INTRODUCTION TO MAGNETIC COMPONENTS

GENERAL

CCP magnetic components are comprised of part numbers from various families of inductors, transformers, and delay lines. In most cases, these are card-mounted components and do not include large high-power magnetic devices. (See Figure 6-1.)

Magnetic component usage has continued in the past several years with improvements in packaging, performance, and cost. Magnetic components are used in all types of IBM manufactured equipment.

The following magnetic component families will be discussed in this section.

RF INDUCTORS AND POWER INDUCTORS

AF TRANSFORMERS AND INDUCTORS (FIXED AND VARIABLE)

PULSE AND WIDEBAND TRANSFORMERS

DELAY LINES

Magnetic components are not normally single parameter elements in that they usually are functionally designed to provide some ac signal response. Component performance must, therefore, be characterized on a functional rather than a purely parametric basis. An attempt will be made to identify those design factors and electrical parameters which are pertinent to the performance of each of the various magnetic component families. The user will obviously have to work closely with the appropriate component engineer to adequately define the component specifications for each magnetic component family, followed by definitions of the more commonly referred to terms. Each component family will be expanded upon in their individual sub-sections.

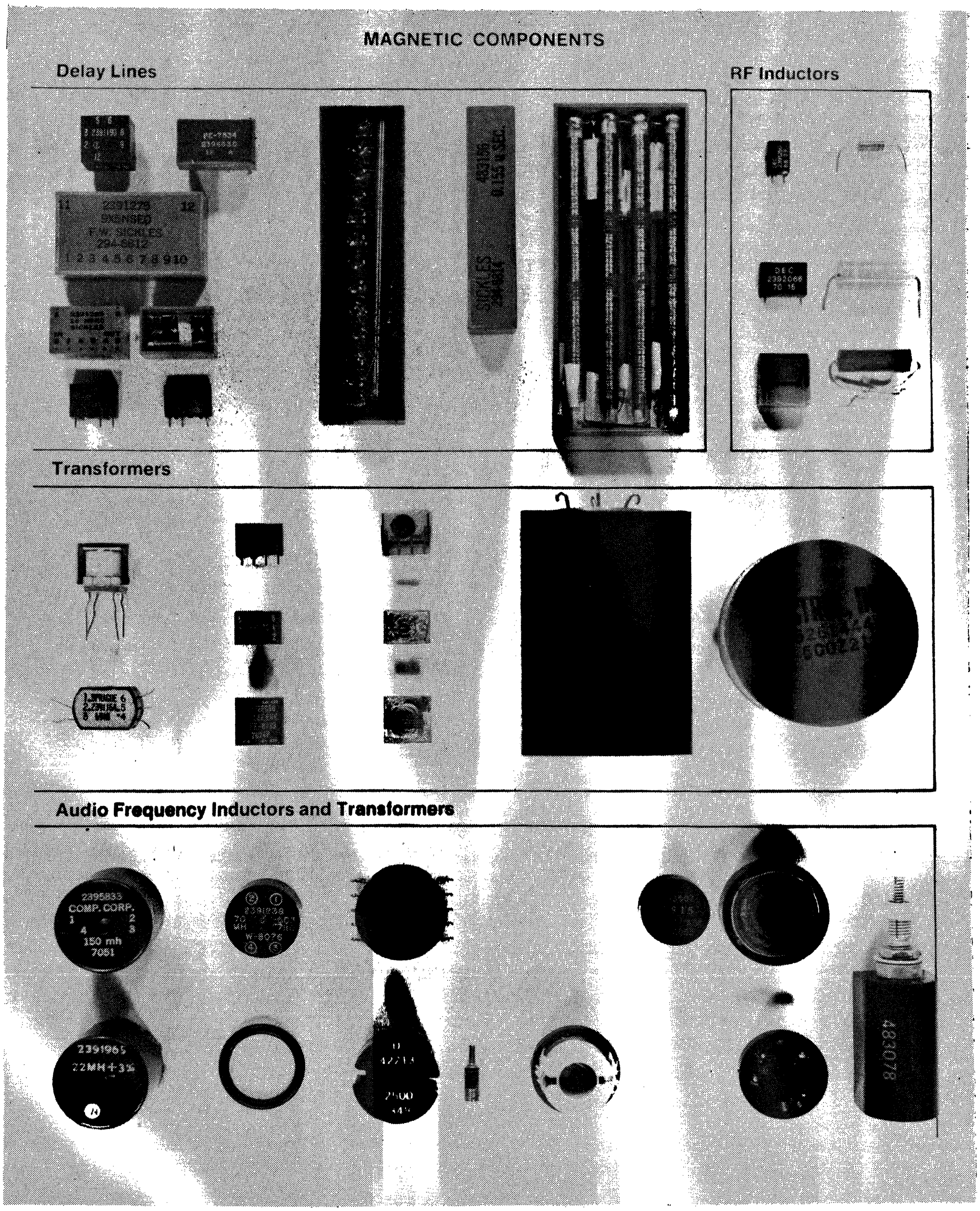


Figure 6-1. Typical Examples of Magnetic Type Components Discussed in This Section

INDUCTORS

Inductors, sometimes called "chokes", fall into three main categories; radio frequency (RF) inductors, audio frequency (AF) inductors, and power inductors. Although the potential applications for each type appear to differ quite widely, each application takes advantage of the fact that inductive reactance (XL) varies directly with frequency. Through the use of this characteristic, selected frequency bands can either be passed, blocked, or "shaped". In this manner, pulse or sinusoidal wave shapes can be controlled.

Besides inductance and dc resistance, the important parameters for RF chokes and power inductors are quite different, so that it is advantageous to discuss each type separately.

RF INDUCTORS

DESCRIPTION

In circuit operation, an RF inductor is generally required to look like an ordinary low-valued resistor up to a specified frequency band. At the onset of this particular band, the inductive reactance (XL) part of the complex impedance begins to become significant and continues to increase with increasing frequency. Electrical energy is increasingly dissipated in the inductor, principally in the form of heat, while lower frequencies are relatively unaffected. Applying this characteristic, an RF inductor in series with a wide-band generator will attenuate the high end of the frequency range, but pass the lower band relatively undiminished, except near the high/low cross-over point. This situation is exactly reversed when the RF inductor shunts the wideband source.

Inductive reactance is described by the expression:

$$X_L = 2 \Pi f L$$

where L is the inductance at the frequency f. It is clear that inductive reactance is directly proportional to frequency and inductance.

The addition of suitably selected capacitance to either type of circuit, to form LC series or parallel resonant loops, enhance the sharpness of the "knee" between the band-pass and band-stop ranges.

RF INDUCTOR TECHNOLOGY

Packaging

RF inductors are constructed by putting turns of wire around a core. The core may be either a solenoid or H-shaped, and is generally composed of phenolic, powdered iron, or ferrite. Other core materials are available for specialized applications. The unit may be encapsulated in heat-shrinkable tubing with epoxy buttered ends (Figure 6-2) or in any of several different kinds of hard Polymer such as alkyd (Figure 6-3). The latter is the more common packaging approach. A ferrite sleeve may be placed over the coil before final encapsulation as a shield to minimize coupling between adjacent components. This is especially important in high-density packaging configurations. Physically, an RF inductor may be either axial or radial-leaded (see Figures 6-4 through 6-6). The body size is determined by the required inductance, DCR, Q value, and current capability. Figure 6-7 relates the two basic radial leaded packages to the approximate range of inductance each is capable of handling under typical performance/size constraints. There is some interest in a 0.100 lead spaced design. This is available. Contact CCP for details. Figure 6-8 shows ranges of inductance for typical axial-leaded inductor dimensions.

Figure 6-2. RF Inductor Packaged in Heat Shrinkable Tubing

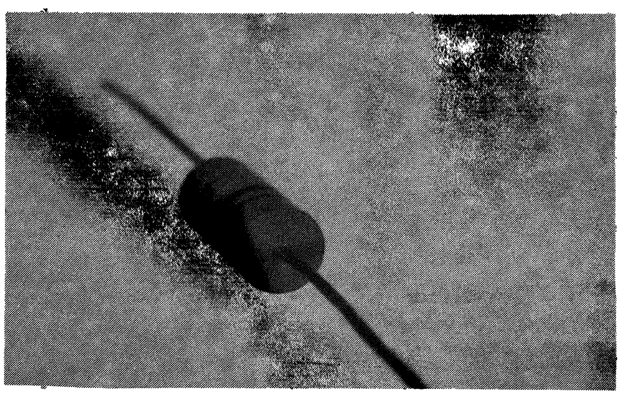


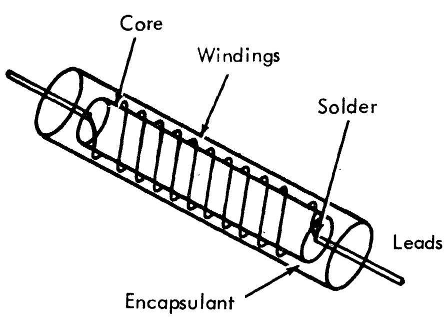
Figure 6-3. RF Inductor Packaged in Molded Polymer

Cores

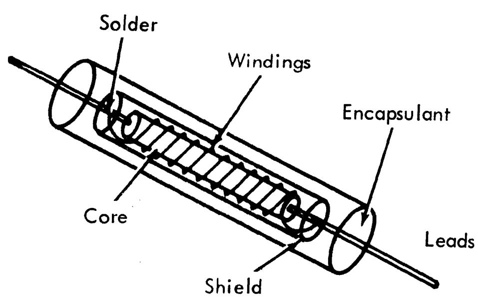
Phenolic - Phenolic core material has no significant magnetic properties. It is used solely as a mechanical form (in place of air) because it is physically stable with respect to current and temperature (up to approximately 155°C). It is used in higher frequency operation where lower inductances are generally required. At extremely high frequencies the capacitance of phenolic becomes appreciable and must be taken into design account. It is the least expensive of all core materials. At temperatures higher than 150-160°C, a ceramic core is used.

Phenolic core inductors show stable performance over a wide temperature range; typically from about -20°C to +150°C.

Powdered Iron and Ferrite Cores - The majority of RF inductor designs controlled by CCP are based on either powdered iron or ferrite cores. In the frequency band from about 1.0 MHz to 8.0 MHz, either material may be used consistent with the several major trade-offs between them. Most paramount is cost. Powdered iron cores are less expensive than ferrite. Raw ferrite is more costly material to begin with. It is a ceramic which must be fired at high temperatures in a kiln after being molded to shape. Dimensions before and after firing can differ by as much as a 2 to 1 reduction. This means that expensive machining operations are necessary to bring ferrite cores into acceptable manufacturing tolerances.



(Non-Shielded)



(Shielded)

Figure 6-4. Axial-Leaded Constructions

However, raw powdered iron, and any of several different binders, are subjected to molding pressure and a certain amount of heat to produce virtually any core form factor in a dimensionally stable condition. Additional machining is seldom required. Raw powdered iron is relatively low-cost material.

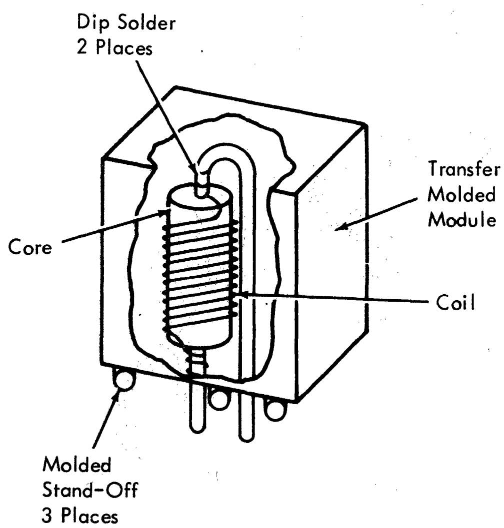


Figure 6-5. Radial-Leaded - 125 mil Spacings

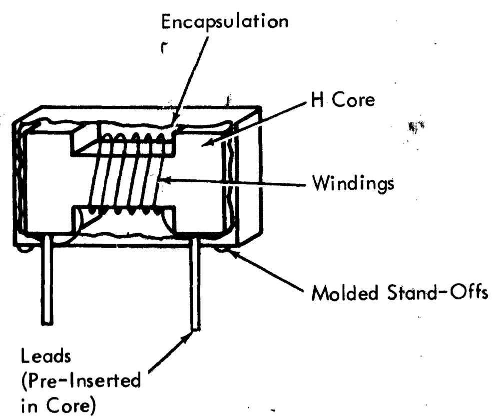
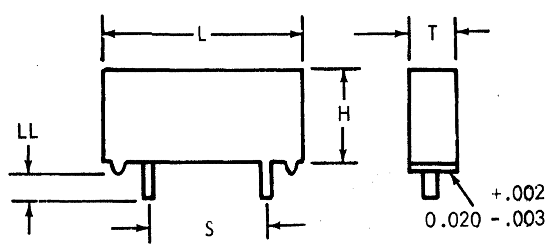
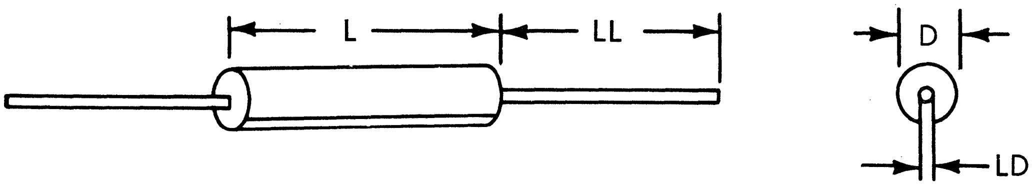


Figure 6-6. Radial-Leaded - 375 mil Spacings



Inductance	S	L(max)	H(max)	T(max)	LL(max)
50 nH to 1 mH	0.125	0.233	0.370	0.125	0.090
330 µH to 10 mH	0.125	0.483	0.375	0.125	0.090

Figure 6-7. Radial Leaded (Module) - Dimensions in Inches



Inductance	L(max)	D(max)	LD(max)	LL(max)
10 nH	0.265	0.105	0.023	1.250
10 mH	1.532	0.782	0.043	1.250

Figure 6-8. Axial Leaded - Dimensions in Inches

Ferrite can be produced with much higher permeabilities than powdered iron. Thus for higher inductance or Q requirements typically above 50 microhenrys and/or a Q of 50, ferrite is more suitable. For the same reason, ferrite is generally more usable for designs in the frequency range below 1.0 MHz if significant inductance is necessary.

Where inductance/Q stability is required under heavy current loads, powdered iron is the better material since it does not saturate nearly so quickly as ferrite. In this function, inductance/Q levels must be fairly low, otherwise the number of turns required would make dc resistance prohibitive.

Powdered iron-based inductors are more temperature stable than typical ferrites. However, in recent years, a number of ferrite manufacturers have developed proprietary formulations which compare favorably with the most stable core materials, retain the high permeabilities available in ferrites, and still cost only 5-10% more than standard ferrites.

Miscellaneous Core Materials - Brass is sometimes used as a core material for low inductance, high resolution, variable inductors. This material actually reduces the permeability below that of a comparable air-core so that more turns may be included for greater resolution during adjustment.

Molybdenum permalloy is generally regarded as the best core material as far as current handling capability, temperature stability, and high permeability are concerned. It is also the most costly of the commonly available materials by a wide margin, and is therefore only used as the last option in difficult designs.

A material sometimes known as "Sendust", but also by other trade names, has been developed by some manufacterers, which is similar to moly permalloy but at a price just slightly above premium quality ferrite. Its disadvantages versus moly permalloy are slightly lower available permeabilities, and more difficulty molding into certain shapes.

Coils

The brunt of the cost of most RF inductors is associated with the coil itself. This is especially true as the intended operational frequency band is raised upward and the manner in which the coil is wound becomes critical.

Coil winding is both a science and an art. Fortunately, for most designs, textbook equations and design guidelines, together with the designer's experience will suffice. In the rare case where applications requirements demand high performance versus tight constraints on one or more parameters, the designer's ingenuity, exotic core materials, and numerous prototype iterations may be the only way to go. This approach inevitably escalates final production cost.

Numerous winding techniques are available, but the majority of designs utilize any one of three formats.

Layer wound, solenoid, or orthocyclic coils involve layers of aligned turns, as opposed to for instance, a randomly wound coil. Layer integrity generally vanishes after 4 to 5 layers. The desireable features of this type winding are, the highest inductance and lowest DCR per turn of any winding technique. The negative characteristic is an extremely high distributed capacitance which severely limits upper frequency operation. This is also the simplest wind and therefore the least expensive and most commonly used.

To minimize distributed capacitance at higher frequencies, a random wind is often used. This reduces distributed capacitance by lowering the voltage gradient between adjacent windings as, for instance in solenoid coils. As indicated, available inductances are lower and DCR's higher. In addition, inductance/Q variation is greater between units wound in the same production lot. The major tradeoff, however, is that inductance/Q stability with temperature is not great.

