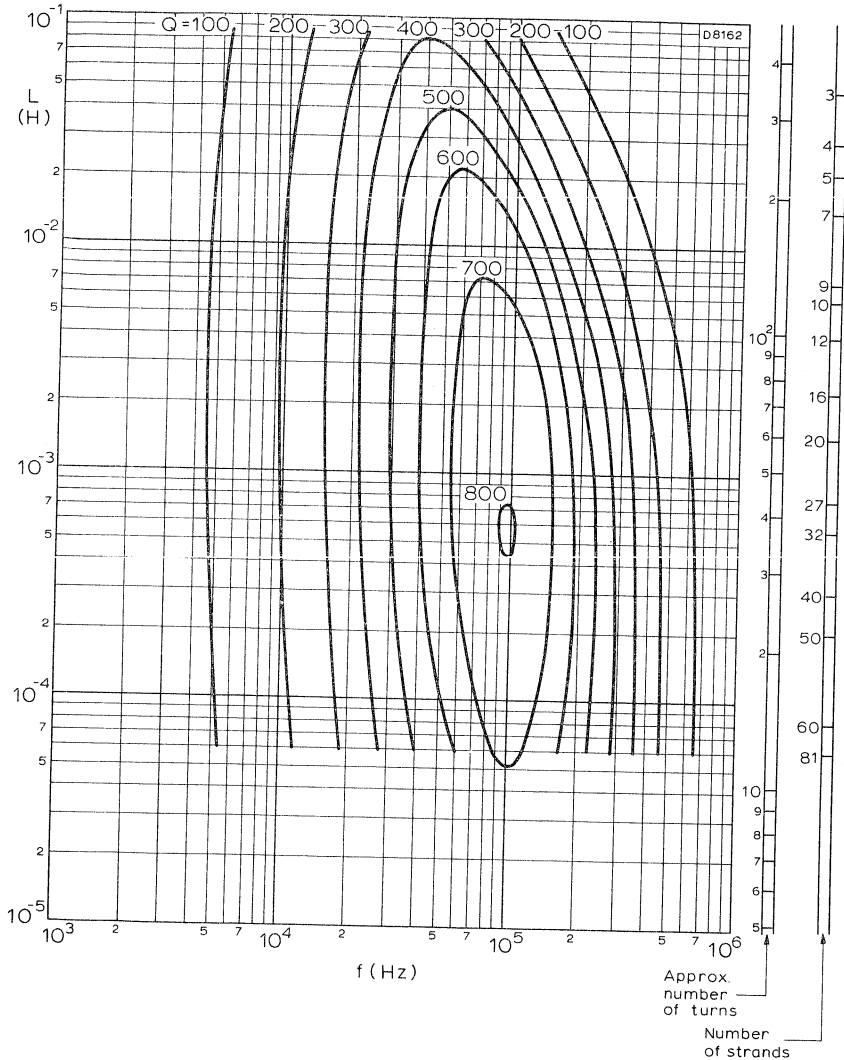
These curves show typical Q-factors obtainable with full windings of 0,040 mm diameter bunched  
 → conductors on coil formers 4322 021 32280/32290. FXC grade 3H1,  $A_L = 250$ .





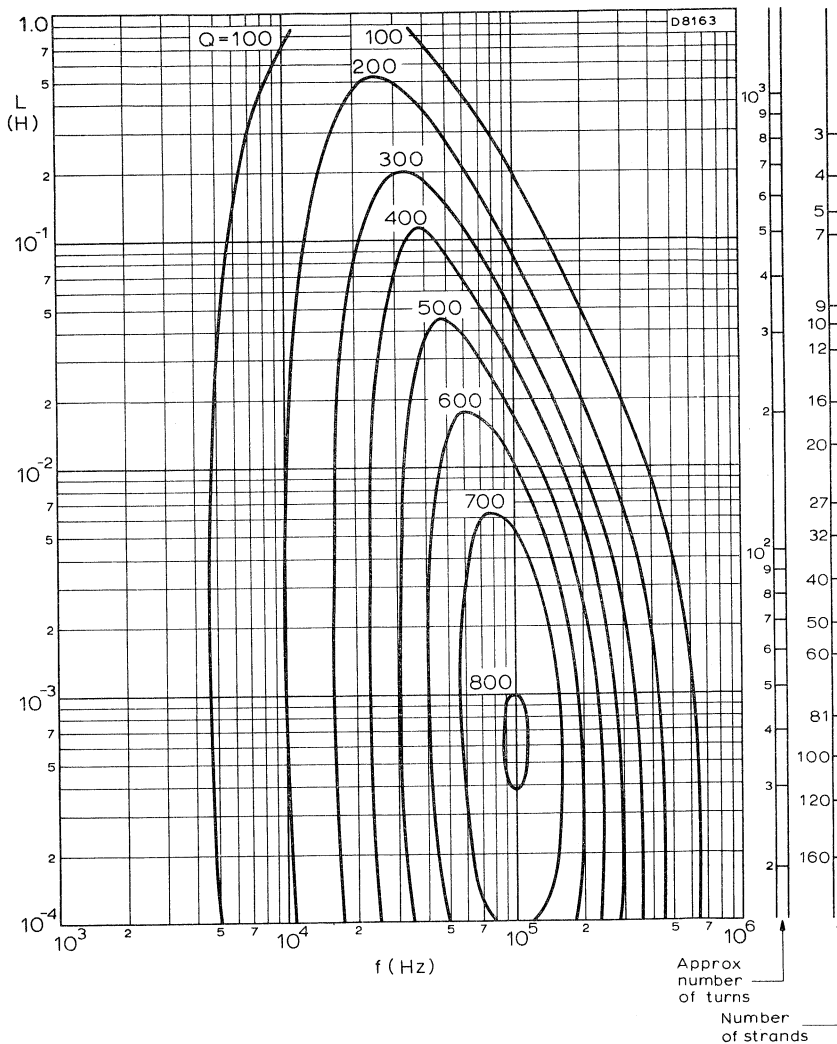
ISO - Q CURVES

These curves show typical Q-factors obtainable with full windings of enamelled copper wire on coil formers 4322 021 32280/32290. Material grade FXC 3H1,  $A_L = 400$ .



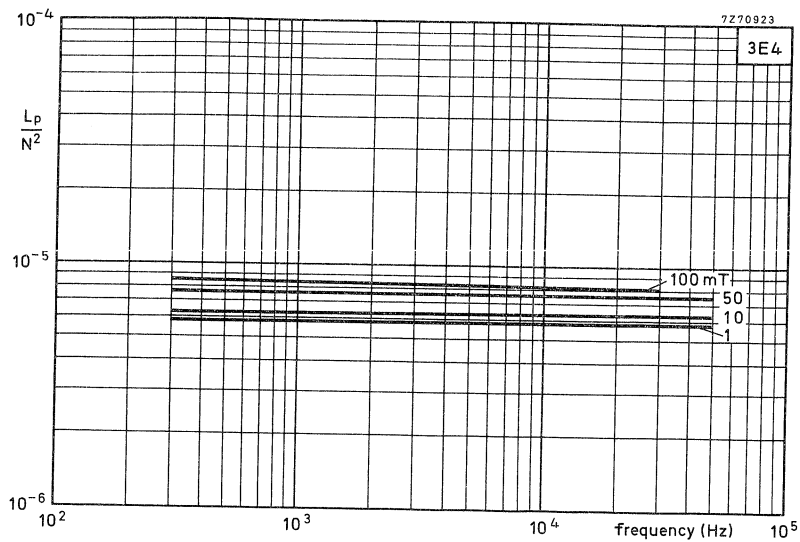
ISO - CURVES

These curves show typical Q-factors obtainable with full windings of 0,071 mm diameter bunched conductors on coil formers 4322 021 32280/32290. FXC grade 3H1,  $A_L = 400$ .

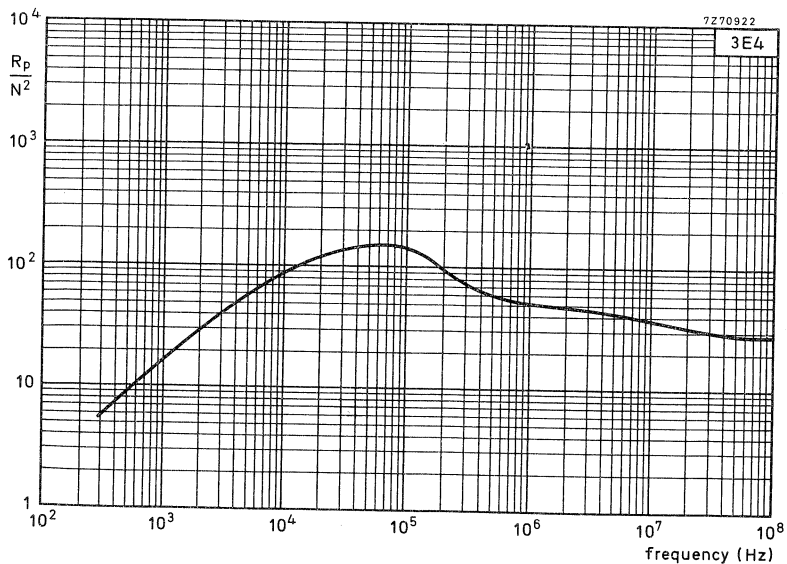


ISO - CURVES

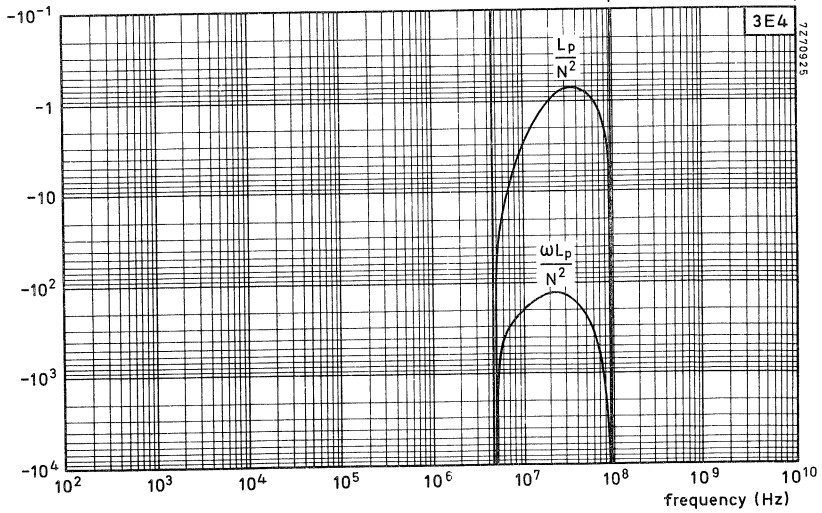
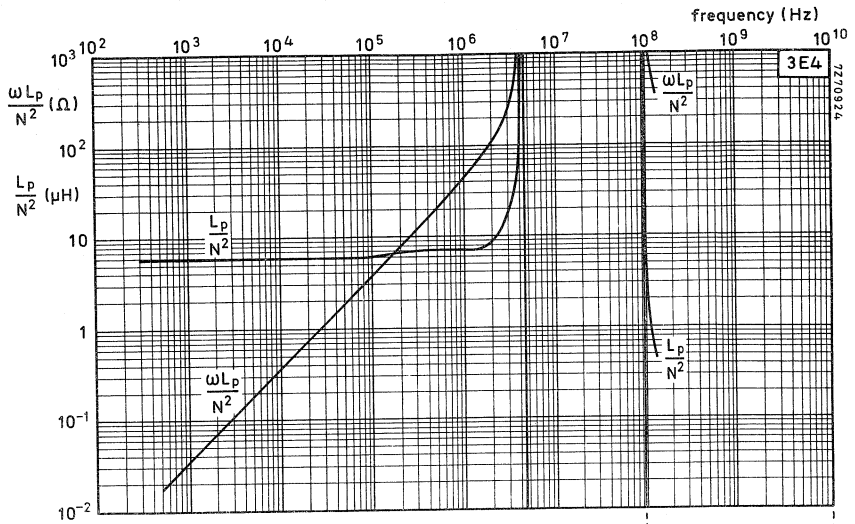
These curves show typical Q-factors obtainable with full windings of 0,040 mm diameter bunched conductors on coil formers 4322 021 32280/32290. FXC grade 3H1,  $A_L = 400$ .



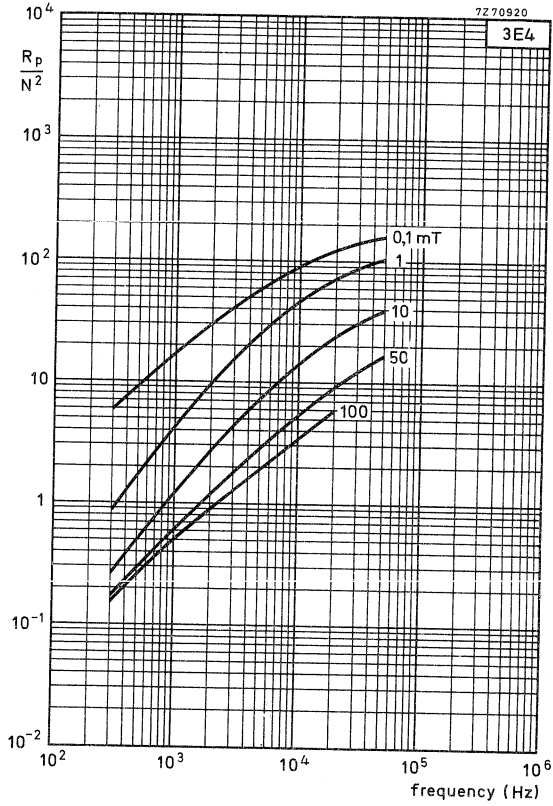
Inductance as a function of the frequency (typical values).



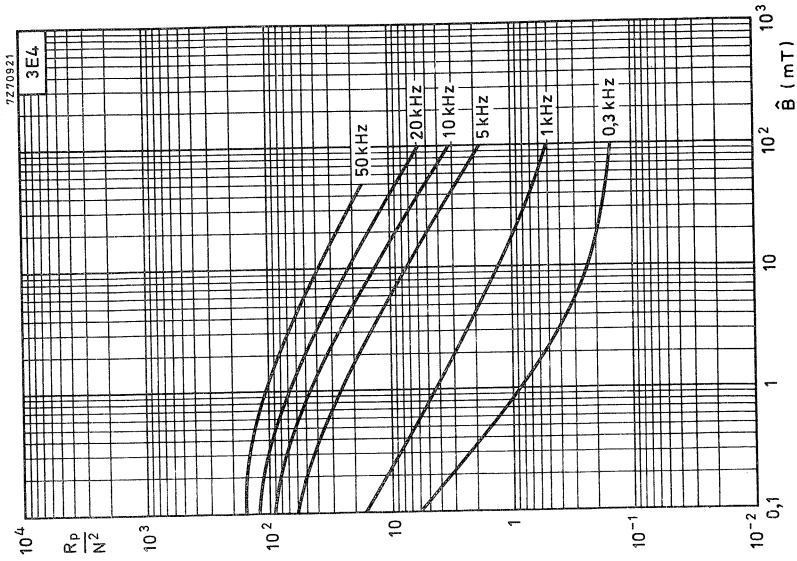
Losses as a function of the frequency at  $\hat{B} \approx 0,1$  mT (typical values).



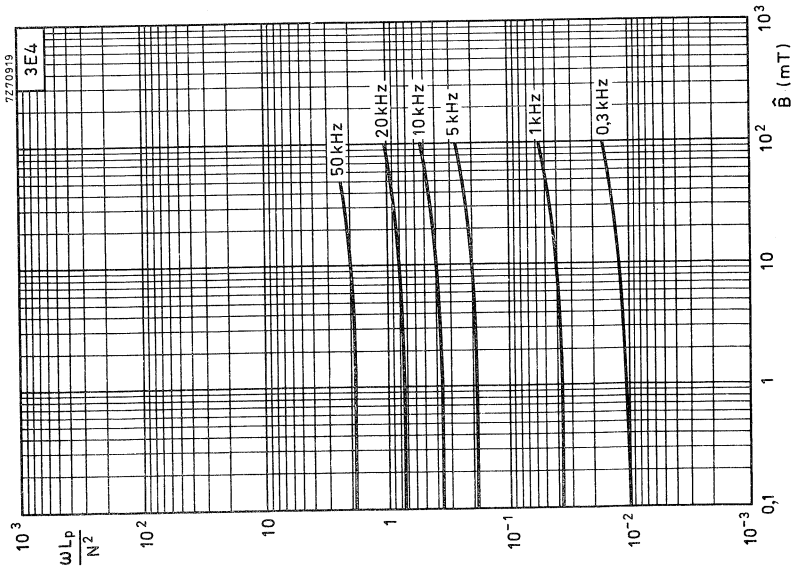
Inductance as a function of the frequency (typical values).



Losses as a function of the frequency (typical values).

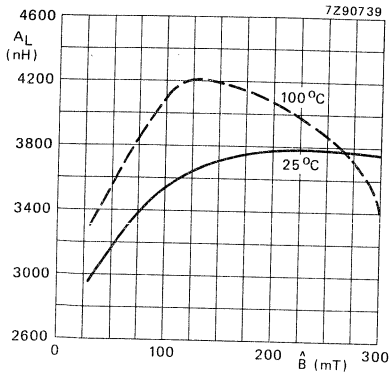


Losses as a function of the peak induction.

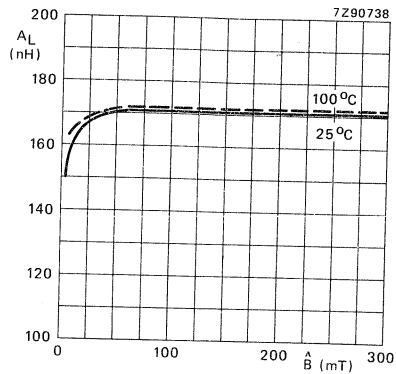


Inductance as a function of the peak induction (typical values).

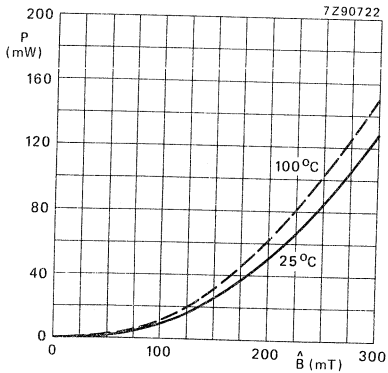
FXC 3B8



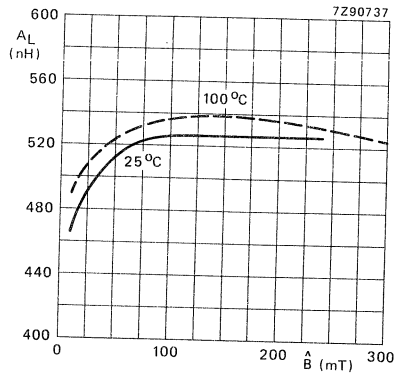
$A_L = f(\hat{B})$  at 16 kHz, and at 25 and 100 °C. No air gap.



$A_L = f(\hat{B})$  at 16 kHz, and at 25 and 100 °C, for  $\mu_e = 100$



$P = f(\hat{B})$  at 16 kHz, and at 25 and 100 °C. No air gap.

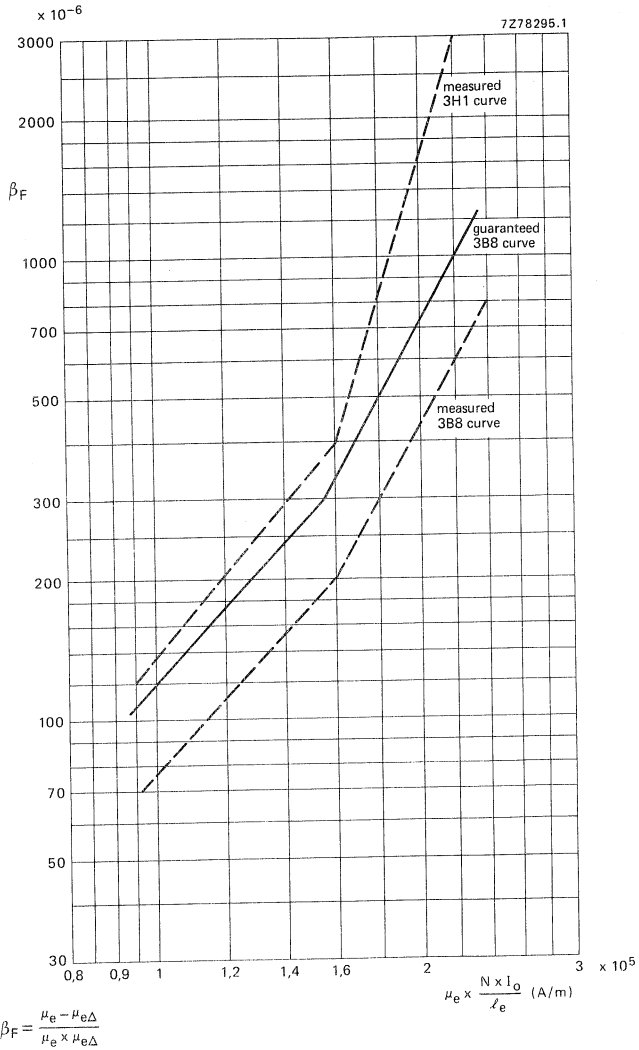


$A_L = f(\hat{B})$  at 16 kHz, and at 25 and 100 °C, for  $\mu_e = 300$ .

$\hat{B}$  is calculated with  $A_{CPmin} = 18,1 \text{ mm}^2$ .



D.C. SENSITIVITY AT 25 °C

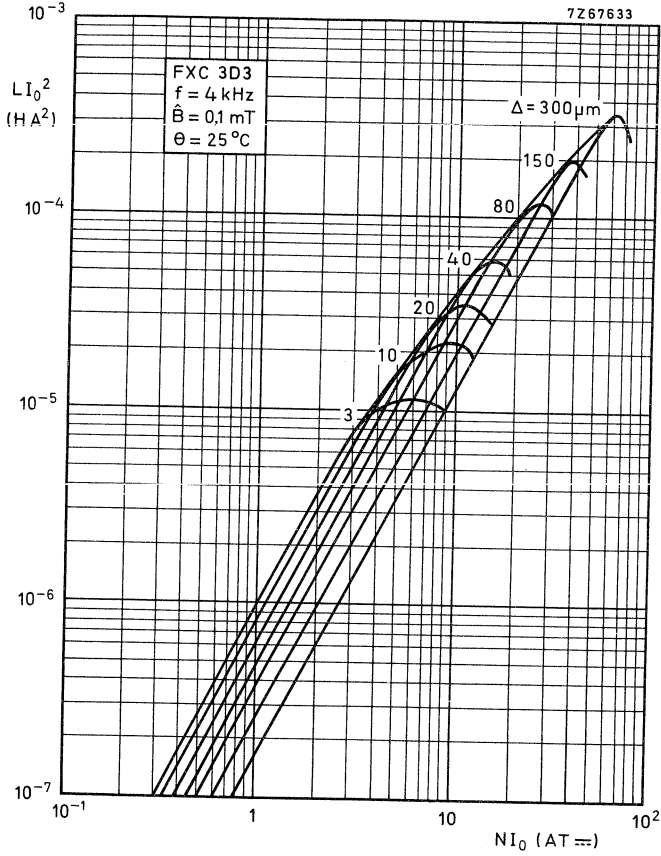


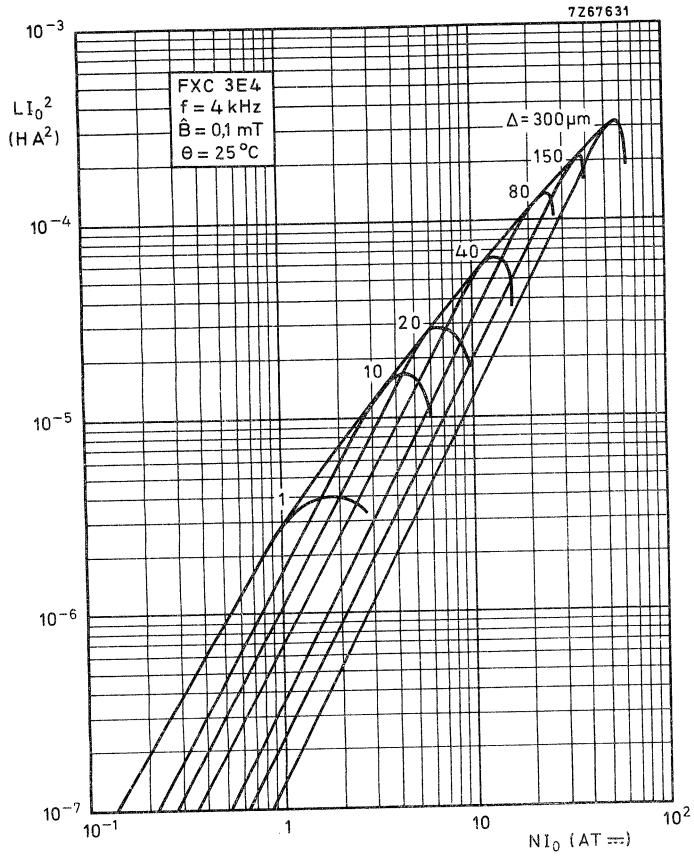
Inductance variation as a function of d.c. polarization.

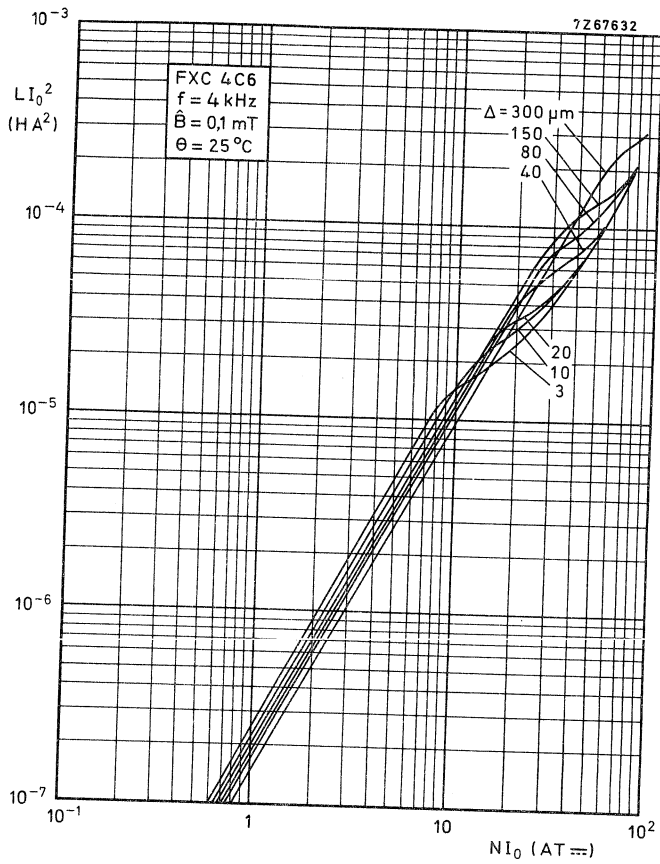
HANNA CURVES

For different material grades.

Indicating optimum inductance for a certain air gap and direct current.







CROSSTALK ATTENUATION

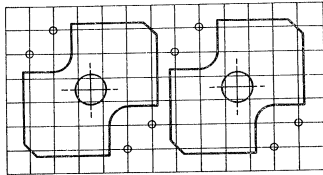
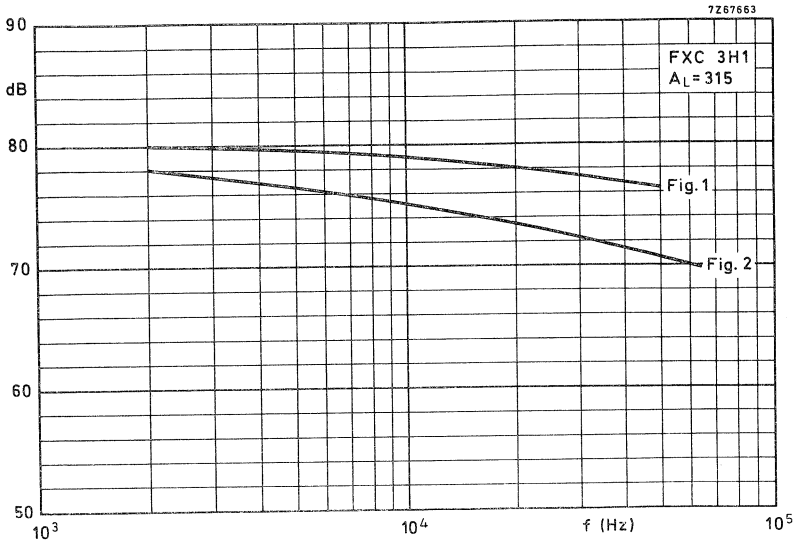


Fig. 1

7Z67659

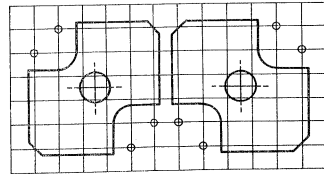


Fig. 2

7Z67660



## SQUARE CORES

Three types of core can be supplied:

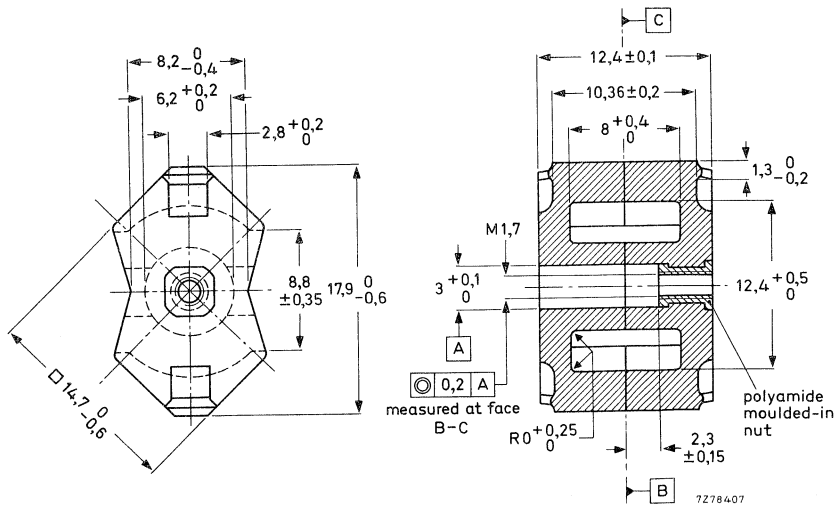
- CORE SETS provided with a nut for an adjuster and pre-adjusted on an inductance factor  $A_L$
- CORE SETS without nut and pre-adjusted on an  $A_L$  value.
- CORE HALVES without air gap.

The square cores are in accordance with the following specifications: IEC 431(international), UTE 83-300 (France), DIN 41980 (Germany).

Square cores and associated parts are ordered by their 12-digit catalogue number. Quantity: a primary pack contains 20 core sets or 40 core halves; a storage pack contains 100 core sets or 200 core halves. Please order in multiples of these quantities.

### MECHANICAL DATA

Dimensions in mm



Note: 4C6 cores have a cemented nut.

Pulling-out force of the nut	≥ 30 N (at ambient temperature)
Torqu of the screw thread	≤ 8 mNm
Extraction force of adjuster from nut	≥ 20 N

**MECHANICAL DATA** (continued)

Dimensional quantities according to IEC 205:

a. Version with centre hole:

$$C_1 = \Sigma \frac{l}{A} = 0,863 \text{ mm}^{-1}; C_2 = \Sigma \frac{l}{A^2} = 0,078 \text{ mm}^{-3}; V_e = 840 \text{ mm}^3; l_e = 27,3 \text{ mm}; A_e = 31,0 \text{ mm}^2;$$

$$\rightarrow A_{CP \text{ min}} = 23,9 \text{ mm}^2.$$

Mass of a core set: 4,5 g.

b. Version without centre hole:

$$C_1 = \Sigma \frac{l}{A} = 0,784 \text{ mm}^{-1}; C_2 = \Sigma \frac{l}{A^2} = 0,0210 \text{ mm}^{-3}; V_e = 1090 \text{ mm}^3; l_e = 29,2 \text{ mm}; A_e = 37,0 \text{ mm}^2;$$

$$\rightarrow A_{CP \text{ min}} = 31,2 \text{ mm}^2.$$

Mass of a core set: 4,7 g.



**ELECTRICAL DATA**

The combination of two square core halves without air gap, randomly chosen from a batch, has the following guaranteed properties. A measuring coil as described in the General section 'Potcores, square cores and cross cores', is inserted; the halves are pressed together with a force of 50 N. The values are valid 5 minutes or more after clamping.

	freq. kHz	$\hat{B}$ mT	temp. °C	grade					
				3B8	3D3	3E4	3H1	3H3	4C6
$A_L \pm 25\%$	100	$\leq 0,1$	$25 \pm 1$	2730			2480	2250	182
$\mu_e \pm 25\%$	100	$\leq 0,1$	$25 \pm 1$	1710			1710	1545	125
$\alpha$	100	$\leq 0,1$	$25 \pm 1$	$\leq 22,1$			$\leq 23,2$	$\leq 24,3$	$\leq 85,5$
$\frac{\tan \delta}{\mu_i} \times 10^6$	4	$\leq 0,1$	$25 \pm 1$			$\leq 2,5$			
	30	$\leq 0,1$	$25 \pm 1$				$\leq 2,5$	$\leq 1,8$	
	100	$\leq 0,1$	$25 \pm 1$		$\leq 3,5$	$\leq 20$	$\leq 5,0$	$\leq 2,6$	
	500	$\leq 0,1$	$25 \pm 1$		$\leq 6,5$	$\leq 200$			
	700	$\leq 0,1$	$25 \pm 1$		$\leq 11$				
	1000	$\leq 0,1$	$25 \pm 1$		$\leq 35$				
	2000	$\leq 0,1$	$25 \pm 1$						$\leq 40$
	10 000	$\leq 0,1$	$25 \pm 1$						$\leq 100$
P (W)	25	200*	$25 \pm 1$	0,30					
			$100 \pm 1$	0,35					
$\eta_B \times 10^3$	4	1,5 to 3,0	$25 \pm 1$			$\leq 1,1$	$\leq 0,86$		
	30	1,5 to 3,0	$25 \pm 1$					$\leq 0,65$	
$\alpha_F \times 10^6/K$	100	0,3 to 1,2	$25 \pm 1$		$\leq 1,8$				$\leq 9,2$
	$\leq 100$	$\leq 0,1$	5 to 25		$+1 \pm 0,5$	0 to +2	$+0,5$ to 1,5	$+0,7 \pm 0,3$	-2 to +4
	$\leq 100$	$\leq 0,1$	25 to 55		$+1 \pm 0,5$	0 to +2	$+0,5$ to 1,5	$+0,7 \pm 0,3$	0 to +6
$D_F \times 10^6$ (10-100 min)	$\leq 100$	$\leq 0,1$	25 to 70		$+1 \pm 0,5$	0 to +2	$+0,5$ to 1,5	$+0,7 \pm 0,3$	
	$\leq 100$	$\leq 0,1$	$25 \pm 0,1$		$\leq 8$	$\leq 4,3$	$\leq 4,3$	$\leq 3,0^{**}$	$\leq 10$
$\beta_F \times 10^6$ measured on sets with $\mu_e = 300 \pm 10\%$ at $25 \pm 1$ °C:									
at $\mu_e \times \frac{N \times I_0}{l_e} = 1,00 \times 10^5$ A/m				$\leq 115$					
				$\leq 300$					
				$\leq 1050$					

\*  $\hat{B}$  is calculated with  $A_{CPmin} = 31,2$  mm<sup>2</sup>.

\*\* This value is valid within the temperature range of 25 to 70 °C.

Core sets with nut and pre-adjusted on  $A_L$ .

$A_L$	corresponding $\mu_e$ -value	tol. on inductance %	catalogue number 4322 022 . . . . .					
			3B8	3D3	3E4	3H1	3H3	4C6
16	11,0	± 1						
25	17,1	± 1						67790
40	27,4	± 1						67810
63	43,1	± 1		● 67420				● 67820
100	68,7	± 2	● 47740*	67430				● 67830
160	110	± 2		● 67440				
200	137	± 2		67450				
250	171	± 2				● 67250		
315	216	± 2				● 67350	● 67680	
400	274	± 2				● 67260**	● 67560	
630	431	± 3				67270	67570	
1000	687	± 10				67280	67580	
1250	856	± 10				67300	67600	
6050	3800	± 25				67310		
						67390		
					● 47920*			

Inductance  $L = N^2 A_L$  (in  $10^{-9} H$ )

Core sets without nut: replace the eighth digit of the catalogue number (6) by 4.

Cores with  $A_L \leq 100$ , have a symmetrical air gap.

Cores with  $A_L \geq 160$  and the 3B8 core, have an asymmetrical air gap.

Core halves without air gap, without nut.

Ferroxcube grade	catalogue number
3B8	4322 020 27930*
3D3	4322 020 25060
3H1	4322 020 25020
3H3	4322 020 25200
4C6	4322 020 25080

\* These types have no centre hole.

\*\* Approved according to CECC 25 100-019.

● Preferred types.

## COIL FORMERS

### GENERAL

Four types of coil former can be supplied:

- with 1 section and 4 pins
- with 2 sections and 4 pins
- with 1 section and 6 pins
- with 2 sections and 6 pins

The arrangement of the soldering pins is suitable for both 0,1 inch and 2,50 mm grids, see "Mounting". The coil formers are supplied in packs of 100 on a polystyrene plate, and in cardboard boxes containing 5 such plates (500 pieces). Please order in multiples of these quantities.

### SINGLE-SECTION, 4-PIN COIL FORMER

Catalogue number	4312 021 29240
Material	phenolformaldehyde reinforced with glass fibre
Window area	16,2 mm <sup>2</sup>
Mean length of turn	30 mm
Max. temperature	180 °C
Inflammability	UL94, class V-0

D.C. losses

$$\frac{R_o}{L} = \frac{1}{\mu_e} \times \frac{1}{f_{cu}} \times 22,6 \times 10^3 \Omega/H$$

Solderability: resistance against  
dip-soldering at 400 °C for 2 s

Mass 0,4 g

### TWO-SECTION, 4-PIN COIL FORMER

Catalogue number	4322 021 32940
Material	phenolformaldehyde reinforced with glass fibre
Window area	2 x 7,7 mm <sup>2</sup>
Mean length of turn	30 mm
Max. temperature	180 °C
→ Inflammability	UL94, class V-0

D.C. losses

$$\frac{R_o}{L} = \frac{1}{\mu_e} \times \frac{1}{f_{cu}} \times 23,6 \times 10^3 \Omega/H$$

Solderability: resistant against  
dip-soldering at 400 °C for 2 s

Mass 0,4 g

**SINGLE-SECTION, 6-PIN COIL FORMER**

Catalogue number 4312 021 29250  
 Material phenolformaldehyde reinforced with glass fibre  
 Window area 16,2 mm<sup>2</sup>  
 Mean length of turn 30 mm  
 Max. temperature 180 °C  
 → Inflammability UL94, class V-0

D.C. losses

$$\frac{R_o}{L} = \frac{1}{\mu_e} \times \frac{1}{f_{cu}} \times 22,6 \times 10^3 \Omega/H$$

Solderability: resistant against dip-soldering at 400 °C for 2 s

Mass 0,4 g

**TWO-SECTION, 6-PIN COIL FORMER**

Catalogue number 4322 021 32950  
 Material phenolformaldehyde reinforced with glass fibre  
 Window area 2 x 7,7 mm<sup>2</sup>  
 Mean length of turn 30 mm  
 Max. temperature 180 °C  
 Inflammability UL94, class V-0

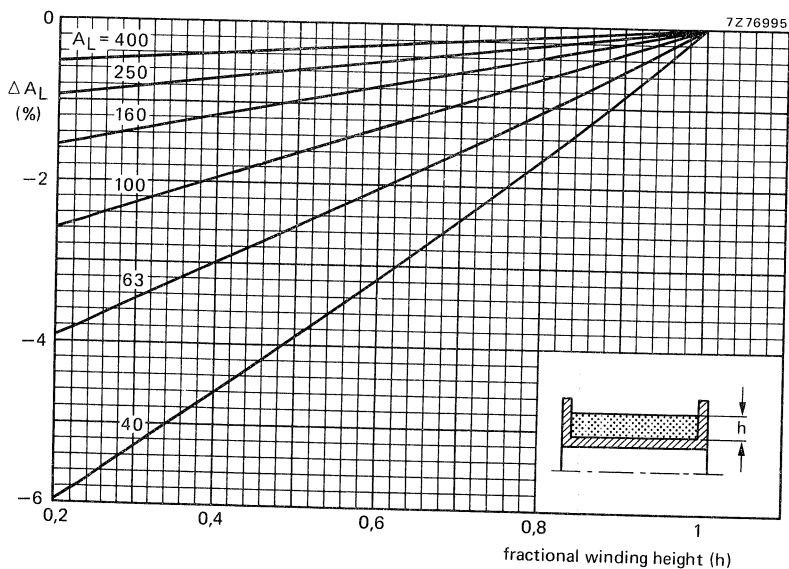
D.C. losses

$$\frac{R_o}{L} = \frac{1}{\mu_e} \times \frac{1}{f_{cu}} \times 23,6 \times 10^3 \Omega/H$$

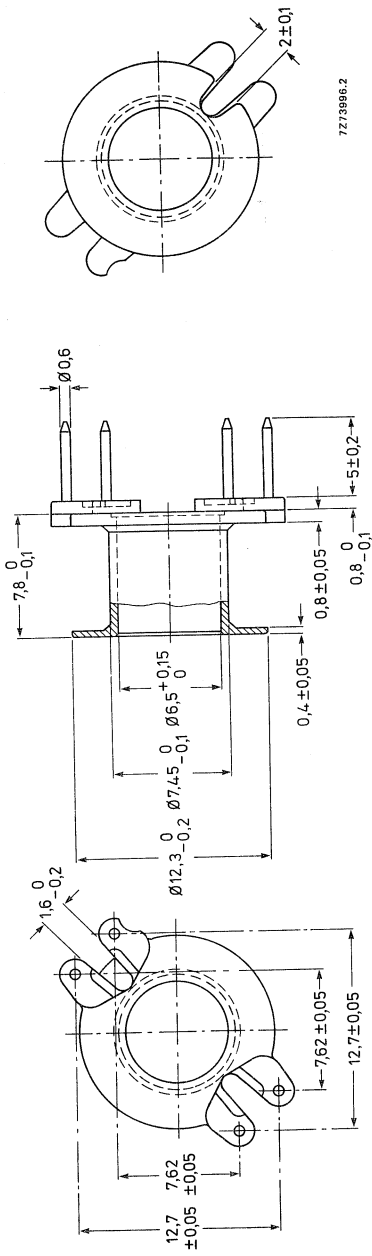
Solderability: resistant against dip-soldering at 400 °C for 2 s

Mass 0,4 g

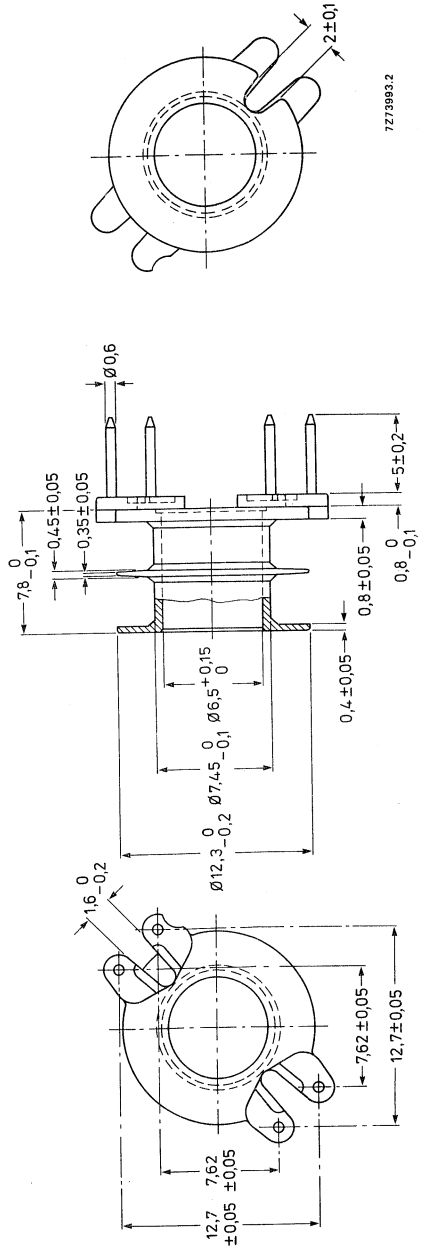
Data for when the coil former is partly filled.



DIMENSIONAL DIAGRAMS

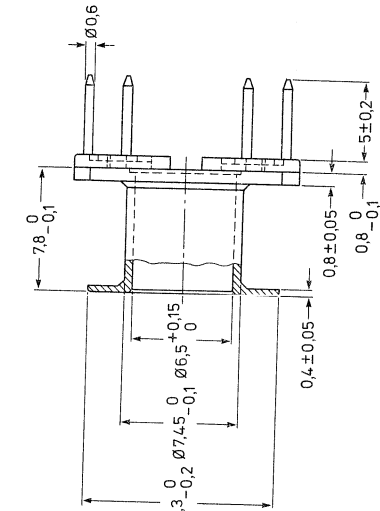
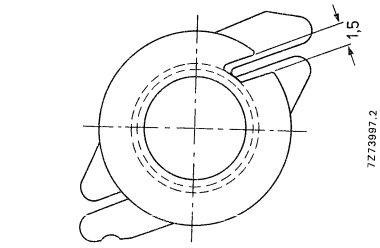


Single-section, 4-pin coil former.

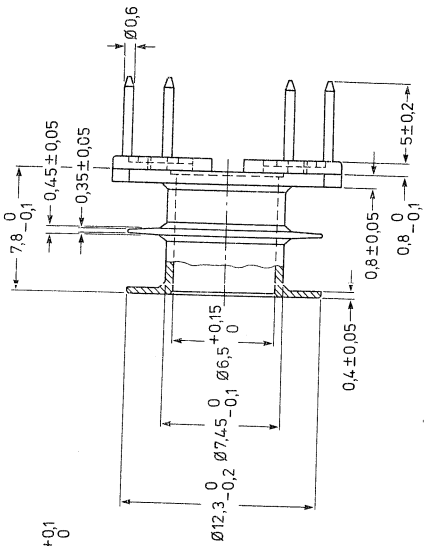
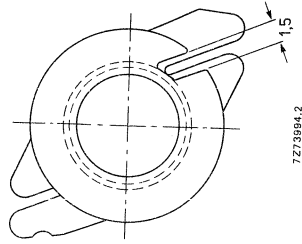


Two-section, 4-pin coil former.

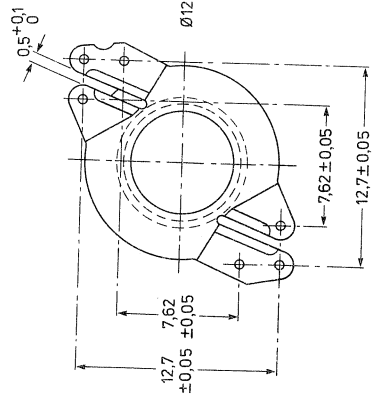
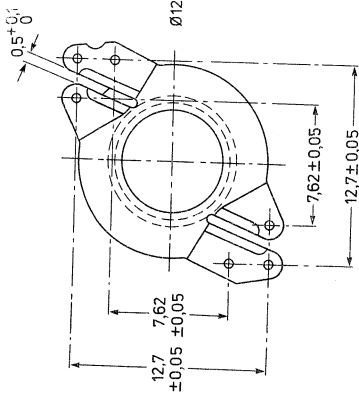
DIMENSIONAL DIAGRAMS (continued)



Single-section, 6-pin coil former.

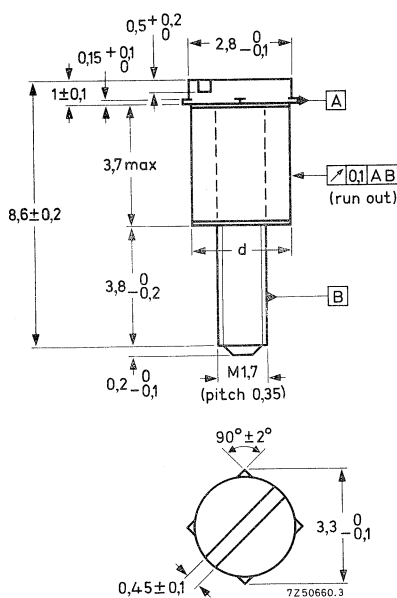


Two-section, 6-pin coil former.

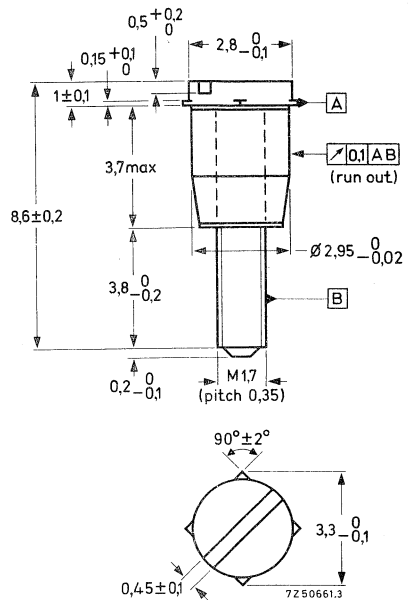


## INDUCTANCE ADJUSTERS (old types)

### ADJUSTERS



Version A, tube dia. 2,5 mm  
Version B, tube dia. 2,7 mm  
Version C, tube dia. 2,77 mm



Version D

The tolerances on inductance of the pre-adjusted cores (without adjuster) are given in the table of pre-adjusted cores with standard  $A_L$  values. After inserting a coil (impregnated or not) in an electrical circuit, its inductance can be adjusted to the required value with an accuracy  $< 0,03\%$  by means of a continuous inductance adjuster. Such an adjuster increases the inductance of the coil (see following pages).

The adjuster is screwed through the centre hole of the core into the nut and is held in position by the four protrusions near the top of the adjuster. For special requirements a larger or smaller adjustment range may be obtained by using an adjuster belonging to the next higher or lower  $A_L$  value.

The influence of the adjuster on the variability of the inductance is negligible. The maximum permissible temperature is 110 °C.

The table shows the type of adjuster recommended for different square cores.

Table I, available types

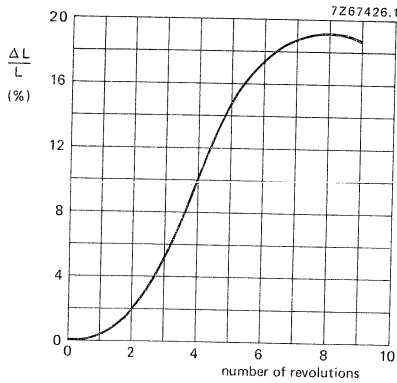
version	colour	catalogue number
A	white	4322 021 32130
B	brown	4322 021 32140
C	black	4322 021 32150
B	natural	4322 021 32160
B	red	4322 021 32170
D	grey	4322 021 32180

The adjusters are packed in bags of 100.  
Please order in multiples of 100.

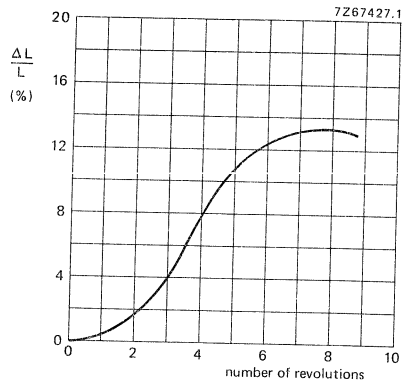
ADJUSTMENT CURVES

Table II, recommended application

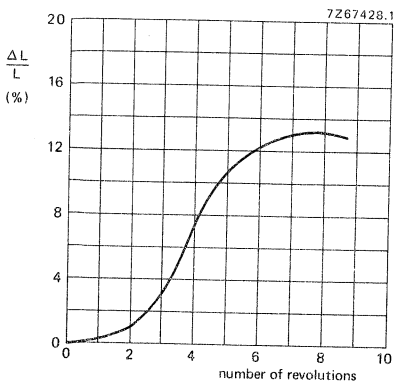
A <sub>L</sub>	3H1/3D3
	catalogue number
40	4322 021 32160
63	4322 021 32160
100	4322 021 32170
160	4322 021 32130
200	4322 021 32130
250	4322 021 32130 or 4322 021 32140
315	4322 021 32140
400	4322 021 32150
630	4322 021 32180



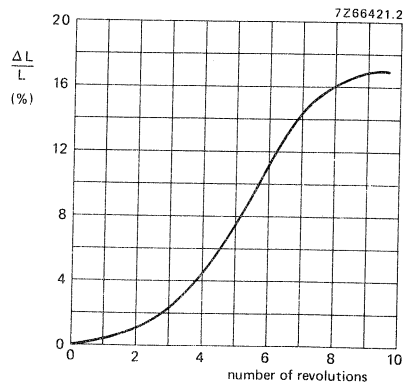
A<sub>L</sub> = 40; FXC 3D3/3H1



A<sub>L</sub> = 63; FXC 3D3/3H1

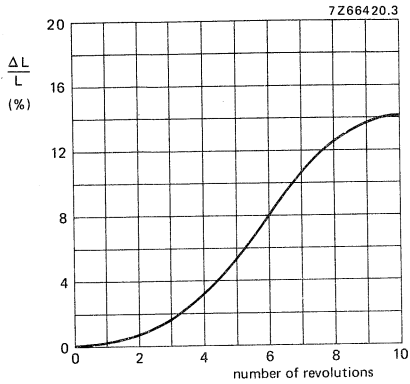


A<sub>L</sub> = 100; FXC 3D3/3H1

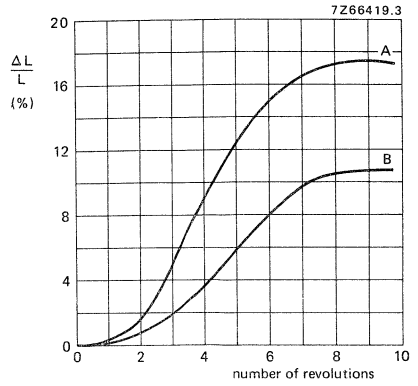


A<sub>L</sub> = 160; FXC 3D3/3H1





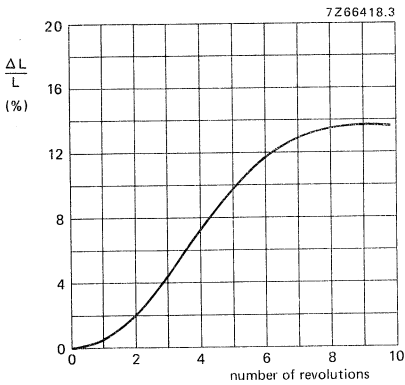
$A_L = 200$ ; FXC 3H1



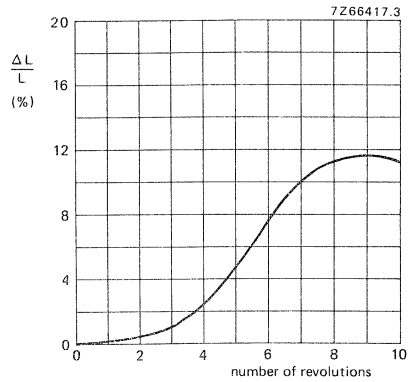
$A_L = 250$ ; FXC 3H1

Curve A: adjuster 4322 021 32140.

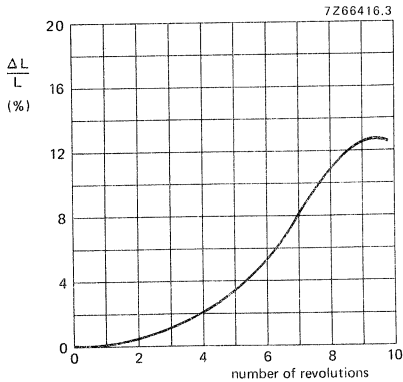
Curve B: adjuster 4322 021 32130.



$A_L = 315$ ; FXC 3H1



$A_L = 400$ ; FXC 3H1



$A_L = 630$ ; FXC 3H1



## INDUCTANCE ADJUSTERS (new types)

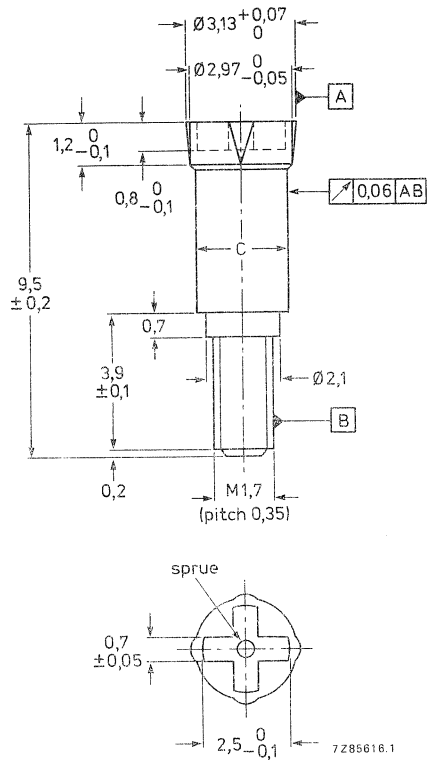


Fig. 1.

Material: polypropylene, reinforced with glass fibre.

The tolerances on inductance factor of the pre-adjusted cores without adjuster are given in the table of pre-adjusted cores with standard  $A_L$  values. The inductance of the pre-adjusted core can be increased to the required value — with a setting accuracy  $< 0,03\%$  — by means of a continuous adjuster.

The adjuster is screwed through the centre hole of the core into the nut and is held in position by the four cones near the top of the adjuster.

The combination of the polyamide moulded-in nut and the polypropylene adjuster — both reinforced with glass fibre — gives an excellent stability with temperature, shocks and vibrations. Besides this, the combination has a very smooth adjustment curve due to the excellent concentricity of the moulded-in nut and the adjuster.

The maximum permissible temperature of the adjustment combination is:  $150\text{ }^\circ\text{C}$ , during 8 h. The maximum working temperature is  $110\text{ }^\circ\text{C}$ .

The tables below show the available types and which adjuster is recommended for typical  $A_L$  values.

Table 1 Colour code of adjusters

catalogue number	colour	dia. C (Fig. 1) mm	material
4322 021 38600 38610	black	2,83	FXC
	brown	2,70	FXC
38670 38680 38690	violet	2,58	FXC
	white	2,48	FXC
	grey	2,93	FXC

Table 2 Catalogue numbers of recommended adjusters for typical  $A_L$  values

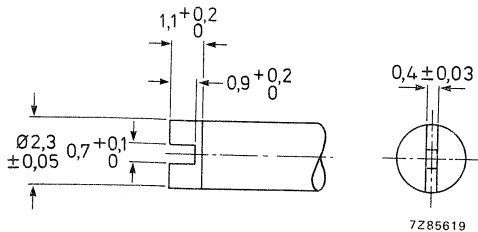
$A_L$	3H1/3H3/3B7	3D3	4C6
25			
40			
63			
100			
160			
200	4322 021 38680 38670 38610 38600 38690	4322 021 38680	
250			
315			
400			
630			

**PACKAGING**

The adjusters are packed in bags of 100. Please order in multiples.

**ADJUSTING TOOL**

An adjusting tool combination for M1,4 and M1,7 is available, catalogue number 4322 058 03260.

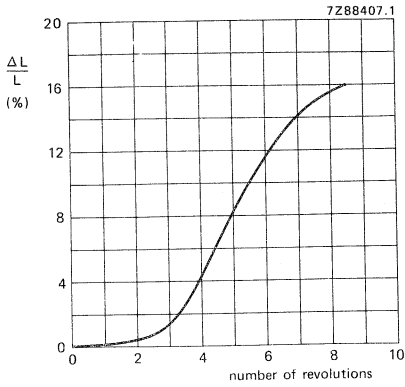


For customers who wish to make the screwdriver themselves the outlines of the essential part are given in Fig. 2.

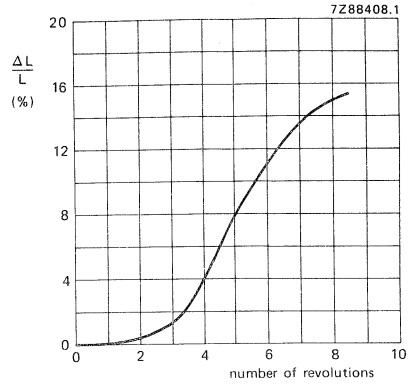
Fig. 2.

ADJUSTMENT CURVES

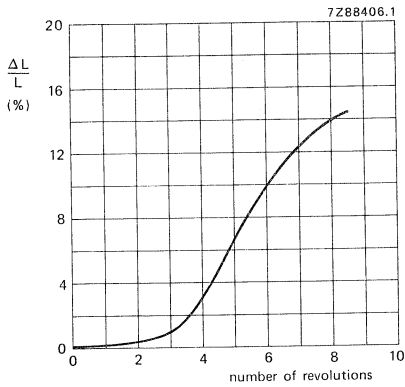
Characteristic curves



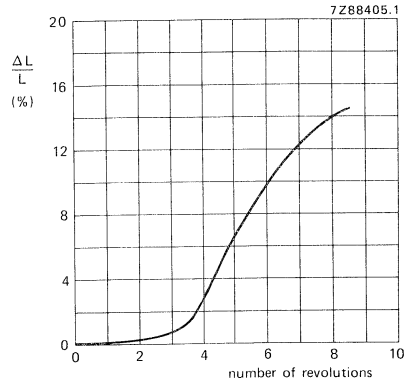
$A_L = 160$ ; FXC 3D3



$A_L = 200$ ; FXC 3H1

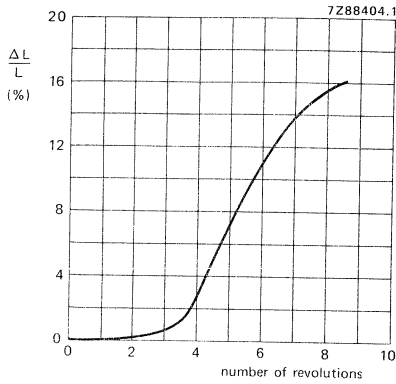


$A_L = 250$ ; FXC 3H1

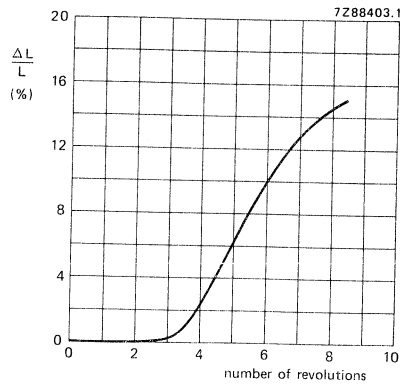


$A_L = 315$ ; FXC 3H1

Note on next page.



$A_L = 400$ ; FXC 3H1

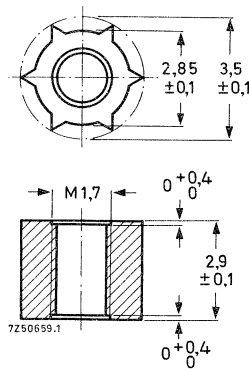


$A_L = 630$ ; FXC 3H1

Note: 0 revolutions corresponds to at least one turn of interaction.

**NUT FOR ADJUSTER**

These data are given for those manufacturers who prefer to insert the nut themselves.



Catalogue number

4322 021 30140

Material

polycarbonate

Maximum impregnation temperature during 24 hours

120 °C

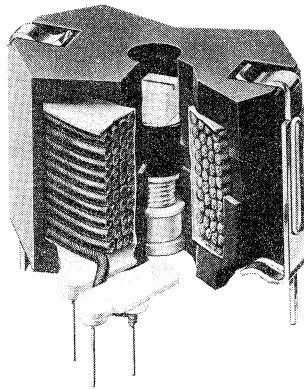
Recommended distance from mating surface to nut

$2,3 \pm 0,15$  mm

The nuts are packed in bags of 100. Please order in multiples of 100.

## ASSEMBLING AND MOUNTING

### ASSEMBLING



A52776

#### Cementing

During the cementing procedure care must be taken that the centre holes are kept in line.

#### Assembly with clips

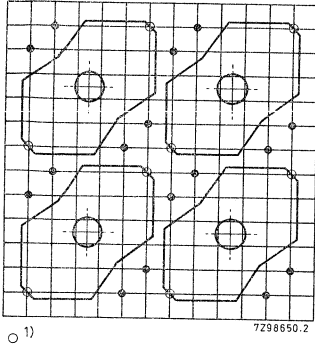
The core halves can be clamped together by using two clips. The tags of the clips are used for mechanical fastening and/or for earthing.

For a stable inductance we recommend that an adhesive be applied between the coil former and the lower core half.

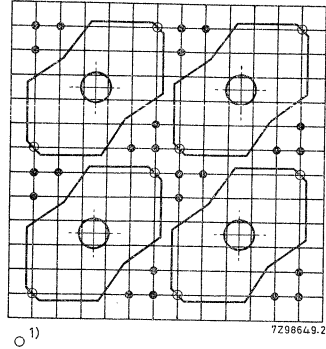
The use of a tool for attaching the clips is recommended. (Drawings of a simple tool for this purpose are available under number 4322 058 00150.)

**MOUNTING**

The soldering pins of coil formers and clips are so arranged that they will fit printed-wiring boards with a 0,1 inch grid as well as those with a 2,50 mm grid. The pin length is sufficient for a board thickness of up to 2,4 mm. The recommended hole diameter in the board is  $1,0 \pm 0,1$  (according to IEC publication 97).

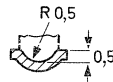


→ Hole pattern for an assembly of 4 cores, each fitted with a 5-pin coil former.

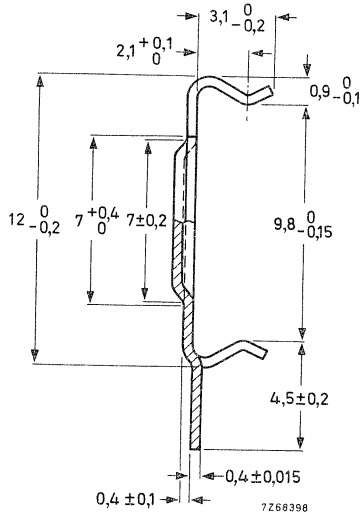
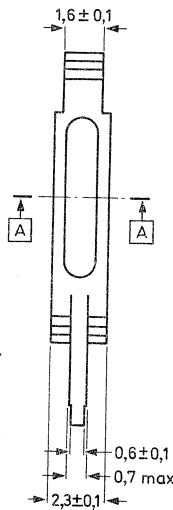


Hole pattern for an assembly of 4 cores, each fitted with an 8-pin coil former.

**PART DRAWING (dimensions in mm)**



A-A



Clip 4322 021 31780

Material: steel; silver plated over nickel, then passivated

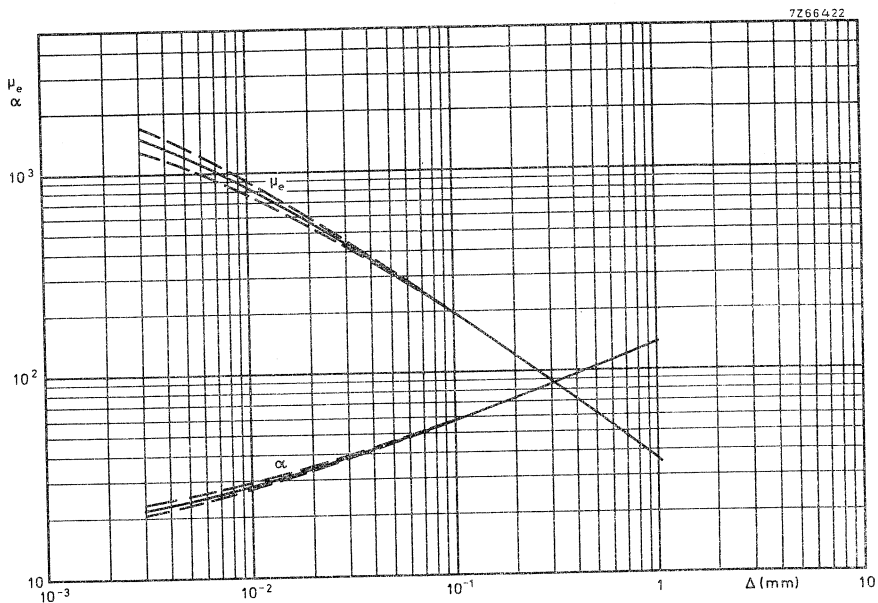
→ Packaging quantity: 5000

1) Holes for tag on clip 4322 021 31780 (earth points).



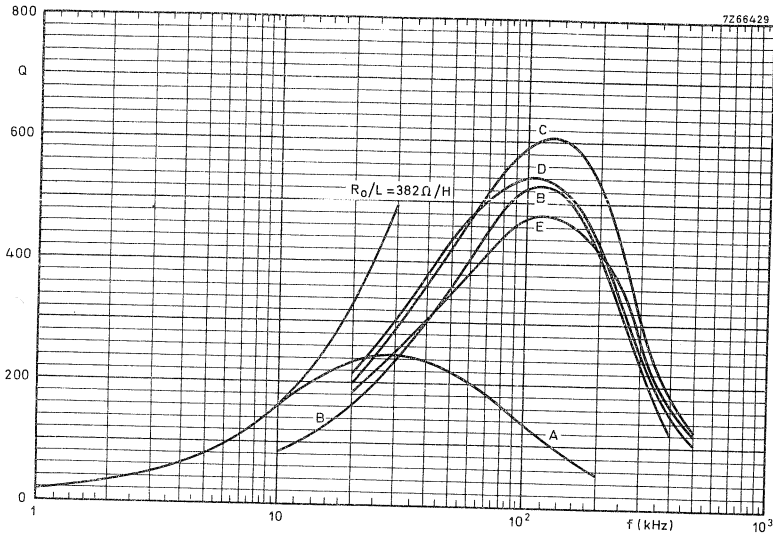
### CHARACTERISTIC CURVES

$\mu_e - \alpha$  CURVES



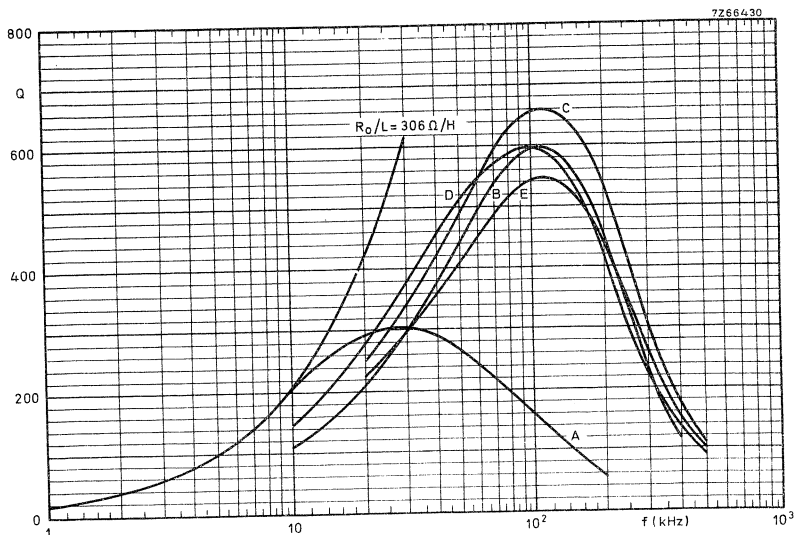
Relative effective permeability and turn factor for 1 mH as a function of the air gap length  $\mu_e \geq 1280$  at  $\Delta = 3 \mu\text{m}$  for 3H1. ←

TYPICAL Q-CURVES FOR FXC 3B7 AND 3H1



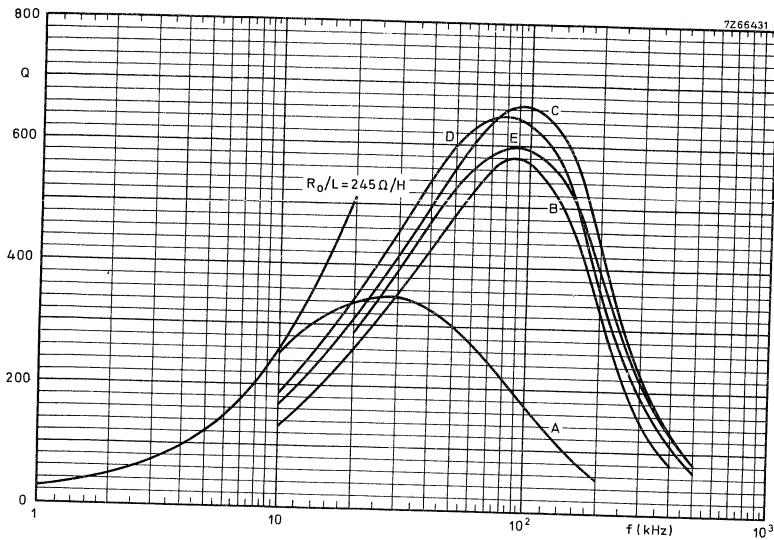
FXC 3H1, single-section coil former,  $A_L = 160$ .

curve	L (mH)	number of turns	wire	$R_0/L$ ( $\Omega/H$ )
A	6.86	207	0.25 E	382
B	1.54	98	50 x 0.04 E.S.	713
C	0.43	52	100 x 0.04 E.S.	570
D	0.52	57	32 x 0.07 E.S.	510
E	0.21	36	50 x 0.07 E.S.	538



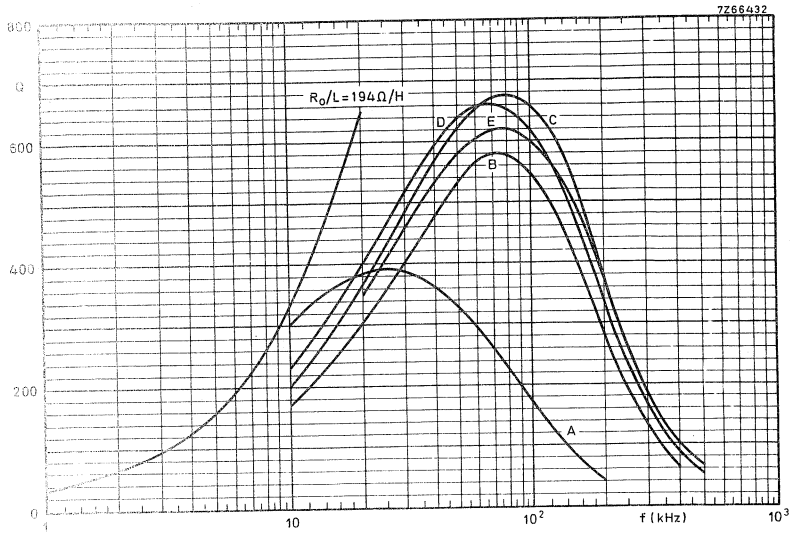
FXC 3H1, single-section coil former,  $A_L = 200$ .

curve	L (mH)	number of turns	wire	$R_0/L$ ( $\Omega/H$ )
A	8.57	207	0.25 E	306
B	1.92	98	50 x 0.04 E.S.	572
C	0.54	52	100 x 0.04 E.S.	454
D	0.65	57	32 x 0.07 E.S.	408
E	0.26	36	50 x 0.07 E.S.	435



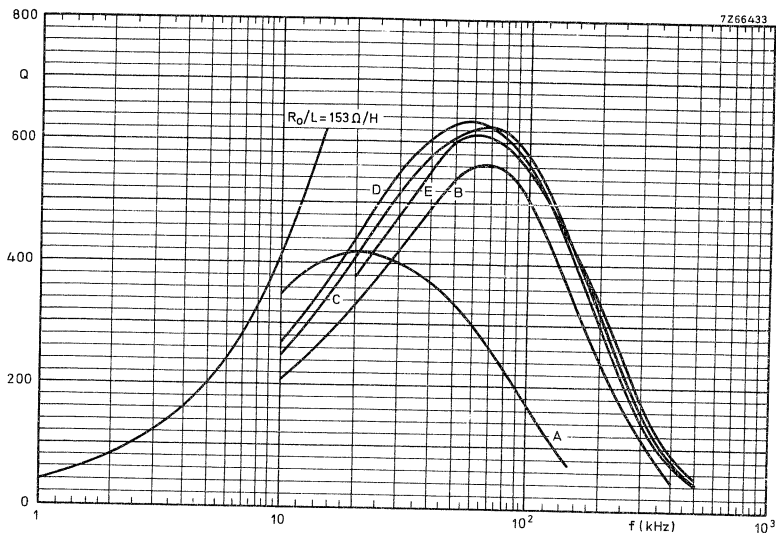
FXC 3H1, single-section coil former,  $A_L = 250$ .

curve	L (mH)	number of turns	wire	$R_0/L$ ( $\Omega/H$ )
A	10.7	207	0.25 E	245
B	2.40	98	50 x 0.04 E. S.	458
C	0.68	52	100 x 0.04 E. S.	360
D	0.81	57	32 x 0.07 E. S.	327
E	0.32	36	50 x 0.07 E. S.	353



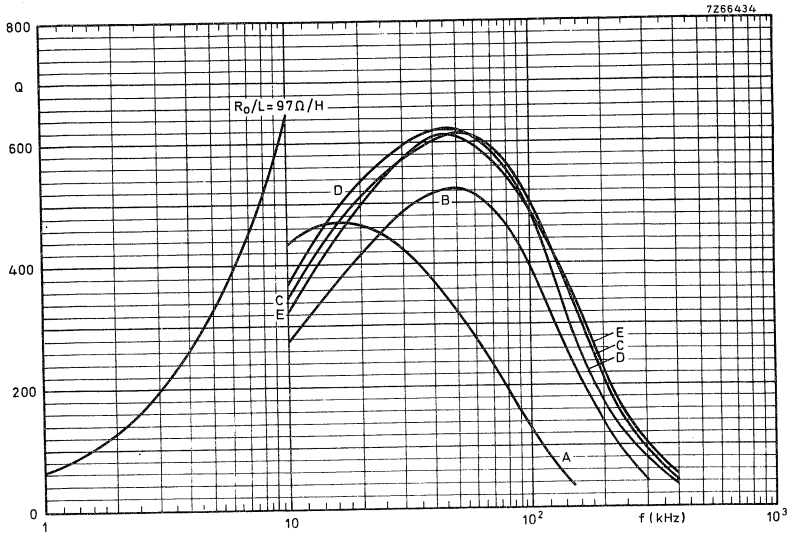
FXC 3H1, single-section coil former,  $A_L = 315$ .

curve	L (mH)	number of turns	wire	$R_0/L$ ( $\Omega/H$ )
A	13.5	207	0.25 E	194
B	3.03	98	50x0.04 E.S.	362
C	0.85	52	100x0.04 E.S.	288
D	1.02	57	32x0.07 E.S.	260
E	0.41	36	50x0.07 E.S.	276



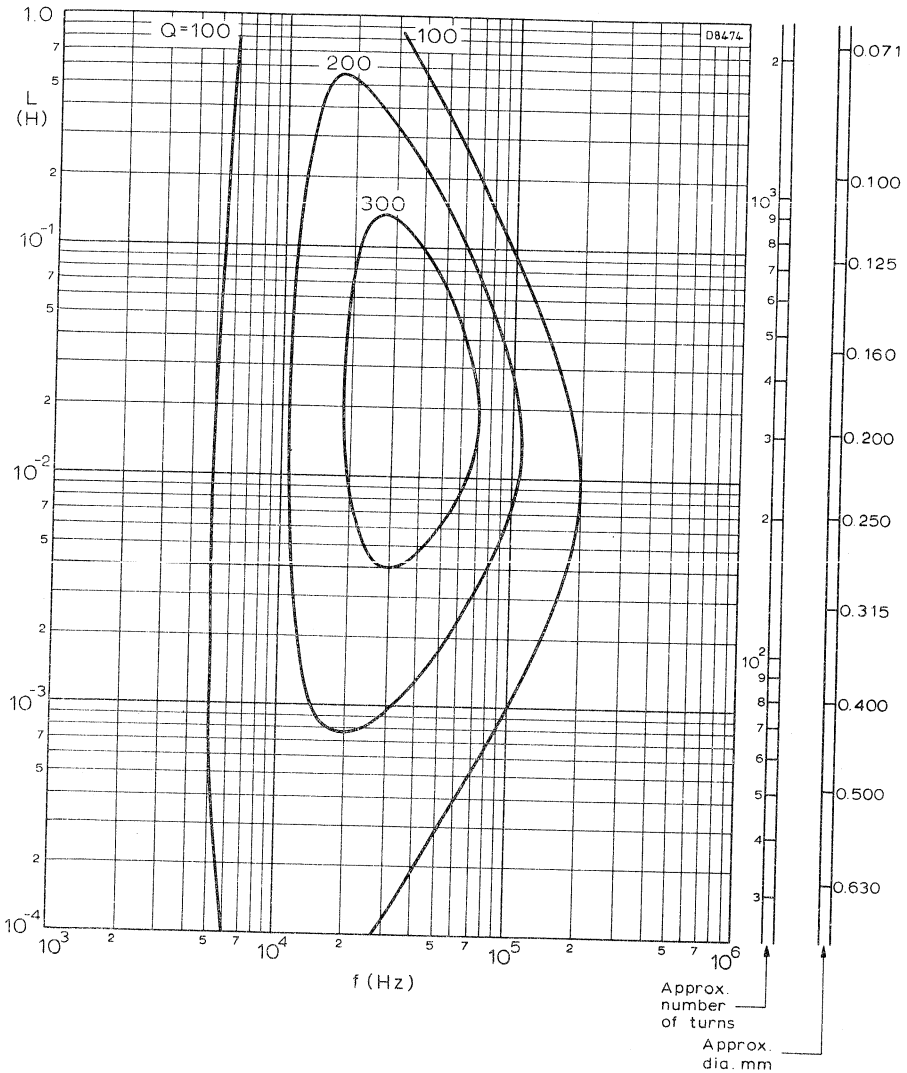
FXC 3H1, single-section coil former,  $A_L = 400$ .

curve	L (mH)	number of turns	wire	$R_o/L$ ( $\Omega/H$ )
A	17.1	207	0.25 E	153
B	3.84	98	50 x 0.04 E. S.	286
C	1.08	52	100 x 0.04 E. S.	227
D	1.30	57	32 x 0.07 E. S.	204
E	0.52	36	50 x 0.07 E. S.	217



FXC 3H1, single-section coil former,  $A_L = 630$ .

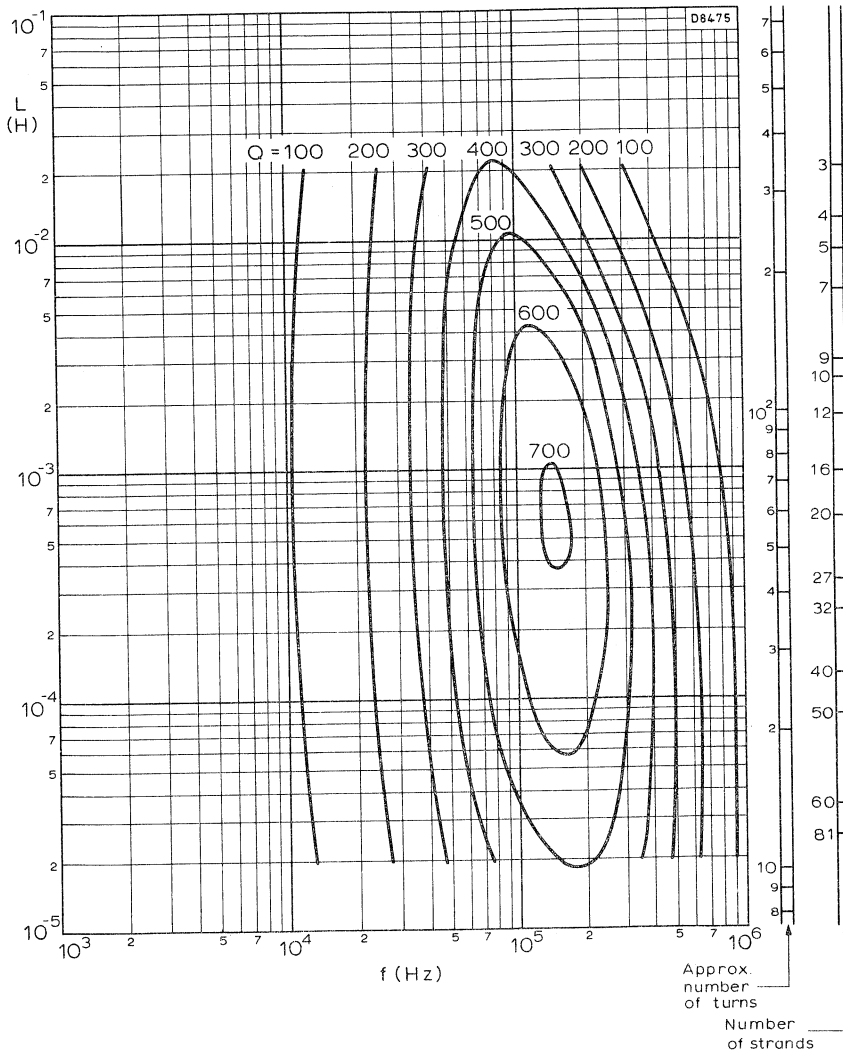
curve	L (mH)	number of turns	wire	$R_0/L$ ( $\Omega/H$ )
A	27.0	207	0.25 E	97
B	6.05	98	50x0.04 E. S.	181
C	1.70	52	100x0.04 E. S.	144
D	2.05	57	32x0.07 E. S.	129
E	0.82	36	50x0.07 E. S.	138



ISO - Q CURVES

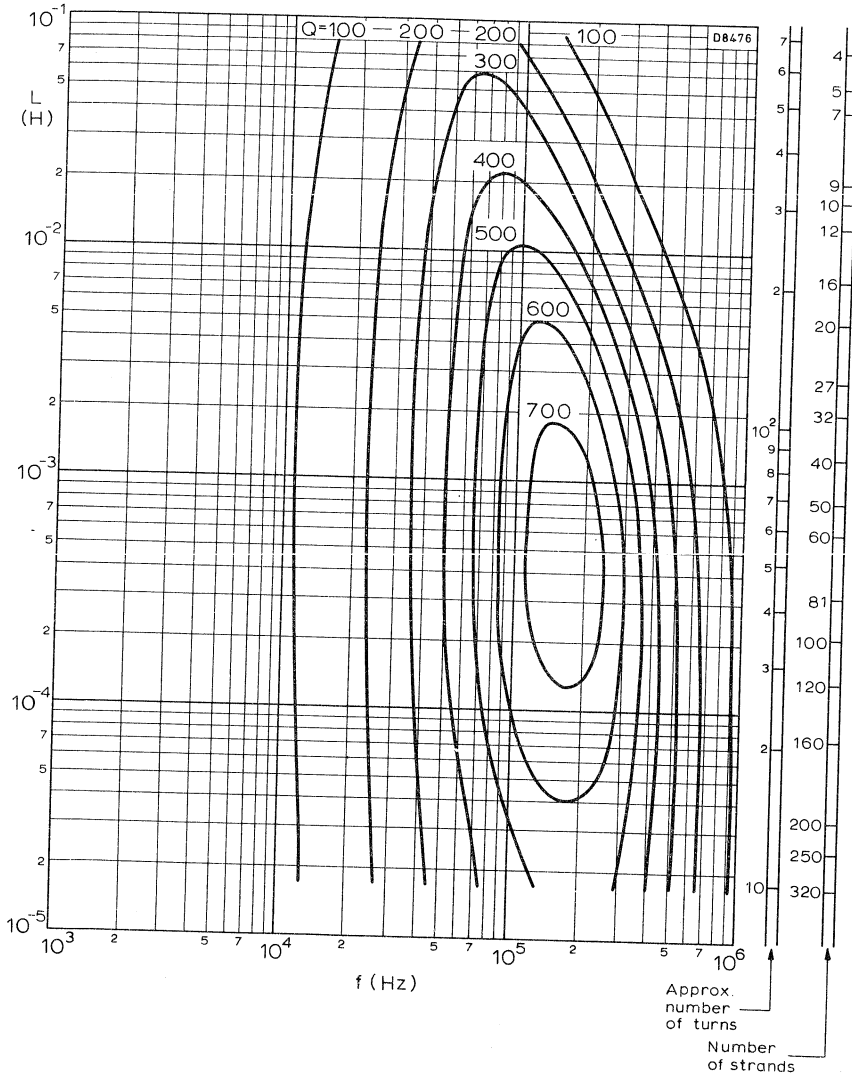
These curves show typical Q-factors obtainable with full windings of enamelled copper wire on coil formers 4312 021 29240/29250. Material grade FXC 3H3,  $A_L = 160$ .





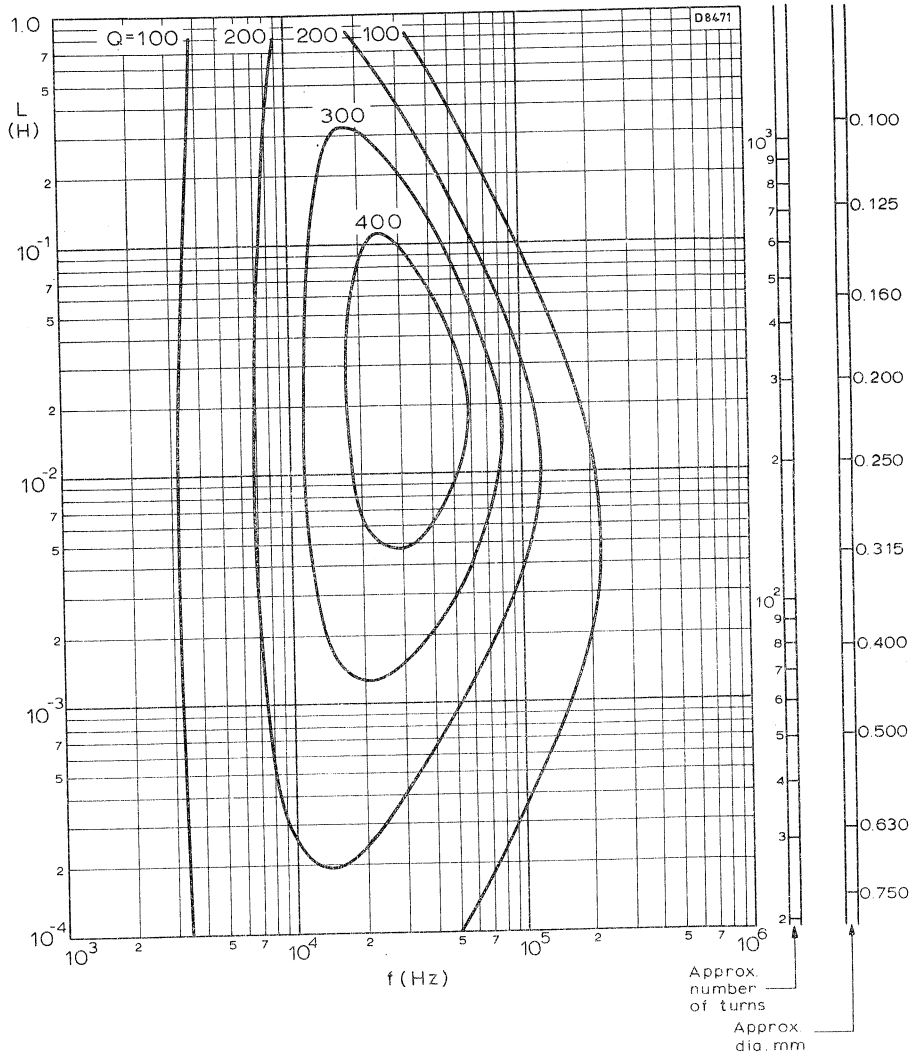
ISO - CURVES

These curves show typical Q-factors obtainable with full windings of 0,071 mm diameter bunched conductors on coil formers 4312 021 29240/29250. FXC grade 3H3,  $A_L = 160$ .



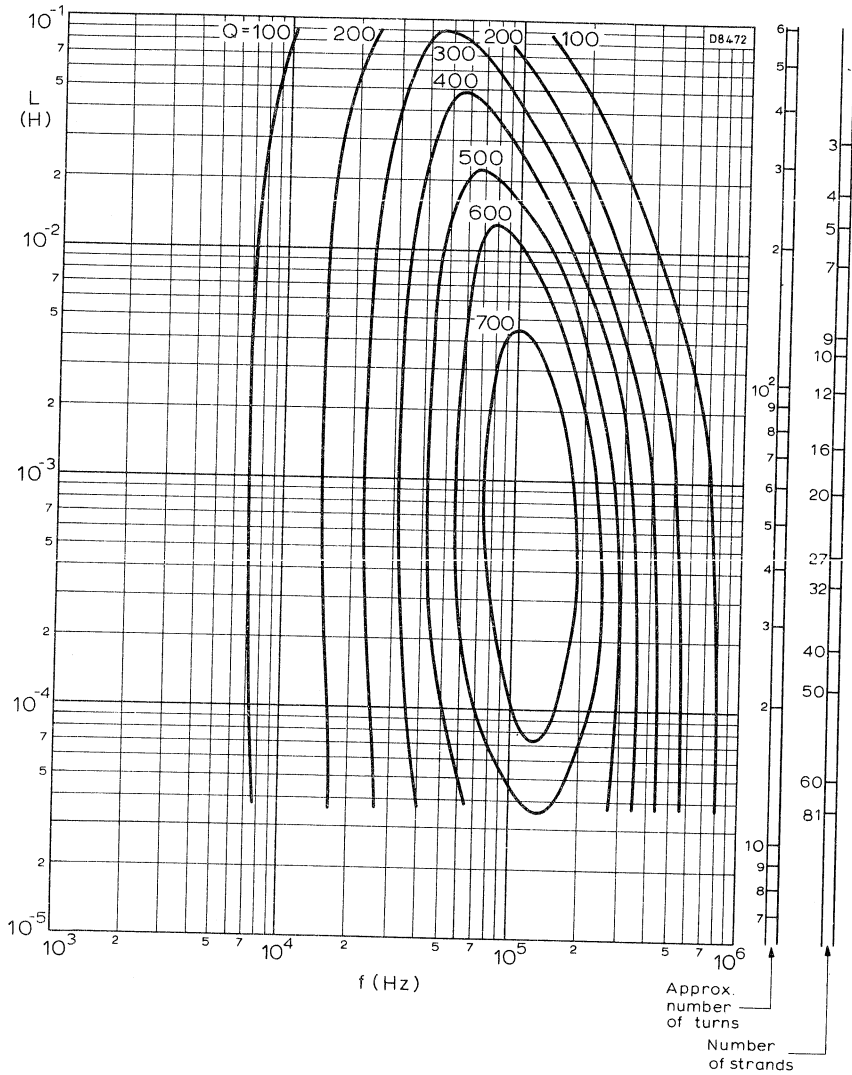
ISO - CURVES

These curves show typical Q-factors obtainable with full windings of 0,040 mm diameter bunched conductors on coil formers 4312 021 29240/29250. FXC grade 3H3,  $A_L = 160$ .



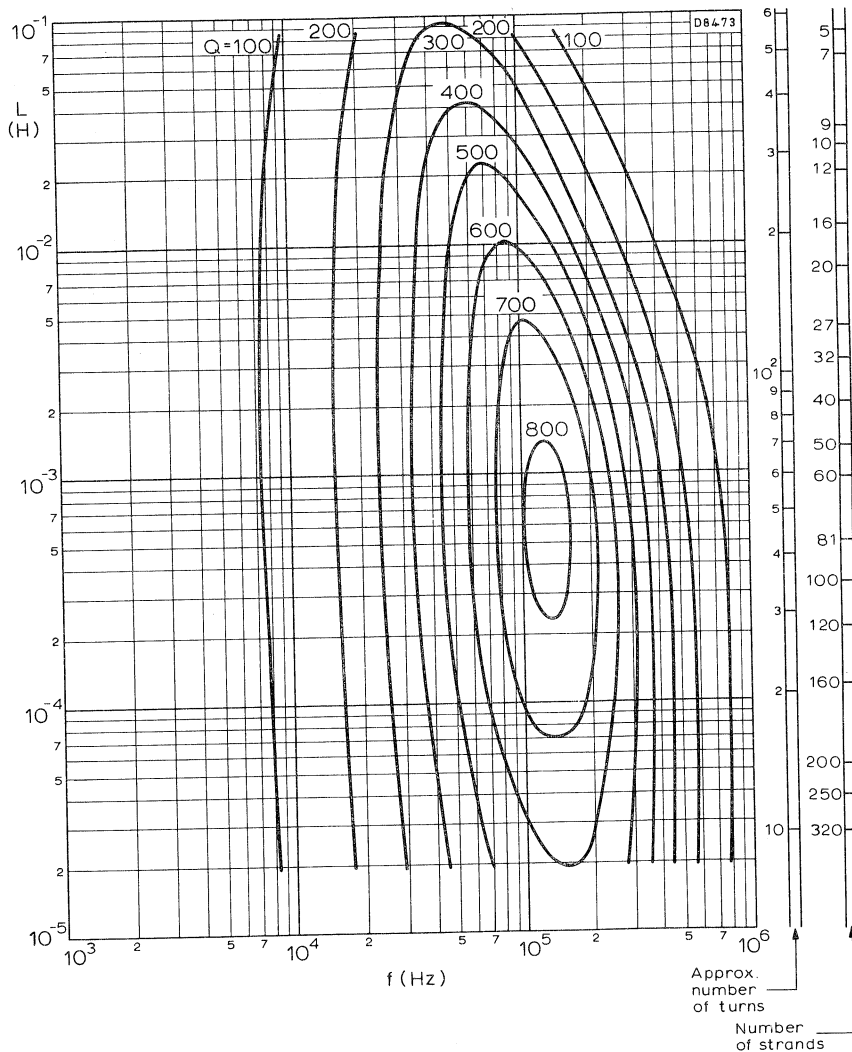
ISO - Q CURVES

These curves show typical Q-factors obtainable with full windings of enamelled copper wire on coil formers 4312 021 29240/29250. Material grade FXC 3H3,  $A_L = 250$ .



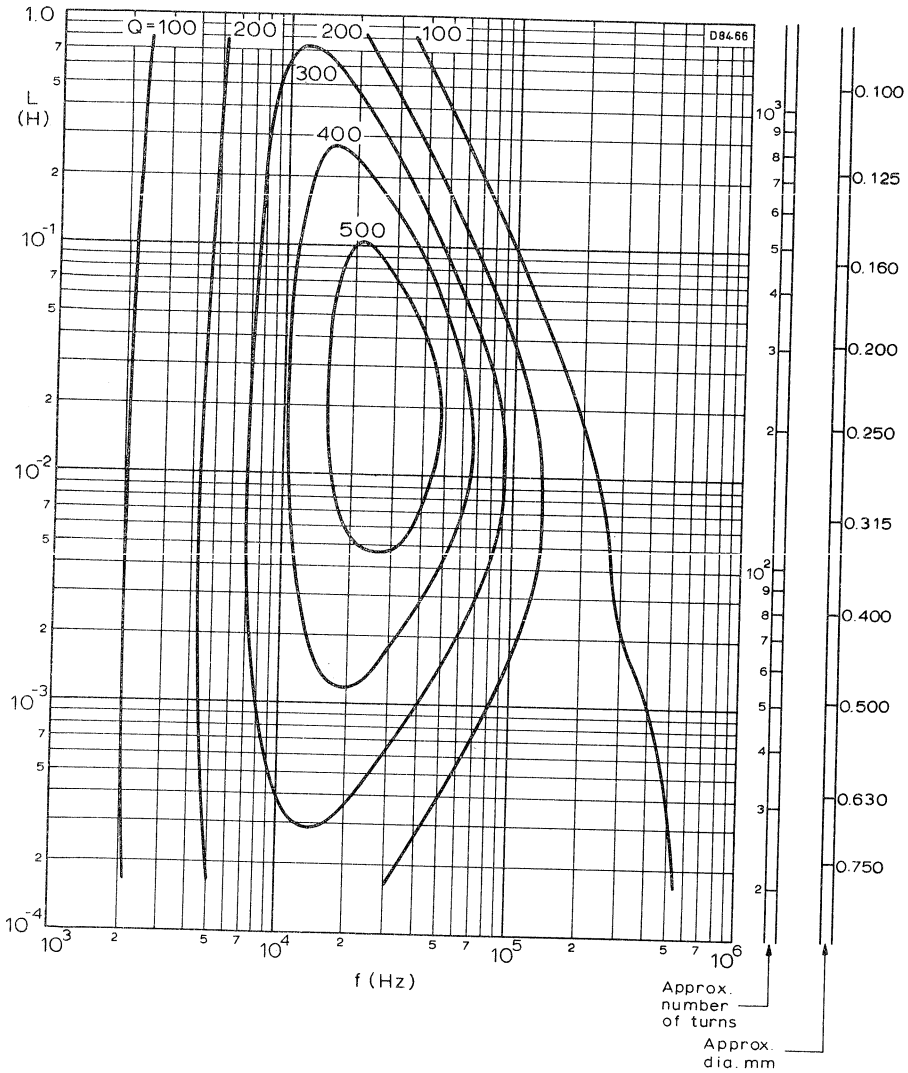
ISO - CURVES

These curves show typical Q-factors obtainable with full windings of 0,071 mm diameter bunched conductors on coil formers 4312 021 29240/29250. FXC grade 3H3,  $A_L = 250$ .



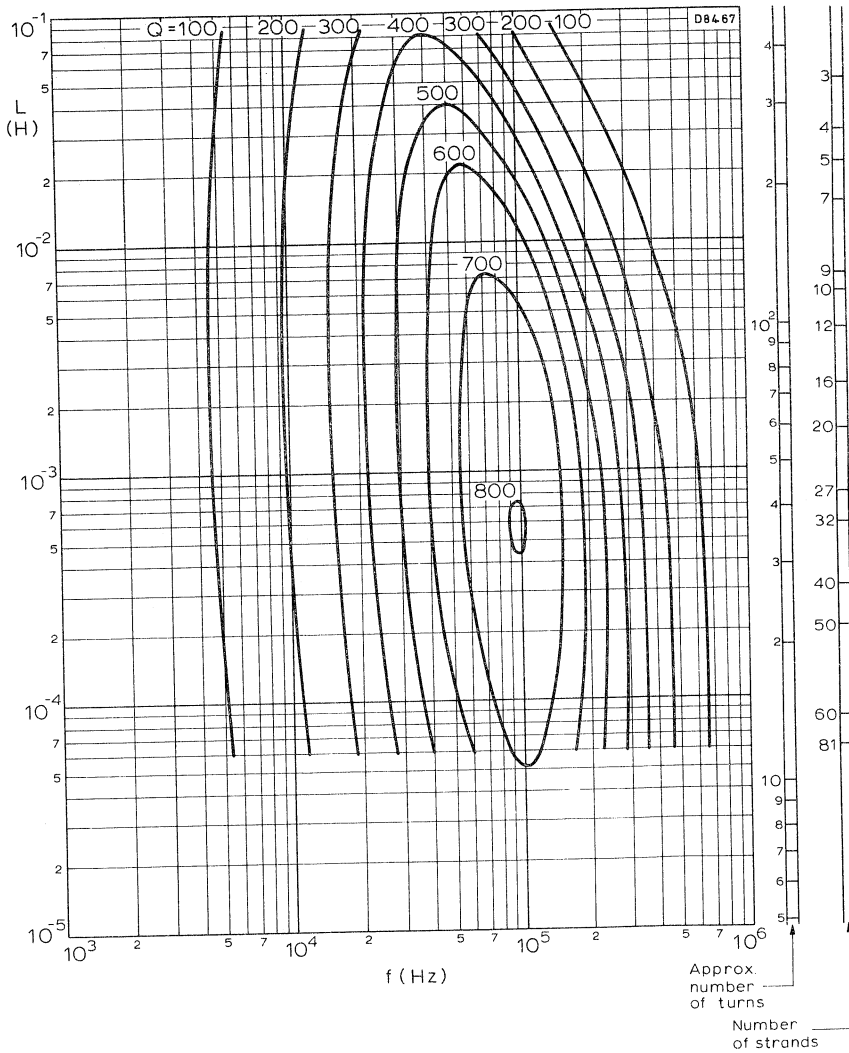
ISO - CURVES

These curves show typical Q-factors obtainable with full windings of 0,040 mm diameter bunched conductors on coil formers 4312 021 29240/29250. FXC grade 3H3,  $A_L = 250$ .