The Universal or Pi technique reduces distributed capacitance still further and thereby further extends the upper frequency range. Coils thus wound appear as an intermeshed diagonal pattern. Cotton-served wire is used in this technique and this limits the number of turns possible within a given volume. Cotton-served wire also tends to accelerate wear in wire feeding mechanisms. The manufacturer is thus obliged to factor his resultantly higher maintenance costs into the component unit cost. Tight control of inductance/Q tolerances are possible with a Pi wind. If the lowest achievable distributed capacitance is called for, a segmented Pi wind is used, in which the coil is wound in two or more sections on the same core. With fine coil wire, #30 AWG or smaller, wire breakage between segments or sections becomes a problem and adversely affects yield and therefore price.

PARAMETERS AND SPECIFICATIONS

RF Inductors are normally specified at several standard operating frequencies. These are summarized by inductance range in Table 6-1.

Table 6-1. Inductance Range versus Standard Measurement Frequency

Inductance	Frequency
Above 0.1 µH to 1.0 µH	25 MHz
Above 1.0 µH to 10 µH	7.9 MHz
Above 10 µH to 100 µH	2.5 MHz
Above 100 µH to 1.0 mH	790 kHz
Above 1.0 mH to 10 mH	250 kHz
Above 10 mH to 100 mH	79 kHz

The measurement frequency is generally selected so that it is about 0.08 to 0.12 of the inductor's self resonating frequency. However, in low frequency applications, an inductor may have its inductance specified at 1 kHz and its Q at a higher frequency. This is primarily due to the favorable equipment accuracy for inductance measurements at 1 kHz, and the fact that inductance is relatively constant with frequency over a given frequency range. The Q has to be specified at its operating frequency since it is a frequency-sensitive parameter and there is the possibility that core losses might significantly affect it.

RF inductors can be used at frequencies other than those specified. However, it should be realized that inductance increases linearly with frequency until the frequency nears the inductor's self-resonating frequency (SRF). At this point, the effective inductance increases exponentially, as shown in Figure 6-9. Beyond the SRF point, the impedance becomes capacitive rather than inductive. Powdered iron and phenolic core inductors exhibit stable performance over a wide range of temperatures (-15°C to +100°C), while typical ferrite core inductors may be subject to significant changes in inductance. This is primarily due to the increase in permeability of ferrite cores with increasing temperature. By specifying the operating temperature range the manufacturer may alter the properties of the ferrite core to either increase or decrease the Curie point of the core. Increasing the Curie point tends to minimize inductance changes in the operating temperature range; however, production yields will decrease, and cost will correspondingly increase. The temperature coefficient of inductance is less than ±1% for phenolic and powdered iron core inductors, and generally less than ±3% for ferrite core inductors, over their useful operating temperature range.

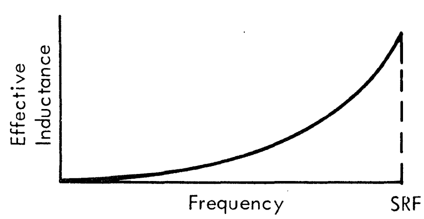


Figure 6-9. Variation of Effective Inductance with Frequency

The temperature coefficient for premium ferrite has become almost interchangeable with comparable powdered iron cores in the range from -10°C to +90°C. This has been accomplished at only a moderate increase in the cost for "better" ferrite.

The worst-case absolute EOL inductance tolerance is primarily a function of the core material used in the inductor's construction. It will also vary from supplier to supplier due to process and material variations.

Phenolic, as might be expected, is the most stable material. Long-term inductance variation, will be very slight and will essentially be due to small geometric changes in overall inductor structure.

Ferrite and powdered iron cores when used according to design intent, show approximately the same magnitude EOL change, and generally, an increase in inductance.

A broad range of W.C. absolute EOL tolerances for RF inductors is presented below for user awareness.

Purchase Tolerance:	±3% to ±10%
TCL:	±1% to ±3%
EOL Drift:	±2% to (+15,-5)%
W.C. absolute EOL Tolerance:	±9% to (+28,-18)%

Powdered iron cores have been improved to the point where EOL Drift (100K hour lifetime) will be on the order of +2%. This is due almost exclusively to improved binder materials.

The current rating of an inductor is determined by the size, length, and type of wire used for the inductive windings, encapsulating material, and core material. RF inductors are presently rated at a current level which will cause a temperature rise of less than 35°C in the windings unless otherwise noted. If an inductor is going to be operated in an ambient temperature of more than 60°C, the current level should be derated linearly to approximately 50% at 80°C. The maximum temperature rise of 35°C and/or a derating factor becomes very critical at high frequencies due to the phenomenon called skin effect. At high frequencies the electrons tend to flow in the windings on or near the surface of the wire; therefore, only a small portion of the wire is carrying all of the current. The effective decrease in wire cross-sectional area causes an effectively higher resistance and therefore a lower Q. This increase in resistance is known as skin effect and may be limited by specifying minimum Q and maximum ac equivalent series resistance.

Ferrite core inductors often have incremental current ratings specified along with a maximum dc rated current.

An incremental current rating is needed because ferrite core inductors tend to saturate under heavy dc current loads, and this can cause a substantial drop in inductance -up to 75% or even higher. It is important that the specified incremental current be such that the decrease in inductance will not exceed 10%. Phenolic and powdered iron core inductors are not adversely affected by rated dc current, and so incremental current is not specified.

Coefficient of coupling or mutual inductance is a parameter which must be considered when packaging several inductors on the same card, or when high density card packaging is required. If two or more inductors or magnetic devices are placed within close proximity to each other, the current flowing in one may induce voltage in another. Often a ferrite shield is used over the core windings before encapsulating to prevent the lines of force from moving beyond the shield. The coefficient of coupling parameter is specified, therefore, to identify the maximum coupling effect which can be tolerated.

COST AND DESIGN CONSIDERATIONS

The major factor affecting inductor cost is over-specification by the user. Often, parameter and tolerance trade-offs are possible, and the application requirements can be met more economically. Total yearly volume and individual part number volumes affect the cost of the radial leaded inductors much more than the cost of axial leaded inductors due to their limited application to date. Below are representative price ranges of user costs for the various inductor types.

Radial lead (0.125")	$.25 to $.85
Radial lead (0.375")	$.45 to $.90
Axial lead	$.25 to $.85
Axial lead (shielded)	$.65 to $1.15

INDUCTOR SPECIFICATIONS

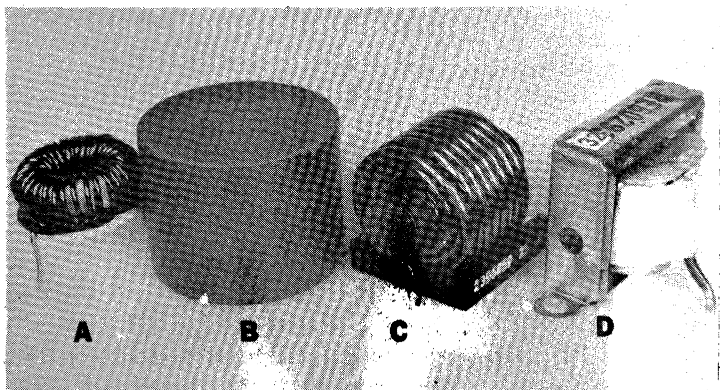
Inductors are covered by Engineering Specification 897833 and other general specifications. Failure rate is supported in Engineering Specification 866451.

POWER INDUCTORS

Description

Low power inductors, more commonly known as power chokes, are primarily used in rectification/filter sections of power supplies. Their function is to provide a high ac impedance to ripple current superimposed on the desired dc component of the rectifier output. The power choke, in conjunction with suitably selected capacitance, therefore "filters out" or reduces the ripple current to a functionally insignificant level. This is of importance in power supplies which are used in solid state systems which are very sensitive to small current fluctuations.

Figure 6-10 shows the several most common forms assumed by low to medium power level power chokes. All of the basic transformer/inductor technologies are normally utilized. This will be discussed in detail later.



1. Toroid
2. Encapsulated Pot Core
3. Solenoid
4. Laminate

Figure 6-10. The Four Basic Power Choke Technologies

Power Inductor Technology

Operating Temperature - The power choke must be able to perform its function with a temperature increase which does not exceed a specified maximum. It must also have a dc resistance low enough so that the voltage drop across it does not inhibit the voltage regulation of the power supply. A rise in temperature is a normal part of a power choke's operating characteristic, just as it is for a power transformer. The materials used in its manufacture must therefore be selected to be compatible with the maximum temperature level which the unit will see in normal operation. These materials are defined by UL for several prescribed temperature ranges and are referred to as "insulation systems". Table 6-2 lists the insulation class and the maximum temperature rise associated with each.

Table 6-2. UL Inspection Classes and Maximum Permissible Temperature Rise

Insulation Class*	Maximum Temperature Rise
105 (formerly class A)	55°C
"E"	70°C
130 (formerly class B)	80°C
155 (formerly class F)	105°C
180 (formerly class H)	130°C

Temperature Rise (ΔT) is calculated using the "change in dc resistance" method. This method is more accurate than the use of thermocouples since it "measures" the integrated temperature rise therefore not susceptible to false readings caused by sensing at localized hot or cold spots. In practice, the units under test are powered at maximum rated power for a specified time, generally at least 2 hours, and in a specified ambient temperature. The dc resistance is measured, using a 4-point probe, before power is applied and immediately after, and the values plugged into the well-known formula:

$$\Delta T = \left[\frac{R_2}{R_1} - 1\right] (234.5 + T_0)$$

where:

R_1 = dc resistance before power-on

R_2 = dc resistance after power-off

234.5 = correction factor for Copper

T_0 = ambient temperature

The fully qualified power choke design, therefore, must be compatible with the materials and temperature considerations defined by UL, as well as electrical, dimensional, and cost specifications and targets, identified by the user.

*The numbers quoted under Insulation Class are the maximum temperatures, in degrees centigrade, which a power choke in that class may reach.

ailable Core Types - Power chokes may be based on any of the four basic trans- rmer/inductor technologies: toroid, pot core, solenoid, or laminate. Figure -10 shows typical power chokes based on each technology. The units may be encapsulated, as is the pot core (unit B, Figure 6-10). This adds mechanical and environmental protection where it is generally not required and also adds significantly to the unit cost. In some hostile environments, pot core designs can benefit from encapsulation. As a general rule, however, a power inductor design is simple and rugged enough so that encapsulation is not necessary and this additional cost need therefore not be borne by the production designs.

Pot Cores - The pot core design is the most expensive of the four design approaches. Because of the relative ease of basic pot core design, however, it is the most popular format among circuit bread-board designers. Pot cores show the best advantage where high inductance and low dc current capability are required. The high permeabilities available in ferrites versus most other core materials, while permitting high inductance levels, also cause earlier and more extreme saturation under increasing dc current loads. Figure 6-11 indicates the relative saturation rates between ferrite pot cores and laminates. Ferrite pot core designs show a very steep inductance versus dc bias roll-off characteristic. To some extent, this can be mitigated by widening the air gap between core halves, but only at the expense of reducing inductance. This characteristic may have to be taken into design account in some applications. Greater current capability at high inductance levels requires more ferrite in addition to the core gap and an even higher cost for an already expensive designing to 10 dc amperes is about the practical maximum dc current level for pot core based power chokes.

Toroids - Figure 6-10, Unit A, shows a typical horizontally mounted open construction toroidal power choke. Toroid power choke technology is fairly versatile. The finished design presents a low silhouette when mounted, thereby offering minimum interference to convection cooling. Unit mass is also relatively low. Above about 20 amps operating current, prohibitive size (and mass) becomes necessary so that premium core materials, such as moly permalloy must be used. On a strict cost basis this type design then becomes less attractive. Both pot core and toroid technologies offer the lowest possibility of interaction with adjacent components on densely packaged boards, since they feature either closed or self-shielded magnetic paths. Unless premium core materials are used, toroid-based power choke designs are less expensive than comparable pot core designs in the region where their design capabilities overlap. The inductance versus increasing dc current load characteristic for toroids tends to resemble that of laminates as in Figure 6-11.

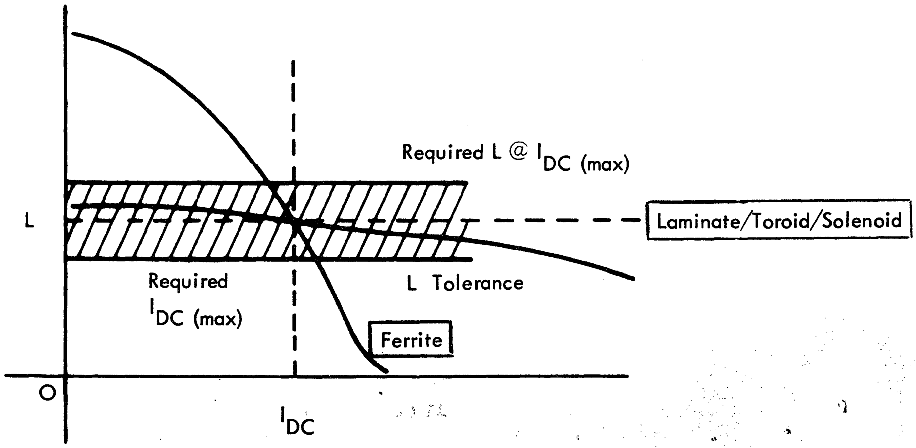


Figure 6-11. Inductance versus DC Current: Typical Ferrite, Laminate, Toroid, and Solenoid Cores

Laminates - The laminate is extremely rugged mechanically. Figure 6-9 unit D, shows a typical vertically mounted laminate. Where relatively low inductance and high dc current capability are required, laminates are admirably suited. Inductance delay versus increasing dc current is generally linear with a very moderate slope up to and exceeding the maximum design limit. Figure 6-11 indicates the relative inductance/dc current response difference between the two technologies. The coil for a laminate may first be wound on a bobbin and the entire unit then assembled, or it can be wound on the center post itself. A wide range of steel core materials are available for design flexibility. Interaction with closely adjacent components may be a problem with laminate designs and board lay-out may have to take this into consideration. The high mass of the typical laminate design may also present a problem where several laminate units must be mounted on a single board.

Solenoids - The remaining inductor technology, solenoid design, is the least expensive by a wide margin. It can involve nothing more than a self-leaded coil on a permeable slug. In actuality, the design is more subtle and sophisticated than this, and only a few manufacturers are capable of designing acceptable solenoids. A base header of some sort is frequently necessary to stabilize pin separation.

Solenoids have the drawback that in some applications circuit performance may be adversely affected due to interactions with susceptible adjacent components. Only moderate inductance levels are possible with a solenoid inductor (up to about 25 - 30 μH) because of the low permeabilities available and also because of the relative inefficiency of the magnetic system. Solenoid designs are significantly less expensive than other approaches both because of the low materials cost and the simple manufacturing processes which can be used.

PARAMETERS AND SPECIFICATIONS

Drawing specifications for power inductors are generally very basic. For the low to medium power designs presently controlled by CCP the following electrical parameters are usually specified:

1. Maximum dc resistance (dcR).
2. Maximum dc current handling capability (I_{dc}).
3. Minimum inductance @ specified frequency, voltage and I_{dc}.
4. Maximum temperature rise above ambient.
5. Insulation class.

In addition to the above, some applications may wish to specify:

1. Minimum dielectric strength.
2. Minimum insulation resistance.
3. Minimum impedance to ground.

Examples of representative part prints are Figures 6-12 and 6-13, which are for medium-power and low-power designs respectively. The pertinent specifications are:

#866476	Engineering
#866477	Quality

Other controlling specifications are common to all purchased components.

COST AND DESIGN CONSIDERATIONS

Design of a power inductor must optimize a number of different and sometimes conflicting requirements and characteristics: minimum package size, required electrical performance, maximum temperature rise under load, compliance with all pertinent IBM and UL specifications, low production cost, and vendor design and manufacturing expertise. As an example of this, when lower production costs are desired for a completely developed design, it can generally only be done by increasing the size, and/or reducing the required electrical performance, and/or raising the maximum temperature rise under load.

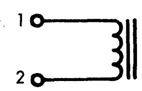
Again, if the size or volume must be reduced, either more costly core materials must be used, raising unit cost, or the limits must be relaxed for one or several of the remaining parameters.

Most user requests for power choke releases tend to specify dimensions so minimal that the required performance and cost targets are difficult to meet.

In other words, "trade-offs" must be negotiated. Invariably, several feasibility design iterations are necessary. These should be accounted for in the release schedule, and may require that the application and component engineer negotiate design tradeoffs. Figures 6-12 and 6-13 show in the lower right hand quarter of each print, three design options. These are included on the print to avoid confusion, in manufacturing areas, which may arise upon receiving designs which do not look exactly like the print. They also allow each potential manufacturer who might be approached, to use the technology with which he is most expert. This gives the manufacturer design flexibility which can permit him to use what his specific experience indicates to be the lowest cost design options.