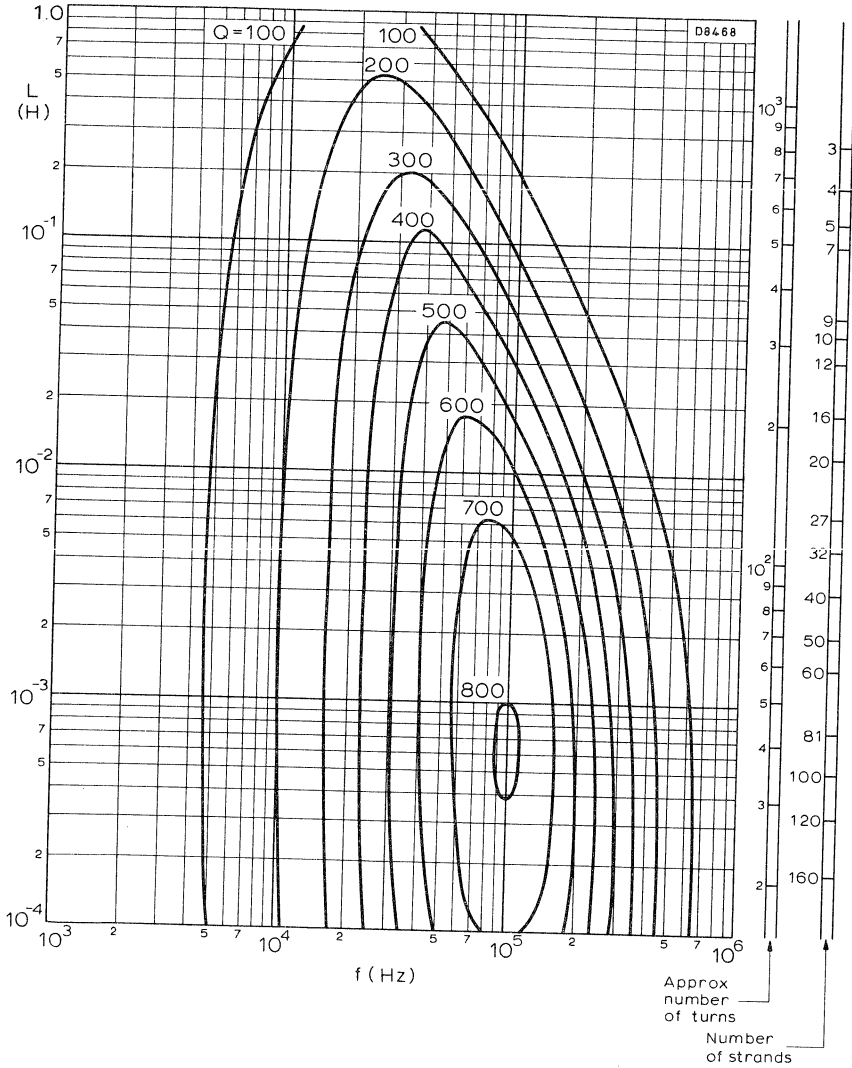
ISO - Q CURVES

These curves show typical Q-factors obtainable with full windings of enamelled copper wire on coil formers 4312 021 29240/29250. Material grade FXC 3H3,  $A_L = 400$ .



ISO - CURVES

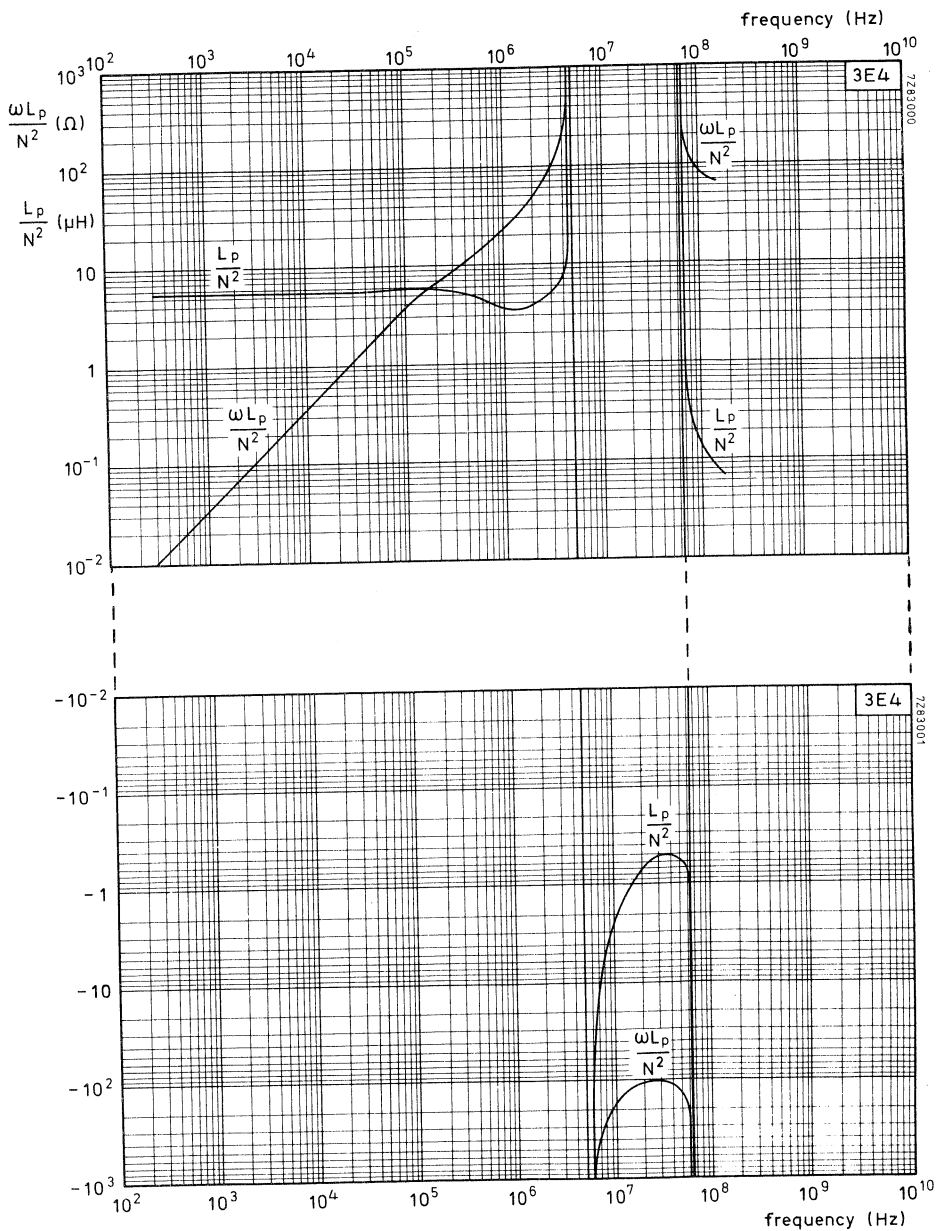
These curves show typical Q-factors obtainable with full windings of 0,071 mm diameter bunched conductors on coil formers 4312 021 29240/29250. FXC grade 3H3,  $A_L = 400$ .



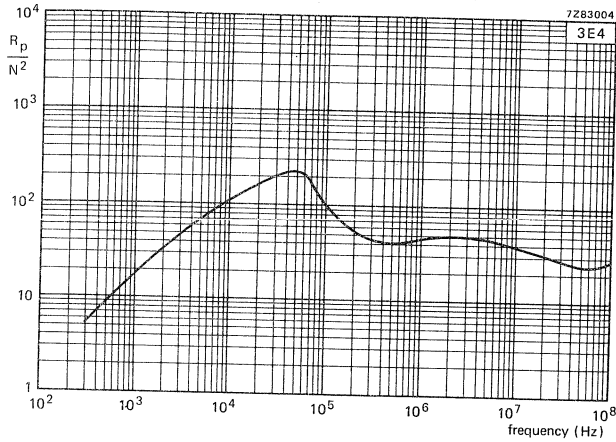
ISO - CURVES

These curves show typical Q-factors obtainable with full windings of 0,040 mm diameter bunched conductors on coil formers 4312 021 29240/29250. FXC grade 3H3,  $A_L = 400$ .

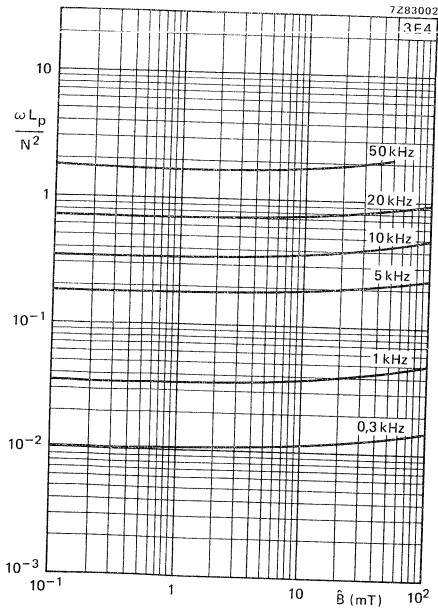




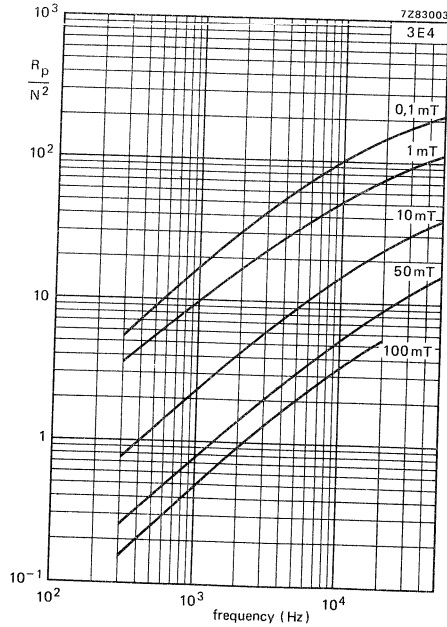
Inductance as a function of the frequency.



Losses as a function of the frequency at  $\hat{B} \approx 0,1 \text{ mT}$ .

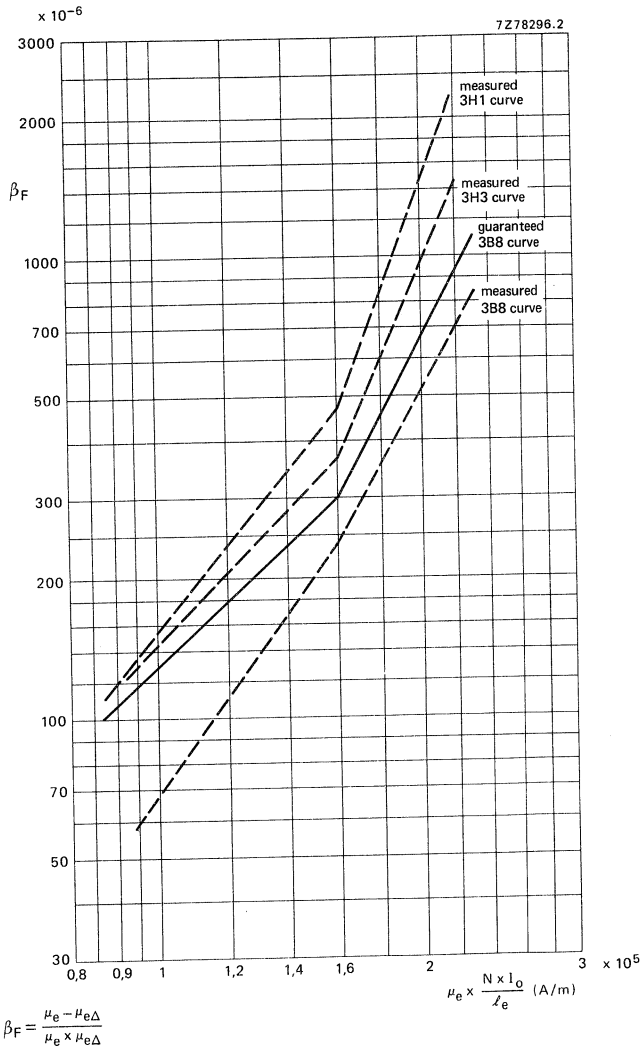


Inductance as a function of the peak induction.



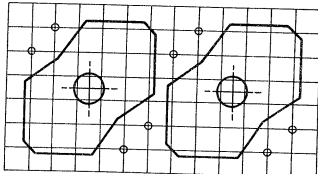
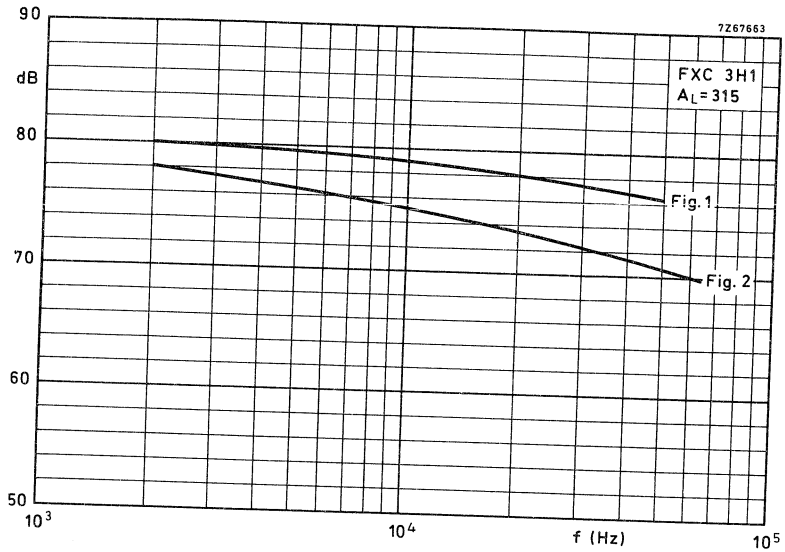
Losses as a function of the frequency.

D.C. SENSITIVITY AT 25 °C

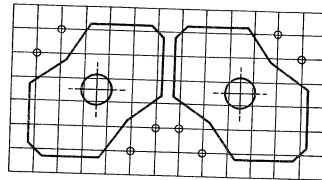


Inductance variation as a function of d.c. polarization.

CROSSTALK ATTENUATION



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7267661

## SQUARE CORES

Three types of core can be supplied:

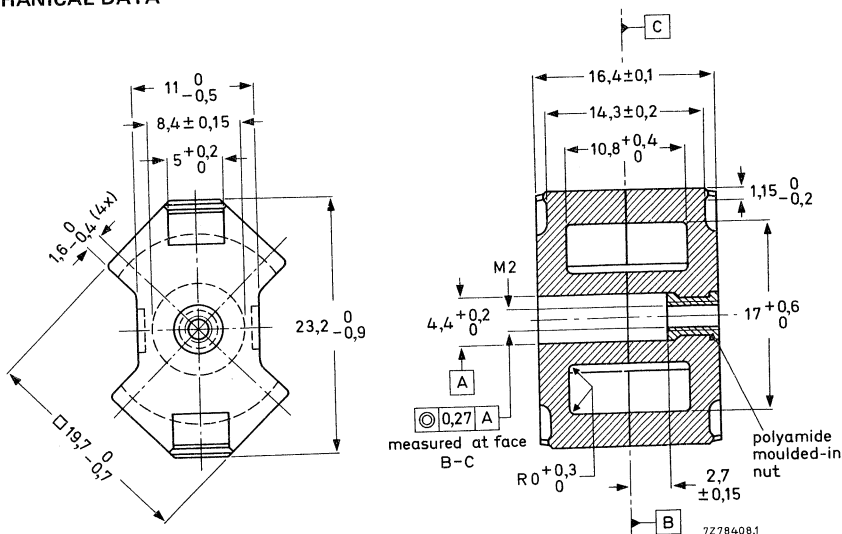
- CORE SETS provided with a nut for an adjuster and pre-adjusted on an inductance factor  $A_L$ .
- CORE SETS without nut and pre-adjusted on an  $A_L$  value.
- CORE HALVES without air gap.

The square cores are in accordance with the following specifications: IEC 431 (international), UTE 83-300 (France), DIN 41980 (Germany).

Square cores and associated parts are ordered by their 12-digit catalogue number. Quantity: a primary pack contains 20 core sets or 40 core halves; a storage pack contains 100 core sets or 200 core halves. Please order in multiples of these quantities.

### MECHANICAL DATA

Dimensions in mm



Note: 4C6 cores have a cemented nut.

Pulling-out force of the nut	$\geq 40$ N (at ambient temperature)
Torque of the screw thread	$\leq 10$ mNm
Extraction force of adjuster from nut	$\geq 30$ N

**MECHANICAL DATA** (continued)

Dimensional quantities according to IEC 205:

a. Version with centre hole:

$$C_1 = \Sigma \frac{l}{A} = 0,683 \text{ mm}^{-1}; C_2 = \Sigma \frac{l}{A^2} = 0,0131 \text{ mm}^{-3}; V_e = 1850 \text{ mm}^3; l_e = 35,5 \text{ mm}; A_e = 52,0 \text{ mm}^2;$$

$$\rightarrow A_{CP \text{ min}} = 39,5 \text{ mm}^2.$$

Mass of a core set: 10,9 g.

b. Version without centre hole:

$$C_1 = \Sigma \frac{l}{A} = 0,604 \text{ mm}^{-1}; C_2 = \Sigma \frac{l}{A^2} = 0,00952 \text{ mm}^{-3}; V_e = 2440 \text{ mm}^3; l_e = 38,4 \text{ mm}; A_e = 63,0 \text{ mm}^2;$$

$$\rightarrow A_{CP \text{ min}} = 55,4 \text{ mm}^2.$$

Mass of a core set: 12,4 g.

**ELECTRICAL DATA**

The combination of two square core halves without air gap, randomly chosen from a batch, has the following guaranteed properties. A measuring coil as described in the General section 'Potcores, square cores and cross cores', is inserted, the halves are pressed together with a force of 80 N. The values are valid 5 minutes or more after clamping.

	freq. kHz	$\dot{B}$ mT	temp. °C	grade						
				3B8	3C8	3D3	3E4	3H1	3H3	4C6
$AL \pm 25\%$	4	$\leq 0,1$	$25 \pm 1$	3910	3300 (1)			3400		230
$\mu_e \pm 25\%$	4	$\leq 0,1$	$25 \pm 1$	1880	1600			1840		126
$\alpha$	4	$\leq 0,1$	$25 \pm 1$	$\leq 18,0$	$\leq 19,5$			$\leq 19,8$		$\leq 75,8$
$\tan \delta \times 10^6$	4	$\leq 0,1$	$25 \pm 1$					$\leq 2,5$		
$\mu_i$	30	$\leq 0,1$	$25 \pm 1$					$\leq 2,5$		
	100	$\leq 0,1$	$25 \pm 1$					$\leq 20$		$\leq 1,8$
	500	$\leq 0,1$	$25 \pm 1$					$\leq 200$		$\leq 2,6$
	1000	$\leq 0,1$	$25 \pm 1$							
	2000	$\leq 0,1$	$25 \pm 1$							
	10000	$\leq 0,1$	$25 \pm 1$							$\leq 40$
P(W)	25	200 (2)	25	$\leq 0,4$	$\leq 0,5$	$\leq 0,5$ (3)		$\leq 0,86$		$\leq 100$
$\eta_B \times 10^3$	4	1,5 to 3,0	100	$\leq 0,5$				$\leq 1,1$		
	30	1,5 to 3,0	25 ± 1							
	100	0,3 to 1,2	25 ± 1							
$\alpha F \times 10^6/K$	$\leq 100$	$\leq 0,1$	5 to 25					0 to + 2		$\leq 9,2$
	$\leq 100$	$\leq 0,1$	25 to 55					0 to + 2		-2 to + 4
	$\leq 100$	$\leq 0,1$	25 to 70					0 to + 2		0 to + 6
DF x 10 <sup>6</sup> (10-100 min)	$\leq 100$	$\leq 0,1$	25 ± 0,1					$\leq 4,3$		$\leq 3,0$ (4)
$\beta F \times 10^6$ measured on sets with $\mu_e = 300 \pm 10\%$ and $25 \pm 1$ °C:										
at $\mu_e \times \frac{N \times l_0}{l_e} = 1,0 \times 10^5$ A/m				$\leq 100$						
				$\leq 300$						
				$\leq 1000$						

- (1)  $\geq 3700$  at  $\dot{B} = 200$  mT and  $T = 100$  °C.
- (2)  $\dot{B}$  is calculated with  $ACP_{min} = 55,4$  mm<sup>2</sup>.
- (3) Dip in loss curve at  $85 \pm 15$  °C.
- (4) Valid from + 25 to + 70 °C.

Core sets with nut and pre-adjusted on  $A_L$ .

$A_L$	corresponding $\mu_e$ -value	tol. on inductance %	catalogue number						4322 025 . . . . .	
			4322 022 . . . . .							
			3B8	3D3	3E4	3H1	3H3	4C6		3C8
40	22	± 1		71420						
63	34	± 1		71430		71230		71820		
100	54	± 1		● 71440		71240		● 71830		
160	87	± 1,5	● 51470*	71450		71250		● 71840	01240*	
250	135	± 2	● 51480*			● 71260	● 71760	71850	● 01250*	
315	170	± 2	51490*			● 71270	71770		● 01260*	
400	220	± 3	51500*			71280	71780			
630	340	± 3				71300				
1000	540	± 10				71310				
1250	680	± 10				71390				
1600	870	± 10	51400*			51320*				
5500	2985	± 25								
6300	3050	± 25								
8000	3850	± 25			● 51900*					

Inductance  $L = N^2 A_L$  (in  $10^{-9}$  H)

Core sets without nut: replace the eighth digit of the catalogue number (7) by 5.

Cores with  $A_L \leq 250$  have a symmetrical air gap.

Cores with  $A_L \geq 315$  and all 3B8 and 3C8 cores have an asymmetrical air gap.

Core halves without air gap, without nut.

Ferroxcube grade	catalogue number
3B8	4322 020 27420 *
3C8	4322 020 28100 *
3D3	4322 020 27270
3H1	4322 020 27260
3H3	4322 020 27390
4C6	4322 020 27280

\* Types without centre hole.

● Preferred types.



## COIL FORMERS

Four types of coil former can be supplied:

- Single-section, 4-pin coil former, catalogue number 4322 021 32360 (Fig. 1)
- Single-section, 8-pin coil former, catalogue number 4322 021 32380 (Fig. 2)
- Single-section, 12-pin coil former, catalogue number 4322 021 32390 (Fig. 3)
- Two-section, 8-pin coil former, catalogue number 4322 021 32420 (Fig. 4)

The coil formers are packed on a polystyrene plate of 100 and 5 plates (500 pcs) in a cardboard box. Please order in multiples of these quantities.

### Properties

Material of former	phenolformaldehyde reinforced with glass fibre,
Material of pins	phosphor bronze, dip-soldered
Window area	
single-section coil former	34,2 mm <sup>2</sup>
two-section coil former	2 x 17,0 mm <sup>1</sup>
Mean length of turn	41 mm
Maximum temperature	180 °C
Inflammability	UL94, class V-0
Solderability	resistant against dip-soldering at 400 °C for 2 s
D.C. losses, $\frac{R_0}{L}$	$\frac{1}{\mu_e} \times \frac{1}{f_{cu}} \times 11,4 \times 10^3 \Omega/H$
Mass	0,55 g

SINGLE-SECTION, 4-PIN COIL FORMER

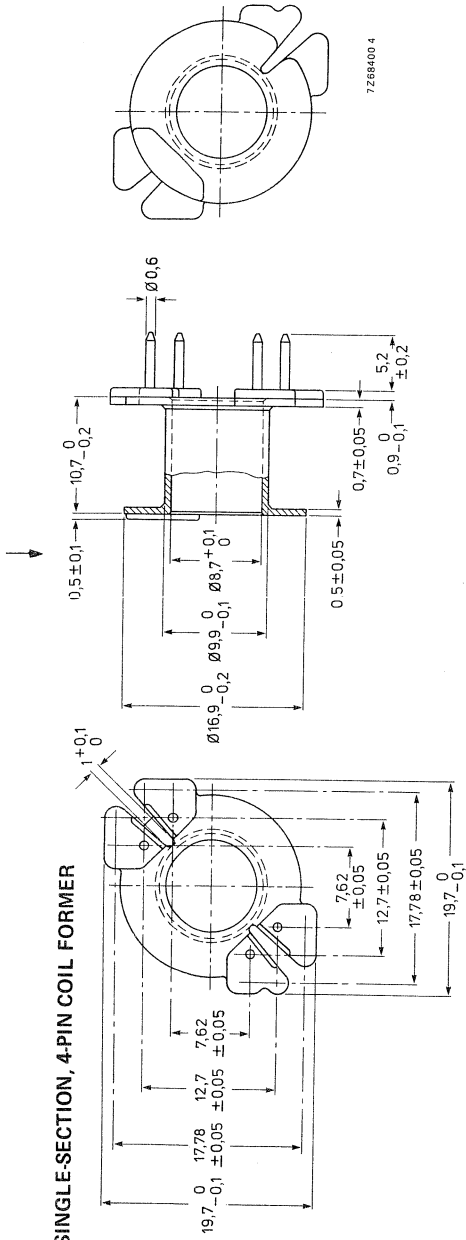


Fig. 1.

SINGLE-SECTION, 8-PIN COIL FORMER

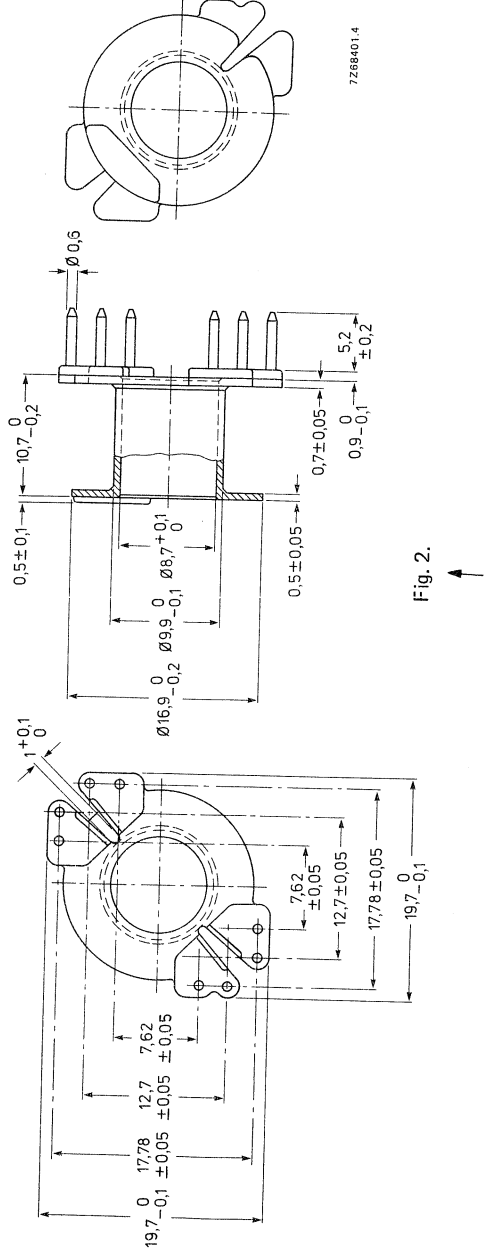


Fig. 2.

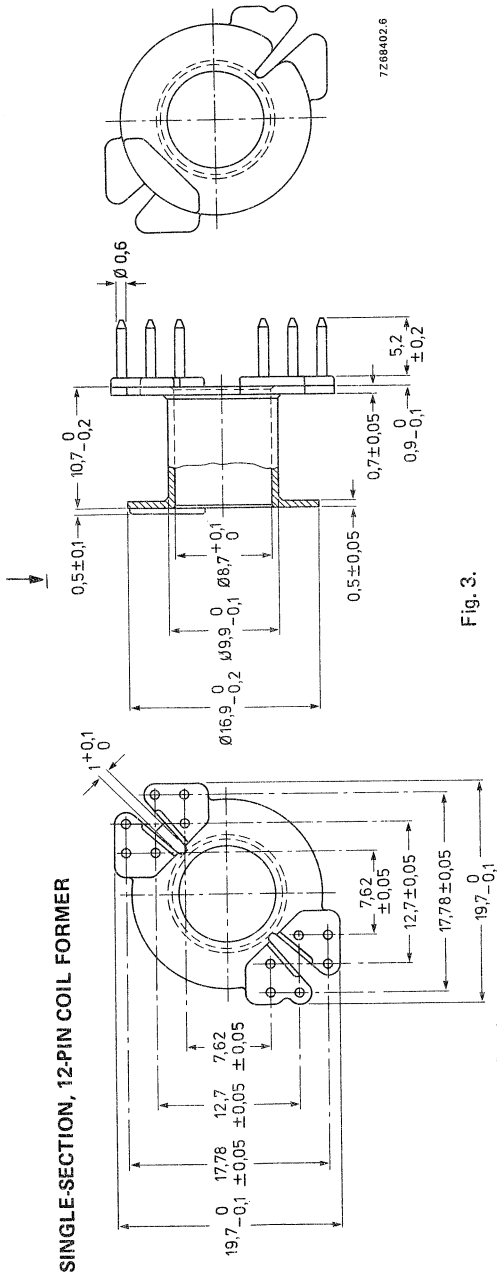


Fig. 3.

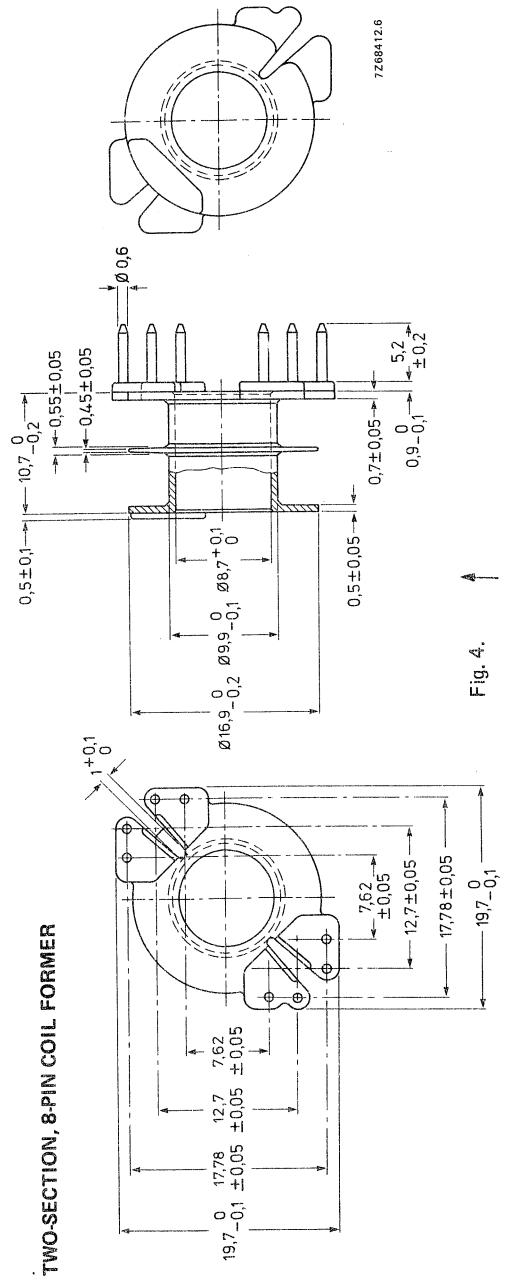
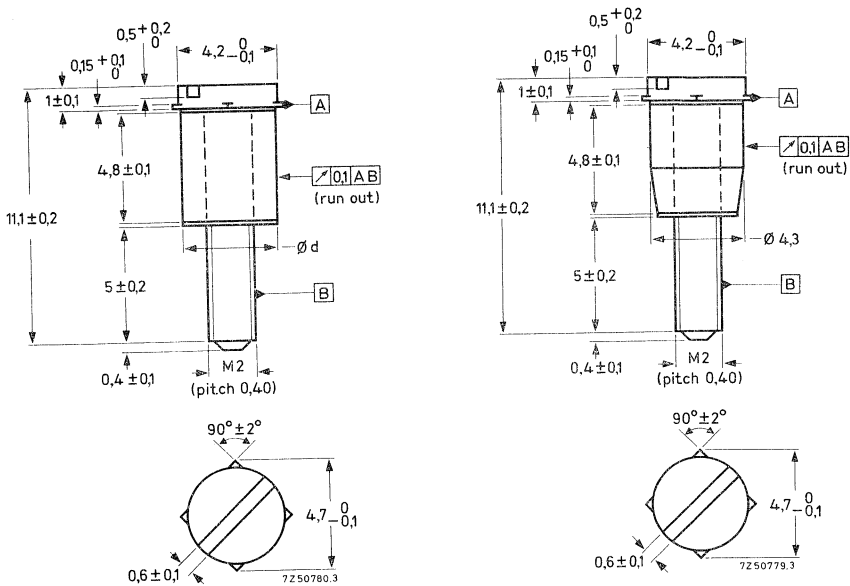


Fig. 4.



# INDUCTANCE ADJUSTERS (old types)

## ADJUSTERS



The tolerances on inductance of the pre-adjusted cores (without adjuster) are given in the table pre-adjusted cores with standard  $A_L$  values. After inserting a coil (impregnated or not) in an electrical circuit, its inductance can be adjusted to the required value with an accuracy  $< 0,03\%$  by means of a continuous inductance adjuster. Such an adjuster increases the inductance of the coil (see following pages).

The adjuster is screwed through the centre hole of the core into the nut and is held in position by the four protrusions near the top of the adjuster. For special requirements a larger or smaller adjustment range may be obtained by using an adjuster belonging to the next higher or lower  $A_L$  value. The influence of the adjuster on the variability of the inductance is negligible. The maximum permissible temperature is  $110^\circ\text{C}$ .

Table II shows the type of adjuster recommended for different square cores.

Table 1, types of adjuster

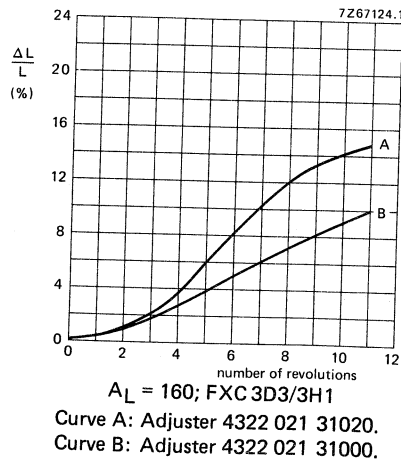
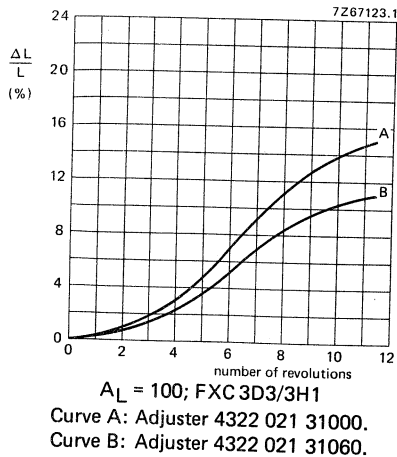
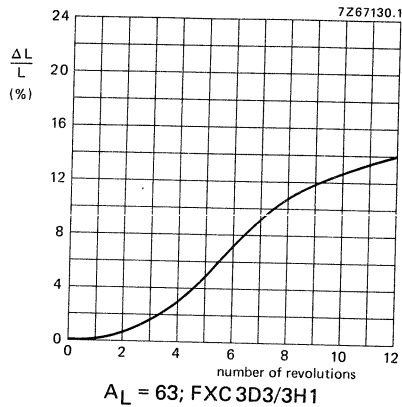
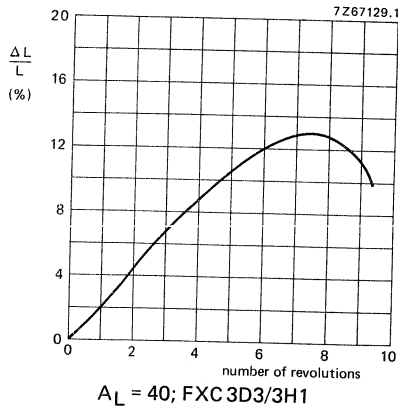
Fig. 1	colour	catalogue number
B	yellow	4322 021 31000
B	white	4322 021 31020
B	red	4322 021 31060
A	brown	4322 021 31100
B	black	4322 021 31240
A	grey	4322 021 32190

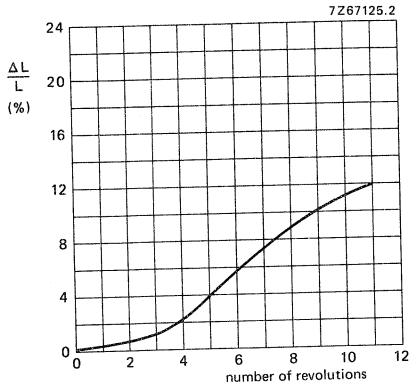
The adjusters are packed in bags of 100.  
Please order in multiples of 100.

Table 2, recommended application

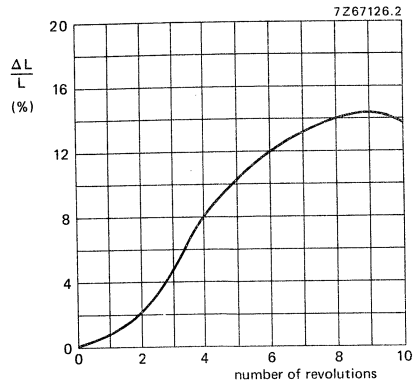
A <sub>L</sub>	3H1/3D3
	catalogue number 4322 021 .....
40	31060
63	31060
100	31000 or 31060
160	31000 or 31020
250	31020
315	32190
400	31100
630	31240

ADJUSTMENT CURVES

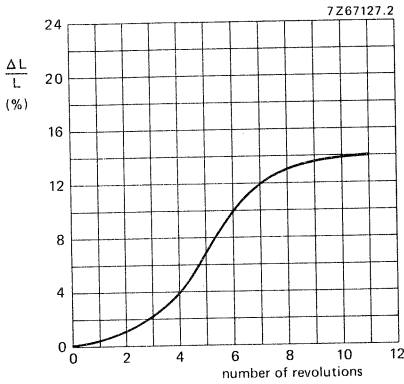




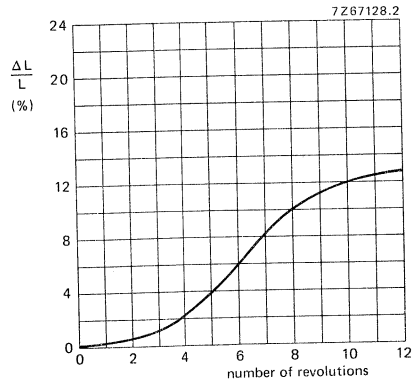
$A_L = 250$ ; FXC 3H1



$A_L = 315$ ; FXC 3H1



$A_L = 400$ ; FXC 3H1



$A_L = 630$ ; FXC 3H1





## INDUCTANCE ADJUSTERS (new types)

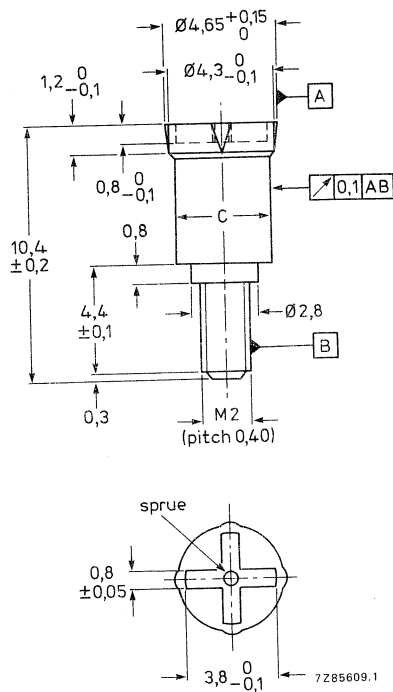


Fig. 1.

Material: polypropylene, reinforced with glass fibre.

The tolerances on inductance factor of the pre-adjusted cores without adjuster are given in the table of pre-adjusted cores with standard  $A_L$  values. The inductance of the pre-adjusted core can be increased to the required value — with a setting accuracy  $< 0,03\%$  — by means of a continuous adjuster.

The adjuster is screwed through the centre hole of the core into the nut and is held in position by the four cones near the top of the adjuster.

The combination of the polyamide moulded-in nut and the polypropylene adjuster — both reinforced with glass fibre — gives an excellent stability with temperature, shocks and vibrations. Besides this, the combination has a very smooth adjustment curve due to the excellent concentricity of the moulded-in nut and the adjuster.

The maximum permissible temperature of the adjustment combination is: 150 °C, during 8 h. The maximum working temperature is 110 °C.

The tables below show the available types and which adjuster is recommended for typical  $A_L$  values.

Table 1 Colour code of adjusters

catalogue number	colour	dia. C (Fig. 1) mm	material
4322 021 38400	black	4,22	FXC
38410	brown	4,04	FXC
38440	yellow	3,52	FXC
38480	white	3,80	FXC
38490	grey	3,94	FXC

Table 2 Catalogue numbers of recommended adjusters for typical  $A_L$  values

$A_L$	3H1/3H3/3B7	3D3	4C6
40			
63			
100			
160	4322 021 38440	4322 021 38440	
250	38480		
315	38490		
400	38410		
630	38400		

**PACKAGING**

The adjusters are packed in bags of 100. Please order in multiples.

**ADJUSTING TOOL**

An adjusting tool combination for M2 and M2, 6 is available, catalogue number 4322 058 03270.

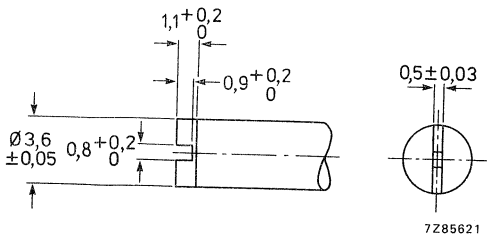
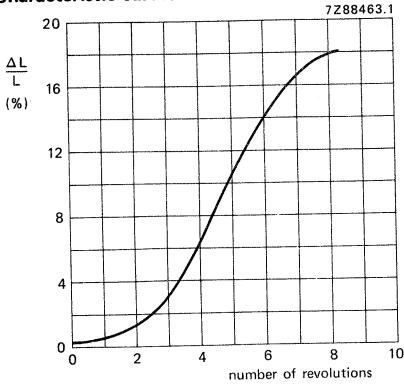


Fig. 2.

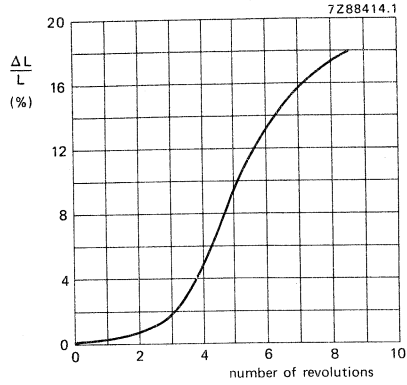
For customers who wish to make the screwdriver themselves the outlines of the essential part given in Fig. 2.

ADJUSTMENT CURVES

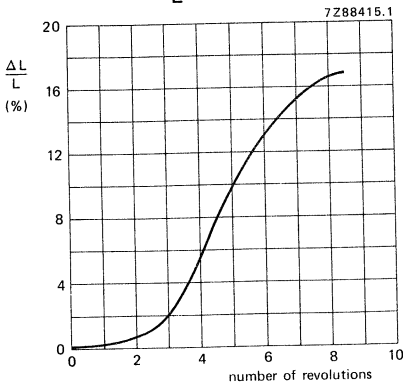
Characteristic curves



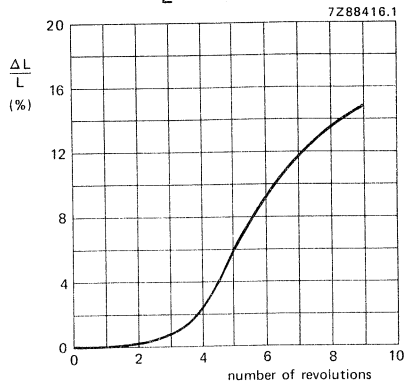
$A_L = 160$ ; FXC 3H1



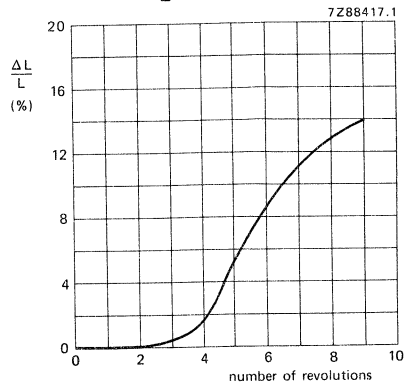
$A_L = 250$ ; FXC 3H1



$A_L = 315$ ; FXC 3H1



$A_L = 400$ ; FXC 3H1

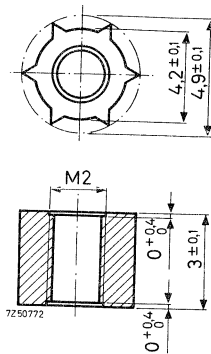


$A_L = 630$ ; FXC 3H1

Note: 0 revolutions corresponds to at least one turn of interaction.

**NUT FOR ADJUSTER**

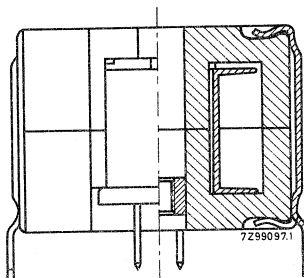
These data are given for those manufacturers who prefer to insert the nut themselves.



Catalogue number	4322 021 30150
Material	polycarbonate
Max. impregnation temperature for 24 hours	120 °C
Recommended distance from mating surface to nut	$2,7 \pm 0,15$ mm

The nuts are packed in bags of 100. Please order in multiples of 100.

## ASSEMBLING AND MOUNTING



### ASSEMBLING

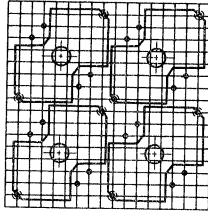
The core halves are clamped together by means of two clips, type 4322 021 31840. As can be seen in the drawing, the hooked ends of each clip fit into recesses made in the core halves.

For a stable inductance we recommend that an adhesive be applied between the coil former flange and the lower core half. We also recommend that a tool be used for assembling. (Drawings of a simple tool are available under number 4322 058 00160.)

### MOUNTING

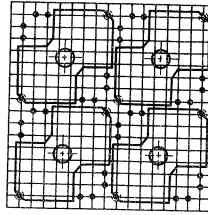
The two retaining clips are also used for mounting the assembled core on a printed-wiring board: the pins are simply soldered into the holes in the board. If so desired, one of the pins can also be used for earthing the core.

The soldering pins of coil formers and clips are so arranged that they will fit printed-wiring boards with a 0,1 – inch grid as well as those with a 2,50 mm grid. The pin length is sufficient for a board thickness of up to 2,4 mm. The recommended hole diameter in the board is  $1,0 \pm 0,1$  mm (according to IEC publication 97).



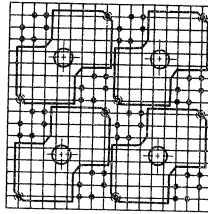
⊗ 1)

Hole pattern for an assembly of 4 cores, each fitted with a 4-pin coil former.



⊗ 1)

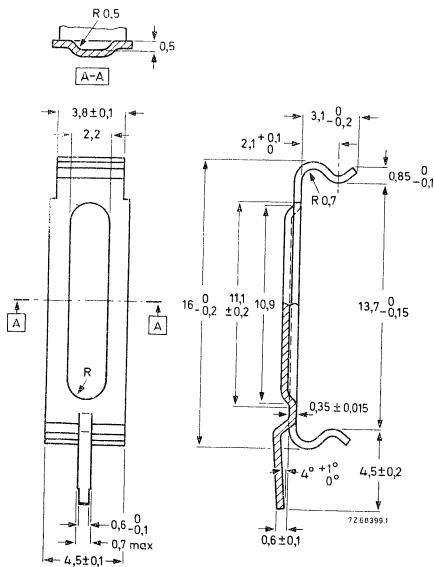
Hole pattern for an assembly of 4 cores, each fitted with a 8-pin coil former.



⊗ 1)

7268397

Hole pattern for an assembly of 4 cores, each fitted with a 12-pin coil former.



**PART DRAWING** (dimensions in mm)

Clip 4322 021 31840

Material: steel, silver plated

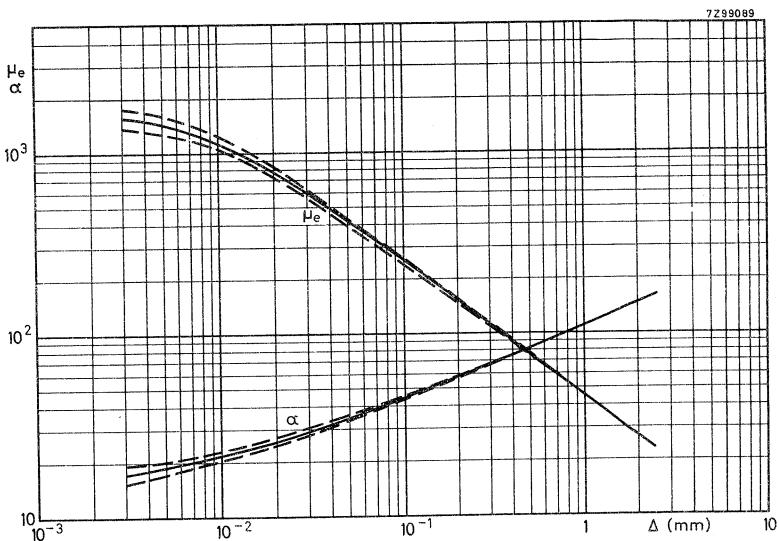
over nickel, then passivated

Packing quantity: 2500

(1) Holes for tag on clip 4322 021 31840.

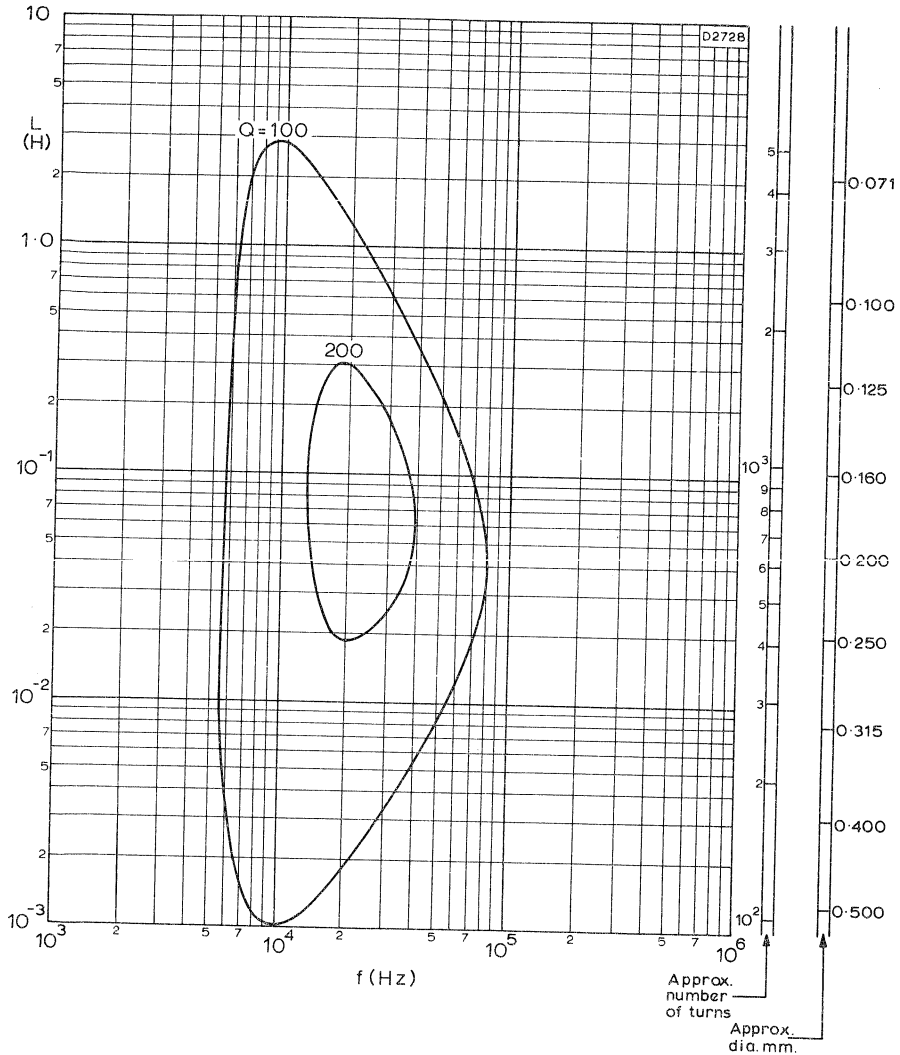
# CHARACTERISTIC CURVES

## $\mu_e$ - $\alpha$ CURVES



Relative effective permeability and turn factor for 1 mH as a function of the air gap length.  
 $\mu_e = 1840 \pm 25\%$  at  $\Delta = 3 \mu\text{m}$  for 3H1.