CLASSIFICATION REVIEWED VENDORABLE

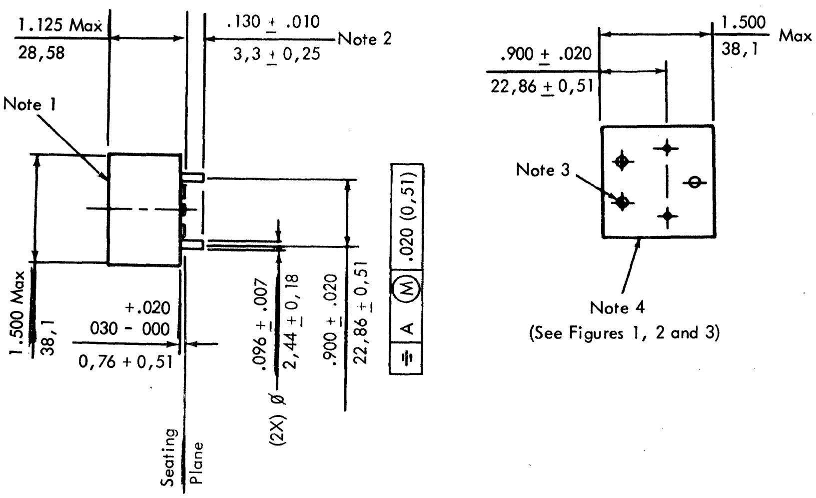
Inductor Data	
Inductance @ 16 kHz, IDC, EAC	25 H
Tolerance	+25%
IDC	20A
EAC	1.0 Volt
DCR Max	9 mohm
Insulation Class	155°C Min
Max Temp Rise Above 65°C Ambient	80°C

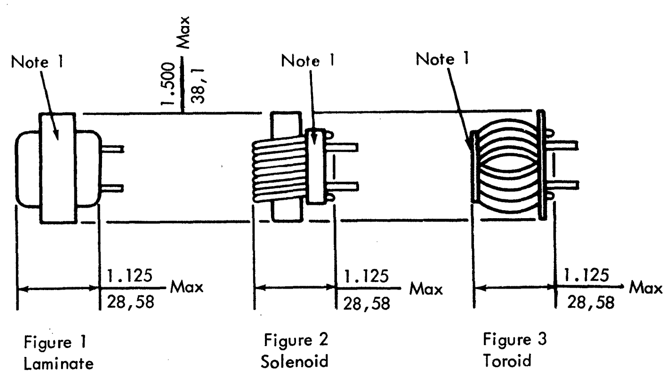


Schematic

Notes

1. IBM Part Number, Date Code, Manufacturer's Identification and Nominal Inductance to Appear on this Surface.
2. Maximum Untinned Lead Length Shall Not Exceed .040 (1,02) from Seating Plane.
3. Location and Shape of Standoffs Optional Minimum of 3 Standoffs. Laminate Designs (Figure 1) Do Not Require Standoffs.
4. Shape of Component Optional. Maximum Dimensions Shall not be Exceeded. Alternate Configurations Shown in Figures 1, 2 and 3.
5. Immersible in Deionized Water Only.
6. Paragraph 3.2 Not Applicable.



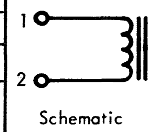


Optional Acceptable Configurations, Notes 3 and 4

Figure 6-12. Medium Power Choke

CLASSIFICATION REVIEWED VENDORABLE

Inductance @ 16 kHz, IDC, EAC	95 H
Tolerance	±25%
IDC	1.5A
EAC	1.0 Volt
DCR Max	30 mohm
Insulation Class	130°C Min
Max Temp Rise Above 65°C Ambient	50°C



Schematic

Notes

1 IBM Part Number, Date Code, Manufacturers Identification and Nominal Inductance to Appear on this Surface.

2 Maximum untinned Lead Length Shall not Exceed .040 (1,02) from Seating Plane.

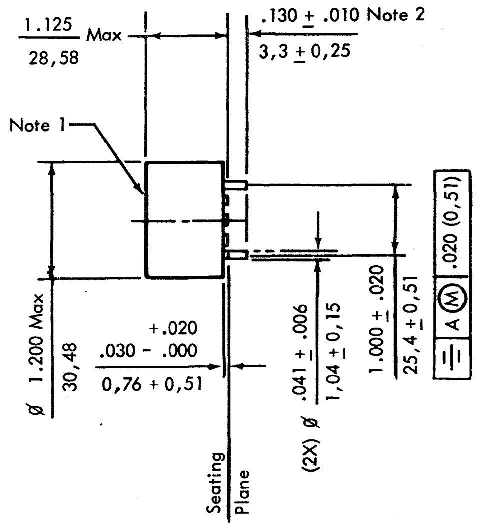
3 Location and Shape of Standoffs Optional Minimum of 3 Standoffs. Laminate Designs (Figure 1) Do not Require Standoffs.

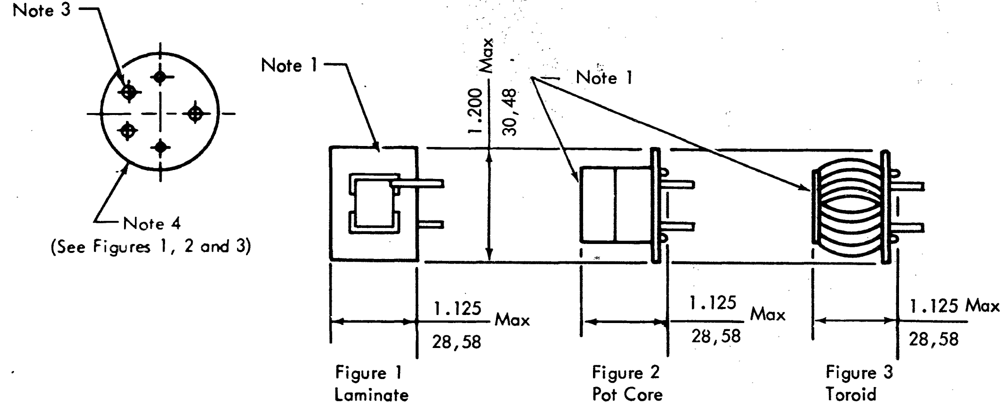
4 Shape of Component Optional Maximum Dimensions Shall not be Exceeded. Alternate Configurations shown in Figures 1, 2 and 3.

5 Immersible in Deionized Water Only.

6 Paragraph 3.2 Not Applicable.

Inch Dimensions





Optional Acceptable Configurations, Notes 3 and 4

Figure 6-13. Low Power Choke

AUDIO TRANSFORMERS AND INDUCTORS

DESCRIPTION

Audio transformers and inductors are used primarily in communications type circuits. Based on functional considerations, however, CCP includes almost all low-power level transformers and inductors which operate in the frequency range up to about 100 kHz, in this category.

Audio transformers are used for most of the classic transformer functions: interconnecting circuit stages; matching impedances (as for instance transducers to amplifiers); providing dc isolation between transmission lines and terminals; signal polarity change; and voltage or current level changes. An adjustable transformer or inductor provides a means for precisely tuning a series of parallel resonant RLC circuits. These types of circuits are used extensively in modulator/demodulator (modem), bandpass or bandstop, and tone generation applications. Audio transformers may also sometimes find application in lightening arrest circuits.

Audio Transformer/Inductor Technology

Theoretically, both AF transformer and AF inductor designs may use pot core, laminate or toroid technologies. In practice however, ferrite pot core designs are almost always superior to others in the optimization of performance, dimensions, and cost so that very few requirements are satisfied with any other format. For this reason only pot core AF transformer/inductor technology will be discussed in detail, in this section.

AF transformers and inductors using pot cores are manufactured by winding a specified number of turns of wire around a bobbin. If the part is a transformer, mylar tape may be placed between each winding to raise the minimum voltage breakdown level between windings. Insulation resistance between windings will typically be greater than $10^{10}\Omega$ The egress wires may also be taped to avoid windings shorting to each other or to the core. The completed coil is then usually vacuum impregnated with either epoxy or transformer varnish. This results in a moisture impervious unit which does not require a hermetically sealed case as proof against operational failure in high humidity environments. The core, which has been selected for proper permeability and gap size (in terms of "inductance factor", A_L) and to have an internal core volume large enough to contain the required coil, is then fastened around the bobbin using either metal clamps or epoxy cement. Core-half joining is described in more detail in the section titled "Cost and Design Considerations."

Figure 6-14 shows a completed pot core transformer on the left, and the varnish impregnated coil/bobbin/pin assembly on the right. The bobbin form and ferrite core are standard items; the coil itself is custom wound.

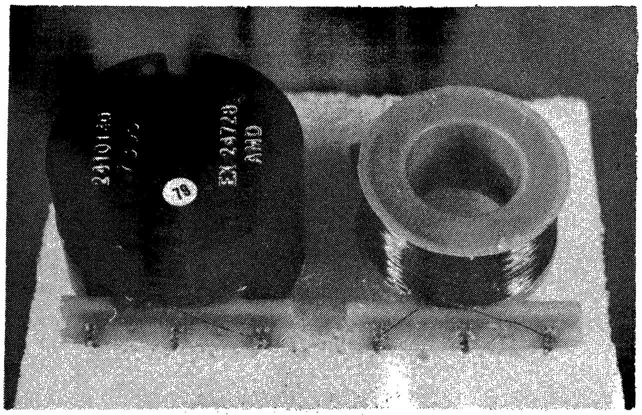


Figure 6-14. Typical Pot Core AF Transformer/Inductor Construction; Complete Unit on Left, Coil/Bobbin/Pin Unit on Right

If for some reason the unit must be encapsulated, the space between case and core can either be left empty (air) or filled with an "unstructured" material. Whatever the encapsulation backfill is, it must not be rigid or hard because it is then likely to introduce mechanical stresses into the ferrite, which in turn tend to alter inductance characteristics in an unpredictable manner. Figure 6-15 shows both a pot core transformer mounted on a specially molded and pinned header base before the case is added, and the completely encapsulated unit. This particular vendor backfills his units with a loose material referred to as "polymer baloons"-microscopic polymer globules.

Figure 6-16 shows a section through the middle plane of a typical pot core transformer with the pertinent features, which are mentioned above, identified.

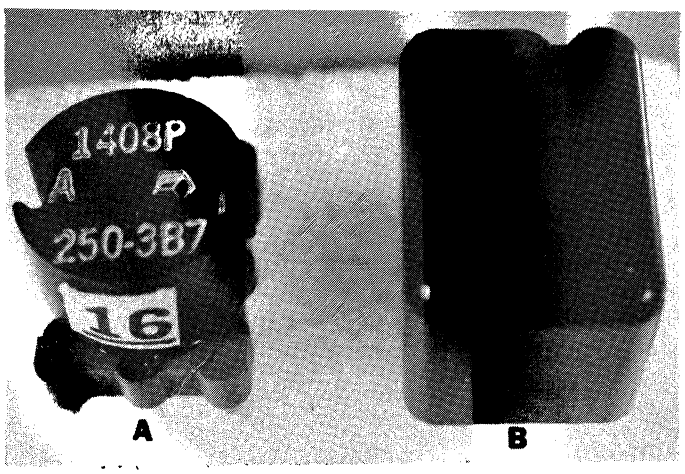


Figure 6-15. Representative "Custom" AF Pot Core Transformer/Inductor Design Showing: "A" Specially Molded Header and "B" Complete Unit in Plastic Case. Not shown is the Unstructured Case Fill Material.

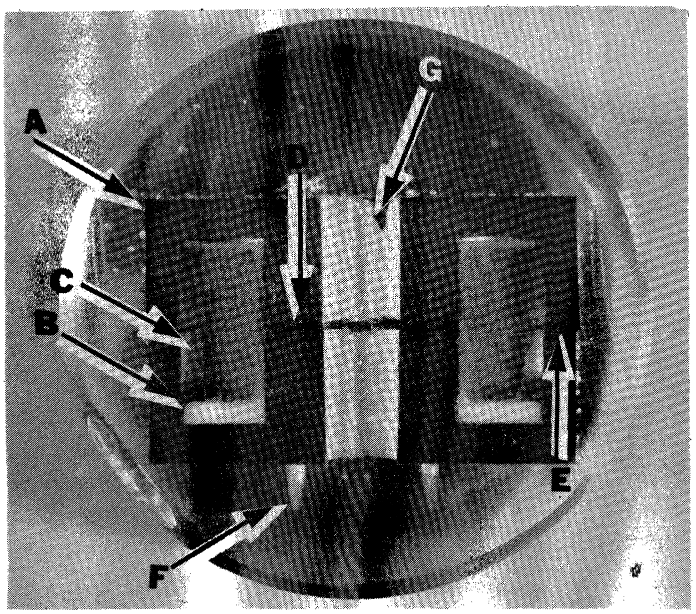


Figure 6-16. Mid-Plane Section through a Typical AF Pot Core Transformer/ Inductor Assembly Showing:

1. Ferrite Core
2. Bobbin
3. Coil
4. Center Post Gap
5. Epoxy Cemented Core Half Plane (Slightly Offset)
6. Pins
7. Center Hole

Although ferrite cores can be obtained according to virtually any specification, it is advisable to base the design on one of the eight internationally standard (IEC) core sizes. These are listed in Table 6-3 which also gives the dimensions. In addition to these eight core form factors, which are available anywhere in the world, there are five or six other common sizes which are so widely used that their cost is comparably low. Each of these form factors can be obtained in a range of inductance factors (AL) and temperature coefficients of inductance (TCL) so that there is considerable design flexibility.

For adjustable designs, several types of adjustor are also available.

Table 6-3. Internationally Standard Pot Core Form Factors

Pot Core Physical Dimensions

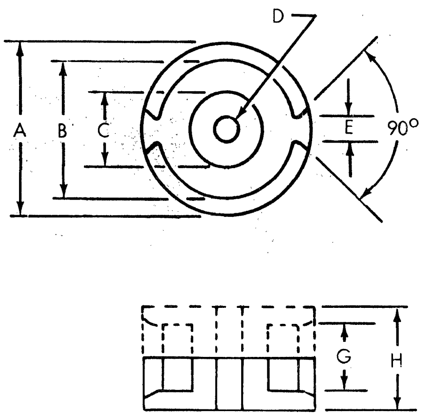


Figure 1

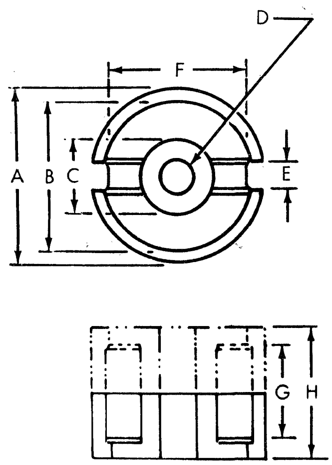


Figure 2

(All dimensions are in inches)

#	Magnetic Path Length (cm.)	Figure	A	B	C	D	E	F	G	H
9 x 5	1.26	1	.362 ± .004	.298 ± .003	.151 ± .002	.073 ± .002	.077 ± .006	---	.145 ± .003	.207 ± .005
11 x 7	1.55	2	.437 ± .007	.362 ± .008	.181 ± .004	.081 ± .002	.077 ± .006	.297 Nom.	.179 ± .006	.256 ± .003
14 x 8	2.0	2	.551 ± .008	.465 ± .008	.232 ± .004	.122 ± .003	.126 ± .006	.376 Nom.	.228 ± .008	.329 ± .005
18 x 11	2.6	2	.709 ± .008	.598 ± .008	.293 ± .006	.122 ± .003	.116 ± .006	.503 Nom.	.291 ± .007	.415 ± .005
22 x 13	3.15	2	.851 ± .015	.717 ± .011	.364 ± .006	.179 ± .004	.122 ± .004	.590 Nom.	.369 ± .007	.528 ± .007
26 x 16	3.75	2	1.004 ± .019	.850 ± .015	.444 ± .007	.219 ± .004	.122 ± .004	.710 Nom.	.440 ± .007	.634 ± .007
30 x 19	4.5	2	1.181 ± .019	.999 ± .015	.524 ± .007	.219 ± .004	.163 ± .006	.902 Nom.	.519 ± .007	.740 ± .008
36 x 22	5.3	2	1.402 ± .015	1.192 ± .015	.626 ± .008	.219 ± .004	.163 ± .006	1.096 Nom.	.582 ± .007	.855 ± .011

*IEC Standard Sizes #Size designation in mm. for O.D. and pair height.

PARAMETER AND SPECIFICATIONS

An AF transformer or inductor may be selected on the basis of the following criteria:

1. Circuit function.
2. Voltage level.
3. Frequency band.
4. Dimensions.
5. Source and load impedances.
6. Shielding requirements.

The use of all of the above parameters may not be necessary in a given application. The choice of parameters as well as exact parameter levels may be selected by calculation and/or testing in a prototype circuit. Based on these considerations the pertinent parameters can be selected and nominal levels together with tolerances can also be set.

The most generally useful parameters for pot core AF transformers and inductors are presented below:

1. Inductance: @ specified frequency and voltage.
2. Adjustment range (if required).
3. DC bias current.
4. Self resonant frequency (SRF).
5. Transformation ratio (T/R).
6. Leakage inductance: @ specified frequency and voltage.
7. Shield efficiency (if required).
8. Temperature coefficient of inductance (TCL).
9. Primary open circuit impedance (OCZ).
10. Insertion loss or frequency response.

Generally, no more than four to six of the above parameters will be required to adequately define most AF transformers or inductors.

Temperature coefficients are available over a fairly wide range, and can be selected to compensate the negative TCC of specific styrene capacitors where this is an application requirement. Stable operating characteristics are available in the temperature range from +10°C to +60°C. Units can also be supplied which will perform satisfactorily with a dc bias on the windings in excess of 60 mA or under the relatively high rms voltages used in series incorporate an airgap in the central core post.

An additional advantage of the airgap is the EOL stability it provides to the component. Worst-case EOL inductance drift will be within ±1% and generally closer to ±0.5%. Changes in Q are insignificant.

Where necessary, an electrostatic shield can be placed between windings to provide a low impedance path to ground for high-voltage transients.

The applicable specifications for AF transformers and inductors are:

Engineering Specification - 5103333
Quality Specification - 866482

UCS Codes:

1. Adjustable AF transformers - 23732
2. Fixed AF transformers - 23731
3. Adjustable AF inductors - 23722
4. Fixed AF inductors - 23721
5. Low power AF transformers - 23736

The failure rate for AF transformers and inductors is listed in failure rate specification 866451.

COST AND DESIGN CONSIDERATIONS

The original AF pot core transformers and inductors released for use within the IBM corporation, were generally encapsulated designs on unique pin formats which were compatible with a 125 mil grid pattern. The pot core halves were fastened together with some form of metal clamp which was either brass or stainless steel. This type design was expensive from both a materials and labor point of view. Figure 6-17 shows typical examples. The three parts shown are the same P/N by three different manufacturers.

Notes:

1. Core halves held together by brass bolts or stainless steel spring clips (in one instance forming a case),
2. Pins set into custom molded plastic base headers, and
3. The apparent high degree of manual labor necessary for the construction of each.

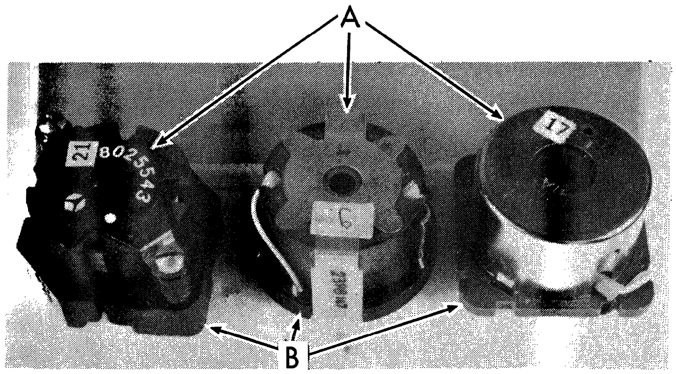


Figure 6-17. Some Examples of Older, Costly AF Transformer/Inductor Construction Practices

For contrast, refer again to Figure 6-14. This inductor is composed of standard components available to any manufacturer with no additional tooling or custom design costs.

Notes:

1. Core halves fastened together with epoxy cement,
2. Coil wound on glass impregnated nylon bobbin which also contains dual-in-line flanges into which pins may be staked at 150 mil seperations between pins. Pins staked in alternate positions will be separated by 300 mils which is compatible with a 100 mil grid,
3. Not readily apparent is the great reduction in the amount of hand operation required for component build.

Because these components are industry-standard, they are manufactured in high-volume by many different vendors and are therefore relatively inexpensive. The part in Figure 6-14 is approximately 50 to 60% less expensive than the same part would be if constructed using the design approach of the parts in Figure 6-17. The open construction unit in Figure 6-14 meets the same IBM specifications as in Figure 6-17. For this reason, CCP has been recommending adoption. This approach may offer additional cost savings where several P/N's are based on the same core/coil components, and the vendor is therefore able to "group" these P/N's into a single large volume lot for pricing.

In order to implement this, component requests should be initiated before the point where pin position on the circuit board becomes unchangeable.

The number of required parameters should be kept as small as possible and tolerances should be as broad as circuit requirements permit.

To-user costs will range between $2.50 and $6.00 per unit with most applications centering near the lower figure.

PULSE AND WIDEBAND TRANSFORMERS

DESCRIPTION

General

Although pulse and wideband transformers address apparently different circuit requirements, from a technical standpoint the two designs are virtually indistinguishable. This can be immediately grasped, if it is recalled that in a mathematical sense, a square wave requires a considerable number of sine-function frequencies to express it. These may actually be isolated by suitable filter circuits and examined. Since a square wave does contain a long series of frequencies, good square wave response is also an indication of smooth frequency response, which is the major performance criteria for wideband transformers. It is this commonality which justifies the usage of a single set of engineering specifications to describe the two types of transformers.

Ferrite toroidal-core transformers have a range of permeabilities from 500 to 10,000 over a frequency range of 1 kHz to 200 MHz. The ferrite cores are wound, conformally coated, and encapsulated (either molded or epoxy filled) for mechanical protection (see Figure 6-18). The particular case size and pin layout are generally tailored for specific applications. The ferrite toroidal-core is the core most commonly used for IBM applications.

The pot-core transformer (see Figure 6-19) is also a ferrite core but larger in size. The effective permeability is considerably lower due to a ground surface air gap between core halves; however, this design has the advantage of excellent inductance stability under extreme temperature and humidity conditions. A bobbin, which has been wound with the required number of turns of wire, is totally enclosed by the two pot core halves. Lead egress is accomplished by vertical slots in the pot core wall. The core is encapsulated by either transfer molding or by back filling an epoxy case.

The laminated-core transformer (see Figure 6-20) employs a ferrous metal (e.g., steel or nickel-iron) instead of a ferrite. The laminates are various shapes and are stacked and epoxied together to form a low reluctance path. The coil is machine wound on a bobbin prior to core lamination. The entire unit is molded or placed in a case and epoxy back filled.

Approximately 60 part numbers, in many different body sizes, are released for wideband and pulse transformer applications; however, three body sizes have emerged as the standard designs and are illustrated in Figures 6-21 through 6-23.

The R-Case is used for primary winding inductance less than 50 µH. The Z-Case is used for primary winding inductances for 50 µH, while the 1/2 × 1/2 case is used for 1 mH to 30 mH.

Most of the released designs have pin spacing on a 125 mil grid. Present board layout practice is based on a 100 mil pattern and all recent releases are consistent with this. Virtually any grid spacing or case size is available on a custom basis, but costs can be held lowest when standard formats are requested. Contact CCP for advice before selecting a format.

Wideband Transformers

Wideband transformers are used to match different impedances, to set accurate current or voltage ratios, to provide interconnection between circuits, and to establish dc isolation. They are generally not required to transmit appreciable amounts of power.

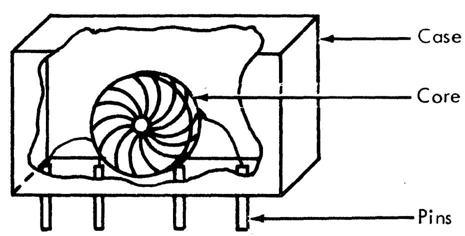


Figure 6-18. Toroidal-Core Transformer

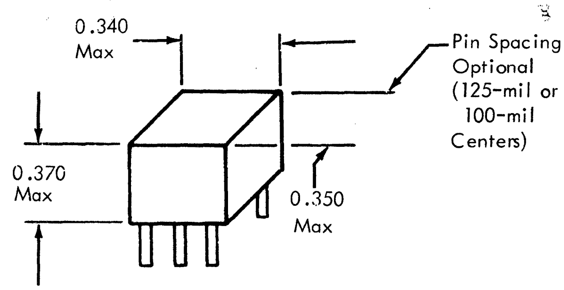


Figure 6-20. Laminated-Core Transformer

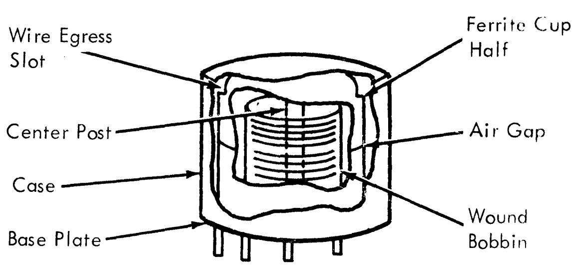


Figure 6-19. Pot-Core Transformer

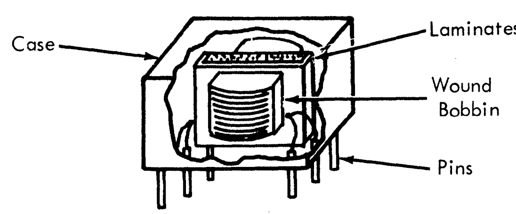


Figure 6-21. R-Case Design

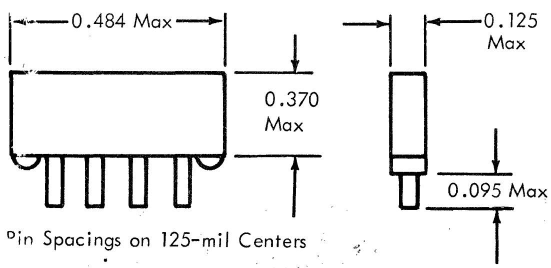


Figure 6-22. Z-Case Design

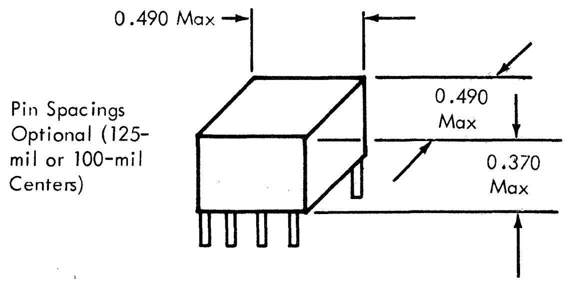


Figure 6-23. 1/2 × 1/2-Case Design

The input voltage seen by a wideband transformer is usually complex, containing energy distributed over a wide frequency spectrum. The requirement is that the voltage waveform appearing across the load shall not have had excessive distortion introduced by the transformer. Accordingly wideband transformers are designed to pass signals in a frequency band specified by acceptable attenuation levels at an upper and lower frequency. The maximum allowable distortion between these limits is defined. A secondary load output no more than 3 dB lower than the mid-band gain is generally chosen as the limit for both the high and low frequency cut-off points.

Pulse Transformers

Pulse transformers are also required to transmit energy spread over a wide frequency spectrum. However, the pulse transformer is specified in terms of its effect on the shape of an input pulse, rather than in terms of the frequency spectrum, as is the wideband transformer. The input pulse shape is accurately described as trapezoidal rather than square (see Figure 6-25). The pulse transformer must transfer the input pulse from the primary circuit, which may sometimes also be the pulse generating circuit, to the load circuit without excessive distortion. It must be capable of doing this while performing any of the traditional transformer functions; for example:

1. dc isolation.
2. Polarity Reversal.
3. Balance or unbalance to ground.
4. Impedance matching.
5. Voltage/current transformation.

PULSE/WIDEBAND TRANSFORMER EQUIVALENT CIRCUIT

Pulse Transformers

As stated, both pulse and wideband transformers can be described by almost exactly the same mathematical or electrical considerations. However, the two differing application requirements must be covered by different part print parameters.

These are set by the desired frequency response in the case of wideband transformers and allowable pulse shaping or distortion for pulse transformers.

Figure 6-24 is a lumped element equivalent circuit for either a wideband or pulse transformer. Secondary elements have been referred to the primary side by multiplying by $1/N^2$, all primary elements are designated by prime notation.

The following discussion for each type of transformer will be based on this circuit.

Pulse Characteristics and Definitions

Figures 6-25 and 6-26 show input and output pulse shapes respectively in a somewhat exaggerated form. Input pulse characteristics can be adjusted at the pulse or function generator so that droop is zero, and input pulse shape and rise/fall times will closely approximate the idealized pulse shape of Figure 6-25. When the pulse energy appears on the loaded transformer secondary it has undergone reshaping or distortion due to the finite reactances associated with any transformer. Figure 6-26 is a typical transformer output or secondary pulse shape. The significant characteristics of a secondary pulse are shown and are described in more detail below. Referring to Figure 6-26.

1. Rise Time - The time required for the input pulse voltage to travel between the 10% and 90% points of the leading edge of the pulse waveform.

2. Overshoot - The amount by which the first maximum occurring in the pulse top region, exceeds the intersection of the extrapolated line segment fitted tangentially to the pulse top and the line tangent to the rise time trace.

3. Ringing - Oscillation occurring immediately after maximum overshoot.

4. Pulse Top - Top part of pulse; between leading and trailing edge.

5. Pulse Duration - The time interval between the 90% point of the leading edge and the 90% point of the trailing edge.

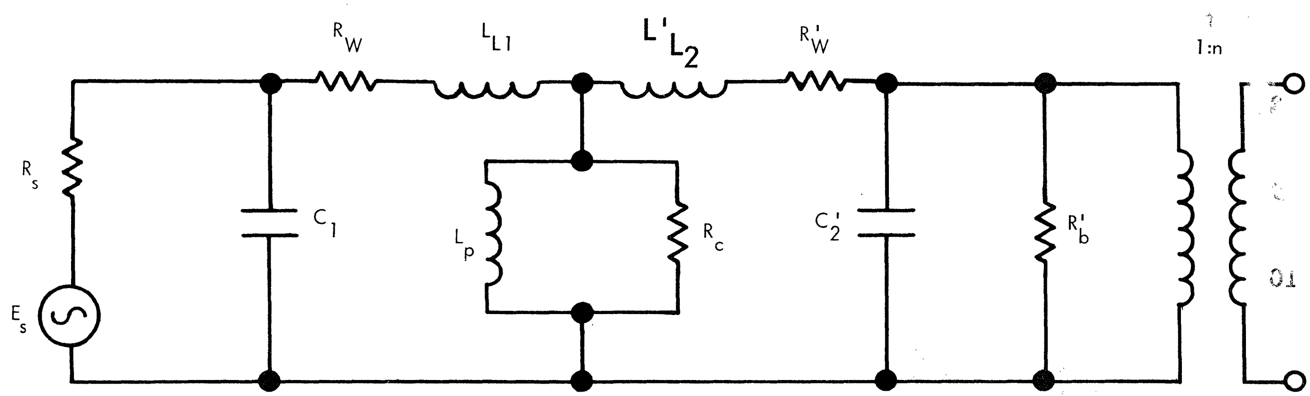
6. Pulse Width - Differentiated from "pulse duration"...The time interval between the 50% point of the leading edge and the 50% point of the trailing edge.

7. Droop (or Tilt) - The amount expressed in percent, of the intersection between the extrapolations for pulse top and trailing edge below the maximum input voltage related to that voltage.

8 Fall Time - The time required for the pulse voltage to travel between the 90% and 10% points of the trailing edge of the pulse waveform.

9. Backswing - The maximum amount of which the instantaneous voltage swings below the zero axis in the region following the fall-time.

10. Pulse Repetition Frequency (PRF) - The number of pulses per second (PPS)... may also be expressed in terms of "duty cycle".



R_s source resistance

R_w primary winding resistance

R'_w secondary winding resistance

R'_b load resistance

R_c shunt resistance (core loss)

C_1 primary shunt capacity (winding and ext.)

C'_2 secondary shunt capacity (winding and ext.)

L_{L_1} primary leakage inductance

L'_{L_2} secondary leakage inductance

L_p open circuit primary inductance

n transformation ratio

Figure 6-24. Lumped Element Equivalent Circuit for Pulse or Wideband Transformers

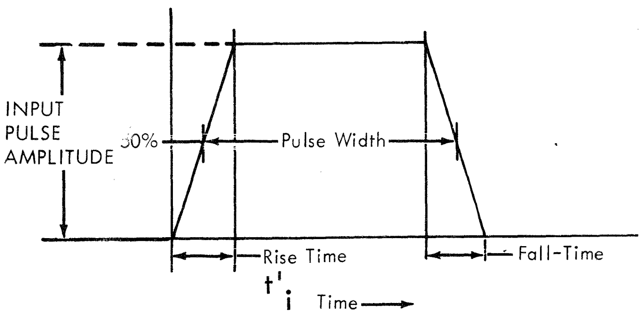


Figure 6-25. Typical Input Pulse Waveform and Characteristics

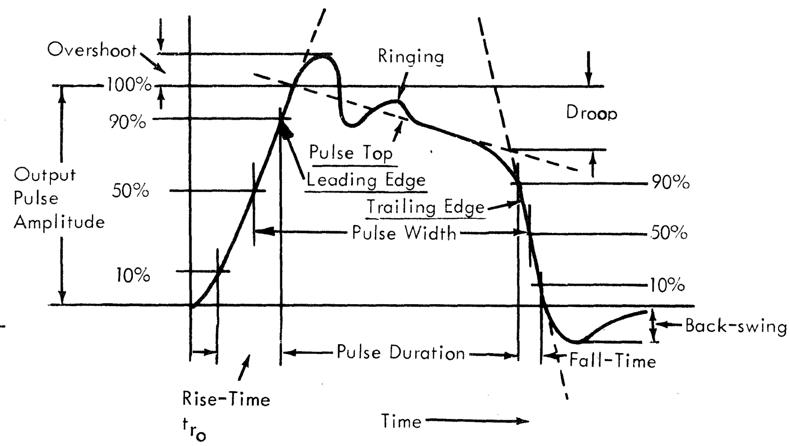


Figure 6-26. Typical Secondary Waveform

It is immediately apparent, that unlike most electrical measurements, all of these pulse characteristics are subject to a considerable degree of operator interpretation. It is therefore important that the required tangential line extrapolations be assigned with extreme care. In practice, all ten characteristics do not have to be specified. In most cases, it will suffice to define pulse amplitude, rise time, duration, and PRF for the input pulse, and rise time and droop for the secondary pulse with both input and output circuits defined.