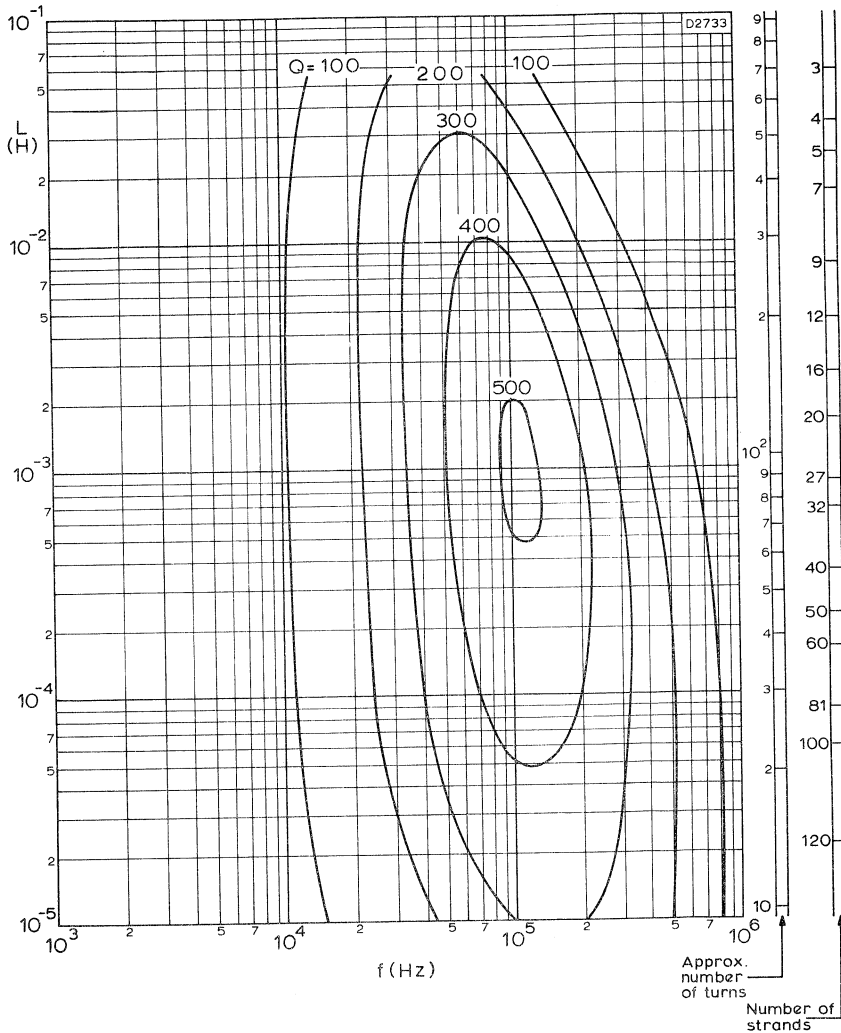




ISO - Q CURVES

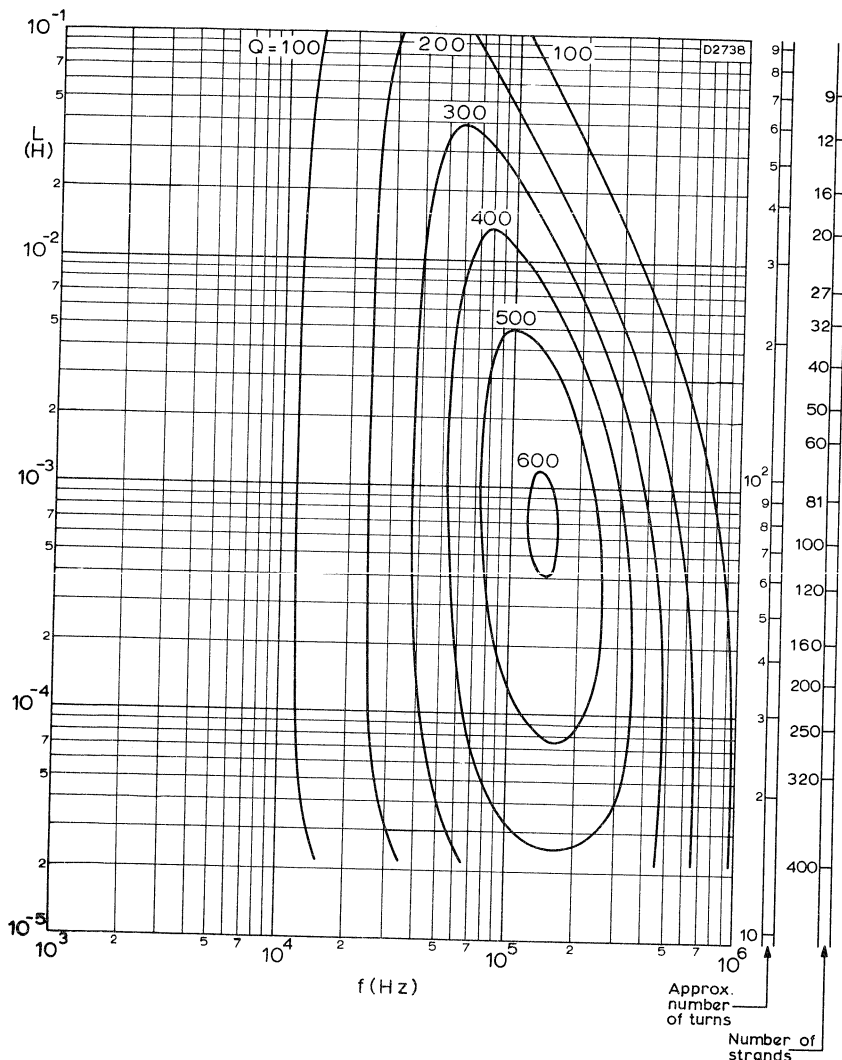
These curves show typical Q-factors obtainable with full windings of enamelled copper wire on coil formers 4322 021 32360/32380. Material grade FXC 3H1,  $A_L = 100$ .





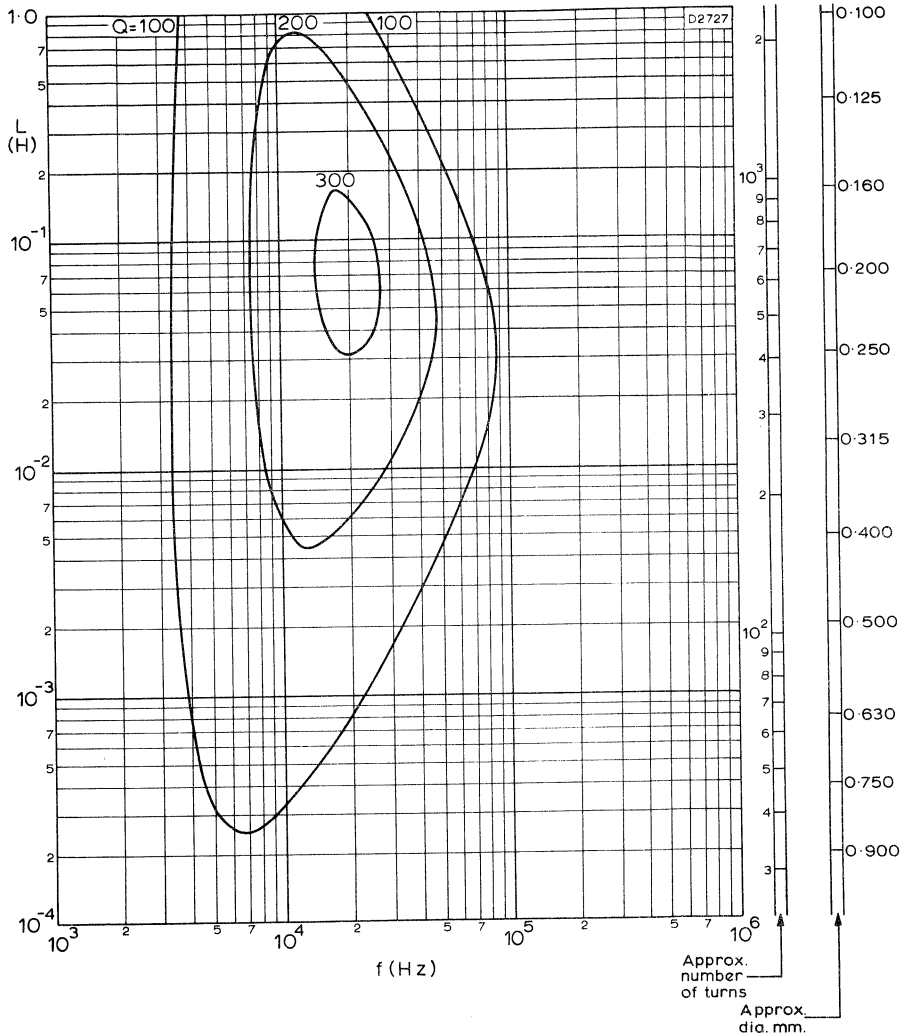
ISO - CURVES

These curves show typical Q-factors obtainable with full windings of 0,071 mm diameter bunched conductors on coil formers 4322 021 32360/32380. FXC grade 3H1,  $A_L = 100$ .



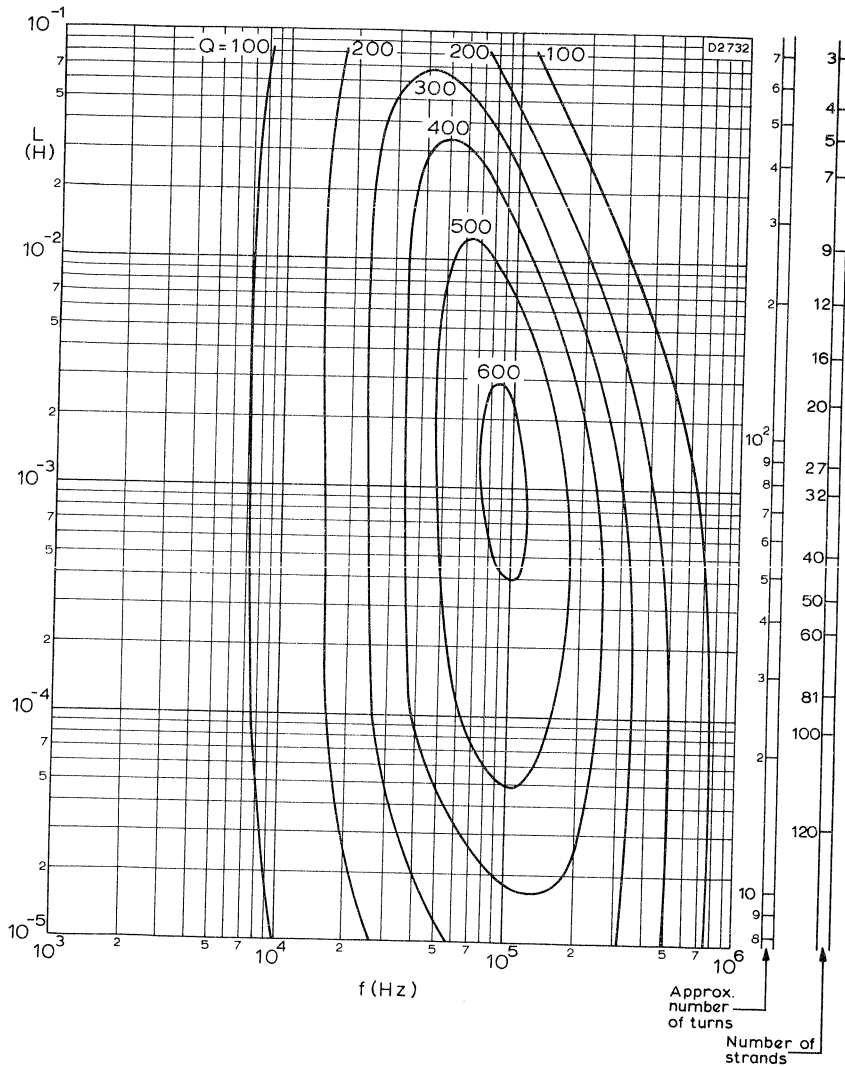
ISO - CURVES

These curves show typical Q-factors obtainable with full windings of 0,040 mm diameter bunched conductors on coil formers 4322 021 32360/32380. FXC grade 3H1,  $A_L = 100$ .



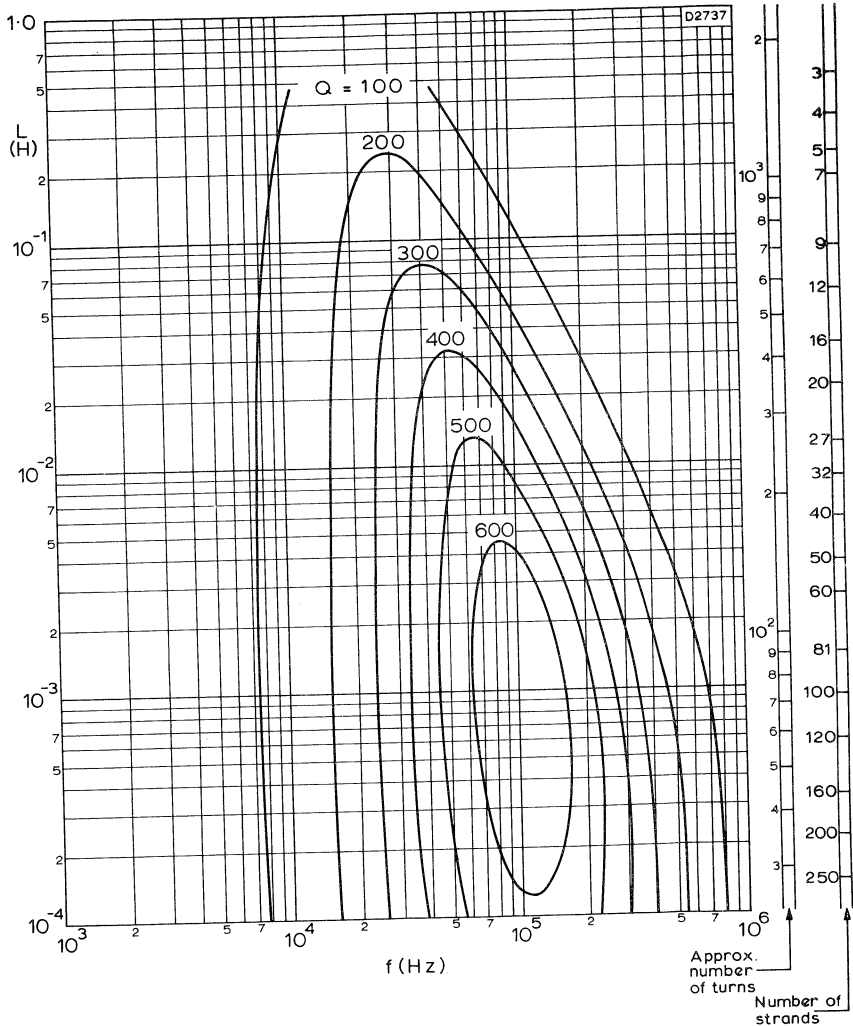
ISO - Q CURVES

These curves show typical Q-factors obtainable with full windings of enamelled copper wire on coil formers 4322 021 32360/32380. Material grade FXC 3H1,  $A_L = 160$ .



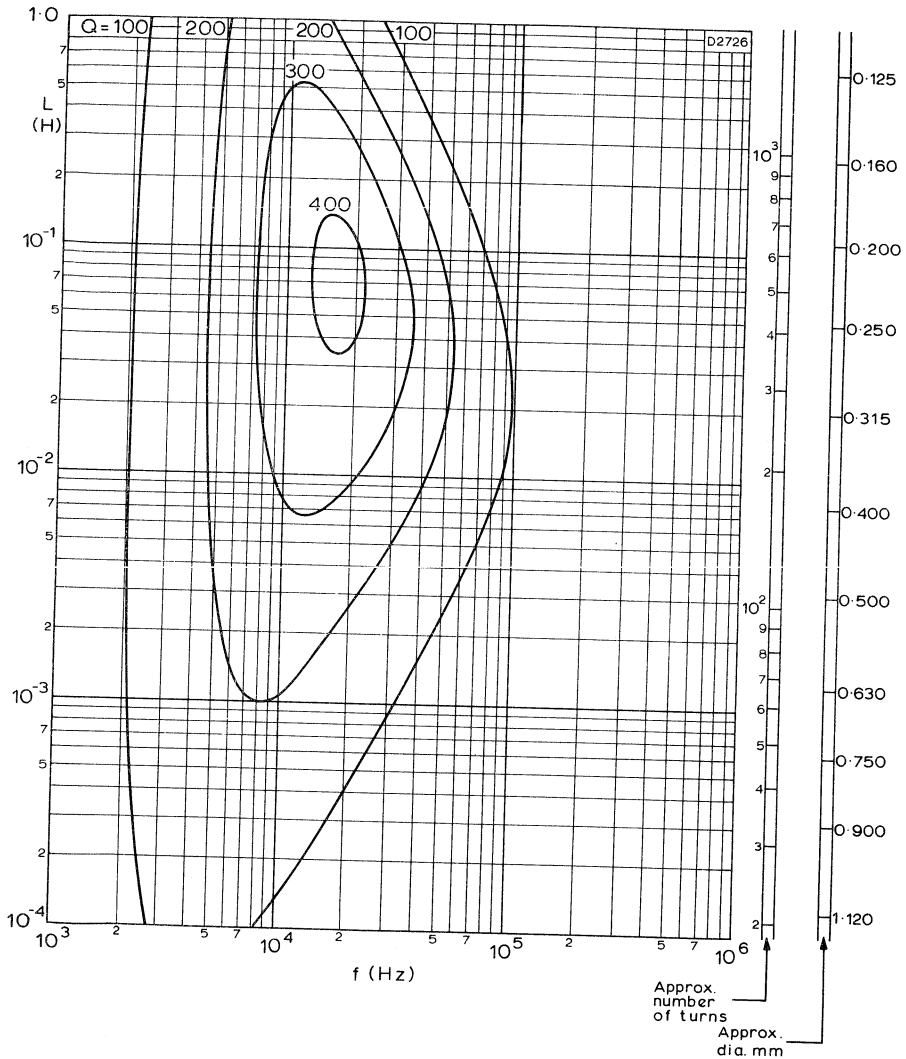
ISO - CURVES

These curves show typical Q-factors obtainable with full windings of 0,071 mm diameter bunched conductors on coil formers 4322 021 32360/32380. FXC grade 3H1,  $A_L = 160$ .



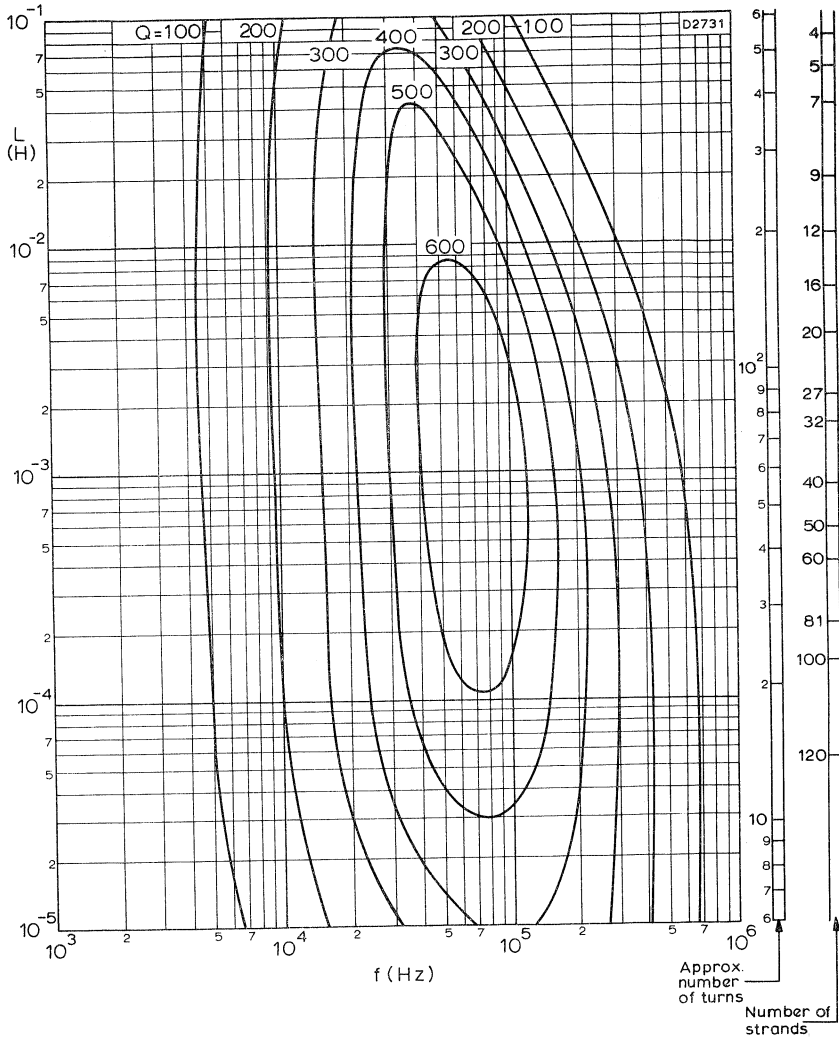
ISO - CURVES

These curves show typical Q-factors obtainable with full windings of 0,040 mm diameter bunched conductors on coil formers 4322 021 32360/32380. FXC grade 3H1,  $A_L = 160$ .



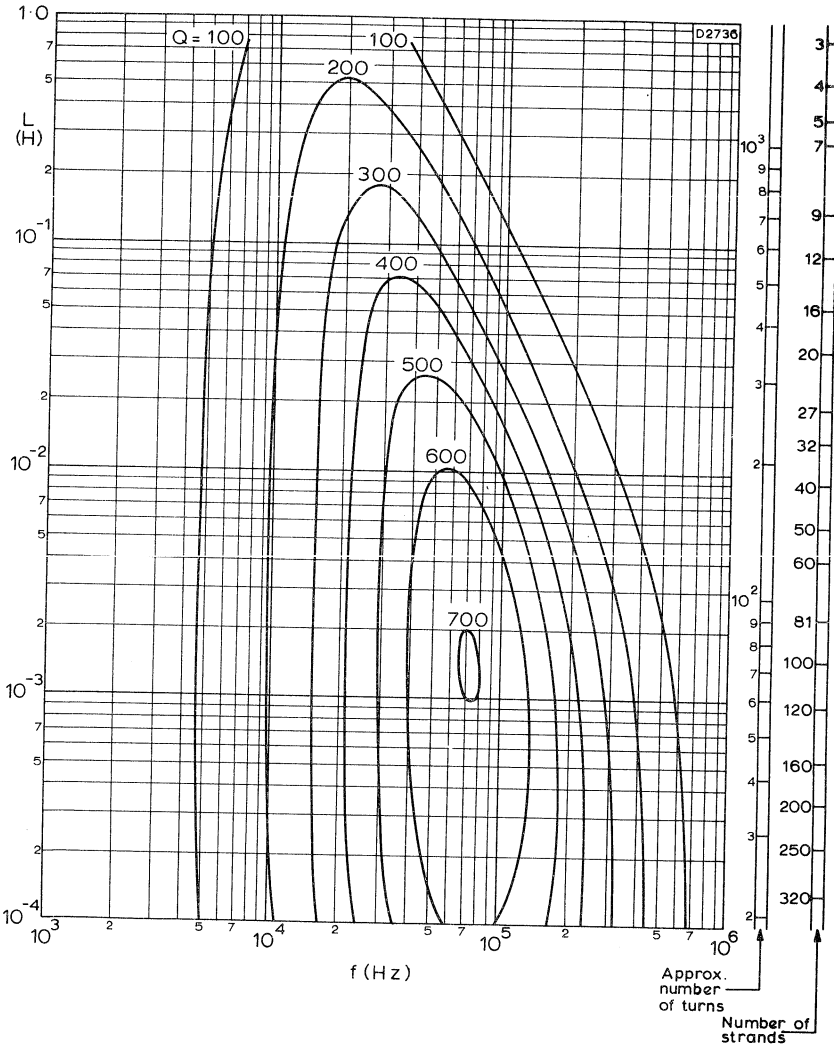
ISO - Q CURVES

These curves show typical Q-factors obtainable with full windings of enamelled copper wire on coil formers 4322 021 32360/32380. Material grade FXC 3H1,  $A_L = 250$ .



ISO - CURVES

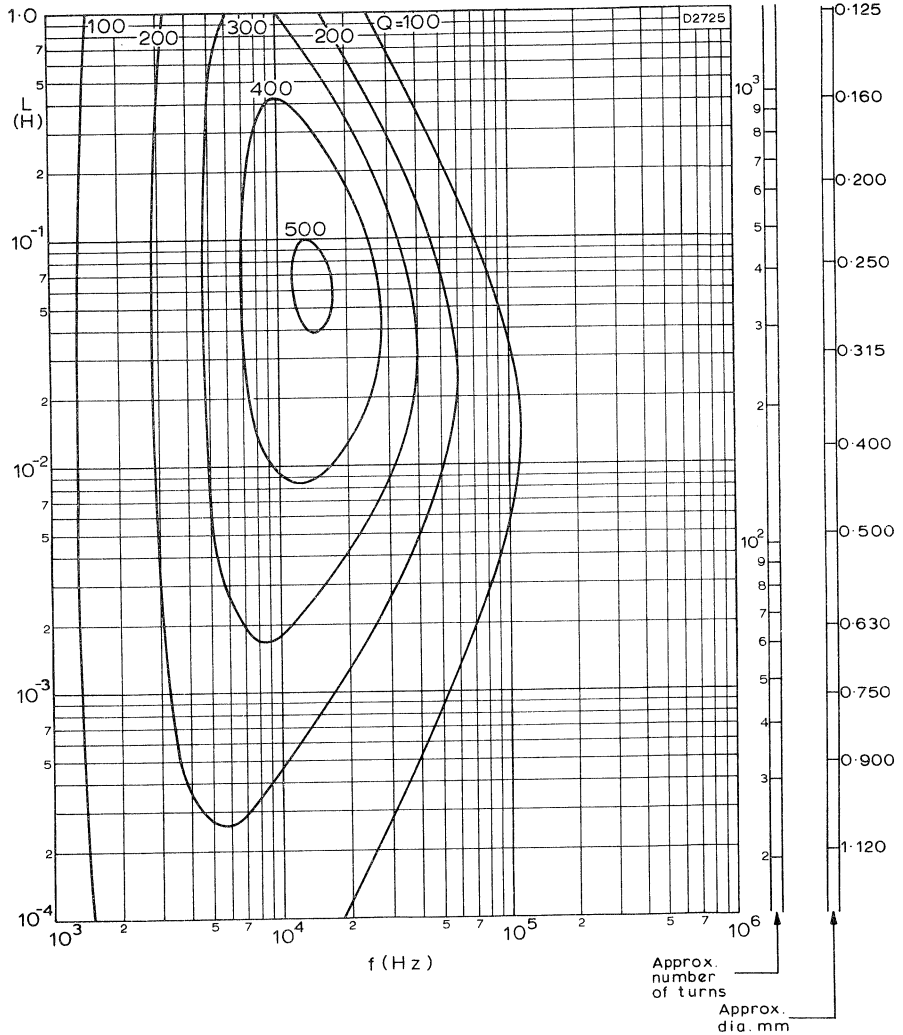
These curves show typical Q-factors obtainable with full windings of 0,071 mm diameter bunched conductors on coil formers 4322 021 32360/32380. FXC grade 3H1,  $A_L = 250$ .



ISO - CURVES

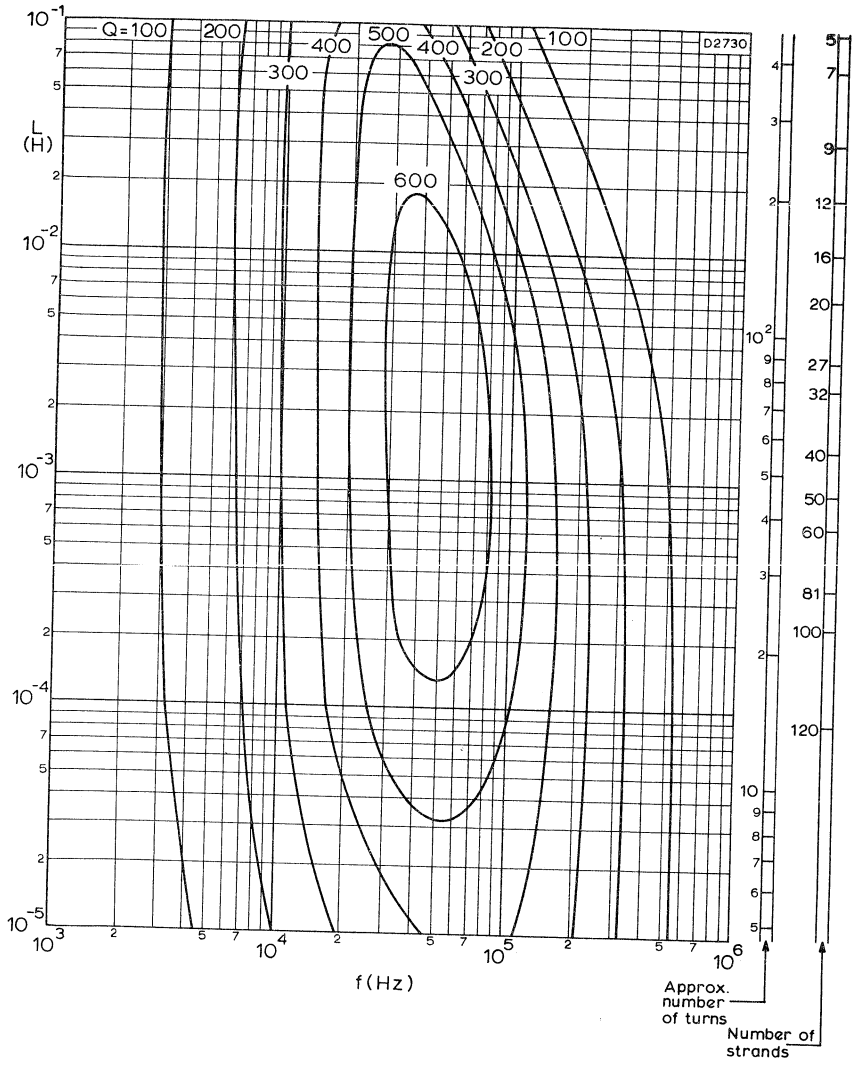
These curves show typical Q-factors obtainable with full windings of 0,040 mm diameter bunched conductors on coil formers 4322 021 32360/32380. FXC grade 3H1,  $A_L = 250$ .





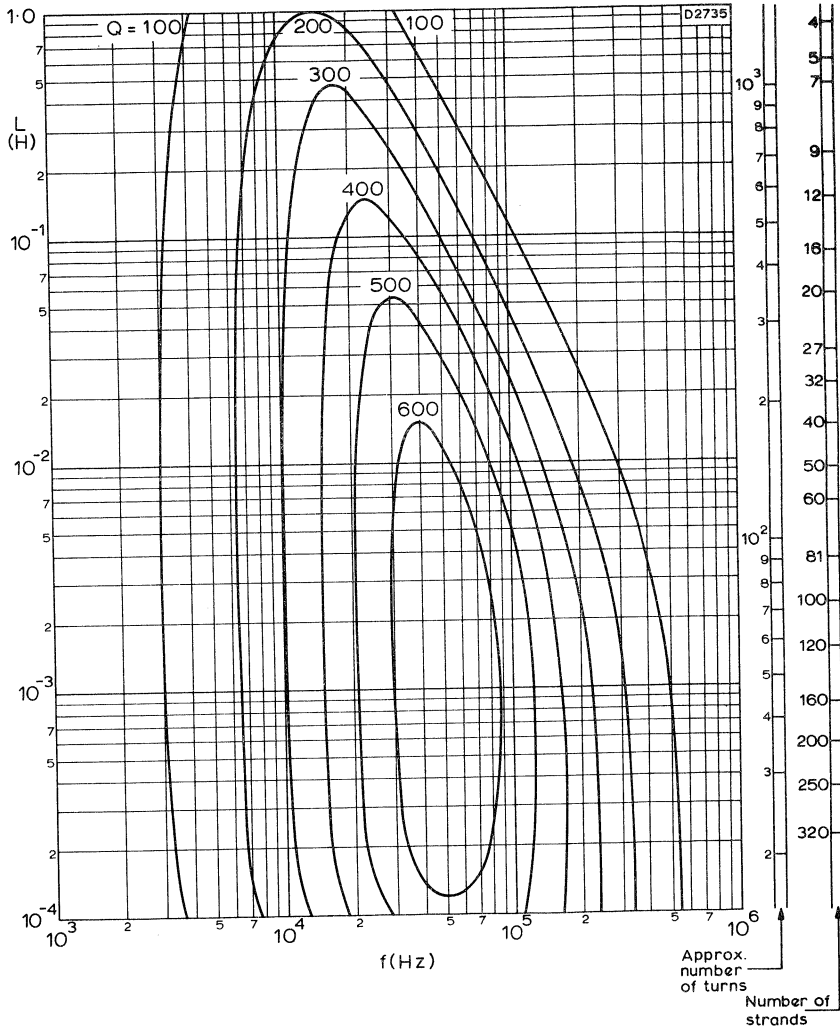
ISO - Q CURVES

These curves show typical Q-factors obtainable with full windings of enamelled copper wire on coil formers 4322 021 32360/32380. Material grade FXC 3H1,  $A_L = 400$ .



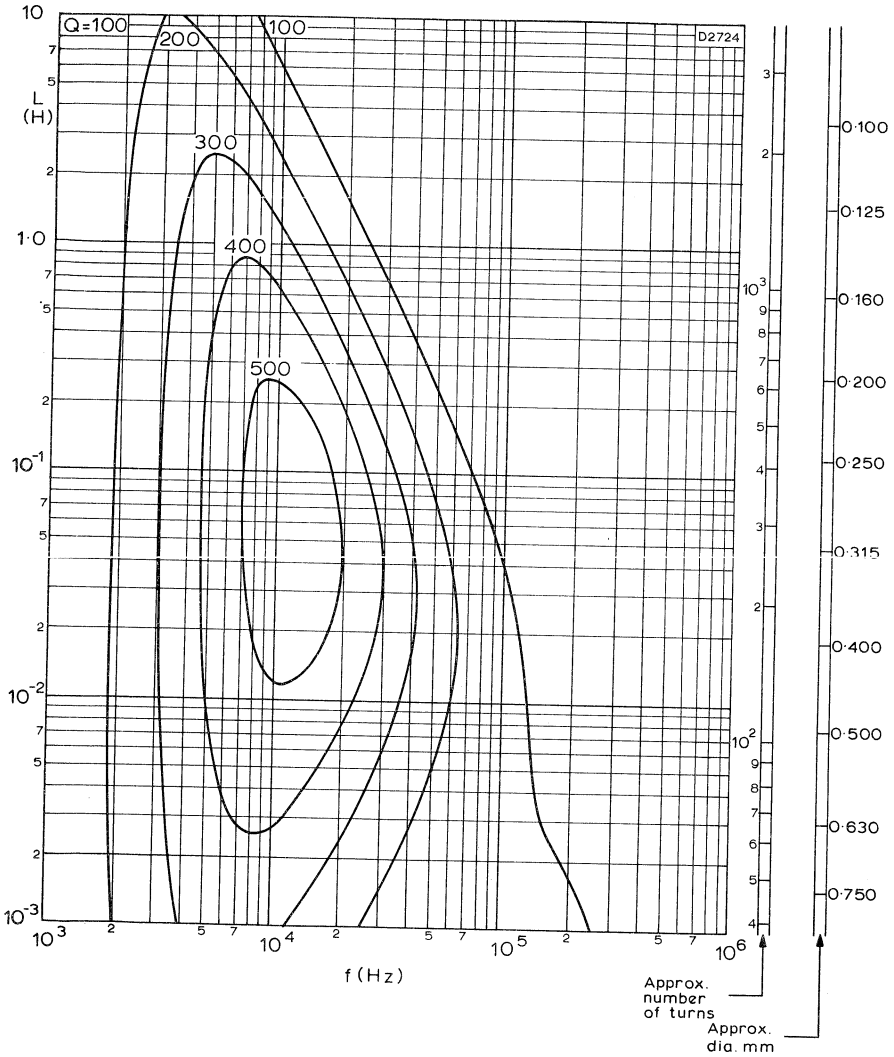
ISO - CURVES

These curves show typical Q-factors obtainable with full windings of 0,071 mm diameter bunched conductors on coil formers 4322 021 32360/32380. FXC grade 3H1,  $A_L = 400$ .



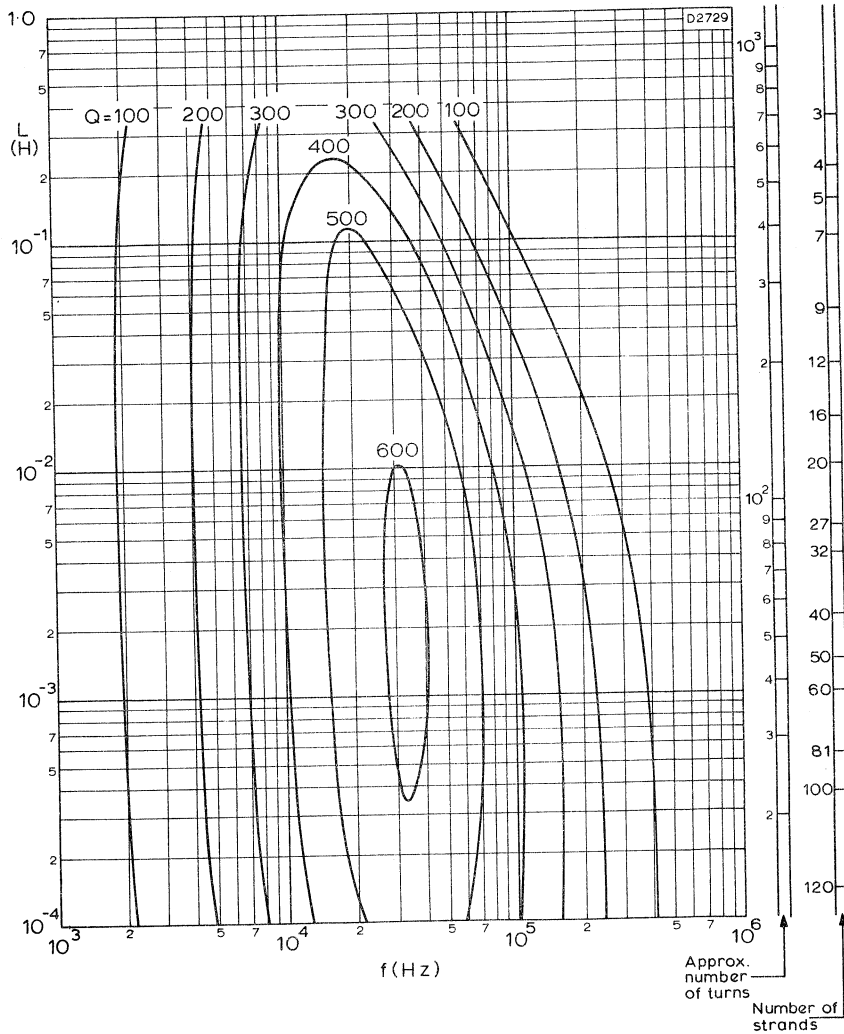
ISO - CURVES

These curves show typical Q-factors obtainable with full windings of 0,040 mm diameter bunched conductors on coil formers 4322 021 32360/32380. FXC grade 3H1,  $A_L = 400$ .



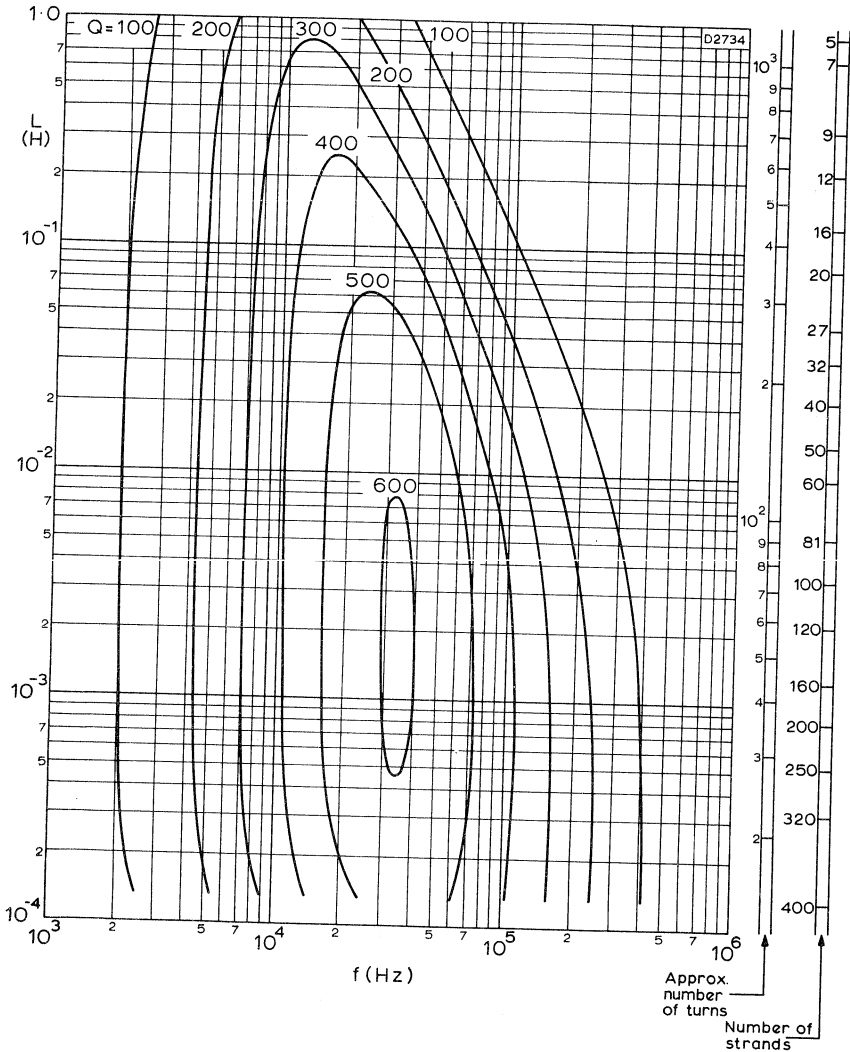
ISO - Q CURVES

These curves show typical Q-factors obtainable with full windings of enamelled copper wire on coil formers 4322 021 32360/32380. Material grade FXC 3H1,  $A_L = 630$ .



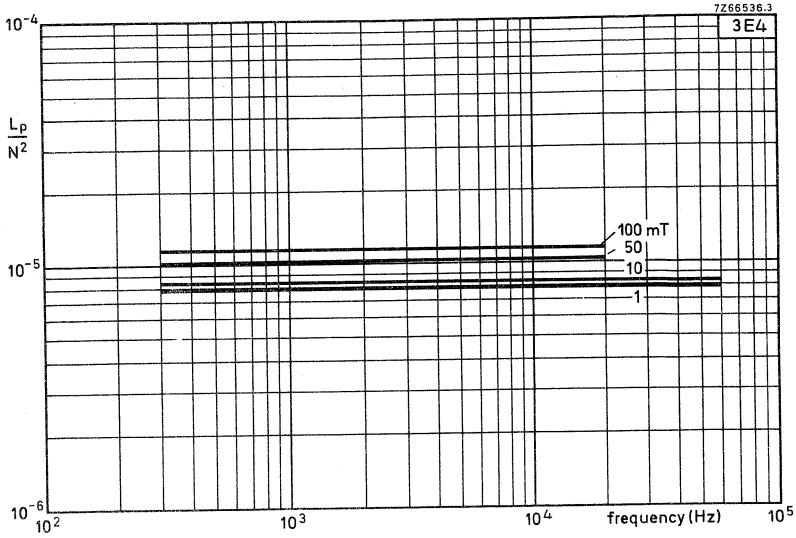
ISO - Q CURVES

These curves show typical Q-factors obtainable with full windings of 0,071 mm diameter bunched conductors on coil formers 4322 021 32360/32380. Material grade FXC 3H1,  $A_L = 630$ .

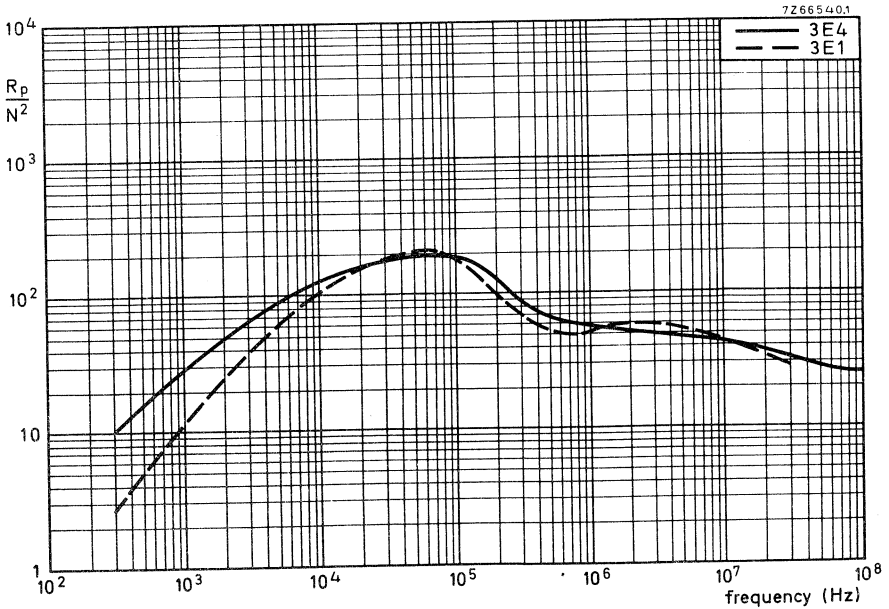


ISO - Q CURVES

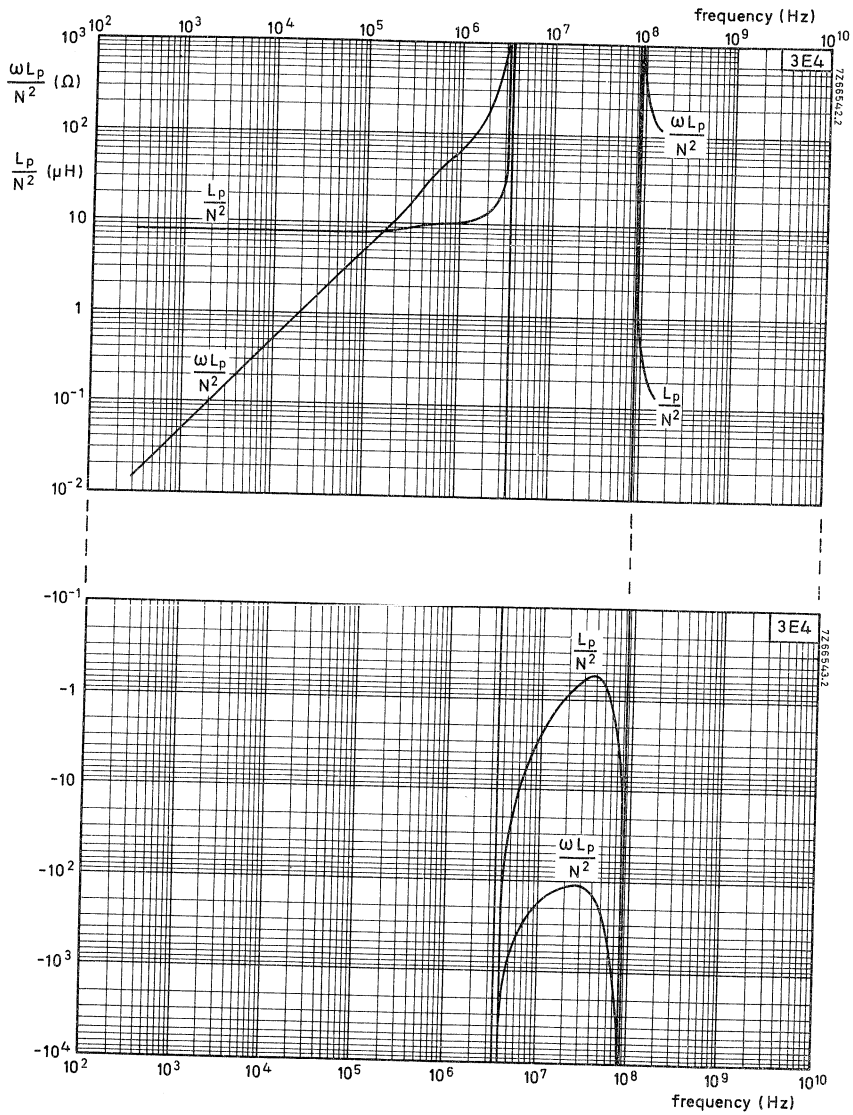
These curves show typical Q-factors obtainable with full windings of 0,040 mm diameter bunched conductors on coil formers 4322 021 32360/32380. Material grade FXC 3H1,  $A_L = 630$ .



Inductance as a function of the frequency (typical values).

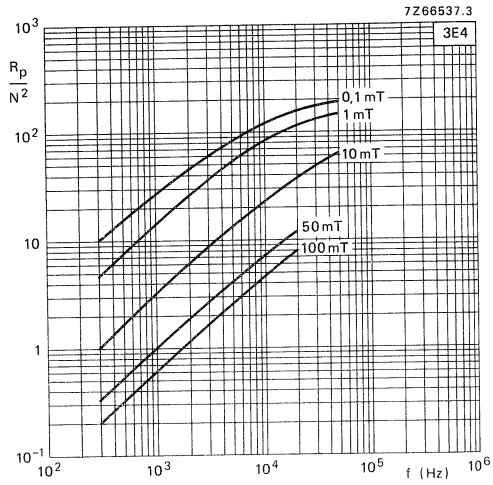


Losses as a function of the frequency at  $\hat{B} \approx 0,1$  mT (typical values).

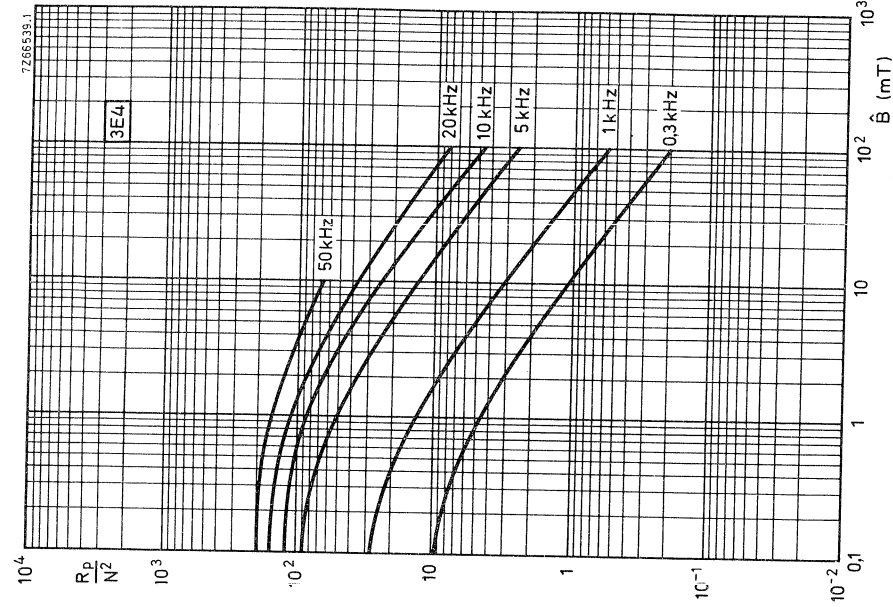


Inductance as a function of the frequency (typical values).

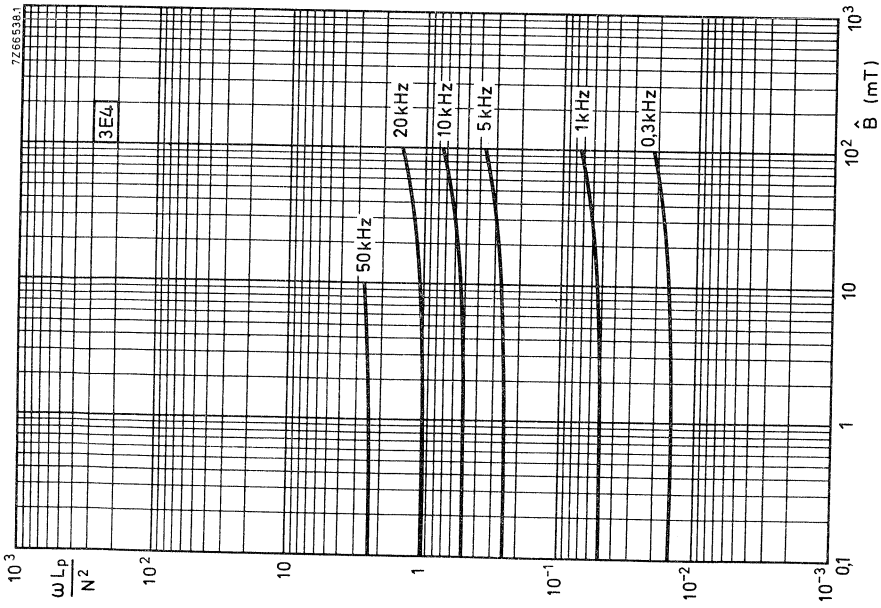




Losses as a function of the frequency (typical values).