The degree of overshoot, or ringing, and backswing are also frequently specified.

The desired secondary waveshape may be assured by defining the proper values for pulse inductance, leakage inductance, interwinding capacitance, dc resistance, and primary and secondary impedances.

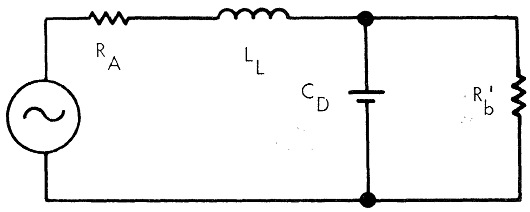
Generally, these values are initially set by calculation and then fine-tuned in the application.

Leading Edge

The leading edge is shown in Figure 6-26. The equivalent circuit for the leading edge only is approximated in Figure 6-27. Output rise that time (t_{ro}) is the combination of input rise time (t_i) and transformer rise (t_t) and is given by the vector sum:

$$t_{ro} = (t_i^2 + t_t^2)^{1/2}$$

Shunt impedances may be ignored because of a negligible build-up of magnetizing current during the relatively short rise time period.



R_A = source resistance (Ω)

L_L = leakage inductance (H)

C_D = total shunt capacitance (F)

R_b = load resistance (Ω) (referred to primary)

Figure 6-27. Equivalent Circuit for Leading Edge Portion of Pulse

Leading edge response is therfore primarily a function of the high frequency characteristics of the transformer and, of course, the load conditions.

The rise time (t_{ro}) may also be expressed in terms of lumped parameters;

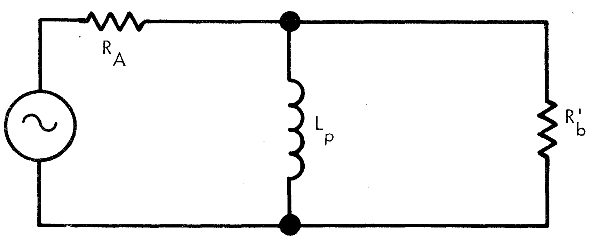
$$t_{ro} = K(L_L C_D)1/2,$$

where K is a dampling constant related to the load conditions. It is clear that rise time can be reduced by minimizing the product of the leakage inductance (L_L) and total shunt capacitance (C_D) and/or the damping constant (K). Actually, for most applications the damping constant will be between 0.8 and 0.5. It is mainly dependent upon winding geometry, which also has an influence on L_L C_D. The latter two parameters must be optimized within the overall application constraints.

Pulse Top

The pulse top and the method of determining it are shown in Figure 6-25. The equivalent circuit having a bearing on pulse top is shown in Figure 6-28. The "pulse top" concept is not altogether obvious because this portion may also include pronounced pulse distortion features such as "ringing" and "droop". The extension of the line drawn tangent to the most linear part of the pulse top is used for calculations.

Winding and source resistances have been lumped together in R_A since they are in series. The effects of leakage inductance and interwinding capacitance are negligible and are therefore not considered in pulse top calculations. A linear L_p is assumed in the time period when the pulse top portion of the pulse envelope is pertinent. Primary inductance dominates top period response. If the inductance and load voltage remain constant, the current associated with L_p (magnetization current) will increase linearly with time. With finite source impedances, the magnetization current will cause an increasing drop in load voltage which is referred to as "droop" and is clearly shown in Figure 6-26.



R_A = source resistance (Ω)

L_p'= shunt inductance (H)

R_b'= load resistance (Ω) (referred to primary)

Figure 6-28. Equivalent Circuit for Top Portion of Pulse

Droop is related to the element values by the expression:

$$D = \left[1 - \left(\mathrm{EXP}\ \frac{-t_d R}{L_p}\right)\right] \times 100\%$$

where:

t_d = pulse duration

$$R = \frac{R_s R'_b}{R_s = R_b'}$$

In practice, droop is measured from the intersection of the extrapolated lines shown in Figure 6-26, and expressed as a percentage of the 100% level of the output voltage which is also shown in this figure. It can be seen from the expression, that droop approaches zero as the exponential function approaches unity. This means that droop is inversely related to L_p, but tends to increase with pulse duration and/or source and load resistances.

This is demonstrated a bit more clearly in Figure 6-29, which is a plot of the exponential argument (L_p/t_dR) versus % pulse droop.

The equivalent circuit for the trailing edge portion of the secondary pulse is shown in Figure 6-30.

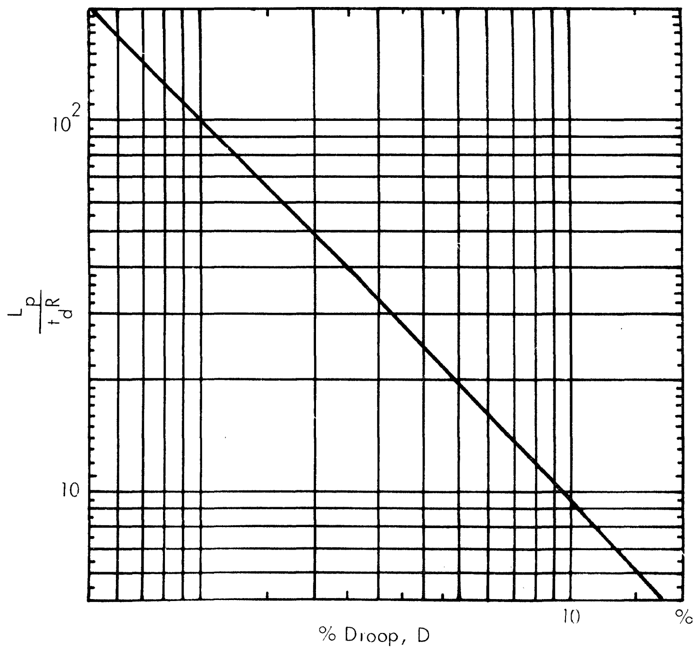
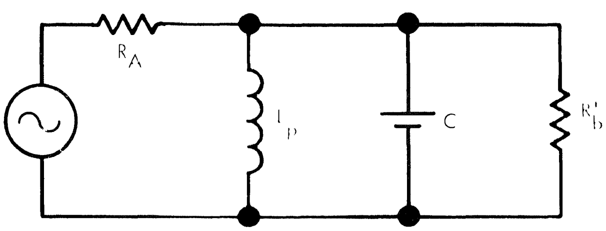


Figure 6-29. L_p/t_dR as a Function of Pulse Droop in %



R_A = source impedance (Ω)

L_p = shunt inductance (H)

C = total shunt capacity (F) (referred to primary)

R'_b = load impedance (Ω) (referred to primary)

Figure 6-30. Equivalent Circuit for Trailing Edge Portion of Pulse

Trailing edge response is primarily a function of stored energies being released. It is usually of much less importance that leading edge and pulse top response so that almost no design attention is assigned to it. Its characteristics are generally predetermined by other design criteria.

ET Rating

Another useful way of specifying pulse transformer performance is to define the flux handling capability of the core. This may be determined by the E-T rating or volt-micro second product, which is given by the expression:

$$ET = NBA,$$

where:

E = pulse voltage (in volts)

T = pulse width (in microseconds)

N = number of primary turns

B = maximum flux density

A = cross-sectional area of core.

It is thus clear that this parameter is also based on pulse shape.

If the input voltage pulse is impressed upon the primary with the secondary open circuited, a characteristic waveform similar to Figure 6-31, will result.

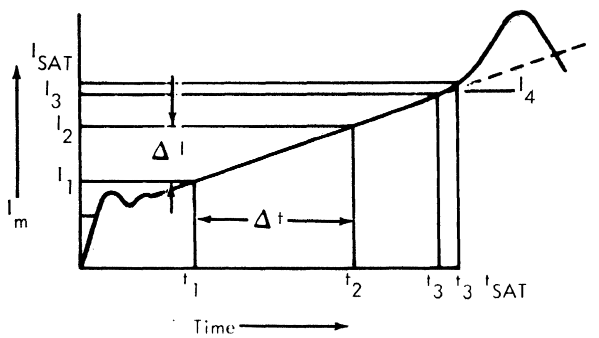


Figure 6-31. Magnetizing Current, I_{MAG} versus Time

The current ramp will begin departure from linearity when the core begins to saturate. This is shown as point (I_3,t_3) in the figure. The time of saturation (t_{SAT}) is arbitrarily defined, by IBM, as that point in time where the magnetizing current is 1.1 times the linear extrapolation of the current ramp. At saturation, point (I_{SAT},t_{SAT}), $I_{SAT} = 1.1 \times I_3$. Since the value of sinewave inductance (L_p) alone is not sufficient to explain the pulse behavior of transformer, the concept of magnetizing pulse inductance (L_m) has been introduced where:

$$L_m = \frac{E(t_2 - t_1)}{I_2 - I_1}; \text{ or } \left[\frac{\text{ET rating}}{\Delta I}\right]$$

L_m can differ from the sinewave inductance by a factor of as much as two or three, so that it is a parameter of limited value when specifying pulse transformers.

It should be mentioned that the rest of the industry generally defines L_{SAT} as $1.5 \times I_3$ instead of 1.1 as is IBM practice.

Wideband Transformers

A transformer designed to pass signals in a given frequency band between specified upper and lower frequency limits is called a wideband transformer. In general, the maximum allowable distortion and attenuation between the upper limit and lower limit and at the mid-band frequency is stipulated. An output response of 3 dB lower than the mid-band response is chosen as the lower limit for both the high frequency (f_2) and the low frequency (f_1) cut-off points.

Figure 6-32 shows a typical frequency response envelope for a wideband transformer. The significant areas are defined.

Each region will be considered separately with electrical performance related to the lumped parameters defined in the equivalent circuit of Figure 6-23.

1. Low-Frequency Region

The low-frequency region is where insertion losses (in addition to mid-band gain attenuation) start to increase and continue to do so to some predetermined limit (f_1) or at some specified rate. The insertion losses at low frequencies are due primarily to the shunt impedances of the primary open circuit inductance (L_p) and the core loss (Rc). Core loss in low power applications is ignored; in higher power applications it is lumped with the load resistance. The attenuation, in dB, is related to the shunt inductance by:

$$A_1 = 10 \log_{10} \left[1 + \left(\frac{R}{\omega Lp} \right)^2 \right]$$

$$\text{where } R = \frac{RsR'b}{Rs + R'b}$$

And the phase shift, ϕ, is given by:

$$\tan \phi = \frac{R}{\omega Lp}$$

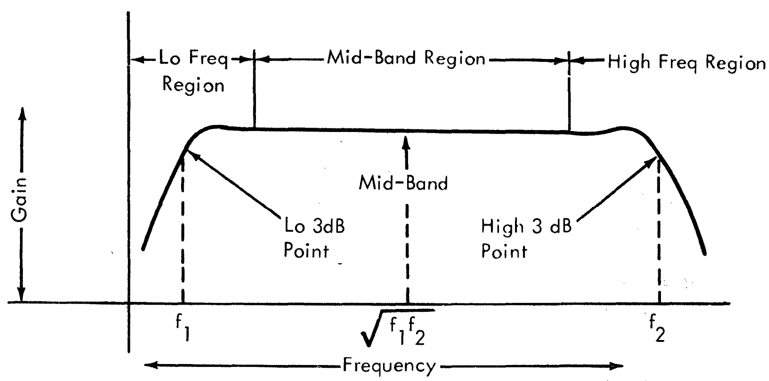


Figure 6-32. Frequency Response

2. Mid-Band Region

The mid-band region is where a relatively flat attenuation characteristic is exhibited over the major portion of the response curve. The major parameters in this region are the circuit resistance values (Rw, R'w, Rs, R_L, Rc). The shunt resistance, Rc, is usually high and is ignored in low frequency transformers (<1 MHz) using ferrite cores. Rw and R'w are lumped and should be kept small in relation to Rs and R_L in order to maintain a low insertion loss.

$$A_1 = 20 \log_{10} \left(1 + \frac{R_W}{R_S + R'_b}\right)$$

$$R_W = R_W + R'_W$$

R_S and R_L should be such that $\eta = (R_L/R_S)^{1/2}$ that is, source and load resistances are matched) so that maximum energy transfer occurs. The attenuation, in dB, can be expressed as follows:

$$A_1 = 20 \log_{10} \frac{1 + m}{2 + \sqrt{m}}$$

where $m = R_L/R_S = \eta^2$

3. High Frequency Region

The high frequency region is where the transmission characteristic starts to droop and continues to do so to some required limit (F_2) or at some specified rate. The major parameters causing high frequency droop are leakage inductance and/or shunt capacitances. The winding resistance is normally neglected because the capacitive and inductive impedances are extremely high as to render the R_W insignificant.

For a step-down or low-impedance circuit, the leakage inductance normally predominates in droop consideration. Attenuation due to leakage is given by:

$$A_1 = 10 \log_{10} \left[1 + \frac{\omega L_L}{Rs + R'_b}\right]$$

where $L_L = L_{L1} + L_{L2}$

and phase shift by:

$$\tan \phi = - \frac{\omega L_L}{Rs + R'_b}$$

For a step-up or high-impedance circuit, the shunt capacitances usually predominate and attenuation is given by:

$$A_1 = 10 \log_{10} [1 + (\omega CR)^2]$$

$$\text{where } R = \frac{RsR'_b}{Rs + R'_b}$$

and phase shift by:

$$\tan \phi = -\omega CR$$

Equivalency of Pulse and Wideband Transformers

Pulse and wideband transformers may be related to each other by a number of standard expressions. Of most general use are the following:

$$\underline{\text{DROOP}} = \Pi \frac{f_1}{f}$$

where:

f_1 = low 3 dB point, and

f = pulse repetition frequency at 50% duty cycle.

$$\text{RISE TIME} = \frac{0.35}{f_2}$$

where: f_2 = high 3 dB point.

Utilizing these expressions it is sometimes possible to use a transformer designed for one mode in the other mode of operation. It should be borne in mind, however, that acceptable performance can only be assured when a design is used within the parameter levels specified on the drawing.

PARAMETERS AND SPECIFICATIONS

Pulse or wideband transformer specifications should be selected to assure proper operation in the intended application. It is also important that criteria are set which can ensure that the quality of the unit is maintained. Towards this end, the following points are pertinent:

1. One parameter should describe core performance,
2. One parameter should describe winding performance, and
3. All of the directly applicable electrical parameters should be included.

The following summary has been prepared as a guide in selection of parameters. It should be borne in mind, that unit cost escalates with over specification, so that the total number of specifications should be as brief as possible.

Sine wave inductance is an effective indicator of core uniformity, but has very little bearing on pulse or wideband performance.

COST AND DESIGN CONSIDERATIONS

In addition to the selection of the proper set of parameters, it is also convenient, as well as cost effective, to specify parameters at levels which are well within the available ranges of typical measurement equipment, and as maximum/minimum.

Some suggestions (to be observed wherever possible):

1. Inductance (either sine wave or pulse) - Specify as a minimum at a PRF = 1.0 kHz for pulse inductance, and either 1.0 kHz or 100.0 kHz for sine wave inductance;
2. ET - Specify as a minimum at a PRF = 1.0 kHz with an I_{MAG} = 1.1 times the linear extrapolation.
3. Leakage Inductance (L_L) - Specify as a maximum at either 10.0 kHz or 100.0 kHz;
4. Interwinding Capacitance (Cw/w) - Specify as a maximum at 10.0 kHz, 100.0 kHz or 1.0 MHz;
5. DC Winding Resistance (DCR) - Specify as a maximum,
6. Hi-Pot - DC test value is preferred,
7. Insulation Resistance (IR) - Minimum of 100 Vdc as stated in engineering specification.

Table 6-4. Significant Pulse Transformer Parameters

Core Performance

Parameters are listed in order of general preference. Only one parameter should be specified.

Parameter	Specification	Tolerance	Comments
1. Sine Wave Inductance	Millihenries	Minimum	Most commonly specified. Not always indicative of performance in pulse circuit. Easy to measure.
2. Pulse Magnetizing Current	Milliamperes	Maximum	Indicative of performance in pulse circuit. Subject to reading error.
3. Pulse Droop; Coupling Circuit	Per Cent	Maximum	Indicative of performance in pulse circuit. Subject to reading error. Requires correlation samples.
4. ET Constant	Volt Microseconds	Minimum	Indicative of core saturation characteristics. Subject to reading error.
5. Performance in Application Circuit	Droop - % Backswing, % Recovery time, (Microseconds)	Maximum Maximum Maximum	Requires special fixture plus correlation sample. Difficult due to transistor and circuit variations. Increases unit cost. Not recommended.

Winding Performance

Listed in order of general preference. Only one parameter should be specified.

Parameter	Specification	Tolerance	Comments
1. Leakage Inductance and Inter Winding Capacity	Microhenries Picofarads	Maximum Maximum	Definitive and easy to measure. Conservative indicator of C_d. Easy to measure.
2. Rise Time and Overshoot	Microseconds Per Cent	Maximum Maximum	Indicative of performance under specific operating conditions. Correlation samples required.
3. Frequency Response High 3 dB Low 3 dB Returns	 Hz Hz dB	 Minimum Maximum Maximum	Indicative of performance under specific operating conditions. Correlation samples required.

Electrical Performance

Several of the specifications below should be included. Coupled with one of the core performance specifications and one winding specification, quality of the transformer is greatly assured.

Parameter	Specification	Tolerance	Comments
Peak Pulse Voltage	Volts	Maximum	
Transformation Ratio	Per Cent	5%	Can be tightened to ±1% on balanced transformers.
RC Resistance of Windings	Ohms	Maximum	
Hi-Pot	Volts RMS	Maximum	
Insulation-Resistance	Ohms	Minimum	

It should be understood that tolerances should be used only wherever a narrow performance "window" is required.

The preceding suggested levels obviate any requirement to purchase special test equipment or to set up special test procedures at additional cost.

At incoming inspections it is also much simpler to read maximum/minimum, on a go/no-go basis, than to adjust test systems and testing personnel to measure tolerances.

Very tight droop requirements, extremely short rise times or increased fractional bandwidths rapidly escalate cost.

In general, unnecessarily high costs can be averted if parameters and dimensions can be negotiated before final release of the part.

SPECIFICATIONS

Specifications applicable to pulse and wideband transformers are:

Engineering - 896953
Quality - 873552
DCS Codes
  Pulse - 23733
  Wideband - 23734

GENERAL COMMENTS ON COST

In the preceding sections, frequent reference is made to practices which directly affect component cost. At this point, it is advisable to make a few comments on cost effectiveness in general.

Some transformer/inductor designs are released costing the user more than is absolutely necessary because component release activity was initiated so late in the machine development program, that the CCP product engineer was locked into cost increasing requirements.

Custom designs are often not absolutely necessary. It is not always necessary to find the optimum solution to a design problem. If trade-offs can be negotiated, it is sometimes possible to use a standart part or a modified standard part at a lower cost. Quite often savings by the manufacturer on quantity material purchases, for use in standard items, can be passed on to the customer.

Another common source of escalated cost is over-specification. This generally is the result of the requester being overly conservative and either specifying too many parameters or using too close tolerances.

Summarized in a list below are some of the more common reasons why transformers and inductors may become expensive:

1. Tight electrical tolerances or parameters which require individual adjustment.
2. Taps in windings.
3. More than 3 windings.
4. Electrostatic shields.
5. Tight coil fit within small dimension ease.
6. Close mechanical tolerances requiring special fixturing or tooling.
7. Hand marking or uniquely dimensioned units.
8. High material cost due to special requirements.
9. High number of turns required.
10. High voltage insulation.
11. Non-standard lead pattern requiring special drill fixtures.
12. Unusual temperature coefficients of inductance.

Electrical parameters should always be toleranced as loosely as is consistent with acceptable circuit performance. If a parameter becomes critical enough so that 100% testing is necessary in production, the cost will be correspondingly greater than if AQL sampling were used.

The escalating cost effect of many of these considerations can be blunted if the product engineer at CCP is contacted early enough in the program so that suitable tradeoffs can be negotiated between program requirements, manufacturer capability and IBM specifications.

DELAY LINE

DESCRIPTION

Electromagnetic delay lines are inductor and capacitor networks which simulate in a miniaturized package the impedance and time delay characteristics of a transmission line. They should be treated in applications exactly as you would handle other transmission lines with respect to reflections, distortion, and loading.

There are two types of delay lines most commonly used; lumped constant, and distributed constant. Lumped constant designs employ wound coils and discrete capacitors to satisfy the following:

Delay per section $(t_d) = \sqrt{LC}$ (1)

Characteristic Impedance $(Zo) = \sqrt{L/C}$ (2)

LC sections of the desired impedance and of small increments of delay are added in series to obtain the desired total delay. The number of sections is dictated by the performance requirements, number of tap (if any), size restrictions, and cost.

The major cost/performance tradeoff of lumped constant designs is that related to the number of sections and high frequency performance. Better high frequency (fast rise time) performance is obtained by using more sections of smaller delay per section. This obviously increases the component count and complexity, and therefore the cost and size. As the number of sections increases, poor pulse fidelity (distortion, reflections) can become a problem due to the buildup of component tolerances and the increased number of interconnections each of which contributes an impedance mismatch.

Figure 6-33 shows a conventional lumped constant design using wound rods and mica capacitors. Because of the demand for smaller packages and faster delays, chip capacitor assemblies are becoming increasingly popular. (See Figure 6-34.)

A distributed delay line most closely resembles an ideal transmission line and is the easiest to build. The conventional distributed delay line design employs a metallized road of glass or phenolic with a dielectric coating. The rod is wound with wire to provide an inductance. The capacitance is obtained between the windings and the metallized plane and is distributed throughout the length of the line. In some cases, capacitors are used on the input and the output of the device to improve frequency response. (See Figure 6-35.)

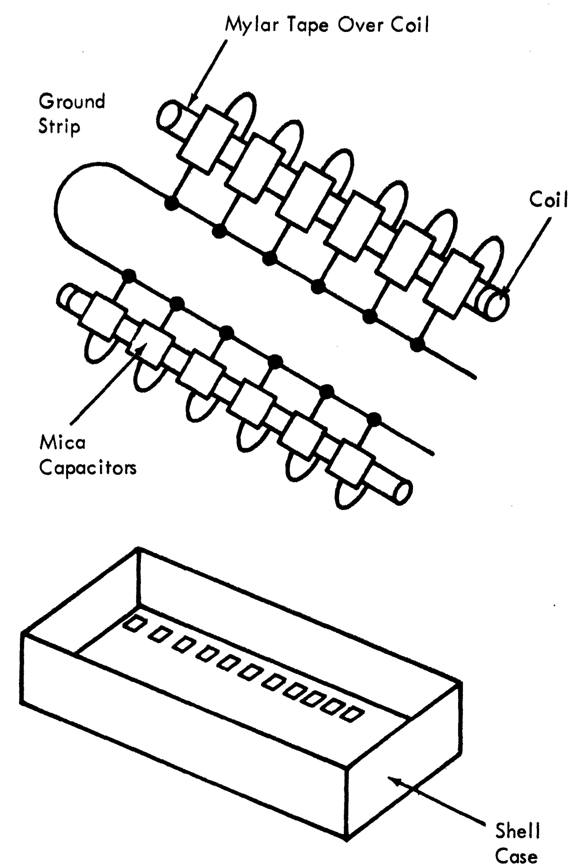


Figure 6-33. Lumped Constant Delay Line

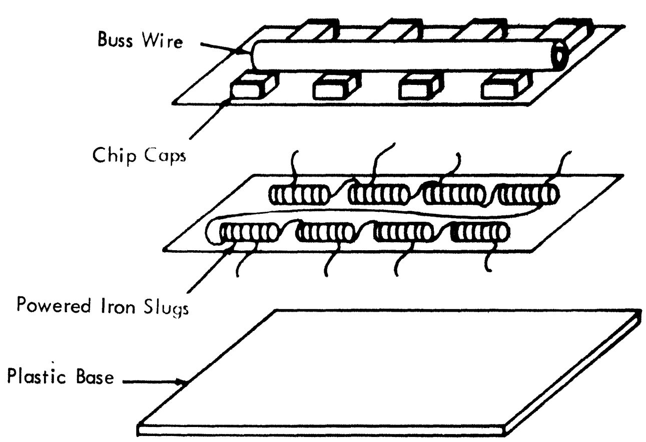


Figure 6-34. Typical Chip Capacitor Assembly

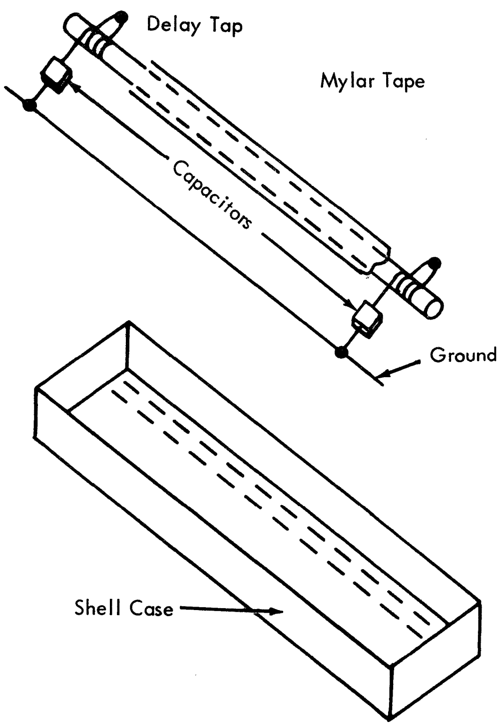


Figure 6-35. Distributed Constant Delay Line

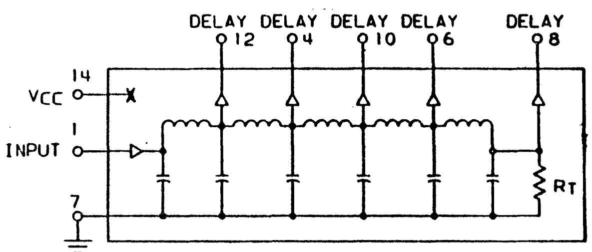


Figure 6-36. Active Delay Line Schematic

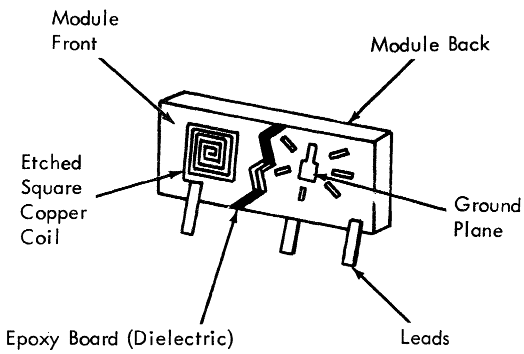


Figure 6-37. Typical R-Pac Delay Line Construction

Distributed lines are the least expensive and provide the best pulse fidelity but have poor high frequency response for longer delays and have the lowest delay density per package. A stripline version of the distributed line is available in a 4-pin R-Pac configuration for delays up to 10 ns (See Figure 6-37). Its advantages and disadvantages are identical to those of other distributed lines.

Recently, CCP developed an active delay line in a 14 pin dip package. This packaging incorporates the marriage of a passive delay line and a logic circuit. The logic circuit is represented by a 74S04 IC which provides an active input and output to the delay line. (See Figure 6-36.)

The TTL buffered active delay line can be used with super high speed TTL, standard TTL and DTL logic; thereby, providing many time applications with minimum interface. The active circuit also permits output rise time less than 4 nsec independently of the total delay.

Active delay line T_2 completion is scheduled for 2Q82 and therefore a matrix of the active delay lines is not available at this time. Any information pertaining to these devices should be referred to the responsible CCP component engineer.

AVAILABLE TYPES

The following definitions are important in understanding delay line performance specifications (see Figure 6-38);

t_d - Time delay; measured from 50% of the amplitude of the leading edge of the input pulse to the 50% amplitude of the leading edge of the output pulse.

t - Input and output pulse width; measured at the 50% amplitude points.

tri - Input rise time; measured from the 10% to the 90% point of the leading edge of the input pulse.

tro - Output rise time; measured from the 10% to the 90% point of the output pulse leading edge.

tfi - Input fall time; time duration between 10% and 90% of the trailing edge of the input pulse.

tfo - Output fall time; time duration between 10% and 90% of the trailing edge of the output pulse.

α - Attenuation (in dB) = 20 $\log_{10}$ Ein/Eo. It is the difference between the input and output pulses.

Z_0 - Characteristic impedance; measured by observing the reflections on the input pulse when the delay line is terminated into a resistor whose value is equal to the nominal characteristic impedance. The following calculation is used (see Figure 6-38).

$$Z_0 = \frac{V2\ R}{Z\ V1 - V2}$$

td/tro - Quality factor: the delay to rise time ratio determines the number of LC sections needed for a given delay line.

Packages/Form Factors

The available types of delay line packages are illustrated in Figure 6-39. They represent both established technology and recent development work. Almost all delay lines are plastic encapsulated and wettable, and are intended for use on standard IBM cards.

The one exception is the top design in Figure 6-40 which shows the newly developed pluggable delay line module series which employs a 32-pin socket handling up to four delay lines. Figure 6-41 shows the delay lines and socket assembly. This arrangement provides delay selectivity from 0 to 8 ns in 1/2 ns increments with an accuracy of ±0.2 ns.

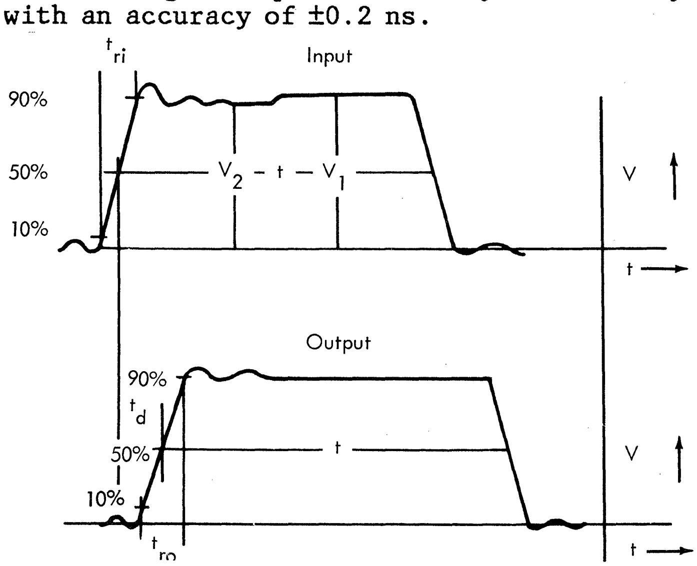


Figure 6-38. Typical Pulse Waveforms

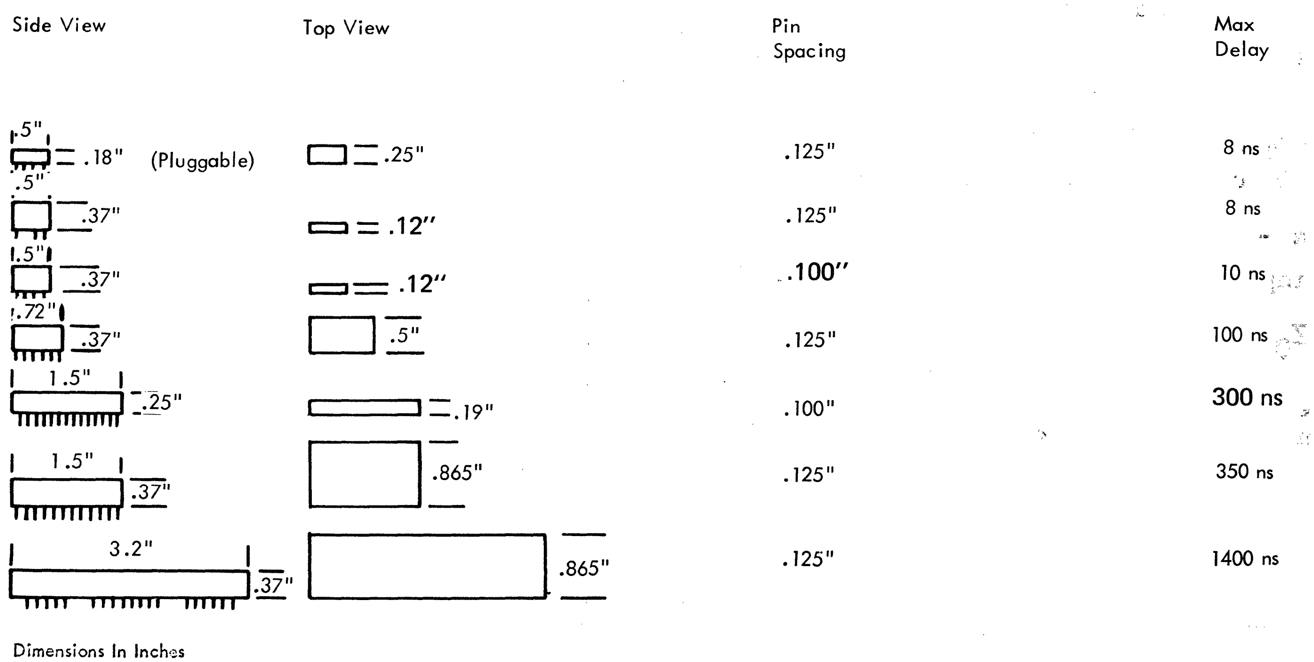
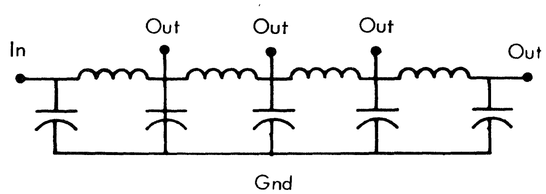
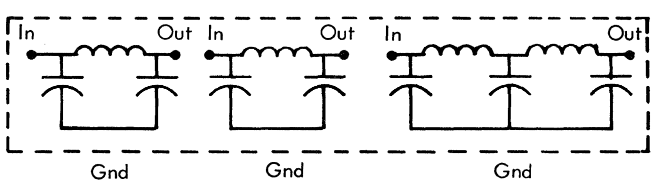