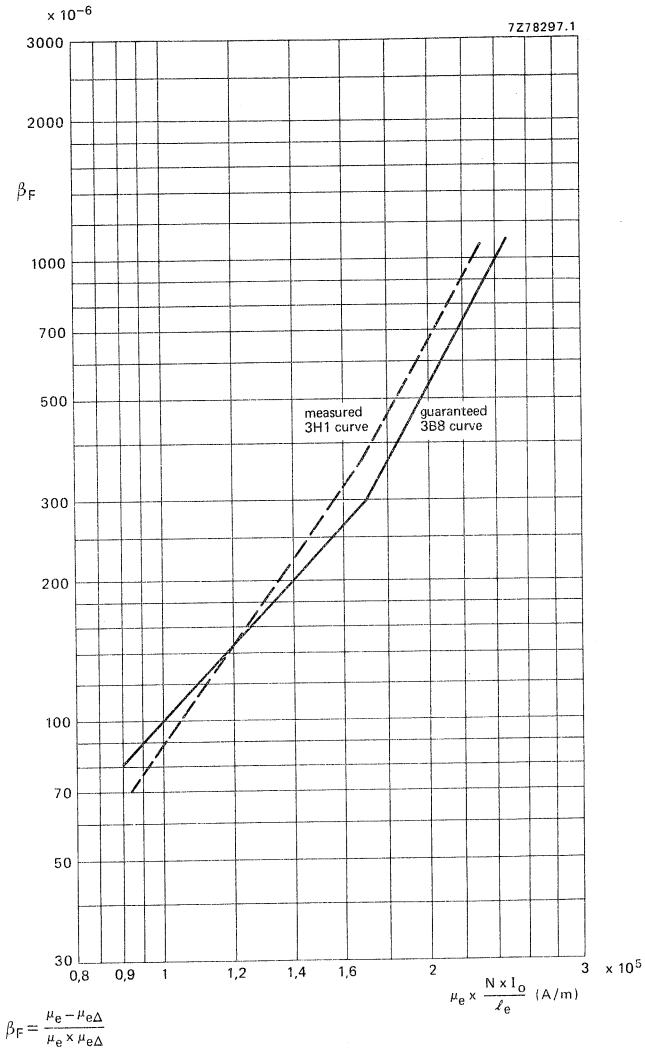


Losses as a function of the peak induction (typical values).



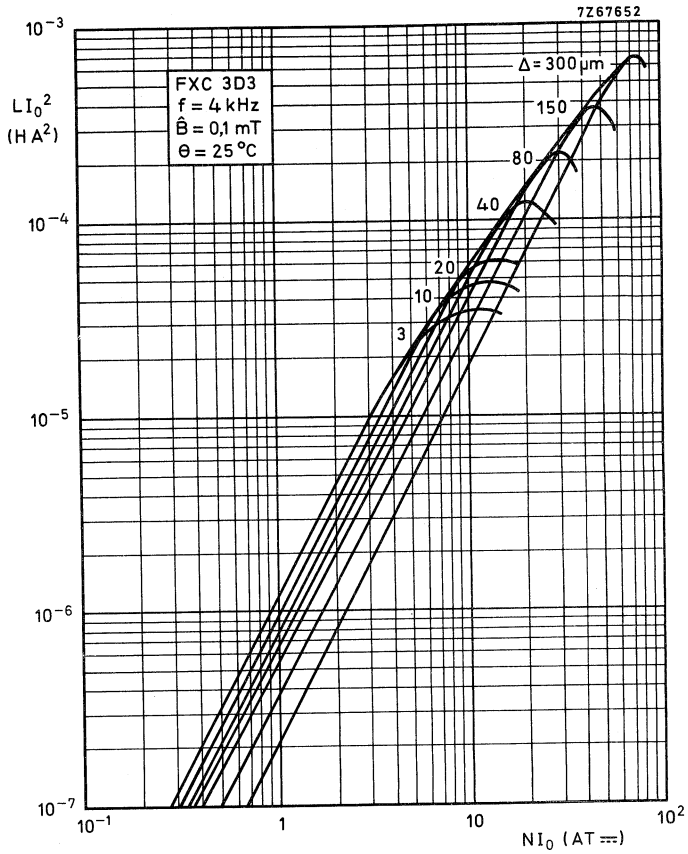
Inductance as a function of the peak induction (typical values).

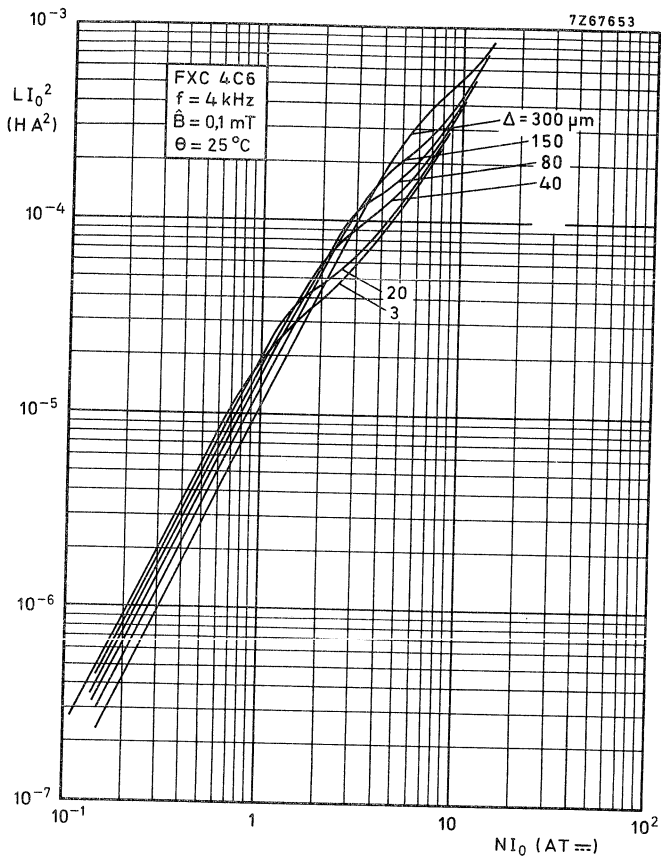
D.C. SENSITIVITY AT 25 °C

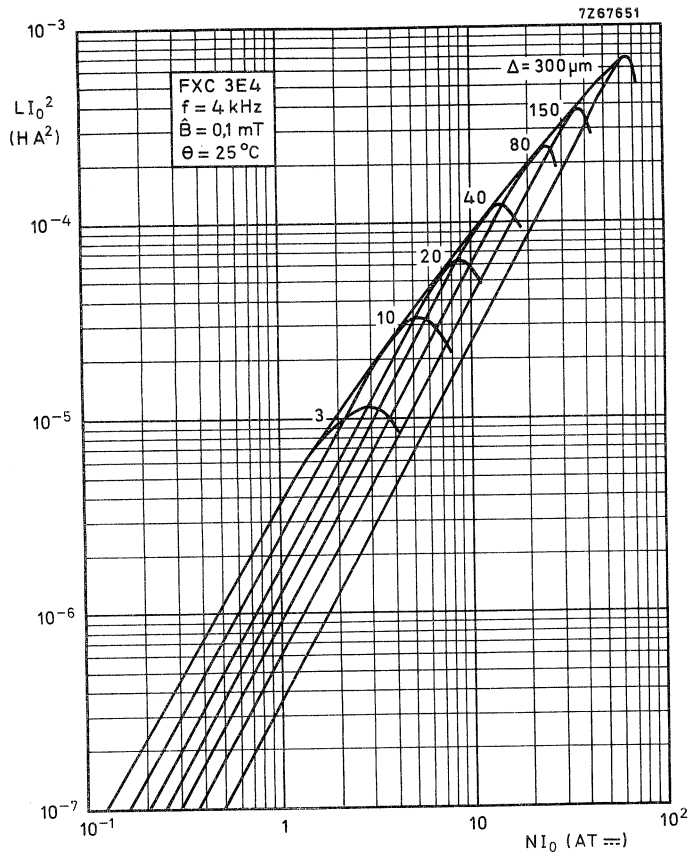


Induction variation as a function of d.c. polarization.

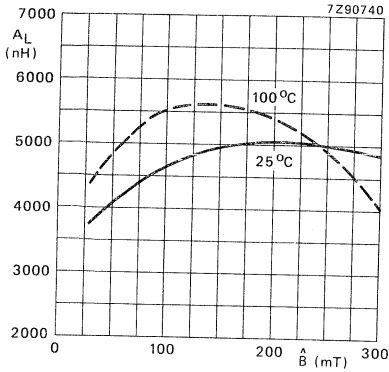




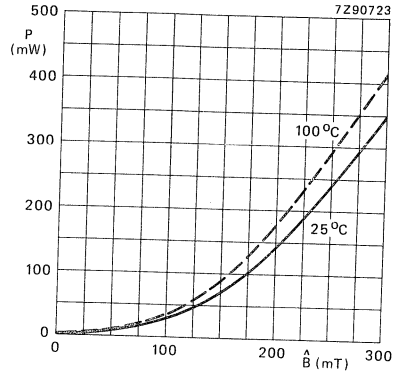




FXC3B8



$A_L = f(\hat{B})$  at 16 kHz, and at 25 and 100 °C. No airgap.



$P = f(\hat{B})$  at 16 kHz, and at 25 and 100 °C.

$\hat{B}$  is calculated with  $A_{CPmin} = 55,42 \text{ mm}^2$ .



## SQUARE CORES

Three types of core can be supplied:

- CORE SETS provided with an injection-moulded nut for an adjuster and pre-adjusted on an inductance factor  $A_L$ .
- CORE SETS without nut and pre-adjusted on an  $A_L$  value.
- CORE HALVES without air gap.

The square cores are in accordance with the following specifications: IEC 431, CECC 25000 series, UTE 83-300 series, DIN 41980.

Square cores and associated parts are ordered by their 12-digit catalogue number. Quantity: a primary pack contains 20 core sets or 40 core halves; a storage pack contains 100 core sets or 200 core halves. Please order in multiples of these quantities.

### MECHANICAL DATA

Dimensions in mm

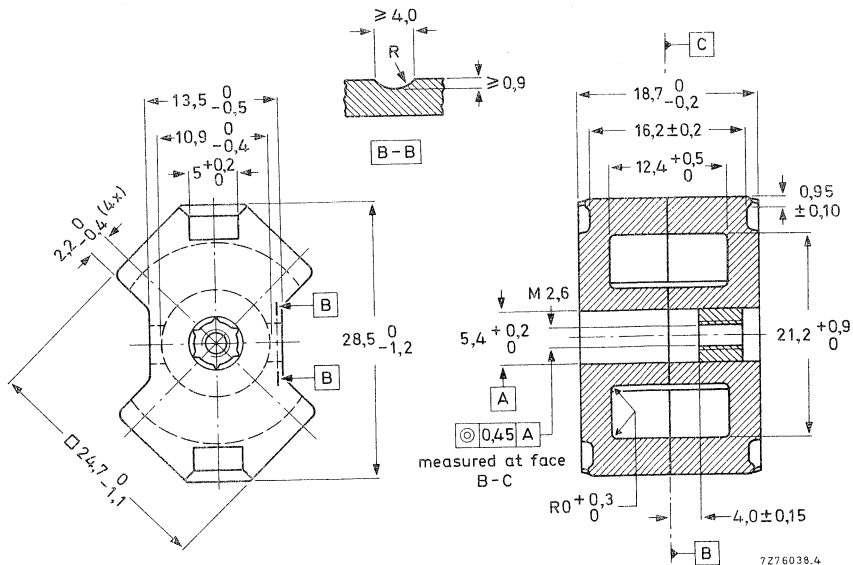


Fig. 1.

Pulling-out force of the nut  $\geq 50$  N

**MECHANICAL DATA** (continued)

Dimensional quantities according to IEC 205:

- Version A (with centre hole):

$$C_1 = \Sigma \frac{l}{A} = 0,501 \text{ mm}^{-1}; C_2 = \Sigma \frac{l}{A^2} = 0,00602 \text{ mm}^{-3}; V_e = 3470 \text{ mm}^3; l_e = 41,7 \text{ mm}; A_e = 83,2 \text{ mm}^2.$$

Mass of a core set: 20 g.

Version B (without centre hole):

$$C_1 = \Sigma \frac{l}{A} = 0,462 \text{ mm}^{-1}; C_2 = \Sigma \frac{l}{A^2} = 0,00479 \text{ mm}^{-3}; V_e = 4310 \text{ mm}^3; l_e = 44,6 \text{ mm}; A_e = 96,6 \text{ mm}^2.$$

$A_{CP \text{ min}} = 89,1 \text{ mm}^2$

Mass of core set: 23 g.

**ELECTRICAL DATA**

The combination of two square core halves without air gap, randomly chosen from a batch, has the following guaranteed properties. A measuring coil as described in the General section 'Potcores, square cores and cross cores', is inserted; the halves are pressed together with a force of 130 N. The values are valid 5 minutes or more after clamping.

	freq. kHz	$\hat{B}$ mT	H A/m	temp. °C	grade			
					3B8	3C8	3E4	3H1
$A_L \pm 25\%$	4	$\leq 0,1$		$25 \pm 5$	5310	4500 (1)	11 000	4900
$\mu_e \pm 25\%$	4	$\leq 0,1$		$25 \pm 5$	1950	1650	4190	1950
$\alpha$	4	$\leq 0,1$		$25 \pm 5$	$\leq 15,8$	$\leq 16,8$	$\leq 11,0$	$\leq 16,5$
$\tan \delta \times 10^6$	4	$\leq 0,1$		$25 \pm 5$			$\leq 2,5$	
$\frac{\mu_i}{\mu_1}$	30	$\leq 0,1$		$25 \pm 5$				$\leq 2,5$
	100	$\leq 0,1$		$25 \pm 5$			$\leq 20$	$\leq 5,0$
	500	$\leq 0,1$		$25 \pm 5$			$\leq 200$	
P (W)	25	200 (2)		$25 \pm 5$	$\leq 0,6$	$\leq 0,7$		
				$100 \pm 5$	$\leq 0,7$	$\leq 0,6$ (3)		
$\eta_B \times 10^3$	4	1,5-3,0		$25 \pm 5$			$\leq 1,1$	$\leq 0,86$
	30	1,5-3,0		$25 \pm 5$				
$\alpha_F \times 10^6 / K$	$\leq 100$	$\leq 0,1$		5 to 25			0 to +2	+ 0,5 to + 1,5
				25 to 55			0 to +2	+ 0,5 to + 1,5
				25 to 75			0 to +2	+ 0,5 to + 1,5
$D_F \times 10^6$ (10-100 min.)	$\leq 100$	$\leq 0,1$		$25 \pm 1$			$\leq 4,3$	$\leq 4,3$
$\hat{B}$ (mT) (2)	25		250	$100 \pm 5$		$\geq 315$		
$\beta_F \times 10^6$ measured on sets with $\mu_e = 300 \pm 10\%$ and $25 \pm 1$ °C:								
at $\mu_e \times \frac{N \times I_0}{l_e} = 1,00 \times 10^5$ A/m					$\leq 110$			
= $1,60 \times 10^5$ A/m					$\leq 300$			
= $2,30 \times 10^5$ A/m					$\leq 1050$			

(1)  $\geq 5050$  at 25 kHz, 200 mT and  $100 \pm 5$  °C.

(2)  $\hat{B}$  is calculated with  $A_{CP \text{ min}} = 89,1 \text{ mm}^2$ .

(3) Dip in loss curve at  $85 \pm 15$  °C.

Versions

1. Core sets with nut and pre-adjusted on  $A_L$

$A_L$	corresponding $\mu_e$ -value	tol. on inductance (%)	catalogue number 4322 022 . . . . .	
			3H1	
160	64	$\pm 2$	70250	
250	100	$\pm 2$	● 70260	
315	126	$\pm 2$	● 70270	
400	160	$\pm 3$	● 70280	
630	251	$\pm 4$	70300	
1 000	399	$\pm 10$	70310	

2. Core sets without centre hole and pre-adjusted on  $A_L$

$A_L$	corresponding $\mu_e$ -value	tol. on inductance (%)	catalogue number 4322 022 . . . . .		
			3B8	3C8	3E4
160	59	2	50460	50650	
250	92	2	● 50480	● 50660	
315	116	2	50490	50670	
400	147	3	● 50500	● 50680	
630	232	4	50520	50700	
1 000	368	10		50710	
1 600	588	10	50550		
11 000	4045	25			● 50910*

All pre-adjusted RM10 cores have an asymmetrical air gap.

3. Core halves

Ferroxcube grade	catalogue number
3B8	4322 020 28370*
3C8	4322 020 28380*
3H1	4322 020 28400

\* This core has no centre hole.

● Preferred type.

## COIL FORMERS

Five types of coil formers can be supplied:

- Single-section, 5-pin, catalogue number 4322 021 32440 (Fig. 1)
- Single-section, 8-pin, catalogue number 4322 021 32450 (Fig. 2)
- Single-section, 12-pin, catalogue number 4322 021 32470 (Fig. 3)
- Two-section, 8-pin, catalogue number 4322 021 32460 (Fig. 4)
- Two-section, 12-pin, catalogue number 4322 021 32790 (Fig. 5)

The arrangement of the soldering pins is suitable for both 0,1 inch and 2,50 mm grid. See "Mounting". The coil formers are packed on a polystyrene plate of 50 and 4 plates (200 pcs) in a cardboard box. Please order in multiples of these quantities.

### PROPERTIES

	SINGLE-SECTION	TWO-SECTION
Material	phenolformaldehyde reinforced with glass fibre	
Solderability	resistant against dip-soldering at 400 °C for 2 s	
D.C. losses: $\frac{R_0}{L}$	$\frac{1}{\mu_e} \times \frac{1}{f_{cu}} \times 8,17 \times 10^3 \Omega/H$	$\frac{1}{\mu_e} \times \frac{1}{f_{cu}} \times 8,12 \times 10^3 \Omega/H$
Window area	44,9 mm <sup>2</sup>	2 x 23,6 mm <sup>2</sup>
Mean length of turn	52 mm	52 mm
Max. temperature	180 °C	180 °C
Inflammability	UL94, class V-0	UL94, class V-0
Mass	1,5 g	1,7 g

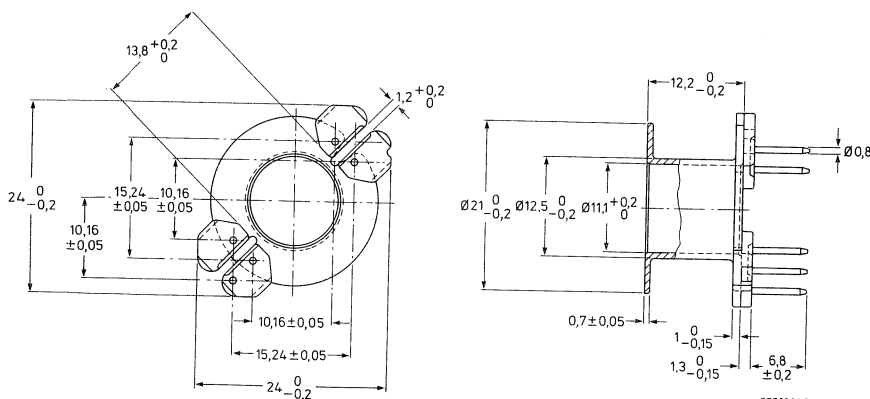


Fig. 1.

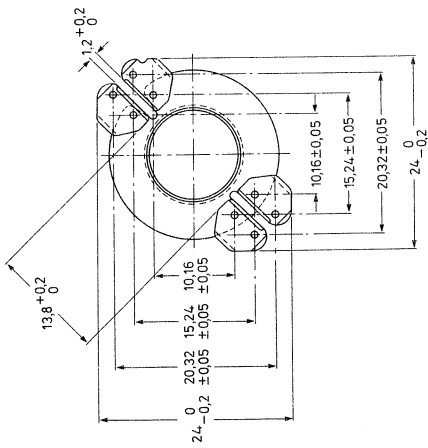
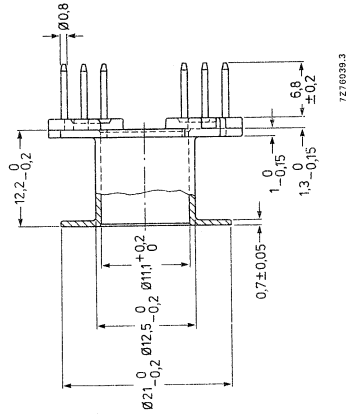


Fig. 2.



7Z76040.3A

Fig. 4.

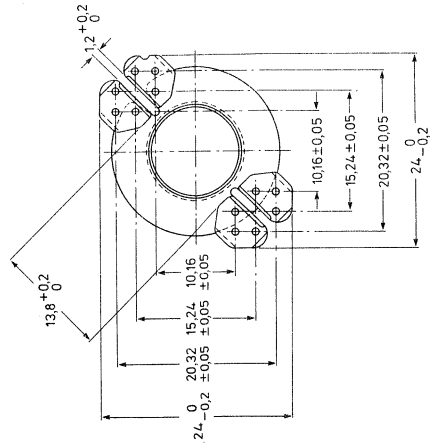
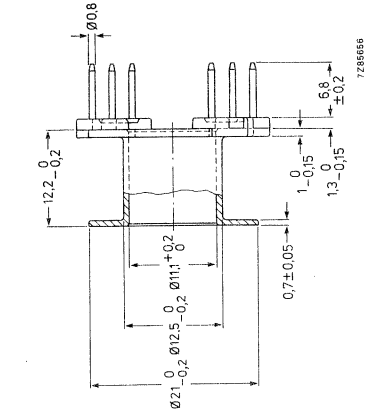


Fig. 3.



7Z76040.3A

Fig. 5.

## INDUCTANCE ADJUSTERS (old types)

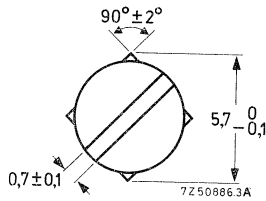
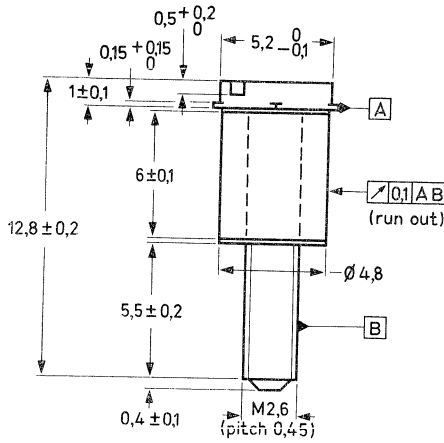


Fig. 1.

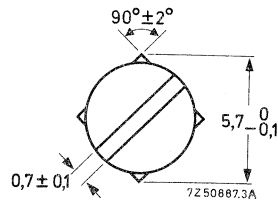
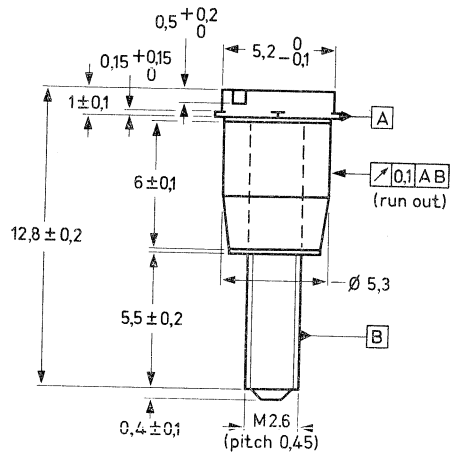


Fig. 2.

The tolerances on inductance of the pre-adjusted square cores (with adjuster) are given on the previous page. After inserting a coil (impregnated or not) in an electrical circuit, its inductance can be adjusted to the required value with an accuracy  $< 0,03\%$  by means of a continuous inductance adjuster. Such an adjuster increases the inductance of the coil, see following pages.

The adjuster is screwed through the square core into the nut and is held in position by the four protrusions near the top of the adjuster. For special requirements a bigger or smaller adjustment range may be obtained by using an adjuster belonging to the next higher or lower inductance factor.

The influence of the adjusters on the variability of the inductance is negligible.

The maximum permissible temperature is  $110\text{ }^{\circ}\text{C}$ .

The table shows the type of adjuster recommended for different square cores.

Types of adjuster and recommended applications

Fig.	colour	catalogue number 4322 021 .....	$A_L$
1	brown	30810	315
1	brown	30810	400
2	grey	31090	630
2	grey	31090	1000

The adjusters are packed in bags of 100, so please order in multiples of 100.

ADJUSTMENT CURVES

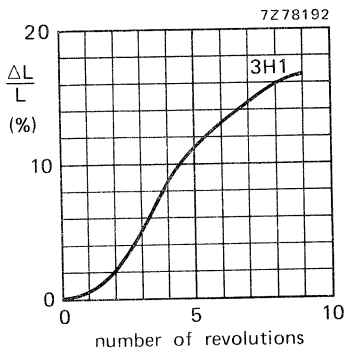


Fig. 4 Adjuster 4322 021 30810,  $A_L = 315$ .

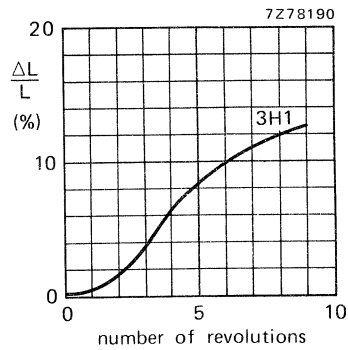


Fig. 5 Adjuster 4322 021 30810,  $A_L = 400$ .

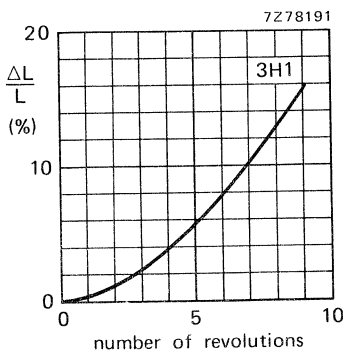


Fig. 6 Adjuster 4322 021 31090,  $A_L = 630$ .

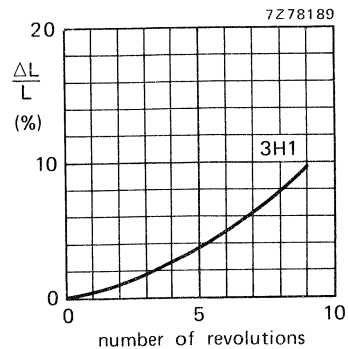


Fig. 7 Adjuster 4322 021 31090,  $A_L = 1000$ .





## INDUCTANCE ADJUSTERS (new types)

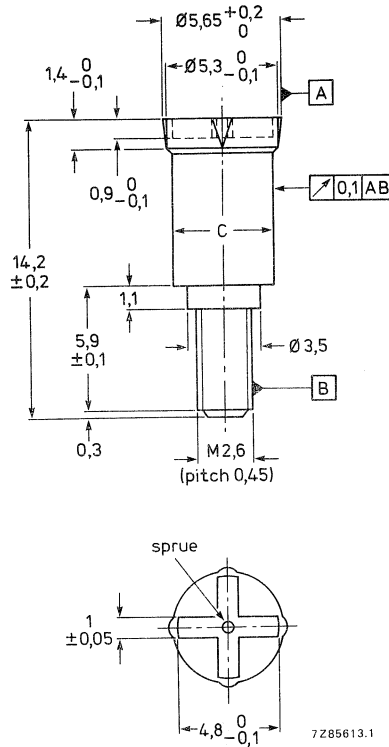


Fig. 1.

Material: polypropylene, reinforced with glass fibre.

The tolerances on inductance factor of the pre-adjusted cores without adjuster are given in the table of pre-adjusted cores with standard  $A_L$  values. The inductance of the pre-adjusted core can be increased to the required value — with a setting accuracy  $< 0,03\%$  — by means of a continuous adjuster.

The adjuster is screwed through the centre hole of the core into the nut and is held in position by the four cones near the top of the adjuster.

The combination of the polyamide moulded-in nut and the polypropylene adjuster — both reinforced with glass fibre — gives an excellent stability with temperature, shocks and vibrations. Besides this, the combination has a very smooth adjustment curve due to the excellent concentricity of the moulded-in nut and the adjuster.

The maximum permissible temperature of the adjustment combination is:  
150 °C, during 8 h. The maximum working temperature is 110 °C.

The tables below show the available types and which adjuster is recommended for typical  $A_L$  values.

Table 1 Colour code of adjusters

catalogue number	colour	dia. C (Fig. 1) mm	material
4322 021 38380	white	4,40	FXC
38390	grey	5,10	FXC

Table 2 Catalogue numbers of recommended adjusters for typical  $A_L$  values

$A_L$	3H1
160	
250	4322 021 38380
315	38380
400	38380
630	38390
1000	38390

**PACKAGING**

The adjusters are packed in bags of 100. Please order in multiples.

**ADJUSTING TOOL**

An adjusting tool combination for M2 and M2, 6 is available, catalogue number 4322 058 03270.

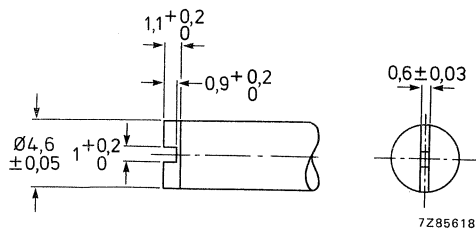


Fig. 2.

For customers who wish to make the screwdriver themselves the outlines of the essential part are given in Fig. 2.

**NUT FOR ADJUSTER**

These data are given for those manufacturers who prefer to insert the nut themselves.

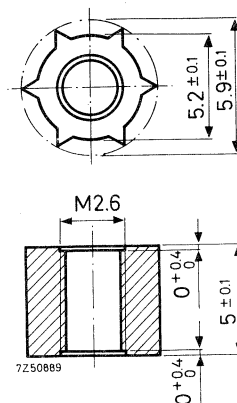


Fig. 3.

Catalogue number

4322 021 30160

Material

polycarbonate

Max. impregnation temperature for 24 hours

120 °C

Recommended distance from mating surface to nut

 $4,0 \pm 0,15$  mm

The nuts are packed in plastic bags of 100. Please order in multiples of this quantity.



## ASSEMBLING AND MOUNTING

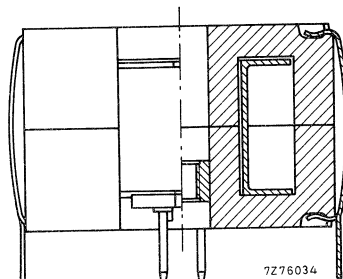


Fig. 1.

### ASSEMBLING

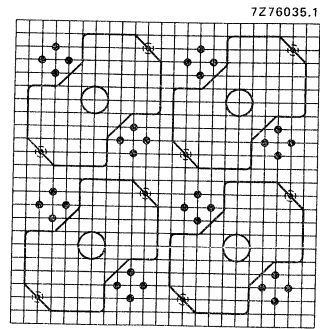
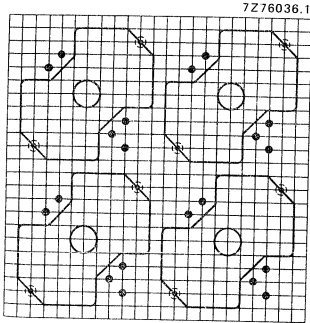
The core halves are clamped together by means of two clips, catalogue number 4313 021 04120. As can be seen in the drawing the hooked ends of both clips fit into the recesses made in the halves. For a stable inductance we recommend that an adhesive be applied between the coil former flange and the lower core half. The use of a suitable tool for attaching the clips is also recommended.

### MOUNTING

The two retaining clips are also used for mounting the assembled core on a printed-wiring board. The pins are simply soldered into the holes in the board. If so desired, one of the pins can also be used for earthing.

The soldering pins of coil formers and clips are so arranged that they will fit printed-wiring boards with a 0,1 inch grid as well as those with a 2,50 mm grid. The pin length is sufficient for a board thickness of up to 2,4 mm.

The recommended hole diameter in the board is  $1,0 \pm 0,1$  or  $1,3 \pm 0,1$  mm (according to IEC publication 97).



(1) Holes for tag on clip 4313 021 04120 (earth points).

Fig. 2 Hole pattern for an assembly of 4 cores, each fitted with a 5-pin coil former.

Fig. 3 Hole pattern for an assembly of 4 cores, each fitted with an 8-pin coil former.

**PART DRAWING**

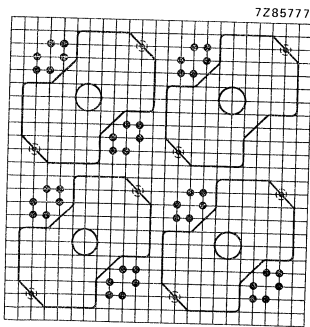


Fig. 4 Hole pattern for an assembly of 4 cores fitted with a 12-pin coil former.

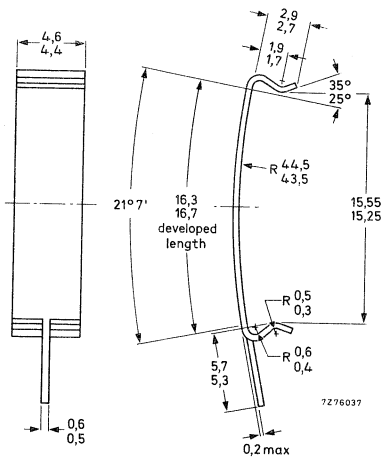
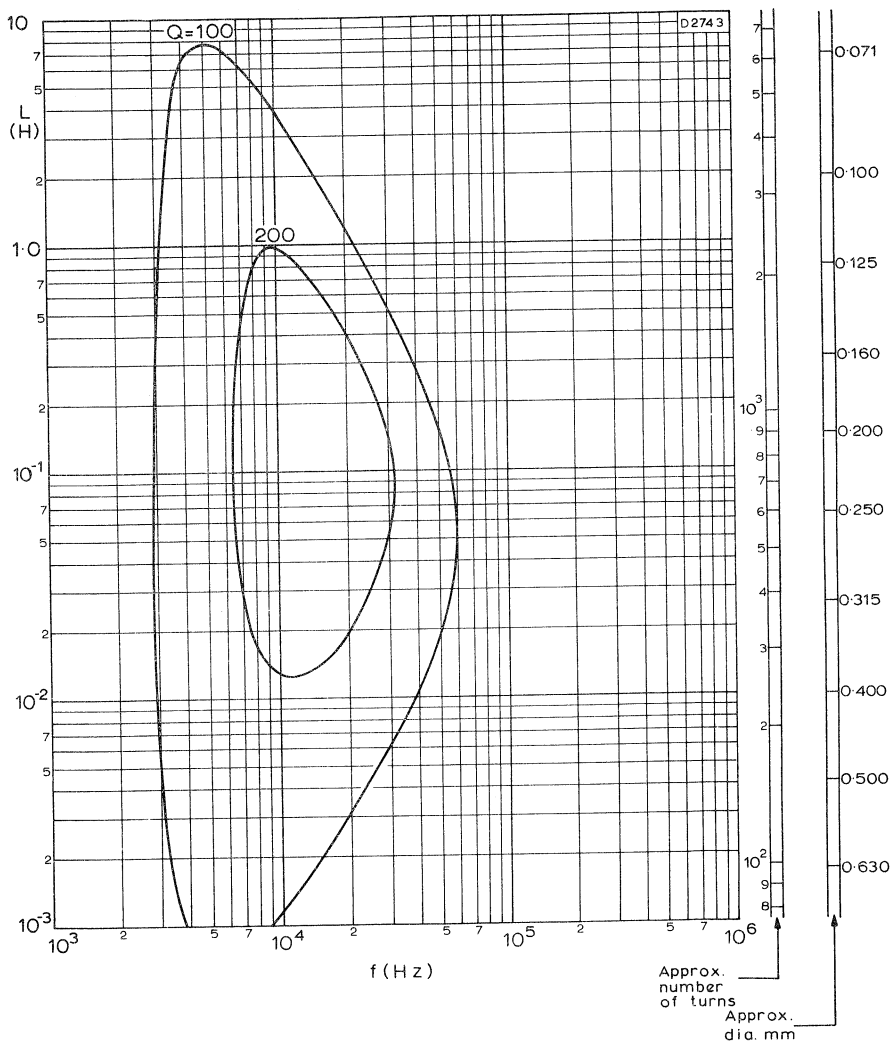
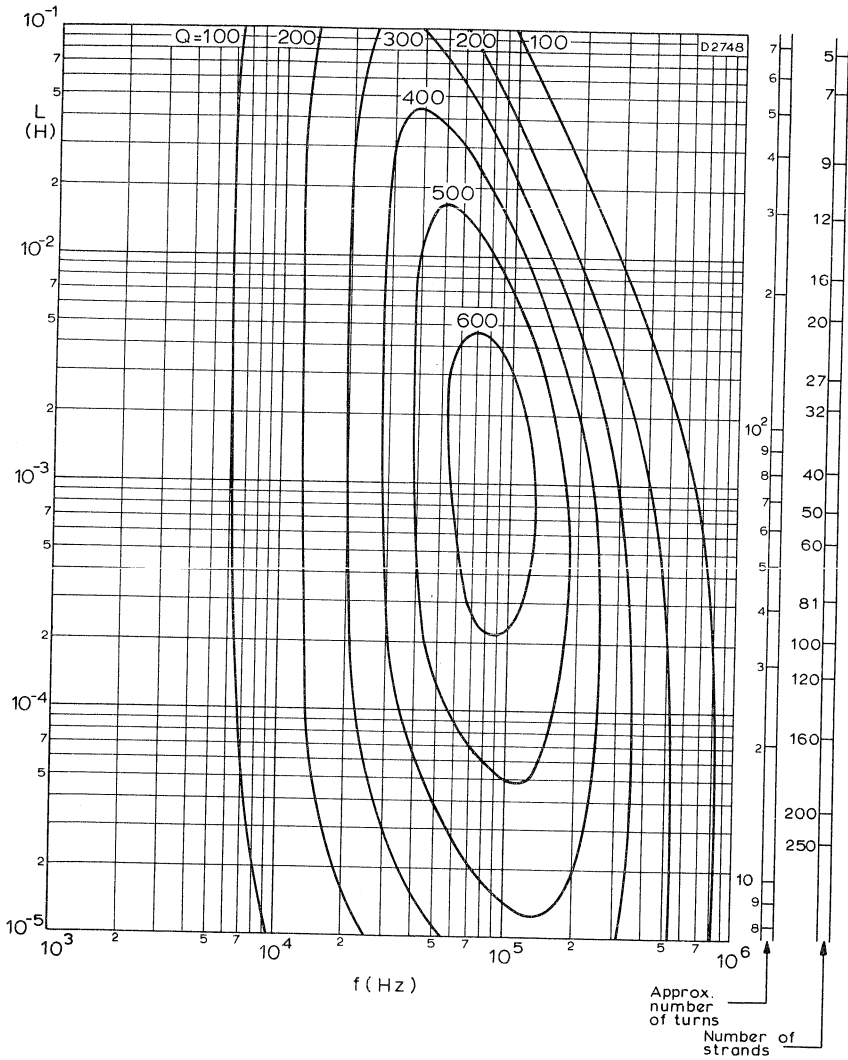


Fig. 5 Clip 4313 021 04120.  
Material: steel, tin plated, over nickel.



ISO-Q CURVES

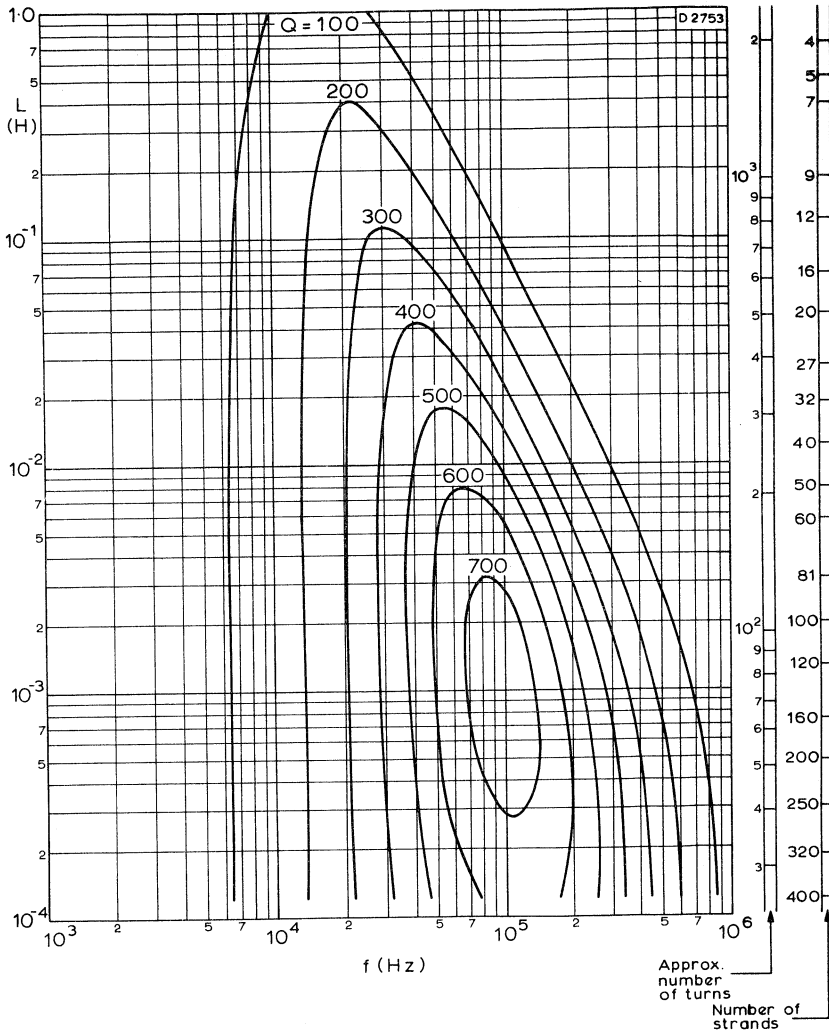
These curves show typical Q-factors obtainable with full windings of enamelled copper wire on a single-section coil former. Material grade FXC 3H1  $A_L = 160$ .



ISO-CURVES

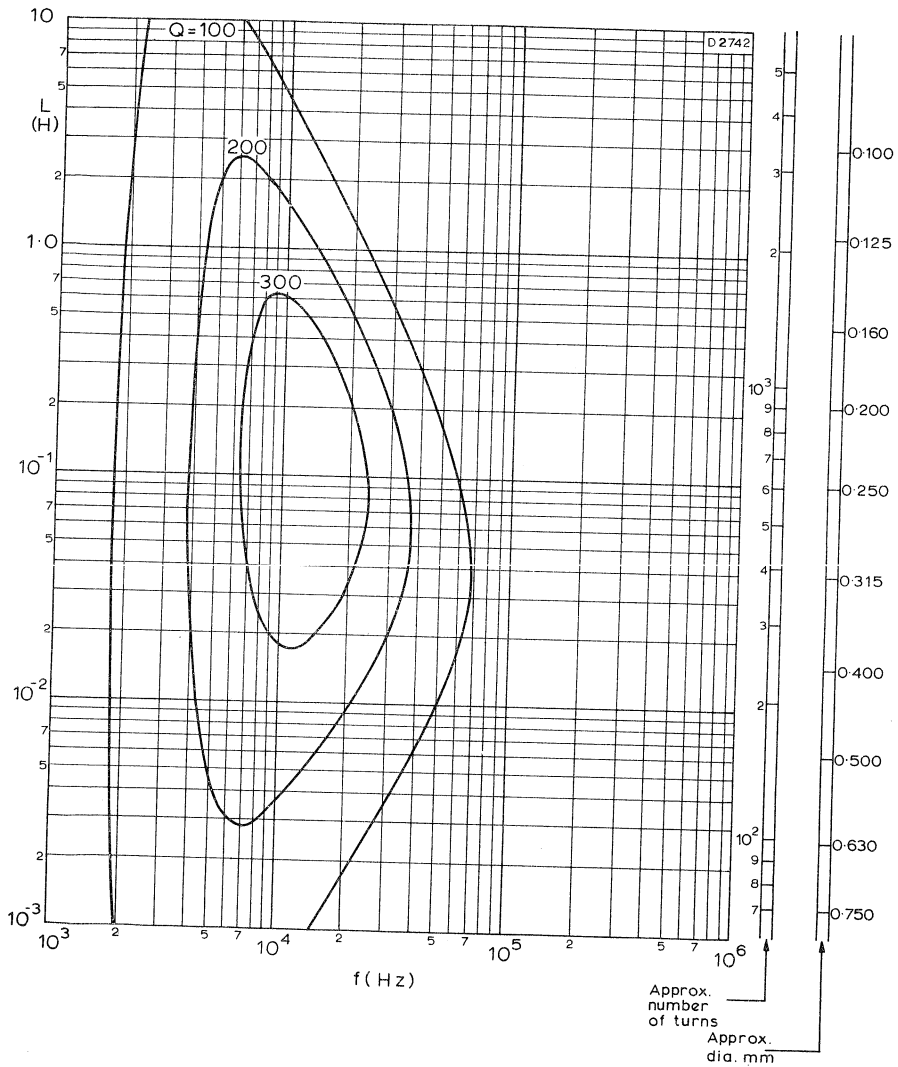
These curves show typical  $Q$ -factors obtainable with full windings of 0,071 mm diameter bunched conductors on a single-section coil former. FXC grade 3H1,  $A_L = 160$ .





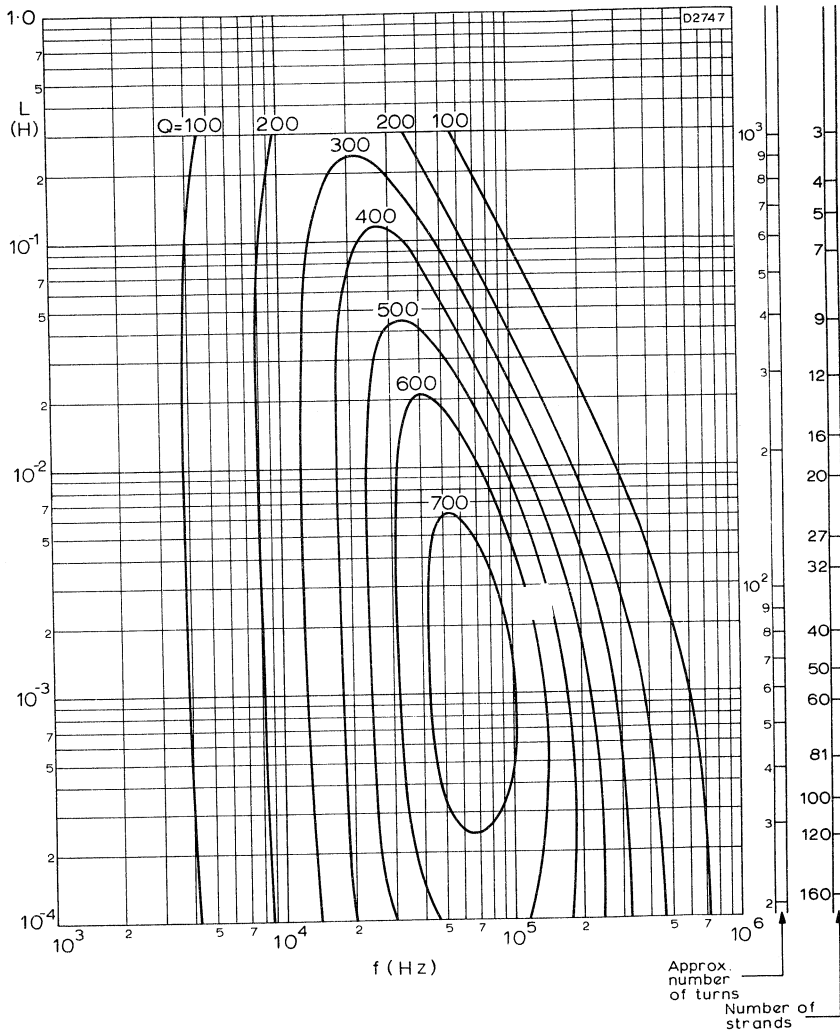
ISO-CURVES

These curves show typical Q-factors obtainable with full windings of 0,040 mm diameter bunched conductors on a single-section coil former. FXC grade 3H1,  $A_L = 160$ .



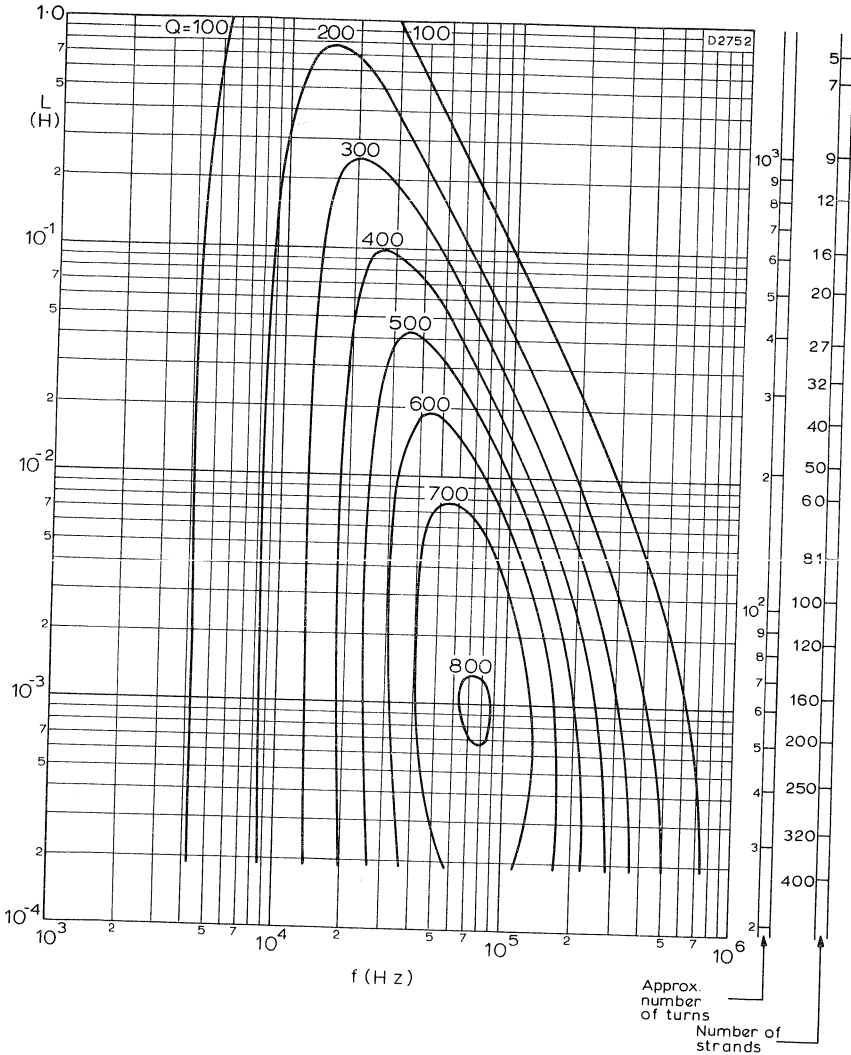
ISO-Q CURVES

These curves show typical Q-factors obtainable with full windings of enamelled copper wire on a single-section coil former. Material grade FXC 3H1,  $A_L = 250$ .



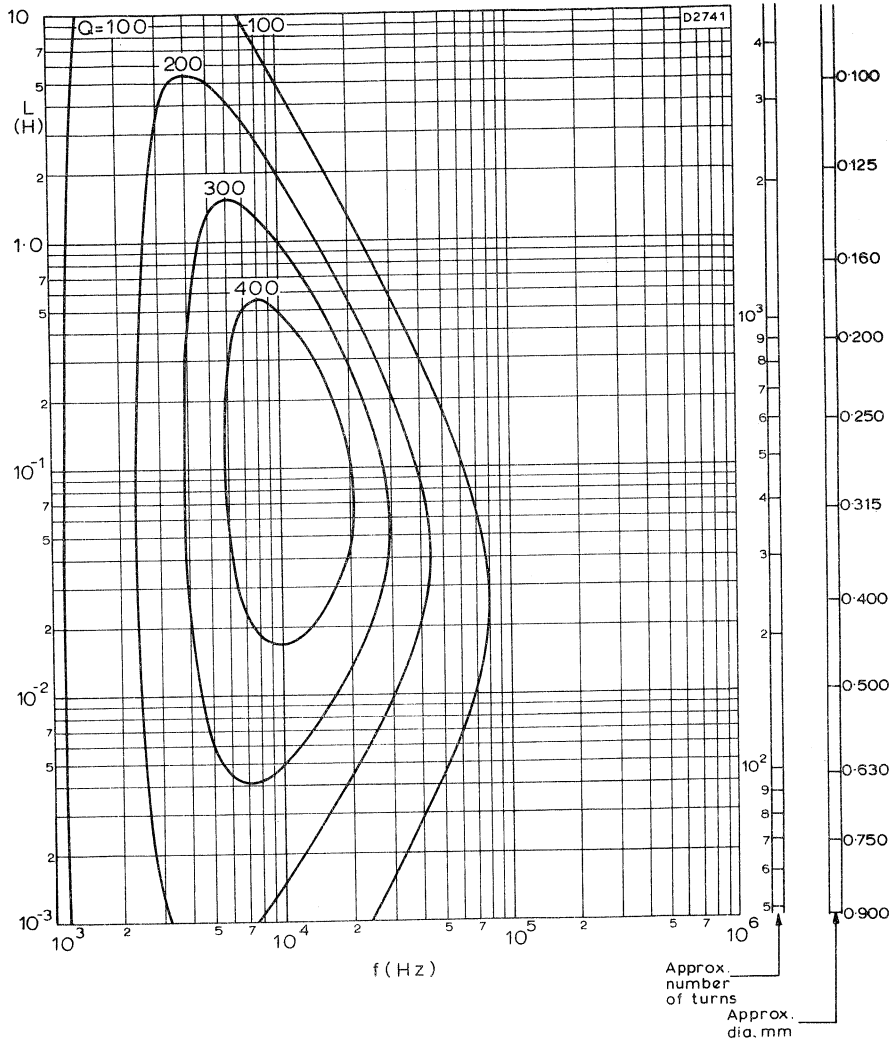
ISO-CURVES

These curves show typical Q-factors obtainable with full windings of 0,071 mm diameter bunched conductors on a single-section coil former. FXC grade 3H1,  $A_L = 250$ .