Figure 6-39. Available Delay Line Packages



(A) Tapped Delay Line



(B) Programmable Delay Line

Figure 6-40. Delay Line Schematics

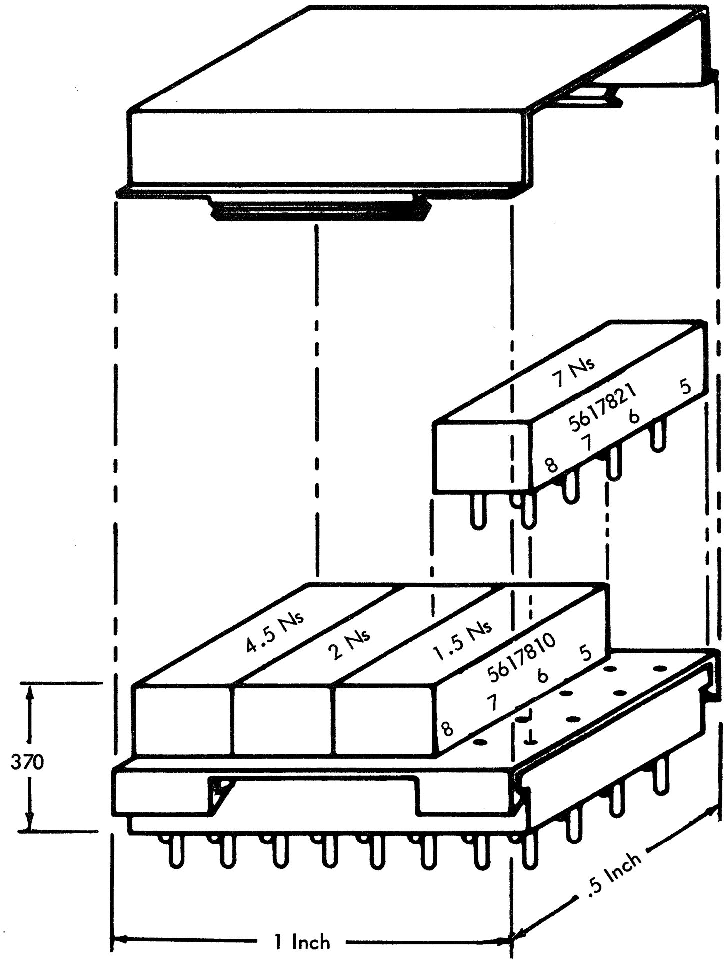


Figure 6-41. Pluggable Delay Line and Socket

PERFORMANCE CHARACTERISTICS

Parametric Limits

Table 6-5 shows the ranges of performance available in current technology delay lines:

Parameter	Range
Delay Time (td)	0 ns to 1.2 µs
Delay tolerance	±5% or 0.2 ns whichever is greater

Parameter	Range
Output rise time (t_{ro})	1 ns minimum
Characteristic Impedance (Z_0)	50 Ω minimum
Temperature Coefficient	+50 PPM/°C minimum
Output distortion	±10% minimum
DC Resistance	typically less than 10 Ω
Operating voltage	typically less than 5 Vdc

Increments of total delay are available in most packages as "taps" or as electrically isolated "programmable sections." The schematics in Figure 6-40 illustrate the differences between tapped and programmable delay lines.

EOL Limits

EOL tolerance is made up of purchase tolerance, temperature coefficient and drift due to aging. The worst-case absolute EOL tolerance for delay is estimated to be:

Purchase tolerance	±5% to ±10%
Temperature coefficient	±0.5% to ±2%
Aging	±0.5% to ±1%
Worst case absolute EOL tolerance	±6% to ±13%

DESIGN/APPLICATION CONSIDERATIONS

Rise Time

The ratio of delay time to rise time is considered a figure of merit for delay lines. As the number of sections is increased, the ratio increases. A 100 ns delay line with a 15 ns rise time may require 10 sections. To decrease the rise time to 10 ns may require 18 to 20 sections of proportionately lower values of inductance and capacitance.

However, as rise times approach 1 ns, performance is limited by stray reactances more than by the values of the component sections. These same considerations make it impractical to specify a delay tolerance of tighter than ±0.2 ns.

Impedance and Loading

The selection of the proper impedance involves several tradeoffs. For best pulse fidelity (lowest distortion), the line should match the impedance of the signal plane (80 Ω to 90 Ω in current technology). However, the logic may not be able to drive this low an impedance (MST may; Dutchess can not). Special line drivers should be used in those cases where the logic capability does not match the signal plane impedance.

In cases where the signal lines are short and some noise (reflections) can be tolerated, a higher impedance can be selected. However, equations (1) and (2) show that a higher impedance for a given delay implies a lower capacitance. Their lower capacitance for each section makes the line more susceptible to load capacitance; especially in the case of multi-tapped delay lines.

The output of each delay line must be terminated into its characteristic impedance. In addition, for tapped delay lines, the selected tap should be terminated into an impedance greater than 10X the characteristic impedance (See Figure 6-42). Also, it is recommended that only one tap at a time be used on a given delay line as the loading at one tap affects the delay and distortion of all others.

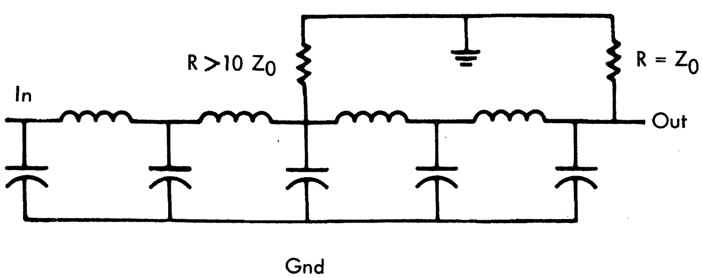


Figure 6-42. Tapped Delay Line Loading Circuit

From an economic standpoint the most important factors with regard to the delay line are the td/tr ratio, delay tolerance, and size. For a given delay, faster rise times require more sections and therefore cost more. As with any other component, tighter tolerances will cost more money. Tolerances tighter than ±5% or ±0.5 ns (whichever is greater) should be avoided. Unreasonable miniaturization also can be very costly. The package limitations outlined in Figure 6-39 should be followed.

Reliability Considerations

The supported SPQL for all delay lines is 100 PPM.

No reliability algorithm has been developed for delay lines but its reliability for the most part depends on that of the capacitors used. It is adversely affected by high temperature, high humidity, and high voltage. Failure rates are presented in F/R specification 866451 or in the component data bank.

APPLICABLE SPECIFICATIONS

Delay lines are covered by the following engineering specifications:

Engineering Specification	- 895491
Quality	- 873559
Flammability	- 2413138

INDUCTORS

COMPONENT DATA BANK - P/N CATALOG

DCS CODES
--- -----

23721 - Audio, Fixed
23723 - RF, Fixed
23724 - RF, Variable

PG. 1 06/30/82 23:34 UR0206 *** IBM INTERNAL USE *** COMPONENT DATA BANK INTERNAL USE ONLY
CDB/IN ALL/IN IN/PAR1 IN/IND/UH GT 000000.00 SEQ/LH IN/IND/UH TECH DCS
NO/LIMIT.

PART NUMBER	INDUCT MICRO HENRY	TOL %	Q/MIN FREQ MHZ	DCR MAX OHMS	DC/MAX CURRENT MILAMP	MIN SRF MHZ	BODY LENGTH MILS	BODY HEIGHT MILS	BODY DIAM MILS	LEAD LENGTH INCHES	LEAD DIAM MILS	VERT PIN SP MILS	TUC	DCS CODE
2391896	.05	10	30AT 50.000	.10	10.00	680.00	228	345	115	.08	20		C	23723
0217103	.10	10	50AT 25.000	.06	1,800.00	500.00	440		172	1.50	24		A	23723
1589018	.10	10	35AT 25.000	.25	200.00	500.00	200		90	1.50	16		A	23723
0217104	.12	10	50AT 25.000	.07	1,700.00	450.00	440		172	1.50	24		A	23723
0217106	.15	10	50AT 25.000	.07	1,700.00	410.00	440		172	1.50	24		A	23723
0217107	.18	10	50AT 25.000	.08	1,600.00	380.00	440		172	1.50	24		A	23723
4429622	.18	2%		.10	100.00	.00	121	340	190	.09	20	100	C	23723
0217108	.22	10	50AT 25.000	.08	1,600.00	350.00	440		172	1.50	24		A	23723
4429624	.22	2%		.10	.12	.00	121	340	190	.09	20	100	C	23723
2391150	.23	100	35AT 50.000	.25	50.00	190.00	228	345	115	.08	20	125	C	23723
5615561	.23	2.0%	35AT 50.000	.25	50.00	190.00	345	228	115	.50	20	125	A	23723
2391269	.24	50	35AT 50.000	.25	50.00	190.00	228	345	115	.08	20	125	C	23723
0217109	.27	10	50AT 25.000	.09	1,500.00	310.00	440		172	1.50	24		A	23723
0217111	.33	10	50AT 25.000	.09	1,500.00	290.00	440		172	1.50	24		A	23723
0217113	.39	10	45AT 25.000	.10	1,400.00	270.00	440		172	1.50	24		A	23723
0222363	.47	10	45AT 25.000	.11	1,350.00	260.00	440		172	1.50	24		A	23723
0550054	.47	5	60AT 2.500	.10	550.00	250.00	450		180	1.31	24		A	23723
0217116	.56	10	45AT 25.000	.14	1,200.00	240.00	440		172	1.50	24		A	23723
0217117	.68	10	45AT 25.000	.15	1,150.00	230.00	440		172	1.50	24		A	23723
0217118	.82	10	45AT 25.000	.27	860.00	210.00	440		172	1.50	24		A	23723
8272104	.90	3%	45AT 25.000	.30	820.00	200.00	440		172	1.50	24		C	23723
0222405	1.00	10	45AT 25.000	.30	815.00	190.00	440		172	1.50	24		A	23723
0550055	1.00	5	60AT 7.900	.12	500.00	160.00	450		180	1.31	24		A	23723
2395860	1.00	100	55AT 0.500	16.50	120.00	2.80	478	370	115	.08	20	125	C	23723
4429670	1.00	+/-4%	45AT 25.000	.30	815.00	190.00	440		188	1.50	24		C	23723
8493173	1.00	10%	130AT 15.000	.03	4,000.00	136.00	900		310	1.50	28		C	23723
0217119	1.10	5	60AT 7.900	.11	1,300.00	155.00	440		172	1.50	24		A	23723
0222433	1.20	5	60AT 7.900	.12	1,250.00	145.00	440		172	1.50	24		A	23723
0492683	1.20	5	35AT 0.250	3.00	400.00	1.10	900		375	1.31	40		A	23723
0550056	1.20	5	60AT 7.900	.15	400.00	150.00	450		180	1.32	24		A	23723
2392068	1.20	100	55AT 0.500	20.00	120.00	1.75	478	370	115	.08	20	125	C	23723
0217121	1.30	5	60AT 7.900	.12	1,250.00	140.00	440		172	1.50	24		A	23723
0492364	1.50	5	60AT 7.900	1.13	1,200.00	130.00	440		172	1.50	24		A	23723
0550057	1.50	5	60AT 7.900	.15	350.00	130.00	450		180	1.31	24		A	23723
0217122	1.60	5	60AT 7.900	.15	1,100.00	125.00	440		172	1.50	24		A	23723
8272103	1.70	3%	60AT 7.900	.16	1,050.00	122.00	440		172	1.50	24		C	23723
0217123	1.80	5	60AT 7.900	.16	1,050.00	120.00	440		172	1.50	24		A	23723
2218773	1.80	5	40AT 7.900	.70	500.00	100.00	265		115	.75	20		A	23723
0217124	2.00	5	60AT 7.900	.17	1,050.00	115.00	440		172	1.50	24		A	23723
0491218	2.20	5	60AT 0.790	.18	1,000.00	110.00	440		172	1.50	24		A	23723
2391006	2.20	10	35AT 7.900	1.00	150.00	50.00	228		115	.08	20	125	C	23723
2391694	2.20	10	35AT 7.900	1.00	150.00	50.00	250		115	1.25	20		N	23723
4429623	2.20	5%		.50	100.00	.00	121	340	190	.09	20	100	C	23723
0217126	2.40	5	60AT 7.900	.21	940.00	105.00	440		172	1.50	24		A	23723
2392069	2.40	100	30AT 0.160	45.00	10.00	1.50	478	370	115	.08	20	125	C	23723
0491219	2.70	5	60AT 7.900	.24	870.00	100.00	440		172	1.50	24		A	23723
0222434	3.00	5	60AT 7.900	.26	845.00	93.00	440		172	1.50	24		A	23723

PG. 2 06/30/82 23:34 UR0206 *** IBM INTERNAL USE *** COMPONENT DATA BANK INTERNAL USE ONLY
CDB/IN ALL/IN IN/PAR1 IN/IND/UH GT 000000.00 SEQ/LH IN/IND/UH TECH DCS
NO/LIMIT.