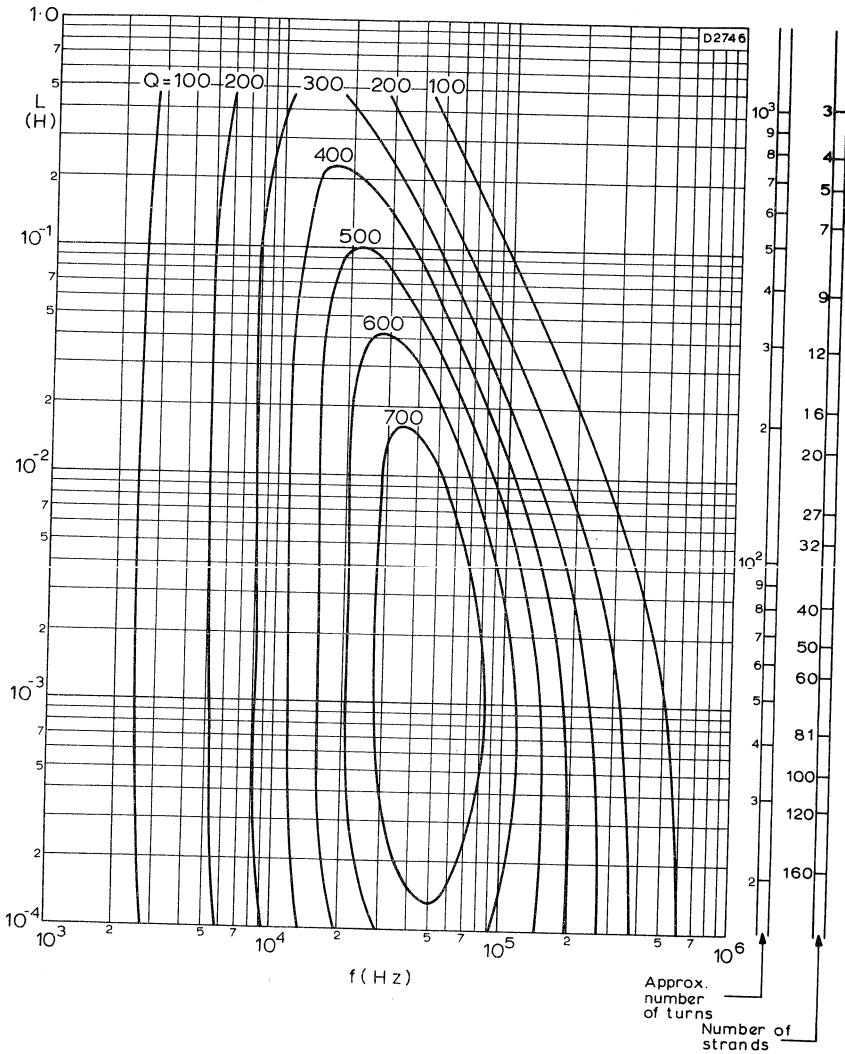
ISO-CURVES

These curves show typical Q-factors obtainable with full windings of 0,040 mm diameter bunched conductors on a single-section coil former. FXC grade 3H1,  $A_L = 250$ .



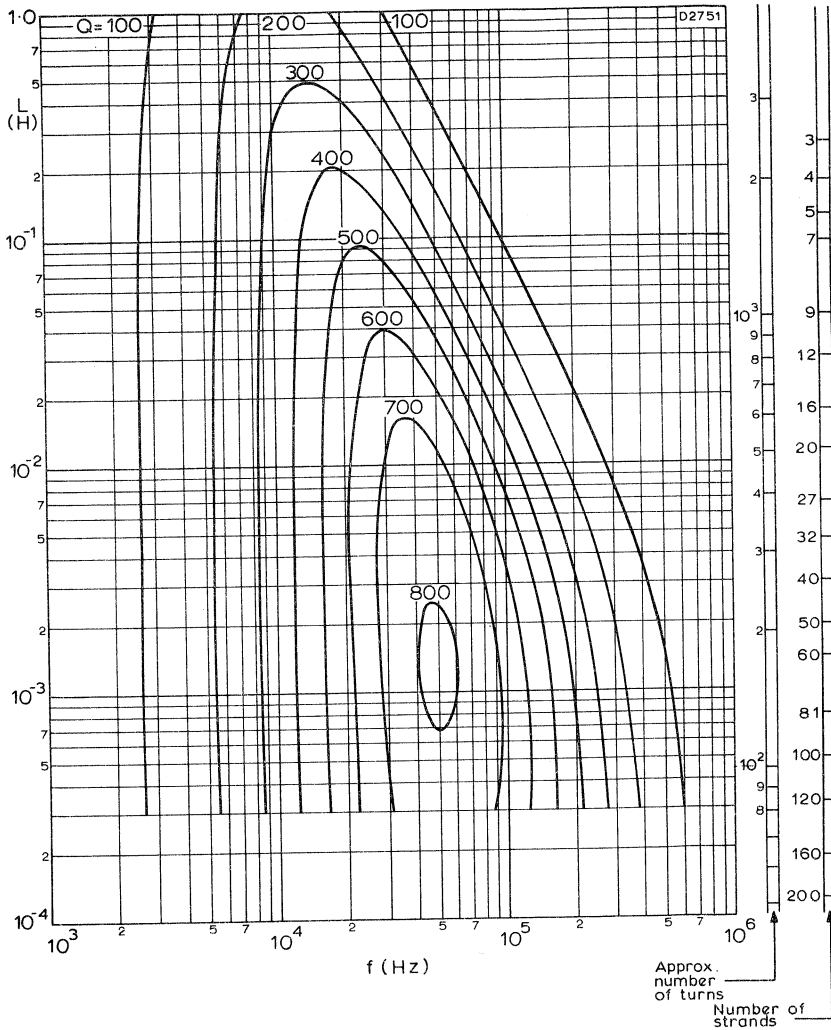
ISO-Q CURVES

These curves show typical Q-factors obtainable with full windings of enamelled copper wire on a single-section coil former. Material grade FXC 3H1,  $A_L = 400$ .



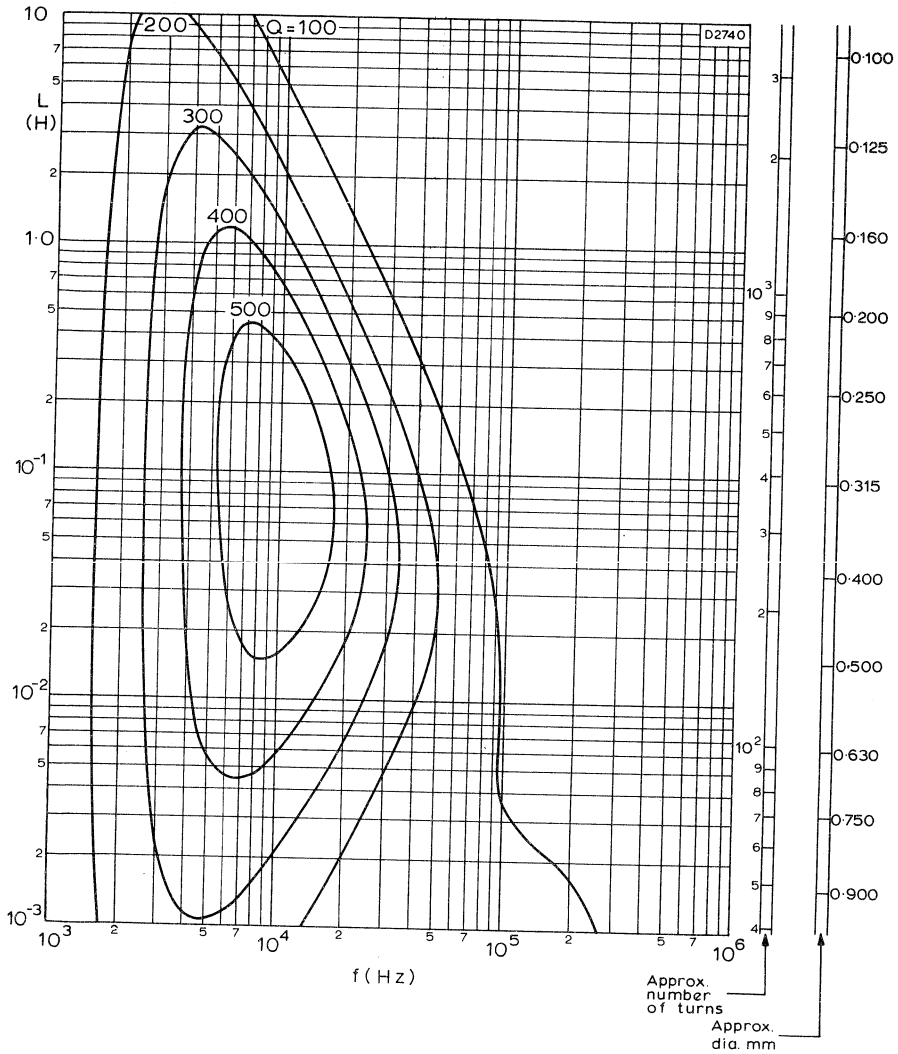
ISO-CURVES

These curves show typical Q-factors obtainable with full windings of 0,071 mm diameter bunched conductors on a single-section coil former. FXC grade 3H1,  $A_L = 400$ .



ISO-CURVES

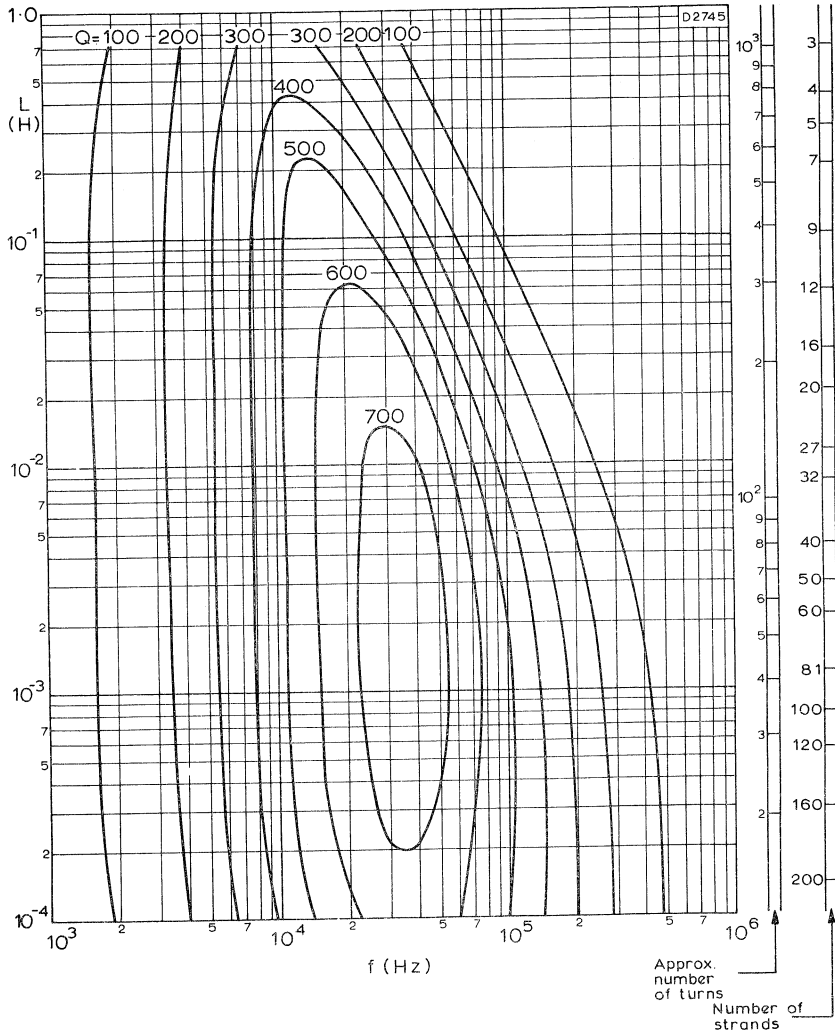
These curves show typical Q-factors obtainable with full windings of 0,040 mm diameter bunched conductors on a single-section coil former. FXC grade 3H1,  $A_L = 400$ .



ISO-Q CURVES

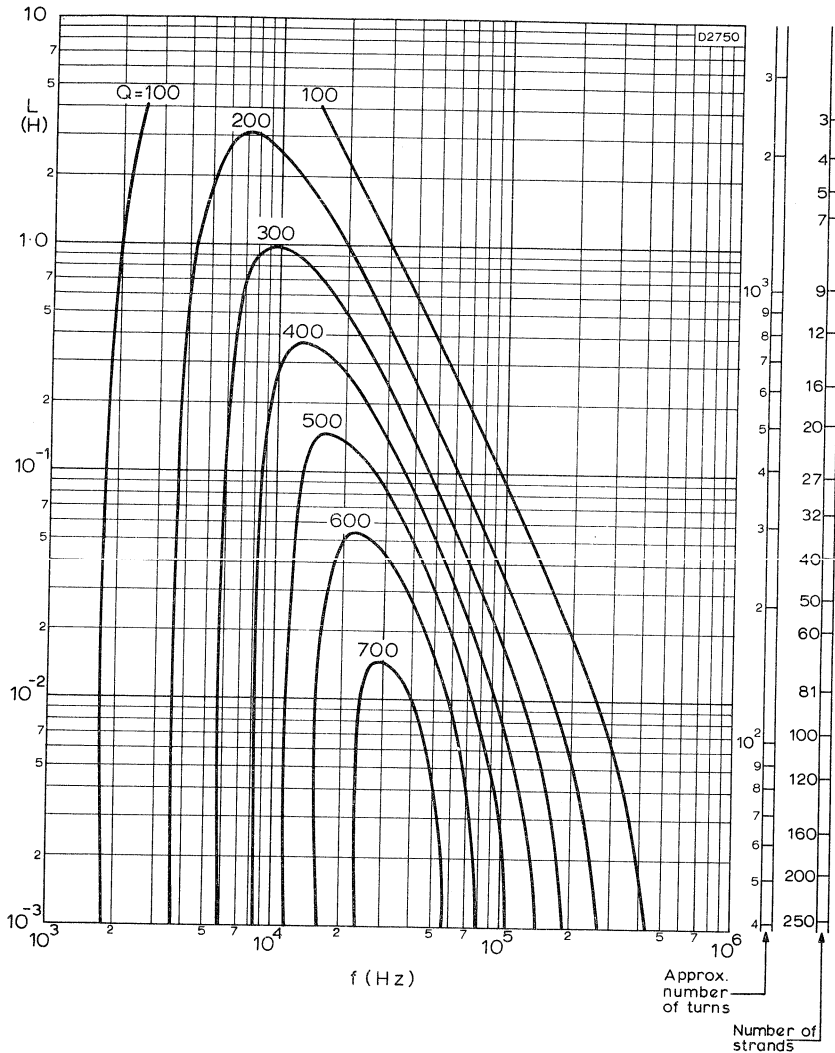
These curves show typical Q-factors obtainable with full windings of enamelled copper wire on a single-section coil former. Material grade FXC 3H1,  $A_L = 630$ .





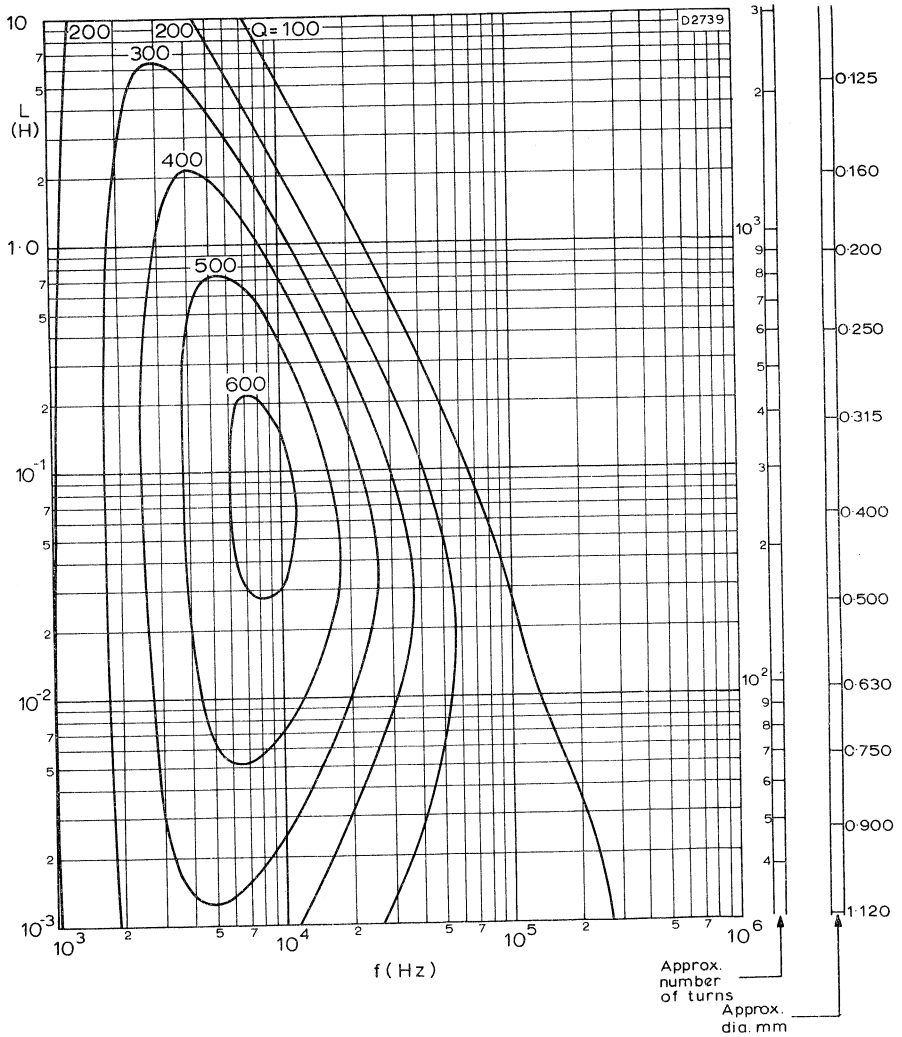
ISO-CURVES

These curves show typical Q-factors obtainable with full windings of 0,071 mm diameter bunched conductors on a single-section coil former. FXC grade 3H1,  $A_L = 630$ .



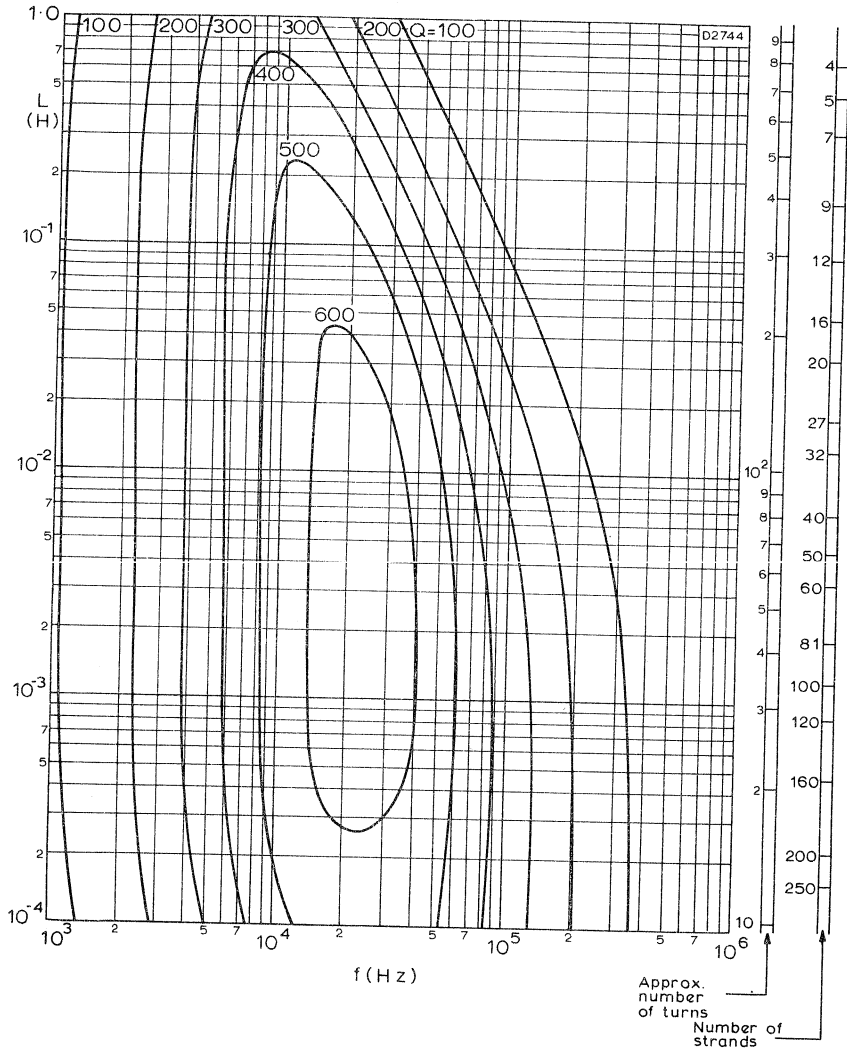
ISO-CURVES

These curves show typical Q-factors obtainable with full windings of 0,040 mm diameter bunched conductors on a single-section coil former. FXC grade 3H1,  $A_L = 630$ .



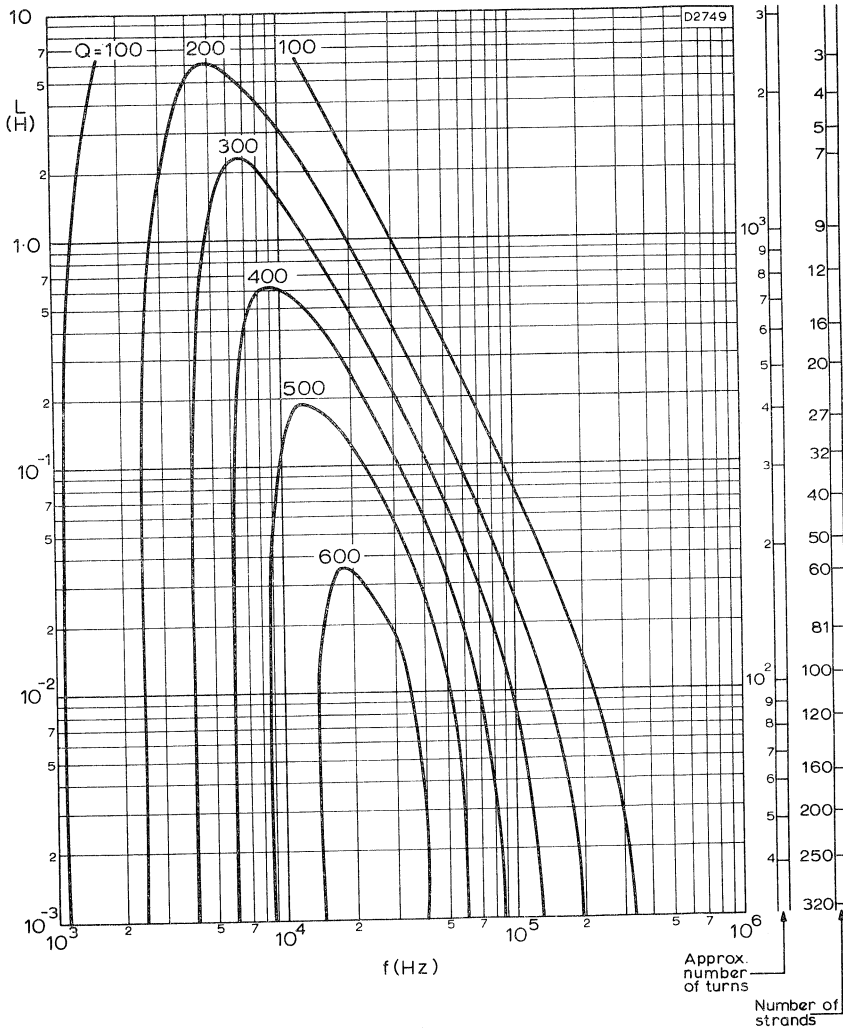
ISO-Q CURVES

These curves show typical Q-factors obtainable with full windings of enamelled copper wire on a single-section coil former. Material grade FXC 3H1,  $A_L = 1000$ .



ISO-CURVES

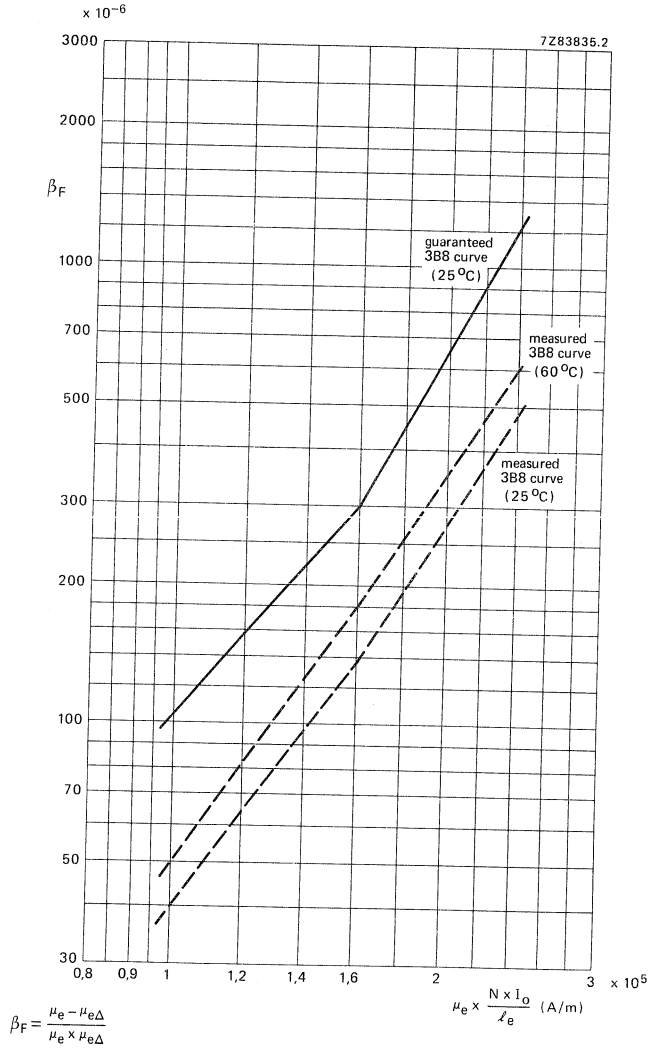
These curves show typical Q-factors obtainable with full windings of 0,071 mm diameter bunched conductors on a single-section coil former. FXC grade 3H1,  $A_L = 1000$ .



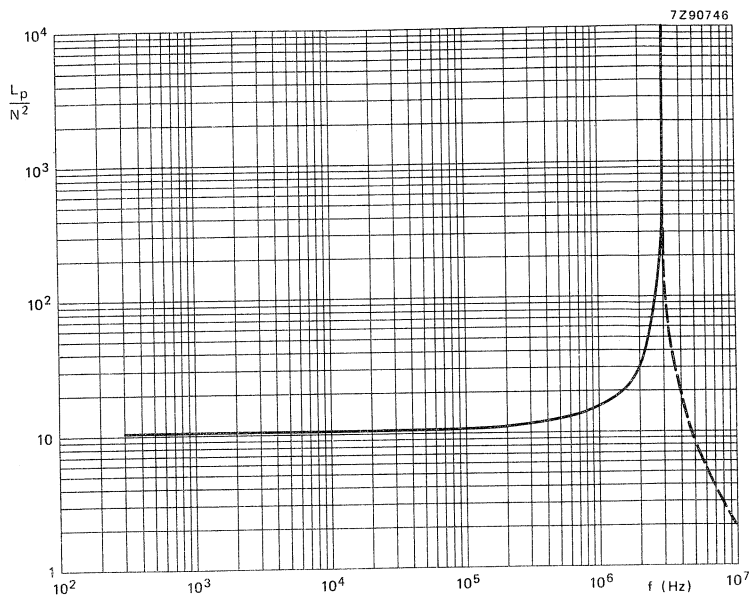
ISO-CURVES

These curves show typical Q-factors obtainable with full windings of 0,040 mm diameter bunched conductors on a single-section coil former. FXC grade 3H1,  $A_L = 1000$ .

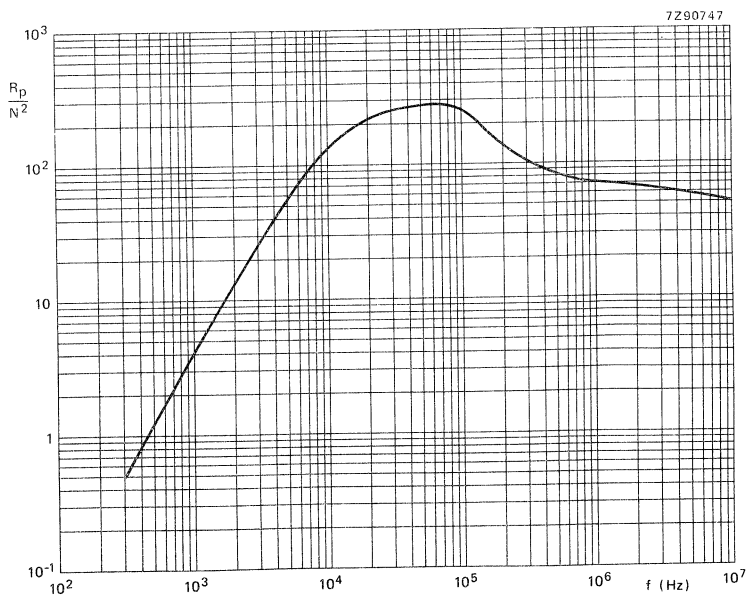
D.C. SENSITIVITY AT 25 °C



Inductance variation as a function of d.c. polarization.

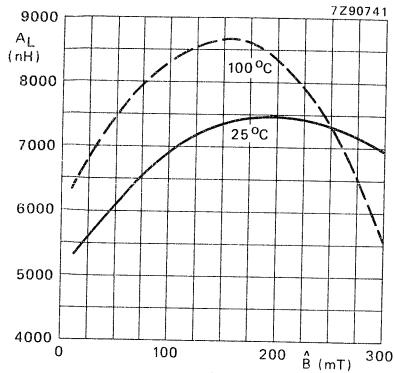


FXC 3E4. Inductance as a function of the frequency.

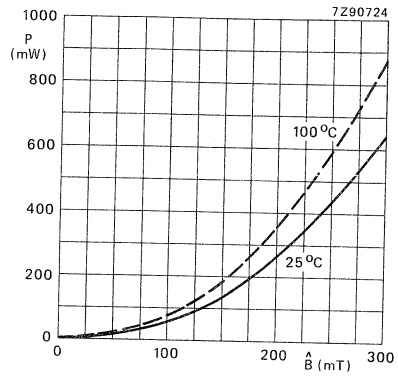


FXC 3E4. Losses as a function of the frequency at  $\hat{B} \leq 0,1$  mT.

FXC 3B8



$A_L = f(\hat{B})$  at 16 kHz, and at 25 and 100 °C. No airgap.



$P = f(\hat{B})$  at 16 kHz, and at 25 and 100 °C. No airgap.

$\hat{B}$  is calculated with  $A_{CPmin} = 89,1 \text{ mm}^2$ .



## SQUARE CORES

Three types of core can be supplied:

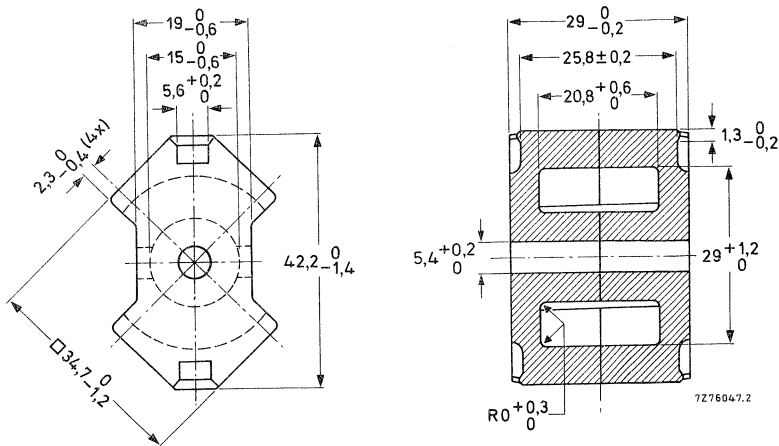
- CORE SETS provided with an injection-moulded nut for an adjuster and pre-adjusted on an inductance factor  $A_L$ .
- CORE SETS without nut and pre-adjusted on an  $A_L$  value.
- CORE HALVES without air gap.

The square cores are in accordance with the following specifications: IEC 431 (international), C83-300 (France), DIN 41980 (Germany).

Square cores and associated parts are ordered by their 12-digit catalogue number. Quantity: a primary pack contains 20 core sets or 40 core halves; a storage pack contains 80 core sets or 160 core halves. Please order in multiples of these quantities.

### MECHANICAL DATA

Dimensions in mm



**MECHANICAL DATA** (continued)

Dimensional quantities according to IEC 205:

$$C_1 = \Sigma \frac{l}{A} = 0,390 \text{ mm}^{-1}; C_2 = \Sigma \frac{l}{A^2} = 0,00219 \text{ mm}^{-3}; V_e = 12400 \text{ mm}^3; l_e = 70,0 \text{ mm}; A_e = 178 \text{ mm}^2.$$

Mass of a core set: 65,5 g.

**ELECTRICAL DATA**

The combination of two square core halves without air gap, randomly chosen from a batch, has the following guaranteed properties. A measuring coil as described in the General section 'Potcores, square cores and cross cores', is inserted; the halves are pressed together with a force of 80 N. The values are valid 5 minutes or more after clamping.

	freq. kHz	$\hat{B}$ mT	temp. °C	grade	
				3C8	3B8
$A_L \pm 25\%$	4	$\leq 0,1$	$25 \pm 5$	5775	6940
	25		$200-100 \pm 5$	$\geq 6500$	
$\mu_e \pm 25\%$	4	$\leq 0,1$	$25 \pm 5$	1790	2150
$\alpha$	4	$\leq 0,1$	$25 \pm 5$	$\leq 14,9$	$\leq 13,5$
P (W)**	25	200*	$25 \pm 5$	$\leq 2,0$	$\leq 1,5$
B (mT)*	25	H = 250 A/m	$100 \pm 5$	$\leq 1,7$	$\leq 1,7$
			$100 \pm 5$	$\geq 315$	
$\beta_F \times 10^6$ measured on sets with $\mu_e = 300 \pm 10\%$ and $25 \pm 1$ °C:					
at $\mu_e \times \frac{N \times I_0}{l_e} = 1,00 \times 10^5$ A/m					
$= 1,55 \times 10^5$ A/m					
$= 2,25 \times 10^5$ A/m					
					$\leq 120$
					$\leq 300$
					$\leq 1100$

Core sets without nut pre-adjusted on  $A_L$

$A_L$	corre- sponding $\mu_e$ -value	tol. on induct- ance (%)	catalogue number	
			grade 3B8 4322 022 followed by	grade 3C8 4322 025 followed by
160	50	$\pm 2$	56960	03250
250	77,6	$\pm 2$	● 56950	● 03260
400	124	$\pm 3$	56910	03280
630	196	$\pm 3$	● 56890	● 03300
1000	310	$\pm 4$	56900	03310
1250	388	$\pm 5$		
1600	497	$\pm 10$	56930	
2000	621	$\pm 10$		
2500	776	$\pm 10$	56940	

All pre-adjusted RM14 core sets have an asymmetrical air gap.

Core half without air gap, without nut, Ferroxcube grade 3B8, catalogue number 4322 020 28320; Ferroxcube grade 3C8, catalogue number 4322 020 28330.

\*  $\hat{B}$  is calculated with  $A_{CP \text{ min}} = 146 \text{ mm}^2$ .

\*\* Dip in loss curve at  $85 \pm 15$  °C.

● Preferred type.

## COIL FORMERS

Two types of coil former can be supplied:

- Single section, 10-pin, catalogue number 4322 021 33520 (Fig. 1)
- Single section, 12-pin, catalogue number 4322 021 33530 (Fig. 2).

The arrangement of the soldering pins is suitable for both 0,1 inch and 2,50 mm grid. See "Mounting".

The coil formers are packed on a polystyrene plate of 30, and 3 plates (90 pieces) in a cardboard box. Please order in multiples of these quantities.

### Properties

Material: phenolformaldehyde reinforced  
with glass fibre

Window area	112 mm <sup>2</sup>
Mean length of turn	71 mm
Max. temp.	180 °C
Inflammability	UL94, class V-0

Solderability: resistant against dip-soldering at  
400 °C for 2 s.

D.C. losses:

$$\frac{R_0}{L} = \frac{1}{\mu_e} \times \frac{1}{r_{cu}} \times 3,50 \times 10^3 \Omega/H$$

Mass 3 g

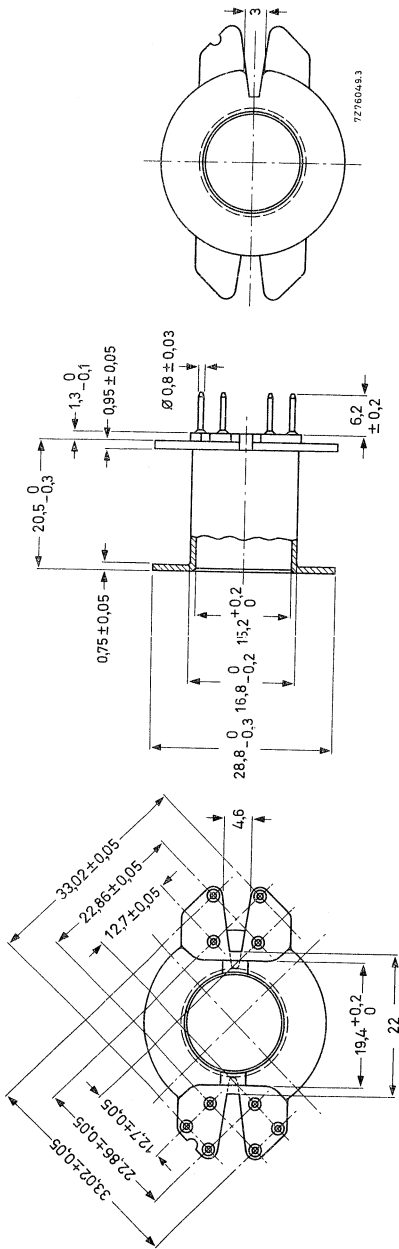


Fig. 1.

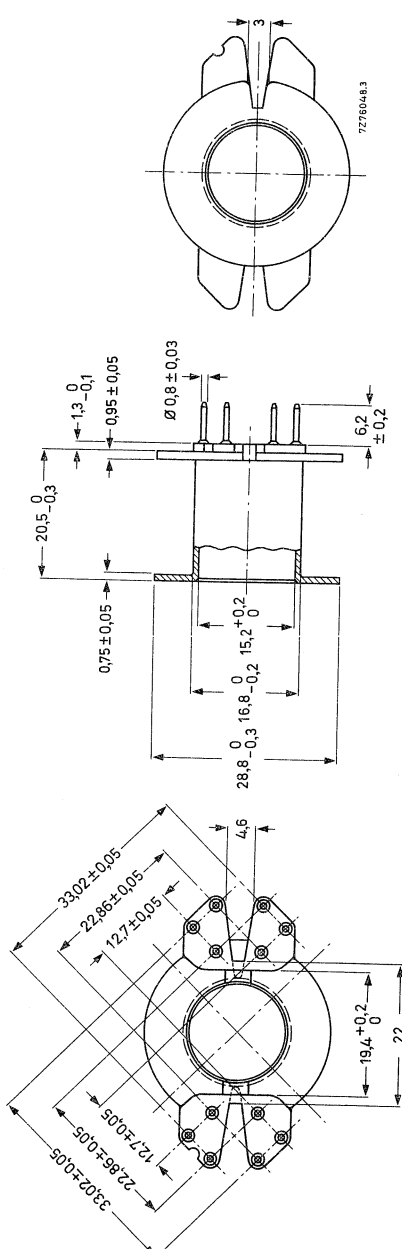
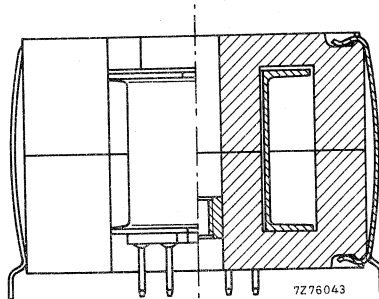


Fig. 2.

## ASSEMBLING AND MOUNTING



### ASSEMBLING

The core halves are clamped together by means of two clips, catalogue number 4322 021 33690. As can be seen in the drawing the hooked ends of both clips fit into the recesses, made in the halves.

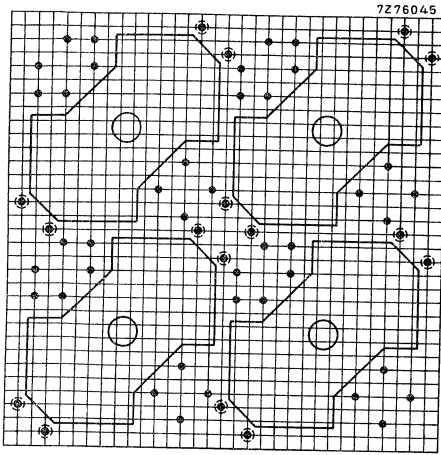
Due to the relatively low mechanical pressure of the two clips, it is recommended to cement the two core halves to each other as well (see under Mounting Data in section 'Potcores, square cores and cross cores').

For a stable inductance we recommend that an adhesive be applied between the coil former flange and the lower core half and around the two core halves, see 'Potcores, square cores and cross cores', General under Mounting Data.

### MOUNTING

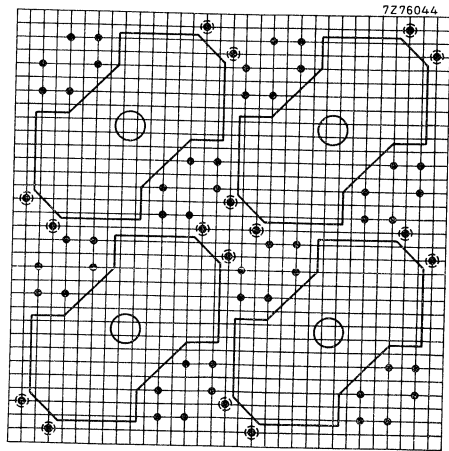
The two retaining clips are also used for mounting the assembled core on a printed-wiring board. The pins are simply soldered into the holes in the board. If so desired, one of the pins can also be used for earthing.

The soldering pins of coil formers and slips are so arranged that they will fit printed-wiring boards with a 0,1 inch grid as well as those with a 2,50 mm grid. The pin length is sufficient for a board thickness of up to 2,4 mm; The recommended hole diameter in the board is  $1,3 \pm 0,1$  mm (according to IEC publication 97).



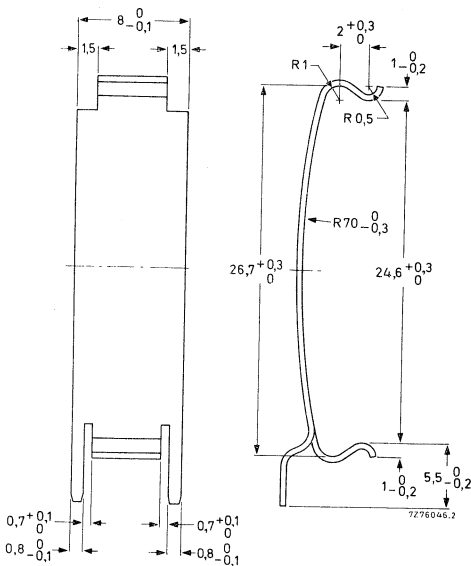
⊙ 1)

Hole pattern for an assembly of 4 cores, each fitted with a 10-pin coil former.



⊙ 1)

Hole pattern for an assembly of 4 cores, each fitted with a 12-pin coil former.

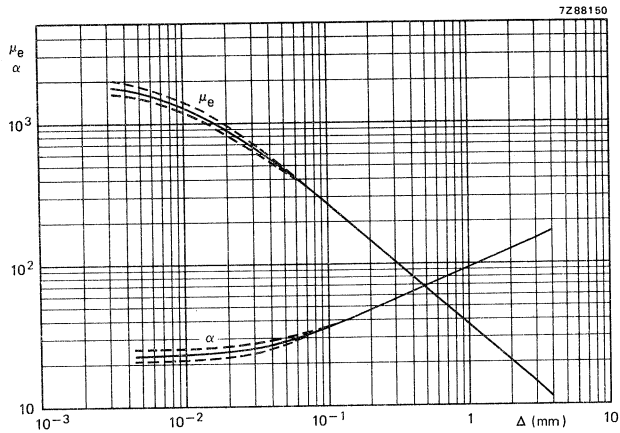


**PART DRAWING**  
 (dimensions in mm)  
 Clip: 4322 021 33690  
 Material: steel, tin plated

1) Holes,  $\phi 1,3 \pm 0,1$  mm, for tags on clip 4322 021 33690 (earth points).

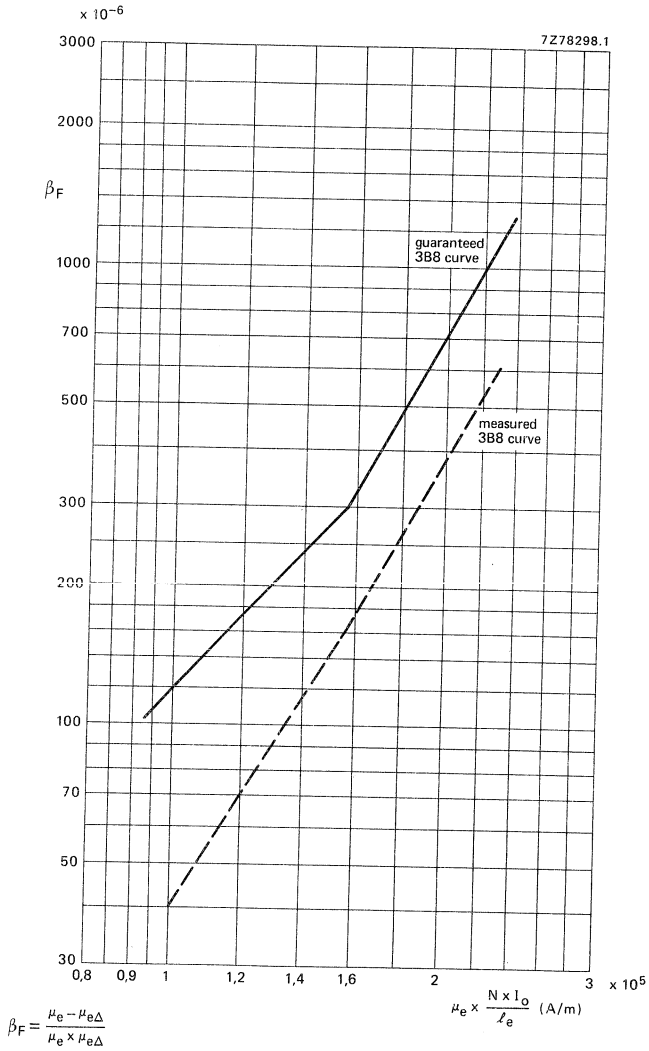
## CHARACTERISTIC CURVES

### $\mu_e - \alpha$ CURVES



Relative effective permeability and turn factor for 1 mH as a function of the air gap length.  
 $\mu_e = 2150 \pm 25\%$  at  $\Delta = 3 \mu\text{m}$  for FXC 3B8.

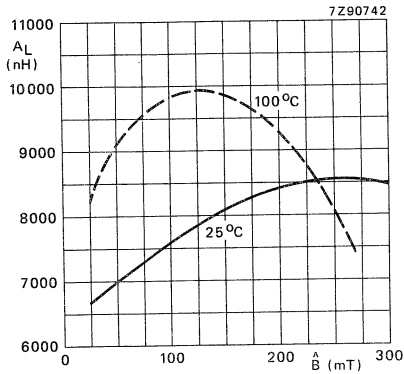
D.C. SENSITIVITY AT 25 °C



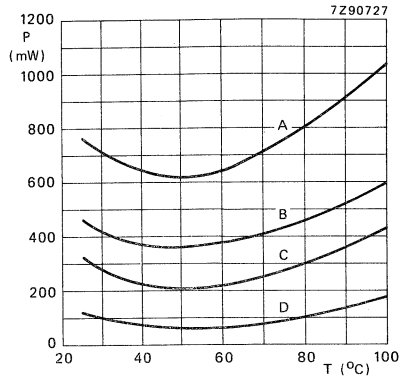
Inductance variation as a function of d.c. polarization.



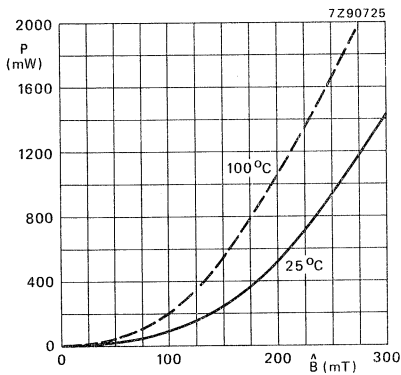
FXC 3B8



$A_L = f(\hat{B})$  at 16 kHz, and at 25 and 100 °C. No air gap.



$P = f(T)$   
 A at 16 kHz and  $\hat{B} = 200$  mT  
 B at 25 kHz and  $\hat{B} = 200$  mT  
 C at 50 kHz and  $\hat{B} = 100$  mT  
 D at 100 kHz and  $\hat{B} = 50$  mT



$P = f(\hat{B})$  at 16 kHz, and at 25 and 100 °C. No air gap.

$\hat{B}$  is calculated with  $A_{CP \min} = 146 \text{ mm}^2$ .



CROSS CORES AND ACCESSORIES



## CROSS CORES

Four types of core can be supplied:

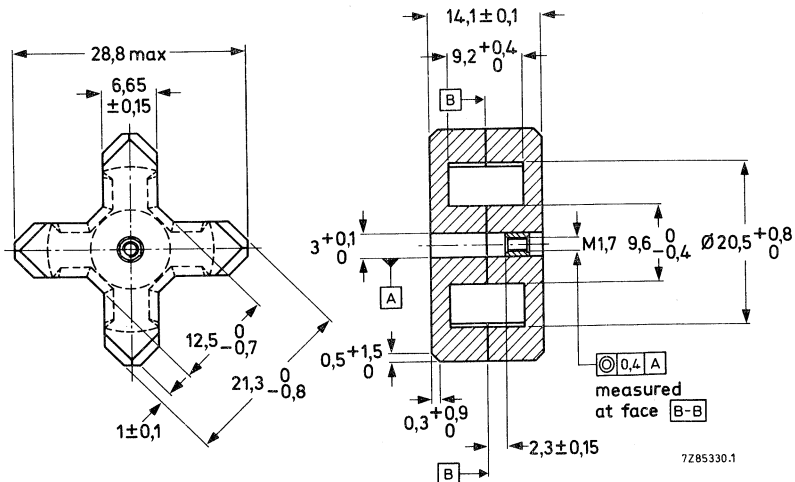
- CORE SETS provided with a nut for an adjuster and pre-adjusted on an inductance factor  $A_L$ .
- CORE SETS without nut and pre-adjusted on an  $A_L$  value.
- CORE HALVES without air gap.
- CORE HALVES with air gap. Standardized air-gap lengths in each core half are: 0,02, 0,05, 0,15 and 0,25 mm.

The cross cores are in accordance with IEC publication 226.

Cross cores and their associated parts are ordered by their 12-digit catalogue number. Quantity: a primary pack contains 10 core sets or 20 core halves; a storage pack contains 200 core sets or 400 core halves. Please order in multiples of these quantities.

### MECHANICAL DATA

Dimensions in mm



Pulling-out force of the nut  $\geq 30$  N.

Dimensional quantities according to IEC 205

$$C_1 = \Sigma \frac{1}{A} = 0,575 \text{ mm}^{-1}; C_2 = \Sigma \frac{1}{A^2} = 0,0871 \text{ mm}^{-2}; V_e = 2510 \text{ mm}^3; l_e = 38 \text{ mm}; A_e = 66,0 \text{ mm}^2;$$

$$A_{CPmin} = 62,1 \text{ mm}^2.$$

Mass of a core set; approx. 12 g

## ELECTRICAL DATA

The combination of two cross core halves without air gap, randomly chosen from a batch, has the following guaranteed properties. A measuring coil as described in the general section 'Potcores, square cores and cross cores' is inserted. The halves are pressed together with a force of 120 N. The values are valid 5 minutes or more after clamping. Parameters  $\alpha_F$  and  $D_F$  are measured on toroid-wound halves.

	freq. kHz	$\bar{B}$ mT	temp. °C	grade			
				3B8	3D3	3H1	4C6
$A_L \pm 25\%$	4	$\leq 0,1$	$25 \pm 1$	4200	1600	4200	275
$\mu_e \pm 25\%$	4	$\leq 0,1$	$25 \pm 1$	1920	735	1920	125
$\alpha$	4	$\leq 0,1$	$25 \pm 1$	$\leq 17,8$	$\leq 28,8$	$\leq 17,8$	$\leq 70$
$\frac{\tan \delta}{\mu_i} \times 10^6$	4	$\leq 0,1$	$25 \pm 1$			$\leq 1,2$	
	100	$\leq 0,1$	$25 \pm 1$		$\leq 8,0$	$\leq 5,0$	
	500	$\leq 0,1$	$25 \pm 1$		$\leq 14$		
	1000	$\leq 0,1$	$25 \pm 1$		$\leq 30$		
	2000	$\leq 0,1$	$25 \pm 1$				$\leq 40$
	10 000	$\leq 0,1$	$25 \pm 1$				$\leq 100$
$\eta_B \times 10^3$	4	1,5 to 3,0	$25 \pm 1$			$\leq 1,1$	
	100	0,3 to 1,2	$25 \pm 1$		$\leq 1,8$		$\leq 6,2$
P (W)	25	200*	$25 \pm 5$	$\leq 0,4$			
	25	200*	$100 \pm 1$	$\leq 0,5$			
$\alpha_F \times 10^6/K$	$\leq 100$	$\leq 0,1$	5 to 25			+ 0,5 to 1,5	-2 to +4
	$\leq 100$	$\leq 0,1$	25 to 55			+ 0,5 to 1,5	0 to +6
	$\leq 100$	$\leq 0,1$	25 to 70				
$D_F \times 10^6$	$\leq 100$	$\leq 0,1$	$25 \pm 1$		$\leq 12$	$\leq 4,3$	$\leq 10$
$\beta_F \times 10^6$ , measured on sets with $\mu_e = 300 \pm 10\%$ and $25 \pm 1$ °C:							
at $\mu_e \times \frac{N \times I_0}{l_e} = 1,10 \times 10^5$ A/m				$\leq 110$			
= $1,80 \times 10^5$ A/m				$\leq 300$			
= $2,55 \times 10^5$ A/m				$\leq 1100$			

\* Determined with  $ACP_{\min} = 62,1 \text{ mm}^2$ .

Core sets, grade 3H1 pre-adjusted on A<sub>L</sub>.

A <sub>L</sub> nH	corre- sponding μ <sub>e</sub> -value	catalogue number 4322 022 . . . .	
		without nut	with nut
160 ± 1%	73	45250	65250
250 ± 1,5%	115	45260	65260
400 ± 2%	183	45280	65280
630 ± 3%	290	45300	65300
1000 ± 10%	458	● 45310	
1600 ± 10%	732	45320	

Cores with A<sub>L</sub> ≤ 250 have a symmetrical air gap.

Cores with A<sub>L</sub> ≥ 400 have an asymmetrical air gap.

Core halves without air gap.

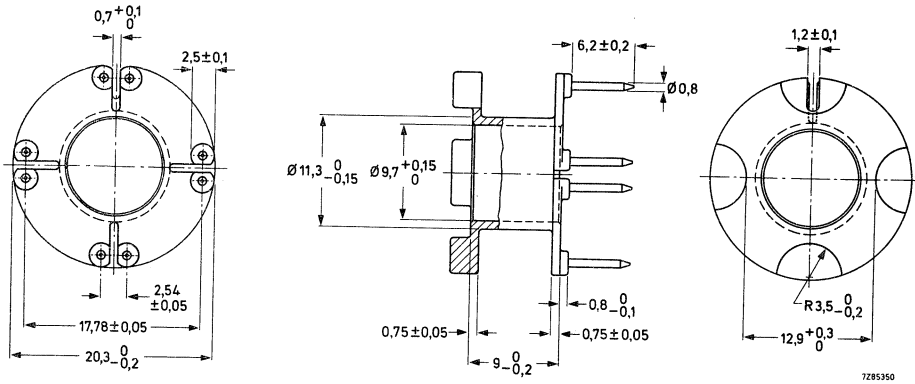
Ferroxcube grade	catalogue number
● 3B8	4322 020 23540
3D3	3522 200 03480
3H1	4322 020 23510
4C6	3522 200 03490

Core halves with air gap.

Ferroxcube grade	air gap Δ in mm	catalogue number
3H1	0,02 ± 0,01	4322 020 23710
3H1	0,05 ± 0,015	4322 020 23720
3H1	0,15 ± 0,015	4322 020 23730
3H1	0,25 ± 0,015	4322 020 23740

● Preferred type.

### COIL FORMER



**Catalogue number 4322 021 32870**

Material	phenolformaldehyde reinforced with glass fibre
Window area	33,9 mm <sup>2</sup>
Mean length of turn	49 mm
Max. temperature	180 °C

Solderability: resistant against dip-soldering at 400 °C for 2 s

D.C. losses:

$$\frac{R_o}{L} = \frac{1}{\mu_e} \times \frac{1}{f_{cu}} \times 11,7 \times 10^3 \Omega/H$$

Mass 0,4 g

Packing quantity	
primary pack:	80
storage pack:	400

→ Please order in multiples of these quantities.



## INDUCTANCE ADJUSTERS

(old types)

Dimensions in mm

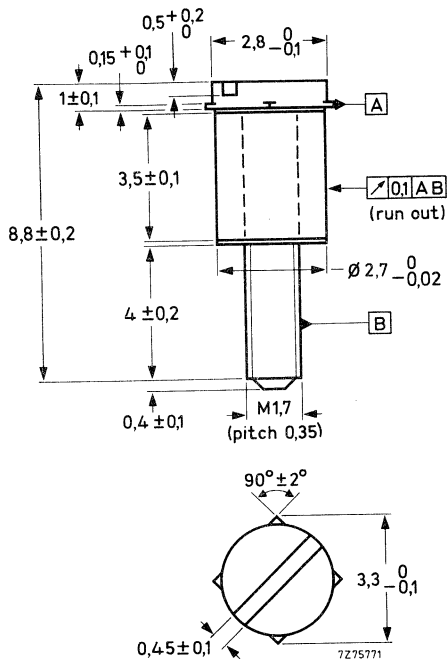


Fig. A.

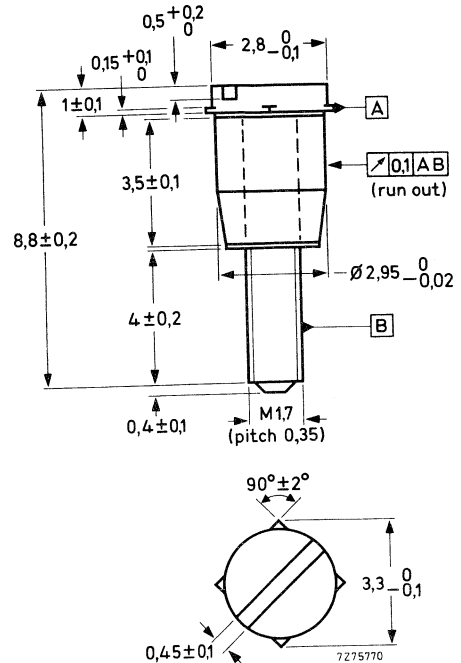


Fig. B.

After inserting a coil in an electrical circuit, its inductance can be adjusted to the required value with an accuracy  $< 0,03\%$  by means of a continuous inductance adjuster. Such an adjuster increases the inductance of the coil, see following pages.

The adjuster is screwed through the cross core into the nut and is held in position by the four protrusions near the top of the adjuster. For special requirements a bigger or smaller adjustment range may be obtained by using an adjuster belonging to the next higher or lower effective permeability.

The influence of the adjusters on the variability of the inductance is negligible. The maximum permissible temperature is  $110\text{ }^{\circ}\text{C}$ .

Table 2 shows the type of adjuster recommended for different cross cores.

Table 1 Available types

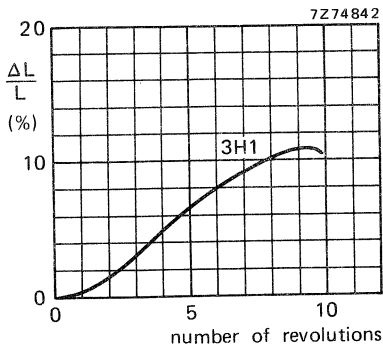
d mm	colour	catalogue number
A	brown	4322 021 32140
B	white	4322 021 32130
B	grey	4322 021 32180

The adjusters are packed in plastic bags of 100.  
Please order in multiples of this quantity.

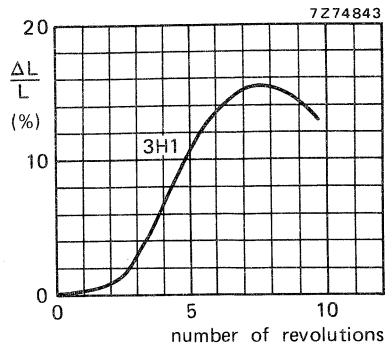
Table 2 Recommended application

A <sub>L</sub>	catalogue number
	grade 3H1
160	4322 021 32130
250	4322 021 32130 or 4322 021 32140
400	4322 021 32140 or 4322 021 32180
630	4322 021 32180

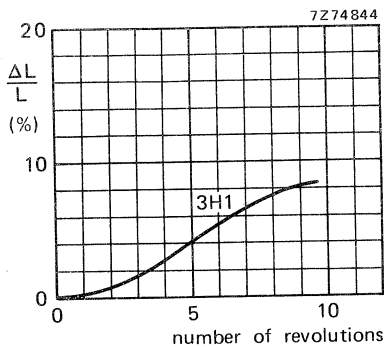
Adjustments curves



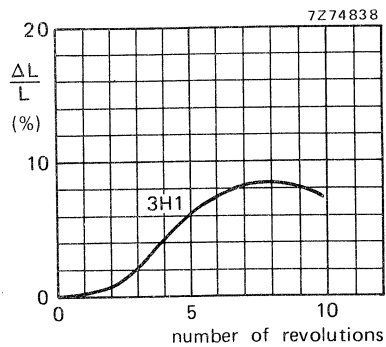
Adjuster 4322 021 32130,  $A_L = 160$ .



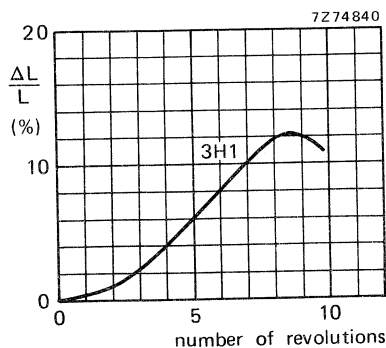
Adjuster 4322 021 32140,  $A_L = 250$ .



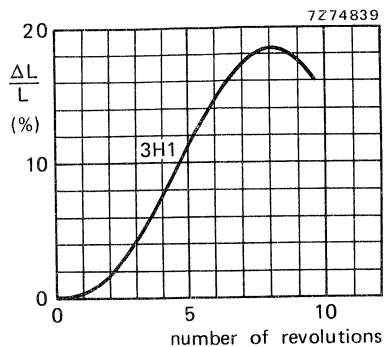
Adjuster 4322 021 32130,  $A_L = 250$ .



Adjuster 4322 021 32140,  $A_L = 400$ .



Adjuster 4322 021 32180,  $A_L = 400$ .



Adjuster 4322 021 32180,  $A_L = 630$ .



## INDUCTANCE ADJUSTERS

(new types)

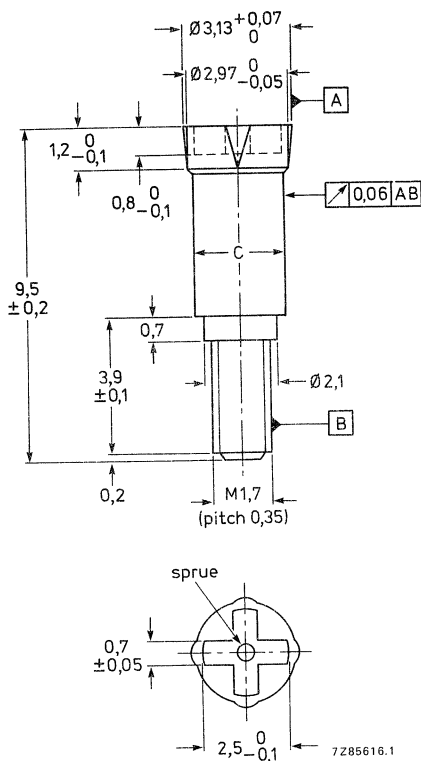


Fig. 1.

Material: polypropylene, reinforced with glass fibre.

The tolerances on inductance factor of the pre-adjusted cores without adjuster are given in the table of pre-adjusted cores with standard  $A_L$  values. The inductance of the pre-adjusted core can be increased to the required value – with a setting accuracy  $< 0,03\%$  – by means of a continuous adjuster.

The adjuster is screwed through the centre hole of the core into the nut and is held in position by the four cones near the top of the adjuster.

The combination of the polyamide moulded-in nut and the polypropylene adjuster – both reinforced with glass fibre – gives an excellent stability with temperature, shocks and vibrations. Besides this, the combination has a very smooth adjustment curve due to the excellent concentricity of the moulded-in nut and the adjuster.

The maximum permissible temperature of the adjustment combination is: 150 °C, during 8 h. The maximum working temperature is 110 °C.

The tables below show the available types and which adjuster is recommended for typical  $A_L$  values.

Table 1 Colour code of adjusters

catalogue number	colour	dia. C (Fig. 1) mm	material
4322 021 38600	black	2,83	FXC
38610	brown	2,70	FXC
38670	violet	2,58	FXC
38680	white	2,48	FXC
38690	grey	2,93	FXC

Table 2 Catalogue numbers of recommended adjusters for typical  $A_L$  values

$A_L$	3H1
160	4322 021 38680
250	38670
400	38600
630	38690

**PACKAGING**

The adjusters are packed in plastic bags of 100. Please order in multiples of this quantity.

**ADJUSTING TOOL**

An adjusting tool combination for M1, 4 and M1, 7 is available, catalogue number 4322 058 03260.

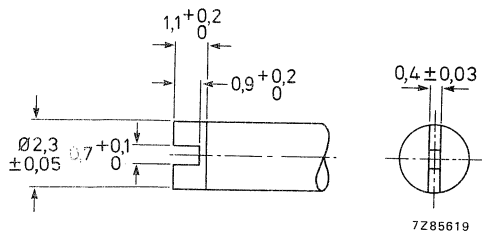
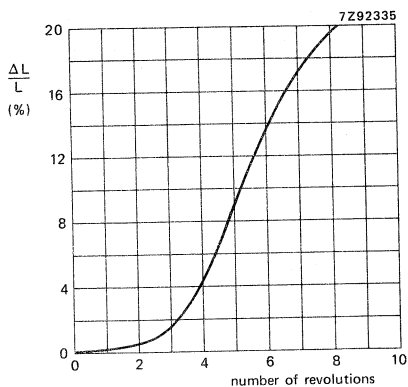


Fig. 2.

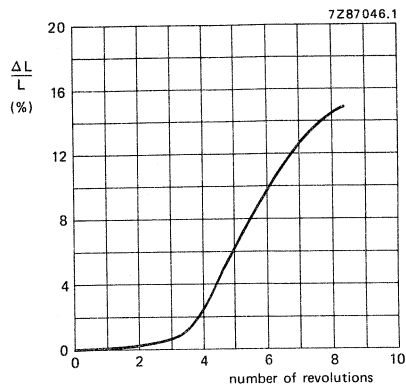
For customers who wish to make the screwdriver themselves the outlines of the essential part are given in Fig. 2.

ADJUSTMENT CURVES

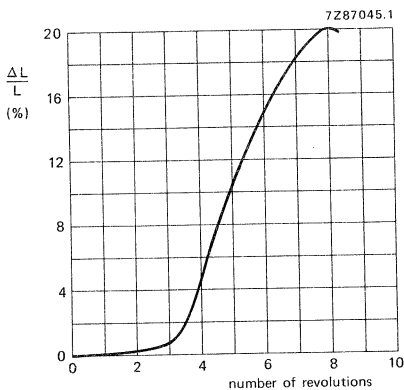
Characteristic curves



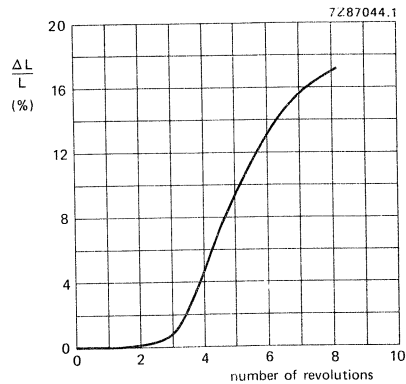
$A_L = 160$ ; FXC 3H1



$A_L = 250$ ; FXC 3H1



$A_L = 400$ ; FXC 3H1

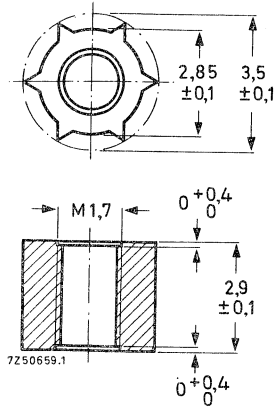


$A_L = 630$ ; FXC 3H1

Note: 0 revolutions corresponds to at least one turn of interaction.

### LOOSE NUT FOR ADJUSTER

These data are given for those manufacturers who prefer to insert a nut themselves.



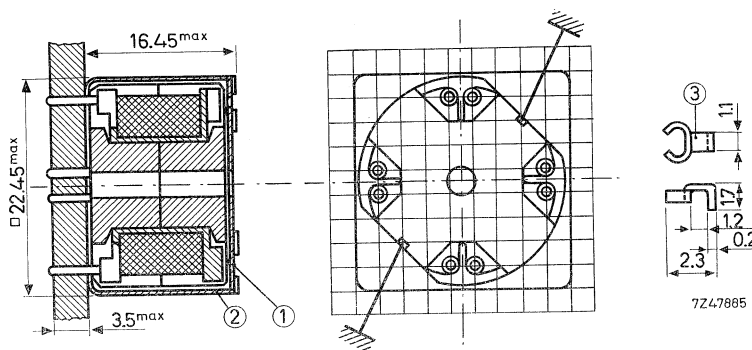
Catalogue number	4322 021 30140
Material	polycarbonate
Maximum impregnation temperature during 24 hours	120 °C
Recommended distance from mating surface to nut	$2,3 \pm 0,15$ mm

For more information see Potcores General, Mounting data, Section Inserting the nut for the adjuster.  
The nuts are packed in plastic bags of 100.  
Please order in multiples of this quantity.

Dimensions in mm



## MOUNTING PARTS



- (1) Cover 4322 021 30230.  
 (2) Container 4322 021 30040.

The cross core has been developed especially for transformers to be mounted on printed-wiring boards with a grid of 0,1 inch.

An advantage of this construction is that the lead-out wires are soldered to pins which are directly mounted on the coil former.

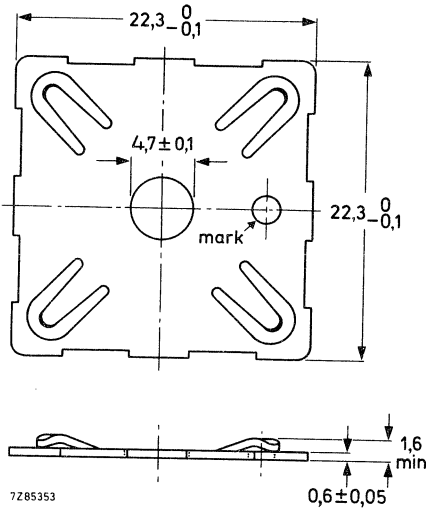
The pin length is sufficient for board thicknesses of up to 3,5 mm. The printed-wiring board should be provided with holes of  $1,0 \pm 0,1$  mm in diameter.

The phosphor-bronze cover has four cut-out lips on the corners, consequently the cover acts as a spring at the same time.

The cover is provided with a marking hole. The mark on the coil former (see drawing of coil former) has to be in line with this hole. These markings facilitate the numbering of the soldering pins and the positioning on the printed-wiring board.

It is recommended that the coil former be cemented in the lower core half in order to obtain the most stable construction possible.

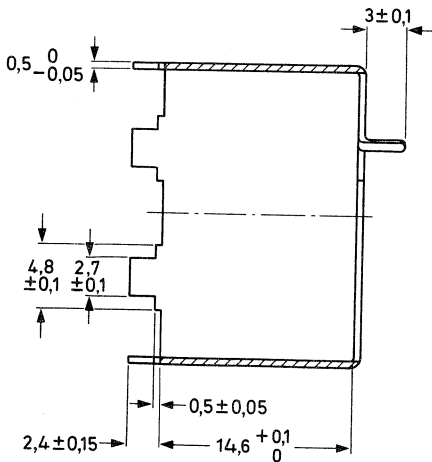
Before bending the lips of the container, pressure should be exerted evenly on the four corners of the cover until the latter meets the container. The required force is approximately 120 N. After bending the lips, the core will have the correct tension.



(1) Cover 4322 021 30230.

Material: phosphor bronze, nickel plated.

Packaging quantity: 2000. Please order in multiples of this quantity.

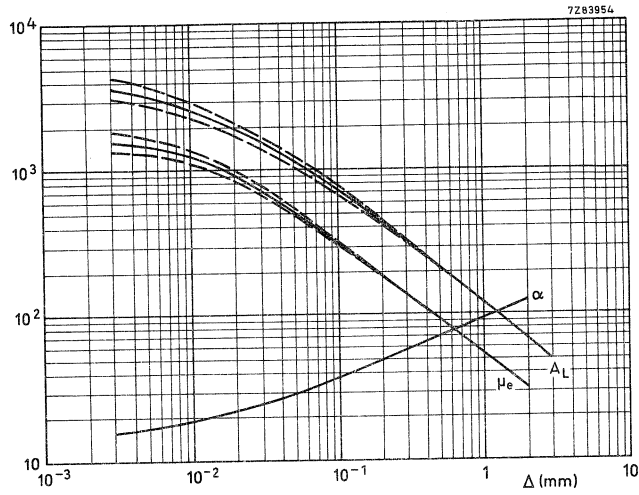


(2) Container 4322 021 30040.

Material: brass, nickel plated, thereafter tin plated.

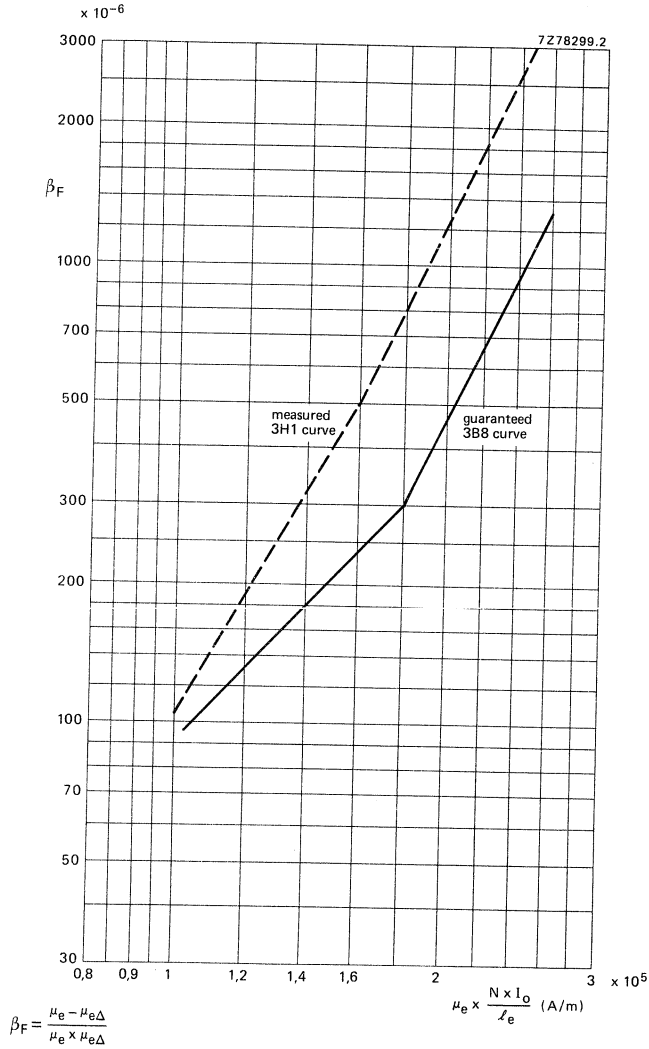
Packaging quantity: primary pack 40, storage pack 200. Please order in multiples of these quantities.

## CHARACTERISTIC CURVES



Effective permeability ( $\mu_e$ ), turn factor for 1 mH ( $\alpha$ ) and inductance factor in nanohenries ( $A_L$ ) as a function of the air-gap length for grade 3H1.

D.C. SENSITIVITY AT 25 °C



Inductance variation as a function of d.c. current.

## CROSS CORES

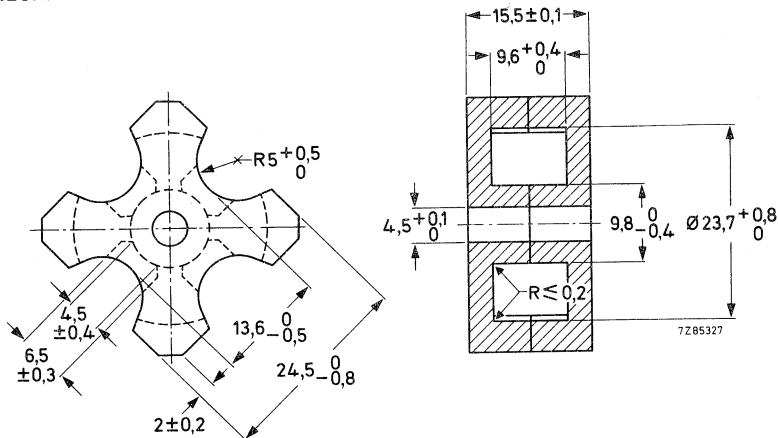
Two types of core can be supplied:

- CORE HALVES without air gap.
- CORE HALVES with air gap.

The cross cores are in accordance with IEC publication 226.

Cross cores and their associated parts are ordered by their 12-digit catalogue number. Quantity: a primary pack contains 10 core sets or 20 core halves; a storage pack contains 200 core sets or 400 core halves. Please order in multiples of these quantities.

### MECHANICAL DATA



Dimensional quantities according to IEC 205:

a. Version with centre hole

$$C_1 = \Sigma \frac{1}{A} = 0,570 \text{ mm}^{-1}; \quad C_2 = \Sigma \frac{1}{A^2} = 0,00782 \text{ mm}^{-3}; \quad V_e = 3030 \text{ mm}^3;$$

$$l_e = 41,5 \text{ mm}; \quad A_e = 72,7 \text{ mm}^2.$$

b. Version without centre hole

$$C_1 = \Sigma \frac{1}{A} = 0,517 \text{ mm}^{-1}; \quad C_2 = \Sigma \frac{1}{A^2} = 0,00630 \text{ mm}^{-3}; \quad V_e = 3482 \text{ mm}^3;$$

$$l_e = 42,4 \text{ mm}; \quad A_e = 82,10 \text{ mm}^2.$$

Mass of a core set: approx. 24 g.

## ELECTRICAL DATA

The combination of two cross core halves without air gap, randomly chosen from a batch, has the following guaranteed properties. A measuring coil as described in the general section 'Potcores, square cores and cross cores' is inserted. The halves are pressed together with a force of 150 N. The values are valid 5 minutes or more after clamping. Parameters  $\alpha_F$  and  $D_F$  are measured on toroid-wound halves.

	freq. kHz	$\bar{B}$ mT	temp. °C	grade	
				3D3	3H1
$A_L \pm 25\%$	4	$\leq 0,1$	$25 \pm 5$	1620	4260
$\mu_e \pm 25\%$	4	$\leq 0,1$	$25 \pm 5$	735	1935
$\alpha$	4	$\leq 0,1$	$25 \pm 5$	$\leq 28,7$	$\leq 15,3$
$\frac{\tan \delta}{\mu_i} \times 10^6$	4	$\leq 0,1$	$25 \pm 5$		$\leq 1,2$
	100	$\leq 0,1$	$25 \pm 5$	$\leq 8$	$\leq 6,0$
	500	$\leq 0,1$	$25 \pm 5$	$\leq 14$	
	1000	$\leq 0,1$	$25 \pm 5$	$\leq 30$	
$\eta_B \times 10^3$	4	1,5 to 3,0	$25 \pm 5$		$\leq 0,86$
	100	0,3 to 1,2	$25 \pm 5$	$\leq 1,8$	
$\alpha_F \times 10^6/K$	$\leq 100$	$\leq 0,1$	5 to 25		+ 0,5 to 1,5
	$\leq 100$	$\leq 0,1$	25 to 55		+ 0,5 to 1,5
	$\leq 100$	$\leq 0,1$	25 to 70	0 to + 2	+ 0,5 to 1,5
$D_F \times 10^6$	$\leq 100$	$\leq 0,1$	$25 \pm 1$	$\leq 15$	$\leq 4,3$

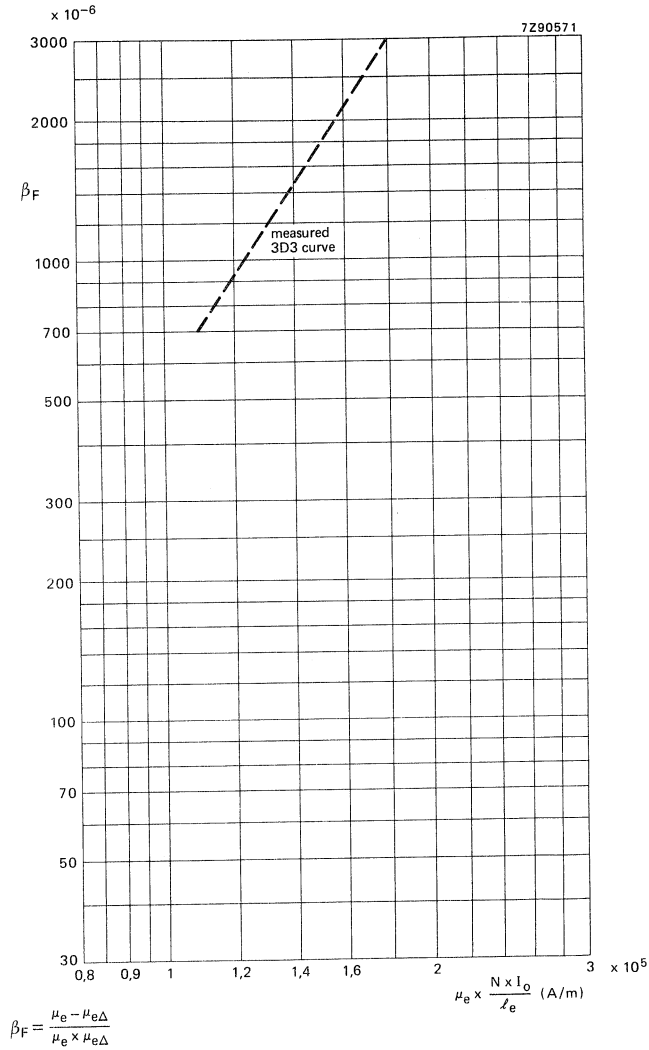
Core halves without air gap.

Ferroxcube grade	catalogue number
3D3	4322 020 24270
3H1	4322 020 24260

Core halves with air gap.

Ferroxcube grade	air gap $\Delta$ in mm	catalogue number
3H1	$0,16 \pm 0,015$	4322 020 24370
3H1	$0,32 \pm 0,015$	4322 020 24470
3D3	$0,8 \pm 0,015$	4322 020 24380

D.C. SENSITIVITY AT 25 °C



Inductance variation as a function of d.c. polarization.





## CROSS CORES

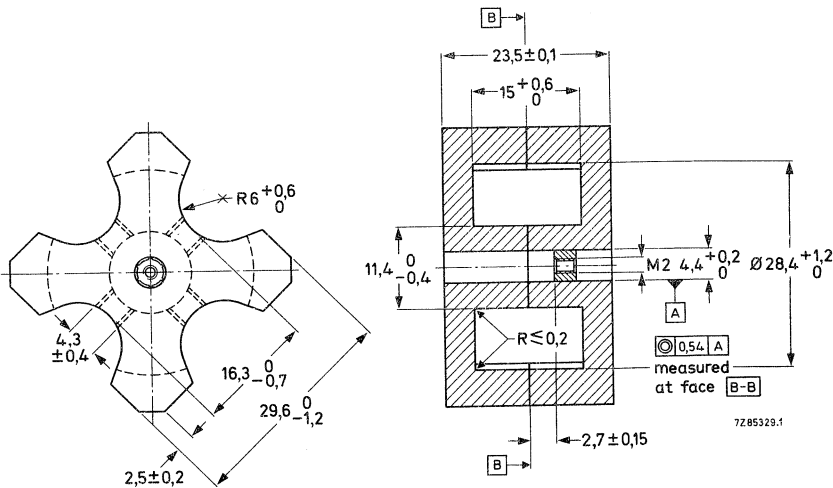
Four types of core can be supplied:

- CORE SETS provided with a nut for an adjuster and pre-adjusted on an inductance factor  $A_L$ .
- CORE SETS without nut and pre-adjusted on an  $A_L$  value.
- CORE HALVES without air gap.
- CORE HALVES with air gap. Standardized air gap lengths in each core half are: 0,02, 0,05, 0,15 and 0,25 mm.

The cross cores are in accordance with IEC publication 226.

Cross cores and their associated parts are ordered by their 12-digit catalogue number. Quantity: a primary pack contains 20 core sets or 40 core halves, a storage pack contains 80 core sets or 160 core halves. Please order in multiples of these quantities.

### MECHANICAL DATA



Pulling-out force of the nut  $\geq 30$  N.

Dimensional quantities according to IEC 205:

$$C_1 = \Sigma \frac{l}{A} = 0,490 \text{ mm}^{-1}; C_2 = \Sigma \frac{1}{A^2} = 0,00430 \text{ mm}^{-3}; V_e = 6360 \text{ mm}^3; l_e = 55,8 \text{ mm}; A_e = 114 \text{ mm}^2;$$

$$A_{CPmin} = 82,6 \text{ mm}^2.$$

Mass of core set approx. 38 g.

## ELECTRICAL DATA

The combination of two core halves without air gap, randomly chosen from a batch, has the following guaranteed properties. A measuring coil as described in the general section 'Potcores, square cores and cross cores' is inserted. The halves are pressed together with a force of 250 N. The values are valid 5 minutes or more after clamping. Parameters  $\alpha_F$  and  $D_F$  are measured on toroid-wound halves.

	freq. kHz	$\hat{B}$ mT	temp. °C	grade	
				3B8	3H1
$A_L \pm 25\%$	4	$\leq 0,1$	$25 \pm 1$	5230	5230
$\mu_e \pm 25\%$	4	$\leq 0,1$	$25 \pm 1$	2040	2040
$\alpha$	4	$\leq 0,1$	$25 \pm 1$	$\leq 17,7$	$\leq 16,0$
$\frac{\tan \delta}{\mu_i} \times 10^6$	4	$\leq 0,1$	$25 \pm 1$		$\leq 1,2$
	100	$\leq 0,1$	$25 \pm 1$		$\leq 6,0$
$\eta_b \times 10^3$	4	1,5 to 3,0	$25 \pm 1$		$\leq 1,1$
P (W)	16	200*	$25 \pm 1$	$\leq 1,0$	
$\alpha_F \times 10^6/K$	$\leq 100$	$\leq 0,1$	$100 \pm 1$	$\leq 1,2$	
	$\leq 100$	$\leq 0,1$	5 to 25		+ 0,5 to 1,5
	$\leq 100$	$\leq 0,1$	25 to 55		+ 0,5 to 1,5
$D_F \times 10^6$	$\leq 100$	$\leq 0,1$	25 to 70		+ 0,5 to 1,5
	$\leq 100$	$\leq 0,1$	$25 \pm 1$		$\leq 4,3$
$\beta_F \times 10^6$ , measured on sets with $\mu_e = 300 \pm 10\%$ and $25 \pm 1$ °C: at $\mu_e \times \frac{N \times I_0}{l_e} = 0,90 \times 10^5$ A/m $= 1,40 \times 10^5$ A/m $= 2,00 \times 10^5$ A/m				$\leq 120$	
				$\leq 300$	
				$\leq 1100$	

Core sets, grade 3H1 pre-adjusted on  $A_L$ .

$A_L$ nH	corre- sponding $\mu_e$ value	tol. on inductance %	catalogue number 4322 022 . . . . .	
			without nut	with nut
315	123	$\pm 2$	19270	39270
400	156	$\pm 2$	19280	39280
630	246	$\pm 3$	19300	39300
1000	390	$\pm 3$	● 19310	39310
1600	624	$\pm 5$	19320	39320

Cores with  $A_L \leq 400$  have a symmetrical air gap.  
Cores with  $A_L \geq 630$  have an asymmetrical air gap.

\* Determined with  $A_{CPmin} = 82,6$  mm<sup>2</sup>.

● Preferred type.

Core halves without air gap.

Ferroxcube grade	catalogue number
● 3B8	4322 020 23780
3H1	4322 020 23750

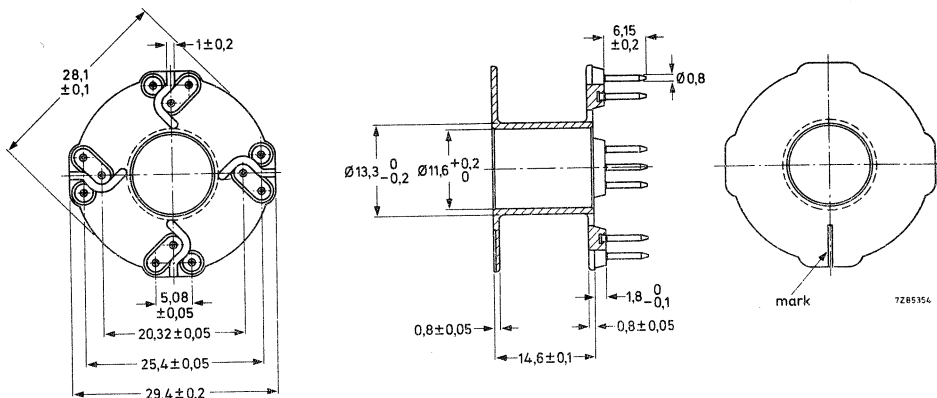
Core halves with air gap

Ferroxcube grade	air gap $\Delta$ in mm	catalogue number
3H1	0,02 $\pm$ 0,01	4322 020 23960
3H1	0,05 $\pm$ 0,015	4322 020 23970
3H1	0,15 $\pm$ 0,015	4322 020 23980
3H1	0,25 $\pm$ 0,015	4322 020 23990

● Preferred type.



## COIL FORMER



Catalogue number	4322 021 33420
Material	phenolformaldehyde reinforced with glass fibre
Window area	97 mm <sup>2</sup>
Mean length of turn	65 mm
Max. temperature	180 °C
Packing quantity	
primary pack	25
storage pack	600

Please order in multiples of these quantities

Solderability: resistant against  
dip-soldering at 400 °C for 2 s

D.C. losses:

$$\frac{R_0}{L} = \frac{1}{\mu_e} \times \frac{1}{f_{cu}} \times 4,52 \times 10^3 \Omega/H$$

Mass 2,5 g

## INDUCTANCE ADJUSTERS

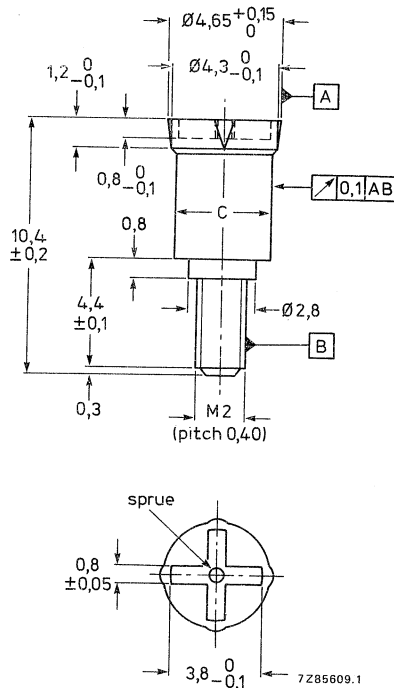


Fig. 1.

Material: polypropylene, reinforced with glass fibre.

The tolerances on inductance factor of the pre-adjusted cores without adjuster are given in the table of pre-adjusted cores with standard  $A_L$  values. The inductance of the pre-adjusted core can be increased to the required value — with a setting accuracy  $< 0,03\%$  — by means of a continuous adjuster.

The adjuster is screwed through the centre hole of the core into the nut and is held in position by the four cones near the top of the adjuster.

The combination of the polyamide moulded-in nut and the polypropylene adjuster — both reinforced with glass fibre — gives an excellent stability with temperature, shocks and vibrations. Besides this, the combination has a very smooth adjustment curve due to the excellent concentricity of the moulded-in nut and the adjuster.

The maximum permissible temperature of the adjustment combination is: 150 °C, during 8 h. The maximum working temperature is 110 °C.

The tables below show the available types and which adjuster is recommended for typical  $A_L$  values.

Table 1 Colour code of adjusters

catalogue number	colour	dia. C (Fig. 1) mm	material
4322 021 38400	black	4,22	FXC
38410	brown	4,04	FXC
38490	grey	3,94	FXC

Table 2 Catalogue numbers of recommended adjusters for typical  $A_L$  values

$A_L$	3H1
315	4322 021 38490
400	38410
630	38400

**PACKAGING**

The adjusters are packed in plastic bags of 100. Please order in multiples of this quantity.

**ADJUSTING TOOL**

An adjusting tool combination for M2 and M2,6 is available, catalogue number 4322 058 03270.

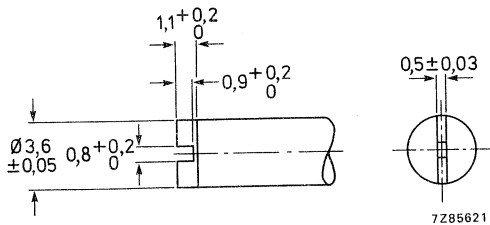


Fig. 2.

For customers who wish to make the screwdriver themselves the outlines of the essential part are given in Fig. 2.

**NUT FOR ADJUSTER**

These data are given for those manufacturers who prefer to insert the nut themselves.

Catalogue number

Material

Max. impregnation temperature for 24 hours

Recommended distance from mating surface to nut

The nuts are packed in plastic bags of 100.

Please order in multiples of this quantity.

4322 021 30150

polycarbonate

120 °C

2,7 ± 0,15 mm

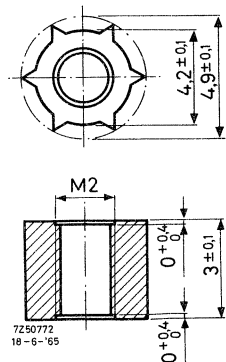
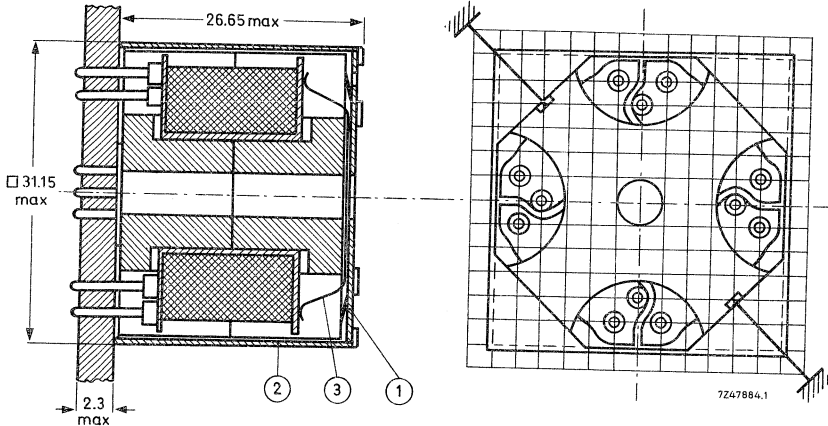


Fig. 3.

## MOUNTING PARTS



- (1) Cover 4322 021 31150  
 (2) Container 4322 021 31170 or 4322 021 33620  
 (3) Spring 4322 021 30210

The cross core has been developed especially for transformers to be mounted on printed-wiring boards with a grid of 0,1 inch.

An advantage of this construction is that the leading-out wires are soldered to the pins which are directly mounted on the coil former.

The pin length is sufficient for board thickness up to 2,3 mm. The printed-wiring board should be provided with holes of  $1,3 \pm 0,1$  mm in diameter.

The phosphor-bronze cover has four cut-out lips on the corners, consequently the cover acts as a spring at the same time.

The cover is provided with a marking hole. The mark of the coil former (see drawing of coil former) has to be in one line with this hole. These markings facilitate the numbering of the soldering pins and the positioning on the printed-wiring board.

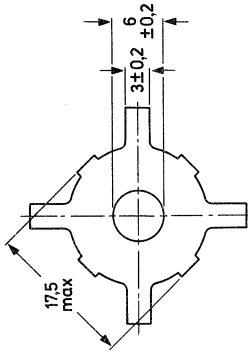
It is recommended that the coil former be cemented on the lower core half or to use the spring (pos. 3) in order to obtain the most stable construction.

Container 4322 021 31170 is identical to container 4322 021 33620, however the latter has four cut-outs (see outline on next page).

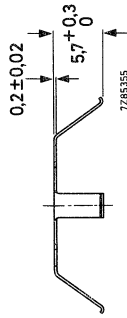
Container 4322 021 31170 gives better cross-talk attenuation, container 4322 021 33620 makes the X30 construction more suitable for a 2000 V test.

Before bending the lips of the container, pressure should be exerted evenly on the four corners of the cover until the latter meets the container. The required force is approximately 250 N. After bending the lips, the core will have the correct tension.

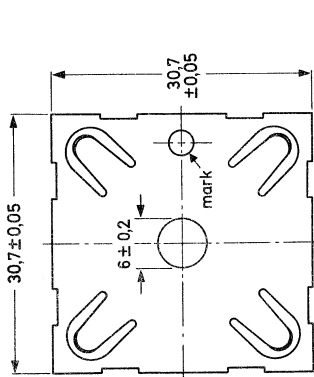




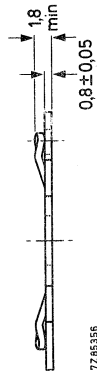
(1) Cover 4322 021 31150  
Material: phosphor bronze,  
nickel plated.



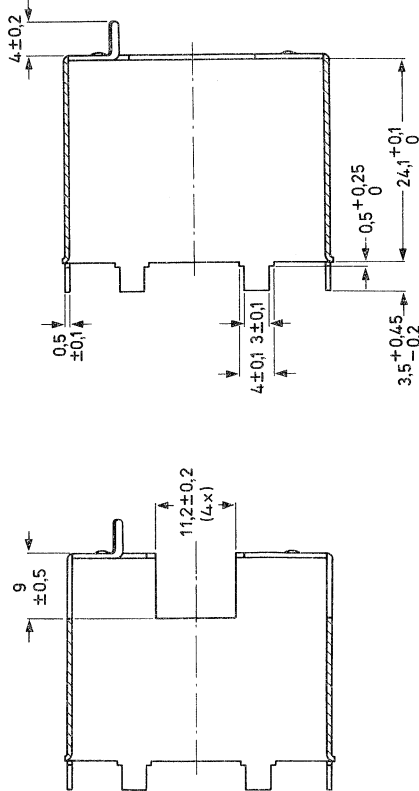
(3) Spring 4322 021 30210  
Material: phosphor bronze.



(2) Container 4322 021 33620



(2) Container 4322 021 31170

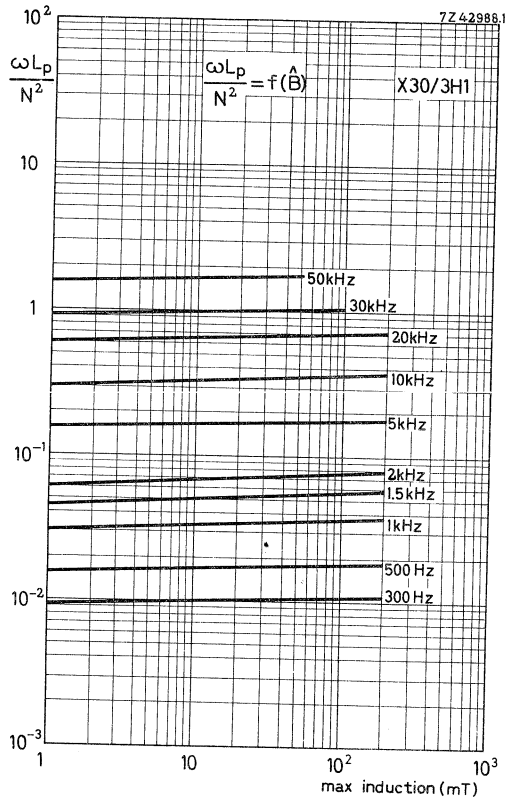


Material: brass, nickel plated.  
Packaging quantity: 750

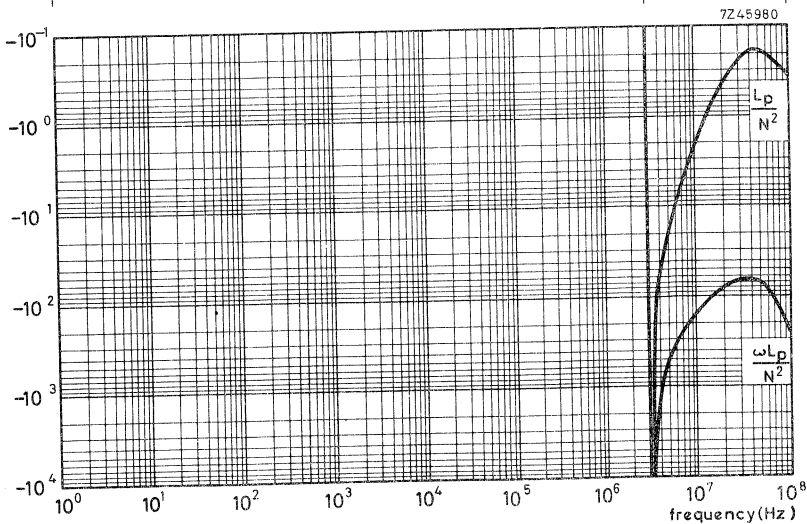
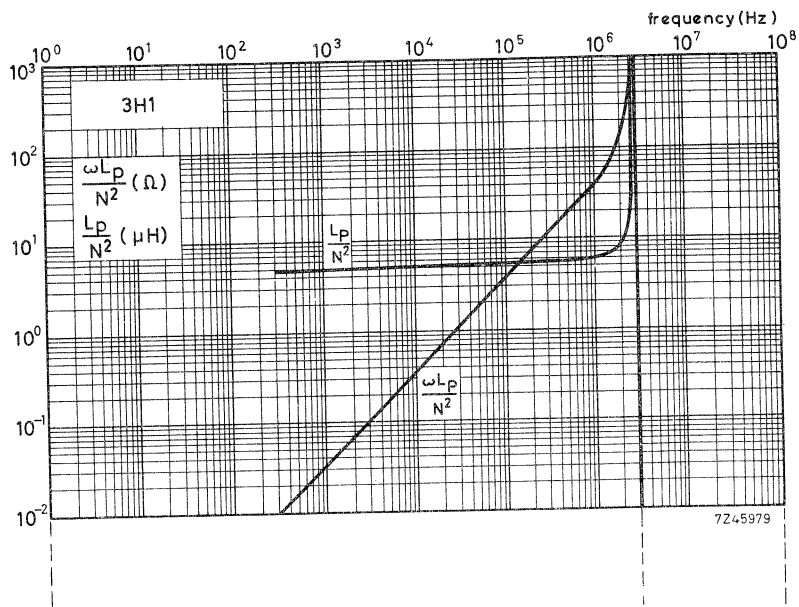
Please order in multiples of the packaging quantity.

# CHARACTERISTIC CURVES

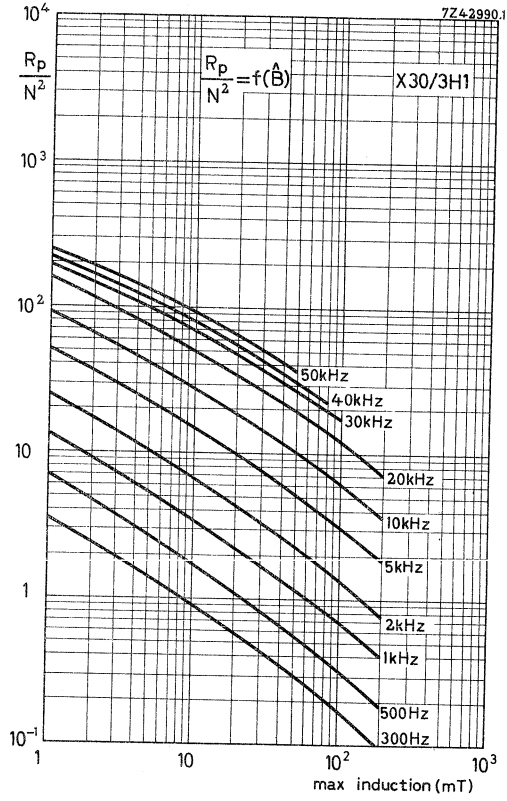
## INDUCTANCE AS A FUNCTION OF THE INDUCTION



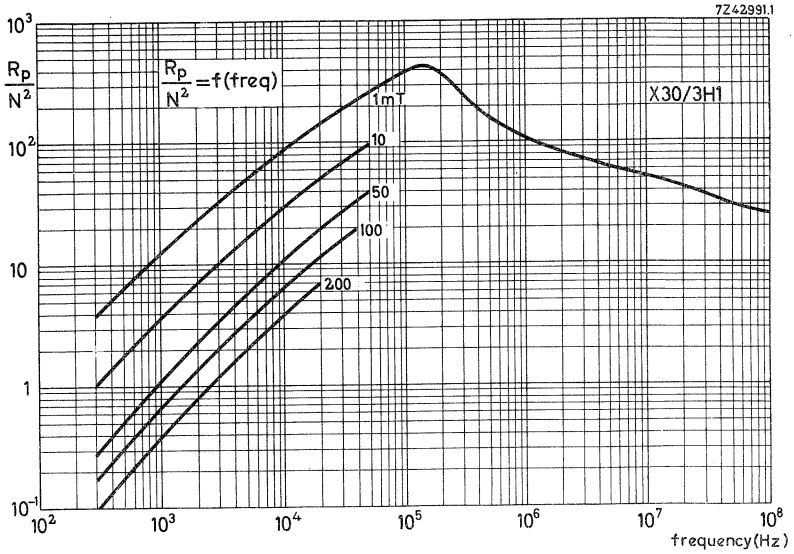
INDUCTANCE AS A FUNCTION OF THE FREQUENCY



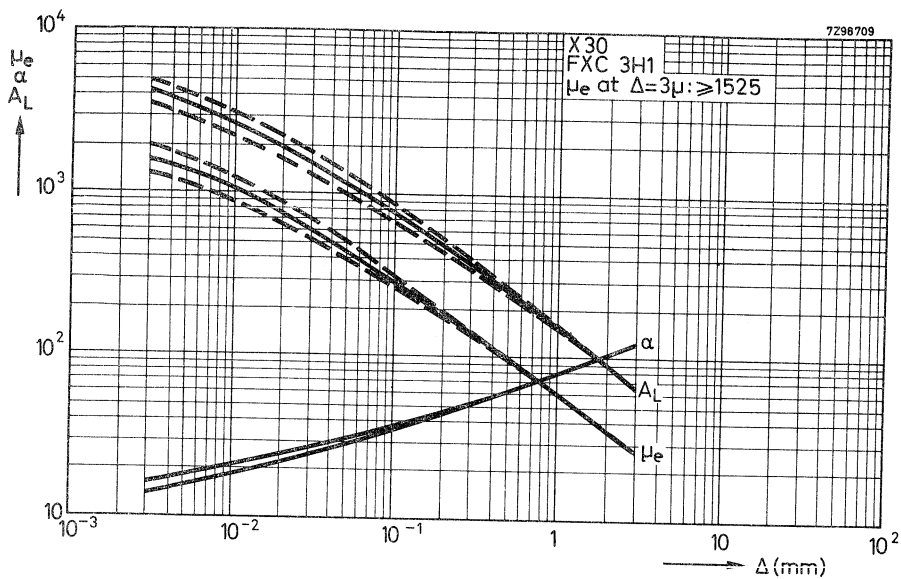
CORE LOSSES AS A FUNCTION OF THE INDUCTION



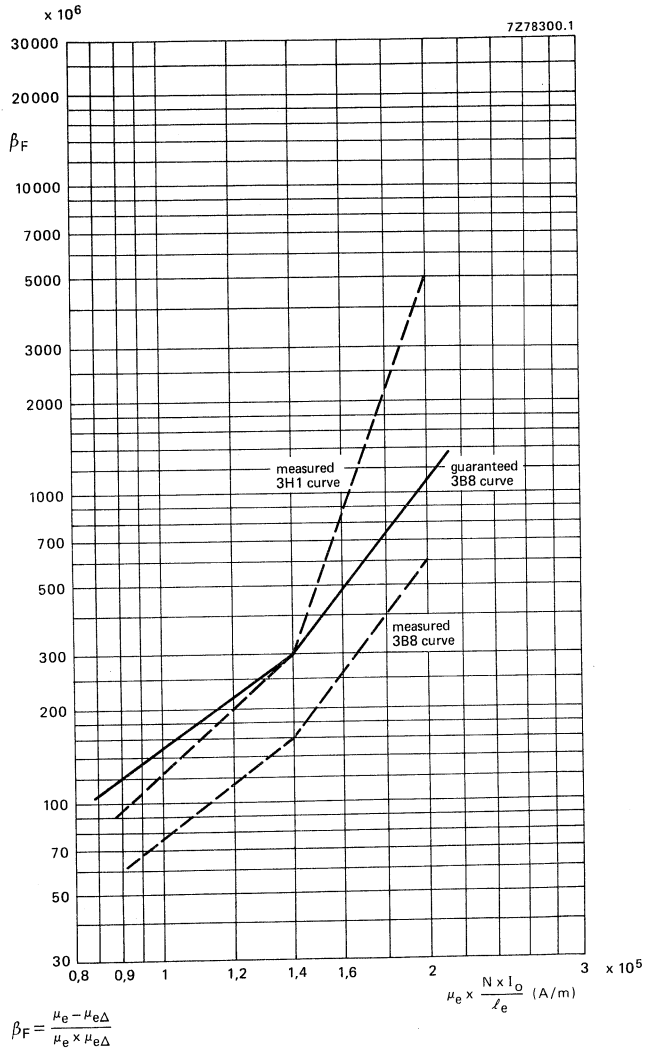
CORE LOSSES AS A FUNCTION OF THE FREQUENCY



$\mu_e$  -  $\alpha$  AND  $A_L$  CURVES

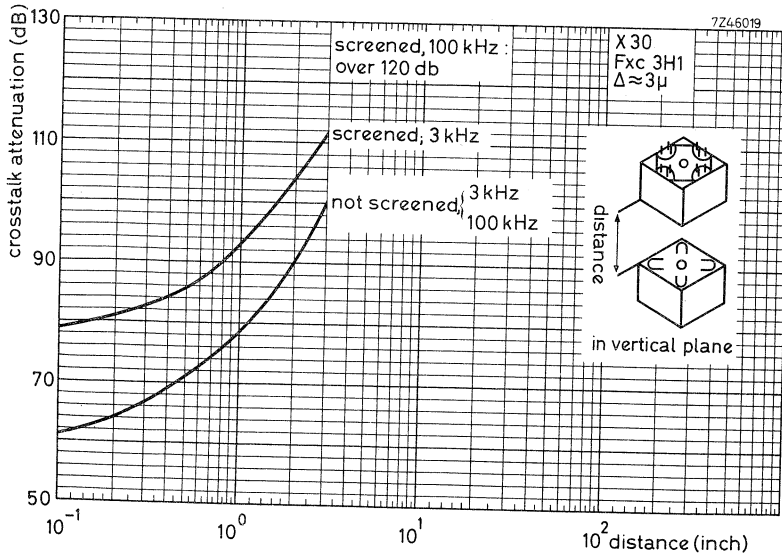
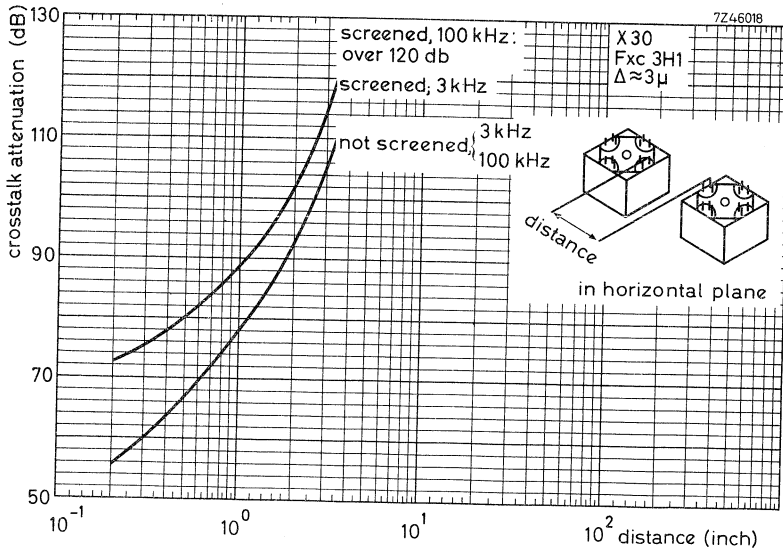


D.C. SENSITIVITY AT 25 °C

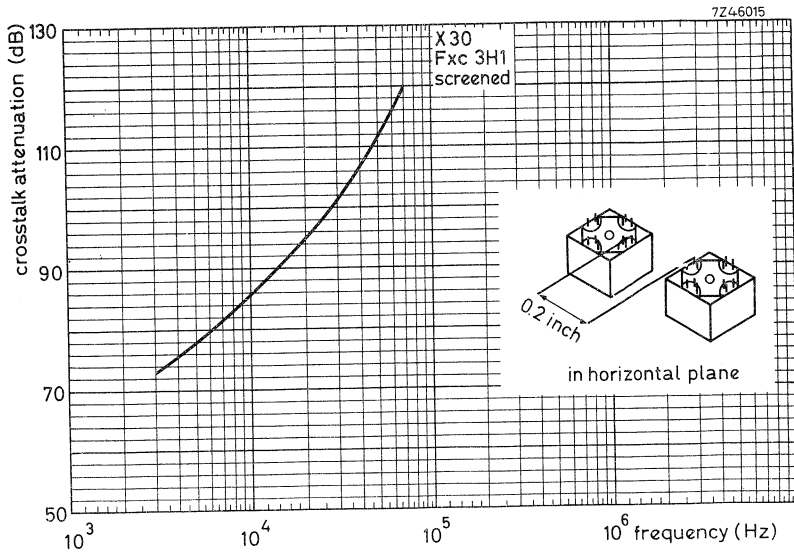


Inductance variation as a function of d.c. current.

CROSSTALK ATTENUATION









## CROSS CORES

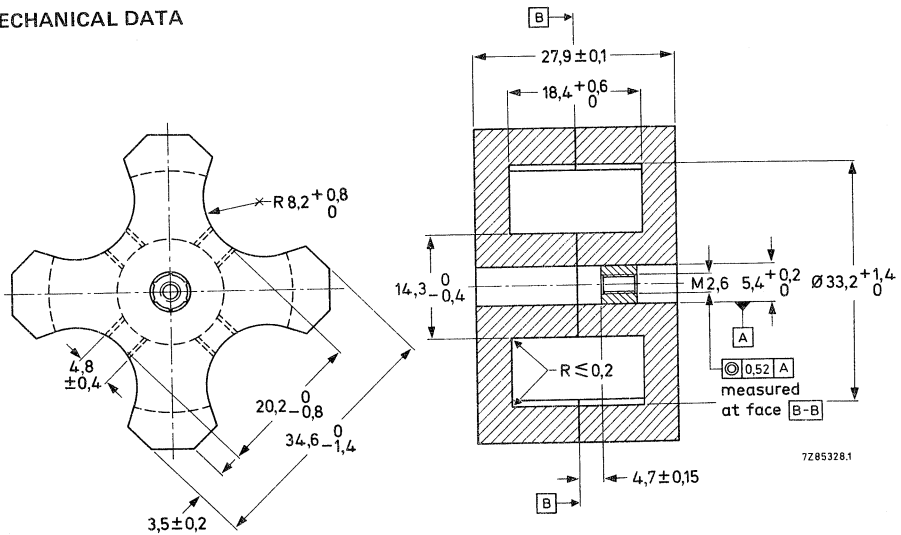
Four types of core can be supplied:

- CORE SETS provided with a nut for an adjuster and pre-adjusted on an inductance factor  $A_L$ .
- CORE SETS without nut and pre-adjusted on an  $A_L$  value.
- CORE HALVES without air gap.
- CORE HALVES with air gap. Standardized air gap lengths in each core half are: 0,02, 0,05, 0,15, 0,25 mm.

The cross cores are in accordance with IEC publication 226.

Cross cores and their associated parts are ordered by their 12-digit catalogue number. Quantity: a primary pack contains 20 core sets or 40 core halves, a storage pack contains 80 core sets or 160 core halves. Please order in multiples of these quantities.

### MECHANICAL DATA



Pulling-out force of the nut  $\geq 50$  N.

Dimensional quantities according to IEC205.

$$C_1 = \Sigma \frac{1}{A} = 0,410 \text{ mm}^{-1}; \quad C_2 = \Sigma \frac{1}{A^2} = 0,00250 \text{ mm}^{-3}; \quad V_e = 11000 \text{ mm}^3; \quad l_e = 67,3 \text{ mm}; \quad A_e = 164 \text{ mm}^2;$$

$$A_{CPmin} = 132 \text{ mm}^2.$$

Mass of a core set approx. 58 g.

**ELECTRICAL DATA**

The combination of two core halves without air gap, randomly chosen from a batch, has the following guaranteed properties. A measuring coil as described in the general section 'Potcores, square cores and cross cores' is inserted. The halves are pressed together with a force of 330 N. The values are valid 5 minutes or more after clamping. Parameters  $\alpha_F$  and  $D_F$  are measured on toroid-shaped halves.

	freq. kHz	$\hat{B}$ mT	temp. °C	grade	
				3B8	3H1
→ $A_L \pm 25\%$	4	$\leq 0,1$	$25 \pm 1$	6450	6450
$\mu_e \pm 25\%$	4	$\leq 0,1$	$25 \pm 1$	2100	2100
$\alpha$	4	$\leq 0,1$	$25 \pm 1$	$\leq 15,8$	$\leq 14,4$
$\frac{\tan \delta}{\mu_i} \times 10^6$	4	$\leq 0,1$	$25 \pm 1$		$\leq 1,2$
	100	$\leq 0,1$	$25 \pm 1$		$\leq 7$
$\eta_B \times 10^3$	4	1,5 to 3,0	$25 \pm 1$		$\leq 1,1$
→ P(W)	25	200*	$25 \pm 1$	$\leq 1,5$	
			$100 \pm 1$	$\leq 1,9$	
$\alpha_F \times 10^6/K$	$\leq 100$	$\leq 0,1$	5 to 25		+ 0,5 to + 1,5
	$\leq 100$	$\leq 0,1$	25 to 55		+ 0,5 to + 1,5
$D_F \times 10^6$	$\leq 100$	$\leq 0,1$	$25 \pm 1$	$\leq 8,0$	$\leq 4,3$
$\beta_F \times 10^6$ , measured on sets with $\mu_e = 300 \pm 10\%$ and $25 \pm 1$ °C:					
at $\mu_e \times \frac{N \times I_0}{l_e} = 1,00 \times 10^5$ A/m				$\leq 120$	
= $1,55 \times 10^5$ A/m				$\leq 300$	
= $2,20 \times 10^5$ A/m				$\leq 1050$	

Core sets pre-adjusted on  $A_L$ .

$A_L$ nH	corresponding $\mu_e$ value	catalogue number 4322 022 . . . . .		
		3B8 without nut	3H1 with nut	3H1 without nut
400 $\pm$ 3%	130		73280	53280
630 $\pm$ 3%	206		73300	● 53300
1000 $\pm$ 3%	326			
→ 1600 $\pm$ 3%	522	● 53990	73320	53320
2000 $\pm$ 10%	652	53100		
2500 $\pm$ 10%	816	53110		

3H1 cores with  $A_L \leq 630$  have a symmetrical air gap.

3H1 cores with  $A_L \geq 1000$  and all 3B8 cores have an asymmetrical air gap.

→ \* Determined with  $A_{CPmin} = 132$  mm<sup>2</sup>.

● Preferred type.

Core halves without air gap.

Ferroxcube grade	catalogue number
● 3B8	4322 020 24030
3H1	4322 020 24000

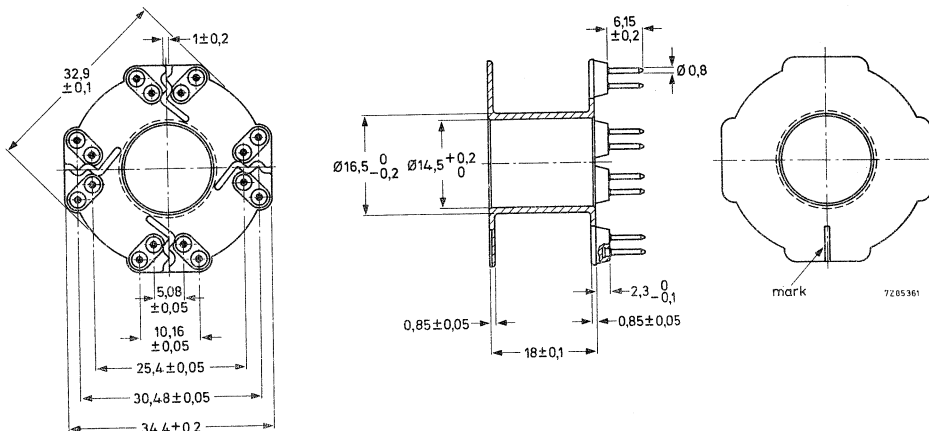
Core halves with air gap.

Ferroxcube grade	air gap $\Delta$ in mm	catalogue number
3H1	$0,02 \pm 0,01$	4322 020 24210
3H1	$0,05 \pm 0,015$	4322 020 24220
3H1	$0,15 \pm 0,015$	4322 020 24230
3H1	$0,25 \pm 0,015$	4322 020 24240

● Preferred type.



## COIL FORMER



## 16-pin coil former

Catalogue number 4322 021 33430

Material phenolformaldehyde reinforced with glass fibre

Window area  $135 \text{ mm}^2$

Mean length of turn  $77 \text{ mm}$

Max. temperature  $180 \text{ }^\circ\text{C}$

Packing quantity primary pack 20  
storage pack 400,  
please order in multiples  
of these quantities.

Solderability: resistant against dip-soldering at  $400 \text{ }^\circ\text{C}$  for 2 s

D.C. losses:

$$\frac{R_o}{L} = \frac{1}{\mu_e} \times \frac{1}{f_{cu}} \times 3,26 \times 10^3 \Omega/\text{H}$$

Mass 4,3 g.

This information is derived from development samples made available for evaluation. It does not necessarily imply that the device will go into regular production.

## INDUCTANCE ADJUSTERS

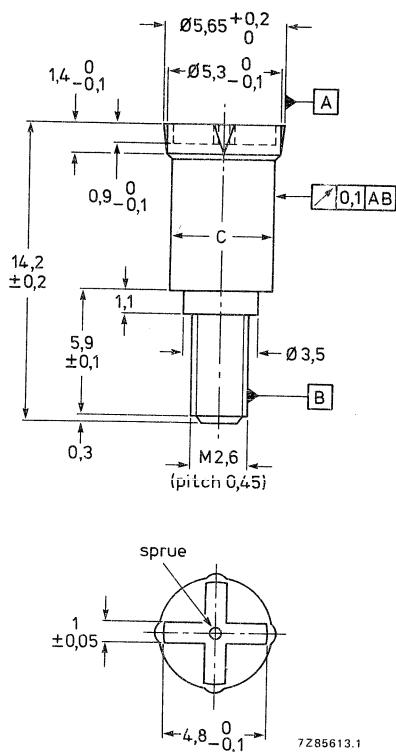


Fig. 1.

Material: polypropylene, reinforced with glass fibre.

The tolerances on inductance factor of the pre-adjusted cores without adjuster are given in the table of pre-adjusted cores with standard  $A_L$  values. The inductance of the pre-adjusted core can be increased to the required value – with a setting accuracy  $< 0,03\%$  – by means of a continuous adjuster.

The adjuster is screwed through the centre hole of the core into the nut and is held in position by the four cones near the top of the adjuster.

The combination of the polyamide moulded-in nut and the polypropylene adjuster – both reinforced with glass fibre – gives an excellent stability with temperature, shocks and vibrations. Besides this, the combination has a very smooth adjustment curve due to the excellent concentricity of the moulded-in nut and the adjuster.

The maximum permissible temperature of the adjustment combination is: 150 °C, during 8 h. The maximum working temperature is 110 °C.



The tables below show the available types and which adjuster is recommended for typical  $A_L$  values.

Table 1 Colour code of adjusters

catalogue number	colour	dia. C (Fig. 1) mm	material
4322 021 38380	white	4,40	FXC
38390	grey	5,10	FXC

Table 2 Catalogue numbers of recommended adjusters for typical  $A_L$  values

$A_L$	3H1
400	4322 021 38380
630	38390
1000	39290

**PACKAGING**

The adjusters are packed in plastic bags of 100. Please order in multiples of this quantity.

**ADJUSTING TOOL**

An adjusting tool combination for M2 and M2, 6 is available, catalogue number 4322 058 03270.

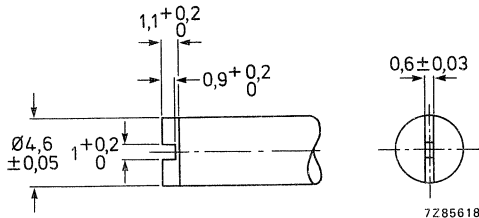


Fig. 2.

For customers who wish to make the screwdriver themselves the outlines of the essential part are given in Fig. 2.

**NUT FOR ADJUSTER**

These data are given for those manufacturers who prefer to insert the nut themselves.

Catalogue number 4322 021 30160

Material polycarbonate

Max. impregnation temperature for 24 hours 120 °C

Recommended distance from mating surface to nut  $4,7 \pm 0,15$  mm

The nuts are packed in plastic bags of 100.

Please order in multiples of this quantity.

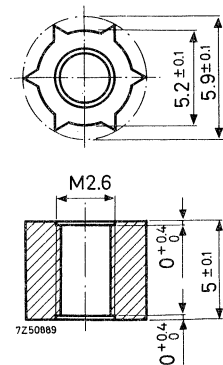
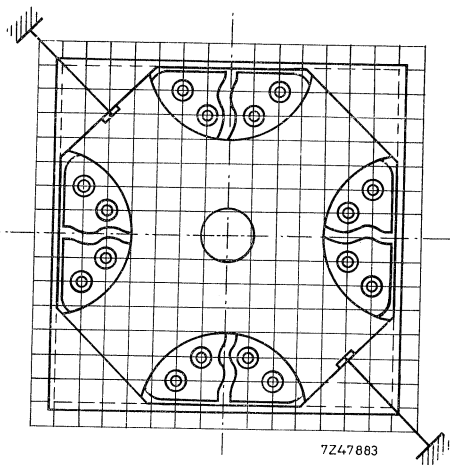
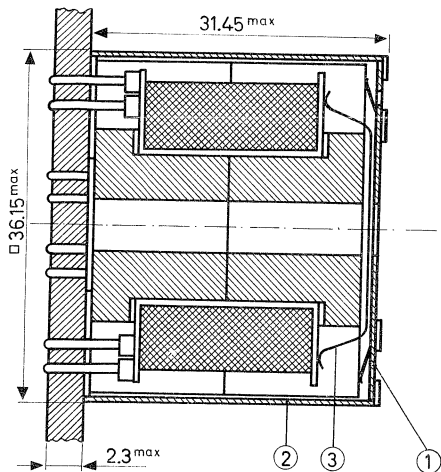


Fig. 3.

## MOUNTING PARTS



- (1) Cover 4322 021 31160  
 (2) Container 4322 021 31180 or 4322 021 33630  
 (3) Spring 4322 021 30220

The cross core has been developed especially for transformers to be mounted on printed-wiring boards with a grid of 0,1 inch.

An advantage of this construction is that the leading-out wires are soldered to the pins, which are directly mounted on the coil former.

The pin length is sufficient for board thicknesses up to 2,3 mm. The printed-wiring board should be provided with holes of  $1,3 \pm 0,1$  mm in diameter.

The phosphor-bronze cover has four cut-out lips on the corners, consequently the cover acts as a spring at the same time.

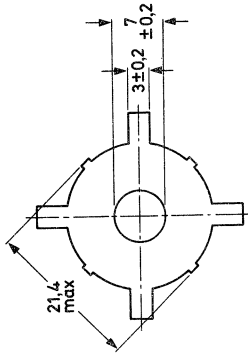
The cover is provided with a marking hole. The mark of the coil former (see drawing of coil former) has to be in one line with this hole. These markings facilitate the numbering of the soldering pins and the positioning on the printed-wiring board.

It is recommended that the coil former be cemented in the lower cross core half or to use the spring (pos. 3) in order to obtain the most stable construction.

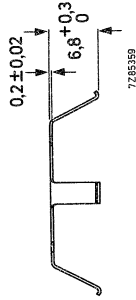
Container 4322 021 31180 is identical to container 4322 021 33630, however the latter has four cut-outs (see outline on next page).

Container 4322 021 31180 gives a better cross-talk attenuation, container 4322 021 33630 makes the X35 construction more suitable for a 2000 V test.

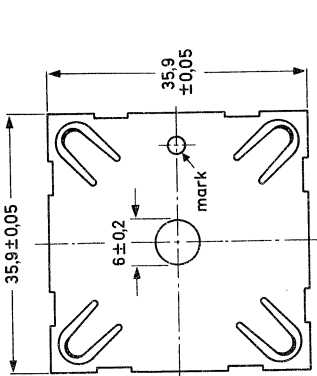
Before bending the lips of the container, pressure should be exerted evenly on the four corners of the cover until the latter meets the container. The required force is approximately 330 N. After bending the lips, the core will have the correct tension.



(1) Cover 4322 021 31160  
Material: phosphor bronze,  
nickel plated.

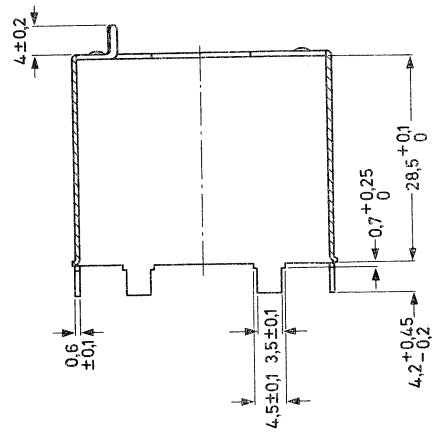
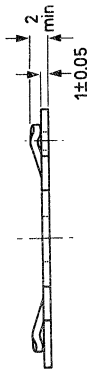


(3) Spring 4322 021 30220  
Material: phosphor bronze.

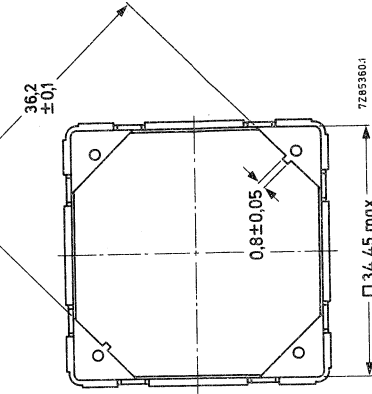


(2) Container 4322 021 33630

Please order in multiples  
of the packing quantity.



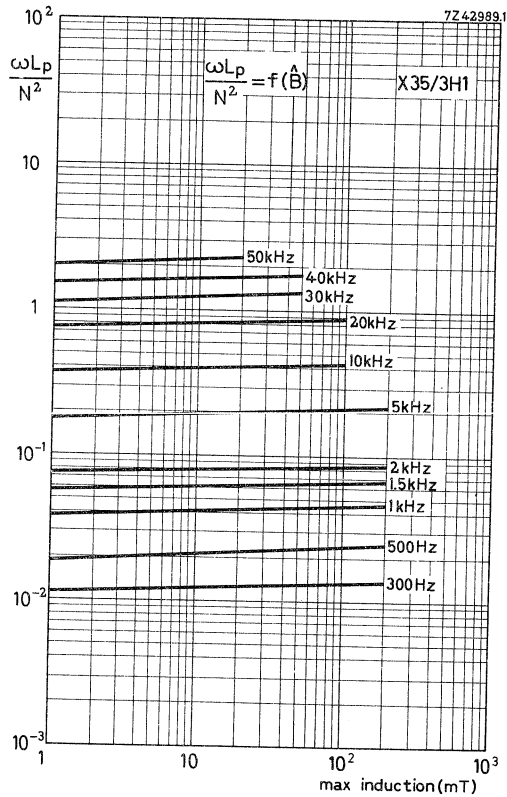
(2) Container 4322 021 31180



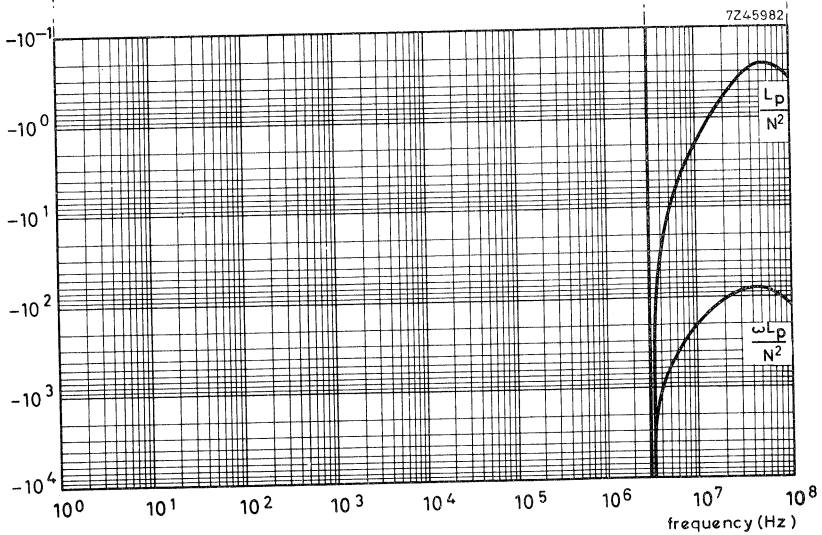
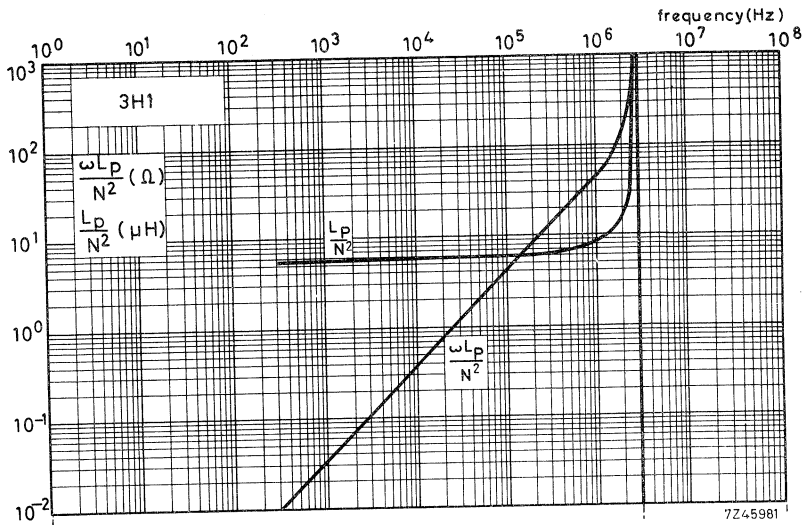
Material: brass, nickel plated.  
Packing quantity: 420.

# CHARACTERISTIC CURVES

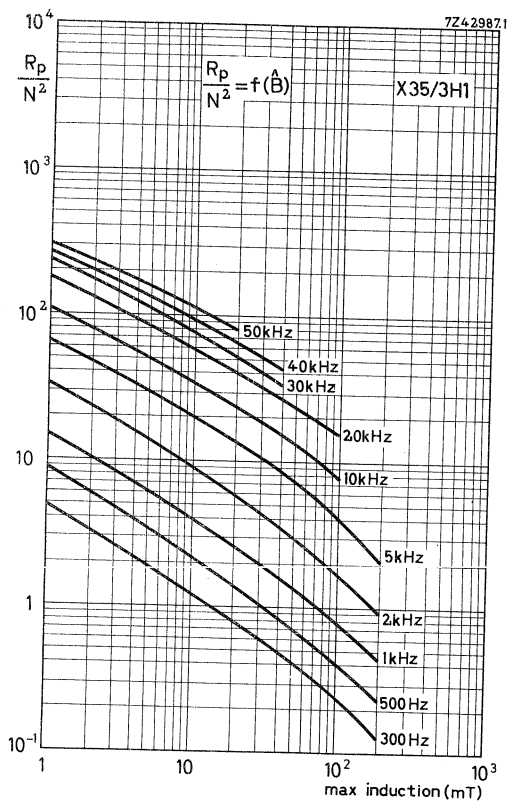
INDUCTANCE AS A FUNCTION OF THE INDUCTION



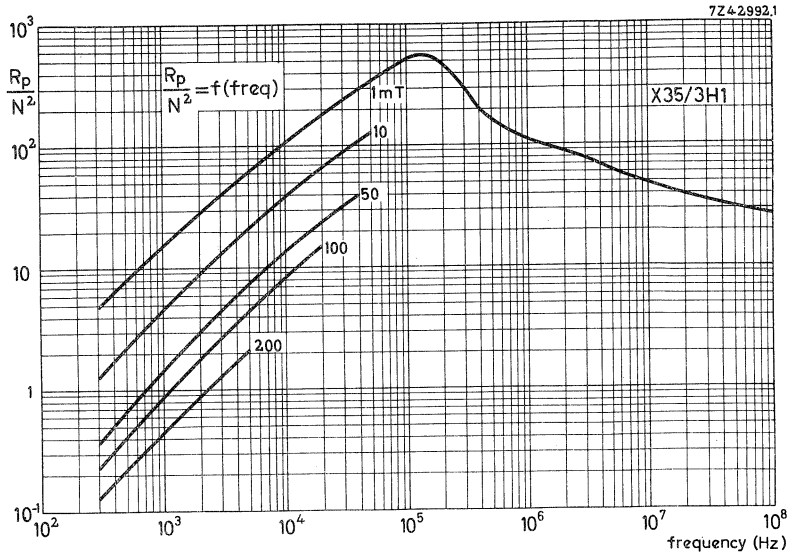
INDUCTANCE AS A FUNCTION OF THE FREQUENCY



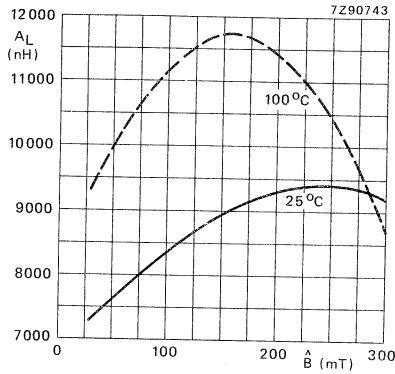
CORE LOSSES AS A FUNCTION OF THE INDUCTION



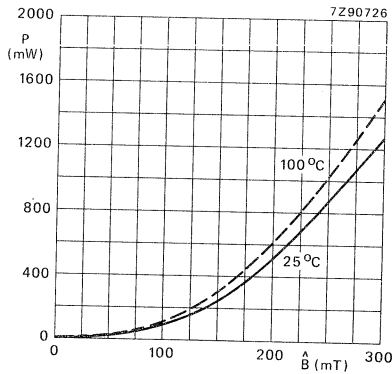
CORE LOSSES AS A FUNCTION OF THE FREQUENCY



FXC 3B8



$A_L = f(\hat{B})$  at 16 kHz, no air gap.

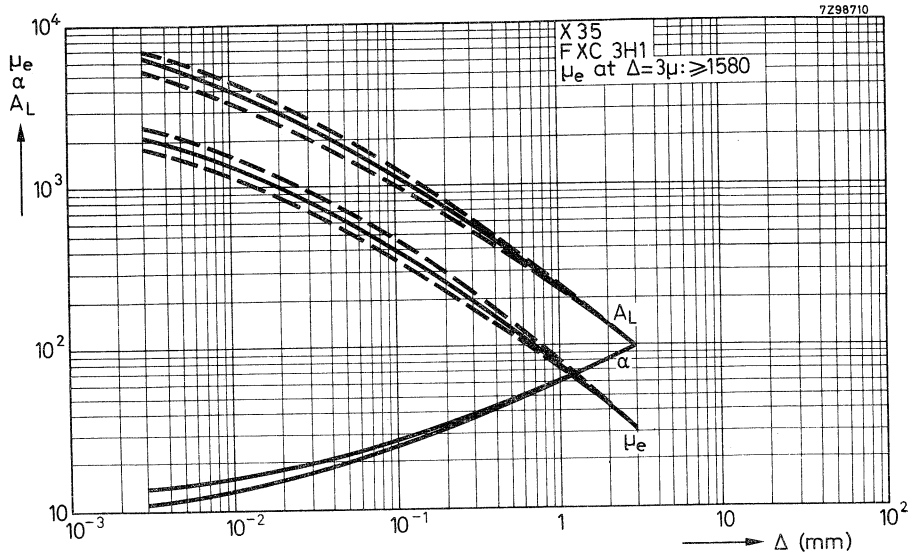


$P = f(\hat{B})$  at 16 kHz, no air gap.

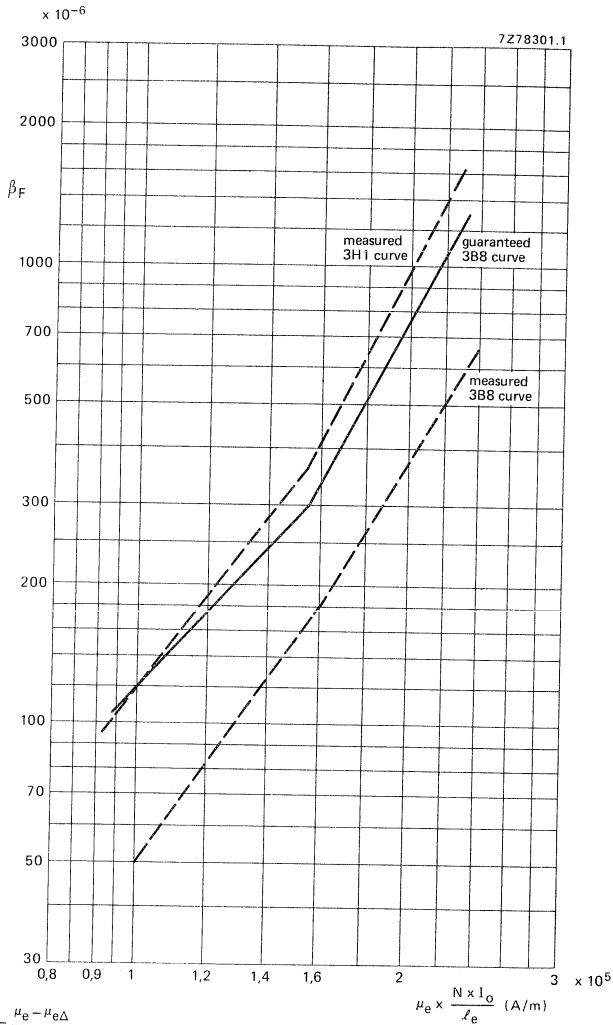
$\hat{B}$  calculated with  $A_{CPmin} = 132 \text{ mm}^2$ .



$\mu_e - \alpha$  AND  $A_L$  CURVES

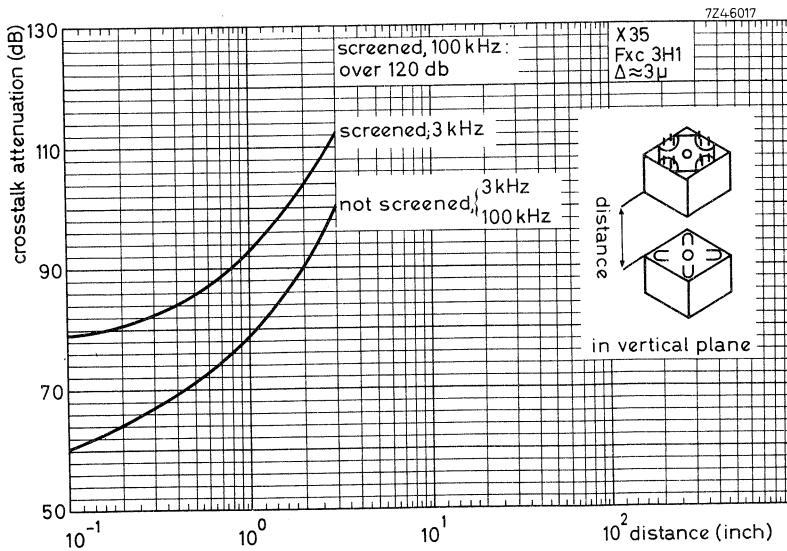
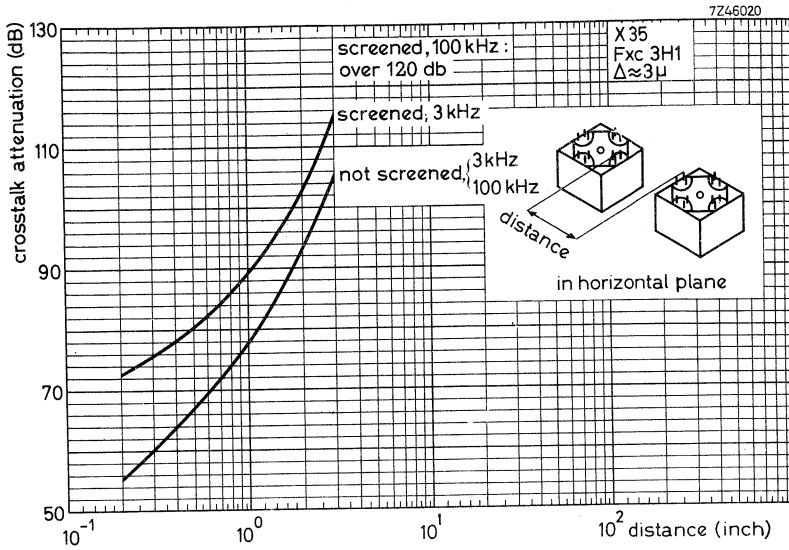


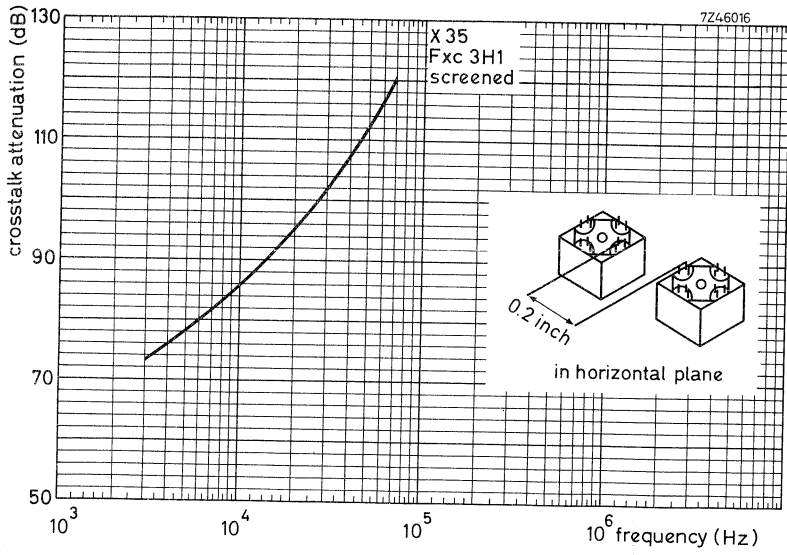
D.C. SENSITIVITY AT 25 °C



Inductance variation as a function of d.c. current.

CROSSTALK ATTENUATION





INDEX OF CATALOGUE NUMBERS

## INDEX OF CATALOGUE NUMBERS

The purpose of this index is to provide identification of the component type when only the catalogue number is known. Details of the particular component are given in the relevant page of this book. See also part C5.

catalogue number	page	description
3522 200 03480	591	Cross core half X22 in 3D3
03490	591	Cross core half X22 in 4C6
4312 021 29240	467	Coil former RM6-S
29250	468	Coil former RM6-S
4313 021 04120	558	Clip RM10
4322 020 20900	98	Potcore half P9/5 in 3D3
20940	98	Potcore half P9/5 in 4C6
20980	98	Potcore half P9/5 in 3H1
21010	109	Potcore half P11/7 in 3H1
21020	109	Potcore half P11/7 in 3D3
21140	109	Potcore half P11/7 in 4C6
21260	128	Potcore half P14/8 in 3H1
21270	128	Potcore half P14/8 in 3D3
21350	128	Potcore half P14/8 in 4C6
21400	128	Potcore half P14/8 in 3B8
21510	159	Potcore half P18/11 in 3H1
21520	159	Potcore half P18/11 in 3D3
21610	159	Potcore half P18/11 in 4C6
21650	159	Potcore half P18/11 in 3H3
21670	159	Potcore half P18/11 in 3B8
21760	193	Potcore half P22/13 in 3H1
21770	193	Potcore half P22/13 in 3D3
21830	193	Potcore half P22/13 in 4C6
21940	193	Potcore half P22/13 in 3B8
22010	225	Potcore half P26/16 in 3H1
22020	225	Potcore half P26/16 in 3D3
22110	225	Potcore half P26/16 in 4C6
22220	225	Potcore half P26/16 in 3B8
22260	259	Potcore half P30/19 in 3H1
22270	259	Potcore half P30/19 in 3D3
22390	259	Potcore half P30/19 in 3B8
22510	289	Potcore half P36/22 in 3H1
22520	289	Potcore half P36/22 in 3D3
22610	289	Potcore half P36/22 in 3B8
22760	319	Potcore half P42/29 in 3H1
23000	337	Potcore half P66/56 in 3E1
23510	591	Cross core half X22 in 3H1
23540	591	Cross core half X22 in 3B8
23710	591	Cross core half X22 in 3H1
23720	591	Cross core half X22 in 3H1

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catalogue number	page	description
4322 020 23730	591	Cross core half X22 in 3H1
23740	591	Cross core half X22 in 3H1
23750	611	Cross core half X30 in 3H1
23780	611	Cross core half X30 in 3B8
23960	611	Cross core half X30 in 3H1
23970	611	Cross core half X30 in 3H1
23980	611	Cross core half X30 in 3H1
23990	611	Cross core half X30 in 3H1
24000	629	Cross core half X35 in 3H1
24030	629	Cross core half X35 in 3B8
24210	629	Cross core half X35 in 3H1
24220	629	Cross core half X35 in 3H1
24230	629	Cross core half X35 in 3H1
24240	629	Cross core half X35 in 3H1
24260	606	Cross core half X25 in 3H1
24270	606	Cross core half X25 in 3D3
24370	606	Cross core half X25 in 3H1
24380	606	Cross core half X25 in 3D3
24470	606	Cross core half X25 in 3H1
25020	466	Square core half RM6-S in 3H1
25060	466	Square core half RM6-S in 3D3
25080	466	Square core half RM6-S in 4C6
25130	412	Square core half RM6-R in 3H1
25140	412	Square core half RM6-R in 3D3
25150	412	Square core half RM6-R in 4C6
25190	412	Square core half RM6-R in 3H3
25200	466	Square core half RM6-S in 3H3
26510	358	Square core half RM4 in 3H1
26760	376	Square core half RM5 in 3H1
26770	376	Square core half RM5 in 3D3
26780	376	Square core half RM5 in 4C6
26790	376	Square core half RM5 in 3H3
27080	376	Square core half RM5 in 3B8
27260	504	Square core half RM8 in 3H1
27270	504	Square core half RM8 in 3D3
27280	504	Square core half RM8 in 4C6
27390	504	Square core half RM8 in 3H3
27420	504	Square core half RM8 in 3B8
27630	412	Square core half RM6-R in 3B8
27930	466	Square core half RM6-S in 3B8
28100	504	Square core half RM8 in 3C8
28320	578	Square core half RM14 in 3B8
28330	578	Square core half RM14 in 3C8
28370	547	Square core half RM10 in 3B8
28380	547	Square core half RM10 in 3C8
28400	547	Square core half RM10 in 3H1
28760	109	Potcore half P11/7 in 3B8
54210	343	Potcore half 5,6 x 3,6 in 3D3
54300	92	Potcore half P5,8/2,5 in 3H1
54400	93	Potcore half P5,8/3,3 in 3H1
54510	345	Potcore half 7,4 x 3,9 in 3D3

catalogue number	page	description
4322 020 54600	95	Potcore half 7,4 x 4,2 in 3H1
54610	95	Potcore half 7,4 x 4,2 in 3H1
54620	95	Potcore half 7,4 x 4,2 in 3H1
54710	347	Potcore half 9,4 x 4,8 in 3D3
54800	349	Potcore half 14 x 7,5 in 3H1
54900	351	Potcore half 26 x 9,2 in 3H1
4322 021 13220	289	Pre-adjusted potcore set P36/22
30040	602	Container for X22
30140	134	Nut for adjuster P14/8, RM6-R, RM6-S, X22
30150	199	Not for adjuster P22/13, RM8, X30
30160	232	Not for adjuster P26/16, P30/19, P36/22, P42/29, RM10, X35
30180	119	Tag plate P11/7
30210	617	Spring X30
30220	635	Spring X35
30230	602	Cover for X22
30240	111	Coil former P22/7
30250	129	Coil former P24/8; 14 x 7,5
30260	130	Coil former P14/8
30270	160	Coil former P18/11
30280	161	Coil former P18/11
30290	161	Coil former P18/11
30300	194	Coil former P22/13
30310	195	Coil former P22/13
30320	195	Coil former P22/13
30330	226	Coil former P26/16
30340	227	Coil former P26/16
30350	227	Coil former P26/16
30360	260	Coil former P30/19
30370	261	Coil former P30/19
30380	261	Coil former P30/19
30390	291	Coil former P36/22
30400	292	Coil former P36/22
30410	292	Coil former P36/22
30420	320	Coil former P42/29
30430	321	Coil former P42/29
30440	142	Tag plate P14/8
30450	173	Tag plate P18/11
30460	206	Tag plate P22/13
30470	240	Tag plate P26/16
30480	273	Tag plate P30/19
30490	303	Tag plate P36/22
30500	331	Tag plate P42/29
30510	118	Container P11/7
30520	142	Container P14/8
30530	174	Container P18/11
30540	207	Container P22/13
30550	241	Container P26/16
30560	274	Container P30/19
30570	304	Container P36/22
30580	332	Container P42/29
30620	119	Spring P11/7



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30640	175	Spring P18/11
30650	208	Spring P22/13
30660	242	Spring P26/16
30670	275	Spring P30/19
30680	305	Spring P36/22
30690	332	Spring P42/29
30710	175	Nut P14/8, P18/11, P22/13, P26/16, P30/19, P36/22, P42/29
30720	175	Fixing bush P18/11, P22/13, P26/16, P30/19, P36/22, P42/29
30750	134	Inductance adjuster P14/8
30780	232	Inductance adjuster P26/16, P30/19
30790	232	Inductance adjuster P26/16, P36/22
30800	232	Inductance adjuster P26/16, P30/19
30810	232	Inductance adjuster P26/16, P30/19, P36/22, P42/29, RM10
30940	134	Inductance adjuster P14/8
30950	134	Inductance adjuster P14/8
30980	232	Inductance adjuster P26/16, P30/19, P36/22, P42/29
31000	199	Inductance adjuster P22/13, RM8
31020	199	Inductance adjuster P22/13, RM8
31040	199	Inductance adjuster P22/13
31060	199	Inductance adjuster P22/13, RM8
31070	134	Inductance adjuster P14/8
31090	232	Inductance adjuster P26/16, P30/19, P36/22, P42/29, RM10
31100	199	Inductance adjuster P22/13, RM8
31110	296	Inductance adjuster P36/22
31120	266	Inductance adjuster P30/19, P36/22, P42/29
31130	134	Inductance adjuster P14/8
31150	617	Cover X30
31160	635	Cover X35
31170	617	Container X30
31180	635	Container X35
31240	199	Inductance adjuster P22/13, RM8
31250	100	Inductance adjuster P9/5, P11/7, RM4, RM5
31260	112	Inductance adjuster P11/7, RM4, RM5
31270	100	Inductance adjuster P9/5, P11/7, RM4, RM5
31280	112	Inductance adjuster P11/7, RM4, RM5
31320	339	Coil former P66/56
31540	100	Inductance adjuster P9/5, P11/7, RM4, RM5
31630	100	Nut for adjuster P9/5, P11/7
31700	99	Coil former P9/5; 9,4 x 4,8
31780	426	Clip RM6-R, RM6-S
31840	518	Clip RM8
31850	366	Nut for adjuster RM4, RM5
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