PART NUMBER	INDUCT MICRO HENRY	TOL %	Q/MIN	FREQ MHZ	DCR MAX OHMS	DC/MAX CURRENT MILAMP	MIN SRF MHZ	BODY LENGTH MILS	BODY HEIGHT MILS	BODY DIAM MILS	LEAD LENGTH INCHES	LEAD DIAM MILS	VERT PIN SP MILS	TUC	DCS CODE
0483318	3.30	10	45AT	7.900	1.00	100.00	90.00	265		94	1.50	19		A	23723
0492551	3.30	5	60AT	7.900	.27	825.00	85.00	740		190	1.50	32		A	23723
0217127	3.60	5	60AT	7.900	.28	810.00	83.00	440		172	1.50	24		A	23723
0222456	3.90	5	60AT	7.900	.29	800.00	75.00	440		172	1.50	24		A	23723
2391124	3.90	10	35AT	7.900	1.20	50.00	60.00	228		115	.08	20	125	C	23723
0217128	4.30	5	60AT	7.900	.30	785.00	74.00	440		172	1.50	24		A	23723
0222457	4.70	5	55AT	7.900	.31	770.00	70.00	440		172	1.50	24		A	23723
1582935	4.70	10	45AT	0.790	2.00	158.00	75.00	250		95	1.25	20		L	23723
2391042	5.00	100	45AT	7.900	1.50	100.00	55.00	228	345	115	.08	20	125	C	23723
0222491	5.10	5	55AT	7.900	.34	735.00	66.00	440		172	1.50	24		A	23723
0217129	5.60	5	60AT	7.900	.36	715.00	62.00	440		172	1.50	24		A	23723
0217131	6.20	5	60AT	7.900	.39	685.00	58.00	440		172	1.50	24		A	23723
0491220	6.80	5	50AT	7.900	.41	670.00	55.00	440		172	1.50	24		A	23723
2391249	6.80	10	50AT	7.900	2.40	200.00	55.00	228		115	.08	20	125	C	23724
0217132	7.50	5	60AT	7.900	.48	620.00	51.00	440		172	1.50	24		A	23723
0222498	8.20	5	50AT	7.900	.55	580.00	48.00	440		172	1.50	24		A	23723
0217133	9.10	5	60AT	7.900	.61	550.00	44.00	440		190	1.50	24		A	23723
0491279	10.00	5	60AT	7.900	.67	525.00	40.00	440		172	1.50	24		A	23723
0813210	10.00	5	35AT	7.900	3.50	90.00	48.00	240		95	1.25	20		A	23723
4481206	10.00	10	35AT	7.9	.25	500.00	45.00	1000		500	1.25	70		A	23723
0217134	11.00	5	60AT	2.500	.80	505.00	33.00	440		190	1.50	24		A	23723
0217136	12.00	5	60AT	2.500	.90	475.00	31.00	440		190	1.50	24		A	23723
0217137	13.00	5	60AT	2.500	1.00	450.00	30.00	440		190	1.50	24		A	23723
0217138	15.00	5	55AT	2.500	1.20	415.00	28.00	440		190	1.50	24		A	23723
0217139	16.00	5	55AT	2.500	1.30	395.00	27.00	440		190	1.50	24		A	23723
2391007	16.00	10	40AT	2.500	5.00	50.00	20.00	228		115	.08	20	125	C	23723
0491268	18.00	5	55AT	2.500	1.40	380.00	25.00	440		190	1.50	24		A	23723
2396865	18.00	10	50AT	25.000	3.10	195.00	32.00	250		95	1.25	20		C	23723
0217141	20.00	5	55AT	2.500	1.30	395.00	22.00	440		190	1.50	24		A	23723
2396862	20.00	25			.09	32,000.00	.00	1750	1125		120.00	96	900	C	23721
0217142	22.00	5	55AT	2.500	1.50	377.00	22.00	440		190	1.50	24		A	23723
1582907	22.00	5	45AT	2.500	1.00	500.00	41.00	400		160	1.44	25		C	23723
0222057	24.00	5	55AT	2.500	1.80	335.00	21.00	440		190	1.50	24		A	23723
2392042	24.00	10	50AT	2.500	3.60	150.00	24.00	250		95	1.25	20		C	23723
0492511	25.00	5	60AT	2.500	1.40	250.00	20.00	440		190	1.62	25		A	23723
2396859	25.00	25			9.00	20,000.00	.00	1500	1125		120.00	96	900	C	23721
0491267	27.00	5	55AT	2.500	2.70	275.00	20.00	440		190	1.50	24		A	23723
1582594	27.00	10	50AT	2.500	3.50	185.00	22.00	250		105	1.25	20		A	23723
2122705	27.00	1	55AT	1.000	2.80	300.00	20.00	440		190	1.62	25		A	23723
0217143	30.00	5	55AT	2.500	2.10	310.00	19.00	440		190	1.50	24		A	23723
0483090	30.00	5	55AT	2.500	2.10	310.00	19.00	440		190	1.62	25		A	23723
0483537	32.00	2	55AT	2.500	2.30	300.00	18.00	440		190	1.25	25		A	23723
0492538	33.00	5	55AT	2.500	2.30	300.00	18.00	440		190	1.50	24		A	23723
0222058	36.00	5	55AT	0.500	2.40	290.00	17.00	440		190	1.50	24		A	23723
0492518	37.00	5	91AT	2.500	2.00	200.00	18.00	440		190	1.62	25		A	23723
0491287	39.00	5	55AT	2.500	2.50	285.00	16.00	440		190	1.50	24		A	23723
1582634	39.00	2	55AT	2.500	2.50	285.00	16.00	440		190	1.50	24		C	23723

PG. 3 06/30/82 23:34 UR0206 *** IBM INTERNAL USE *** COMPONENT DATA BANK INTERNAL USE ONLY
CDB/IN ALL/IN IN/PAR1 IN/IND/UH GT 000000.00 SEQ/LH IN/IND/UH TECH DCS
NO/LIMIT.

PART NUMBER	INDUCT MICRO HENRY	TOL %	Q/MIN	FREQ MHZ	DCR MAX OHMS	DC/MAX CURRENT MILAMP	MIN SRF MHZ	BODY LENGTH MILS	BODY HEIGHT MILS	BODY DIAM MILS	LEAD LENGTH INCHES	LEAD DIAM MILS	VER PIN SP MILS	TUC	DCS CODE
0222702	43.00	5	55AT	2.500	3.00	260.00	15.00	440		190	1.50	24		A	23723
0217144	47.00	5	55AT	2.500	3.40	245.00	14.00	440		190	1.50	24		A	23723
0335989	50.00	5	13AT	2.500	3.20	30.00	15.30	428		365	1.31	32		A	23723
0222703	51.00	5	55AT	2.500	3.70	235.00	14.00	440		190	1.50	24		A	23723
0492372	54.00	2	40AT	2.50υ	10.00	100.00	10.00	440		190	1.62	24		A	23723
0491311	56.00	5	45AT	2.500	4.10	225.00	14.00	440		190	1.50	24		A	23723
0492516	62.00	5	45AT	2.500	4.20	220.00	12.00	440		190	1.50	24		A	23723
2391008	62.00	100	40AT	2.500	10.00	50.00	8.00	228	345	115	.08	20	125	C	23723
0483538	63.00	2	45AT	2.500	4.20	220.00	11.00	440		190	1.25	25		A	23723
0492587	68.00	5	45AT	2.500	4.20	220.00	11.00	440		190	1.50	24		A	23723
2123018	68.00	1	45AT	2.500	4.20	220.00	11.00	440		190	1.62	25		A	23723
0492517	75.00	5	45AT	2.500	4.20	220.00	10.00	440		190	1.50	24		A	23723
2154527	75.00	2	45AT	2.500	4.20	220.00	10.00	440		190	1.62	25		A	23723
2396860	80.00	25			14.00	6,000.00	.00		1125	1500	120.00	65	1000	C	23721
0814032	81.50	2	45AT	2.500	4.20	220.00	11.00	440		190	1.25	25		A	23723
0222048	82.00	5	45AT	2.500	4.40	215.00	9.00	440		190	1.50	24		A	23723
0492373	82.00	2	40AT	2.500	6.00	100.00	7.00	440		190	1.62	24		A	23723
2391251	82.00	100	50AT	2.500	7.30	100.00	14.00	228	345	115	.08	20	125	C	23723
0492510	87.50	5	40AT	2.500	6.00	50.00	6.60	440		190	1.62	25		A	23723
0222059	91.00	5	45AT	0.500	4.70	210.00	9.10	440		190	1.50	24		A	23723
4429944	91.00	5	40AT	2.500	3.50	250.00	8.00	375		133	1.30	20		B	23723
2396861	95.00	25			30.00	1,500.00	.00		1125	1500	120.00	41	1000	C	23721
0491292	100.00	5	45AT	2.500	4.90	205.00	8.50	440		190	1.50	24		A	23723
0492374	100.00	2	50AT	0.790	5.00	100.00	5.00	440		190	1.62	24		A	23723
0813209	100.00	5	50AT	2.500	8.50	150.00	14.00	270		105	1.25	20		C	23723
0492622	110.00	5	60AT	0.790	5.10	200.00	7.50	440		190	1.50	24		A	23723
0814033	115.00	2	60AT	0.790	5.40	200.00	7.30	440		190	1.25	25		A	23723
0483135	120.00	5	60AT	0.790	5.40	195.00	7.30	440		190	1.62	25		A	23723
0492350	120.00	5	60AT	0.790	5.40	195.00	7.30	440		190	1.50	24		A	23723
0483050	125.00	5	45AT	0.790	5.00	150.00	3.00	740		240	1.43	32		A	23723
0483078	125.00	5	4AT	0.001	180.00	50.00	.50	1500		750	.15	40	600	A	23723
0217146	130.00	5	60AT	0.790	5.70	190.00	6.50	440		190	1.50	24		A	23723
0483142	130.00	5	70AT	0.790	5.00	50.00	7.00	750		312	1.75	32		A	23723
0217147	150.00	5	60AT	0.790	6.20	180.00	6.20	440		190	1.50	24		A	23723
2122709	150.00	1	45AT	1.000	3.30	.00	6.80	440		[illegible]	1.62	25		A	23723
5615684	150.00	3.0%	60AT	0.790	6.20	180.00	6.20	440		190	1.50	24		C	23723
0222049	160.00	5	60AT	0.790	6.60	175.00	6.00	440		190	1.50	24		A	23723
0814034	163.00	2	60AT	0.790	6.20	180.00	6.20	440		190	1.25	25		A	23723
0492509	175.00	5	60AT	0.790	9.00	100.00	4.50	440		190	1.62	25		A	23723
0222060	180.00	5	60AT	0.790	7.10	170.00	5.70	440		190	1.50	24		A	23723
0483083	180.00	5	60AT	0.790	7.10	170.00	5.70	440		190	1.62	25		A	23723
0492380	200.00	2	50AT	0.790	10.00	100.00	3.00	440		190	1.62	24		A	23723
0492634	200.00	5	60AT	0.790	7.50	165.00	5.50	440		190	1.50	24		A	23723
2391250	200.00	100	30AT	0.790	17.00	50.00	6.50	228	345	115	.08	20	125	C	23723
5440907	200.00	5	8AT	0.790	.75	500.00	1.65	750		305	1.50	32		A	23724
0217148	220.00	5	60AT	0.790	7.90	160.00	5.20	440		190	1.50	24		A	23723
0482146	240.00	5	60AT	0.790	8.30	155.00	5.00	440		190	1.50	24		A	23723

PG. 4 06/30/82 23:34 UR0206 *** IBM INTERNAL USE *** COMPONENT DATA BANK INTERNAL USE ONLY
CDB/IN ALL/IN IN/PAR1 IN/IND/UH GT 000000.00 SEQ/LH IN/IND/UH TECH DCS
NO/LIMIT.

PART NUMBER	INDUCT MICRO HENRY	TOL %	Q/MIN	FREQ MHZ	DCR MAX OHMS	DC/MAX CURRENT MILAMP	MIN SRF MHZ	BODY LENGTH MILS	BODY HEIGHT MILS	BODY DIAM MILS	LEAD LENGTH INCHES	LEAD DIAM MILS	VERT PIN SP MILS	TUC	DCS CODE
0483429	240.00	2	60AT	0.790	9.00	150.00	4.50	440		190	1.25	25		A	23723
0491285	250.00	5	80AT	0.790	12.00	100.00	5.00	440		190	1.50	25		A	23723
1589486	250.00	5	21AT	0.016	.57	500.00	.00	370		570	.50	25	30	C	23723
0217149	270.00	5	60AT	0.790	8.90	150.00	4.80	440		190	1.50	24		A	23723
0217151	300.00	5	60AT	0.790	9.20	150.00	4.40	440		190	1.50	24		A	23723
0492501	330.00	5	60AT	0.790	9.50	145.00	4.10	440		190	1.50	24		A	23723
2123017	330.00	2	60AT	0.790	9.50	145.00	4.10	440		190	1.62	25		A	23723
0492358	350.00	5	30AT	0.790	2.50	300.00	2.00	750		250	1.31	32		A	23723
0482147	360.00	5	55AT	0.790	11.00	135.00	3.90	440		190	1.50	24		A	23723
0814010	360.00	10	1AT	0.790	1.50	400.00	1.60	687		370	1.50	32		A	23723
0217152	390.00	5	55AT	0.790	11.00	135.00	3.70	440		190	1.50	24		A	23723
0483369	425.00	+40	55AT	0.790	4.60	180.00	2.50	375		156	1.50	25		C	23723
0217153	430.00	5	55AT	0.790	12.00	130.00	3.50	440		190	1.50	24		A	23723
5382126	430.00	2	55AT	0.790	15.00	130.00	3.50	440		190	1.75	190		C	23723
0217154	470.00	5	55AT	0.790	12.00	130.00	3.30	440		190	1.50	24		A	23723
0483033	500.00	5	60AT	0.790	20.00	100.00	2.50	440		190	1.62	25		A	23723
0483085	510.00	5	55AT	0.790	12.00	130.00	3.10	440		190	1.62	25		A	23723
0491280	510.00	5	55AT	0.790	12.00	130.00	3.10	440		190	1.50	24		A	23723
2391211	510.00	10	35AT	0.790	35.00	50.00	4.00	228		115	.08	20	125	C	23723
0217156	560.00	5	55AT	0.790	13.00	125.00	2.90	440		190	1.50	24		A	23723
0217157	620.00	5	55AT	0.790	14.00	120.00	2.80	440		190	1.50	24		A	23723
2392067	620.00	100	55AT	0.500	12.00	10.00	2.60	478	370	115	.08	20	125	C	23723
0483255	670.00	5	65AT	0.790	13.00	100.00	3.00	750		312	1.50	32		A	23723
0483563	670.00	2	55AT	0.790	14.00	220.00	2.60	440		190	1.25	25		A	23723
0217158	680.00	5	55AT	0.790	14.00	120.00	2.60	440		190	1.50	24		A	23723
0814075	680.00	2	55AT	0.790	14.00	120.00	2.60	440		190	1.50	25		A	23723
0491317	750.00	5	55AT	0.790	15.00	115.00	2.50	440		190	1.50	24		A	23723
0737617	750.00	5	40AT	0.790	4.50	300.00	2.50	740		240	1.62	32		A	23723
0217159	820.00	5	55AT	0.790	16.00	110.00	2.30	440		190	1.50	24		A	23723
0217161	910.00	5	55AT	0.790	17.00	110.00	2.10	440		190	1.50	24		A	23723
0483086	1,000.00	5	50AT	0.790	20.00	110.00	2.00	440		190	1.62	25		A	23723
0492474	1,000.00	5	50AT	0.790	17.00	110.00	2.00	440		190	1.50	24		A	23723
0483329	1,050.00	2	50AT	0.790	20.00	110.00	2.00	740		240	1.25	32		A	23723
0217162	1,100.00	5	60AT	0.250	20.00	120.00	1.90	740		240	1.50	32		A	23723
8493073	1,100.00	5%	60AT	0.190	20.00	62.00	2.00	410		172	1.50	24		A	23723
0222055	1,200.00	5	60AT	0.250	21.00	115.00	1.80	740		240	1.50	32		A	23723
0492415	1,250.00	5	85AT	0.250	6.00	100.00	1.00	740		240	1.43	32		A	23723
0222052	1,300.00	5	60AT	0.250	22.00	115.00	1.80	740		240	1.50	32		A	23723
0217163	1,500.00	5	60AT	0.250	24.00	110.00	1.70	740		240	1.50	32		A	23723
0217164	1,600.00	5	60AT	0.250	25.00	105.00	1.60	740		240	1.50	32		A	23723
0217166	1,800.00	5	60AT	0.250	27.00	100.00	1.60	740		240	1.50	32		A	23723
0483371	1,800.00	10	25AT	0.0135	3.50	50.00	.74	740		300	1.50	32		C	23723
0482150	2,000.00	5	60AT	0.250	28.00	100.00	1.60	740		240	1.50	32		A	23723
0217167	2,200.00	5	60AT	0.250	30.00	98.00	1.60	740		240	1.50	32		A	23723
0482151	2,400.00	5	70AT	0.250	32.00	95.00	1.60	740		240	1.50	32		A	23723
0492416	2,500.00	5	70AT	0.250	14.00	60.00	.65	740		240	1.43	32		A	23723
0217168	2,700.00	5	70AT	0.250	34.00	92.00	1.50	740		240	1.50	32		A	23723

PG. 5 06/30/82 23:34 UR0206 *** IBM INTERNAL USE *** COMPONENT DATA BANK INTERNAL USE ONLY
CDB/IN ALL/IN IN/PAR1 IN/IND/UH GT 000000.00 SEQ/LH IN/IND/UH TECH DCS
NO/LIMIT.

PART NUMBER	INDUCT MICRO HENRY	TOL %	Q/MIN	FREQ MHZ	DCR MAX OHMS	DC/MAX CURRENT MILAMP	MIN SRF MHZ	BODY LENGTH MILS	BODY HEIGHT MILS	BODY DIAM MILS	LEAD LENGTH INCHES	LEAD DIAM MILS	VERT PIN SP MILS	TUC	DCS CODE
2396650	2,700.00	10	45AT	0.250	48.00	83.00	.92	395		157	1.31	25		B	23721
0217169	3,000.00	5	70AT	0.250	37.00	88.00	1.50	740		240	1.50	32		A	23723
0492502	3,300.00	5	70AT	0.250	41.00	84.00	1.50	740		190	1.50	32		A	23723
1589132	3,300.00	10	43AT	250.000	53.00	80.00	.80	402		160	1.45	25		C	23723
0222033	3,600.00	5	70AT	0.250	42.00	83.00	1.40	740		240	1.50	32		A	23723
0222050	3,900.00	5	70AT	0.250	44.00	81.00	1.30	740		240	1.50	32		A	23723
0222034	4,300.00	5	70AT	0.250	47.00	78.00	1.30	740		240	1.50	32		A	23723
0222037	4,700.00	5	70AT	0.250	49.00	77.00	1.20	740		240	1.50	32		A	23723
0483372	4,700.00	10	25AT	0.013	10.00	45.00	.34	740		300	1.50	32		A	23723
0491290	5,000.00	5	60AT	0.250	65.00	50.00	.45	740		240	1.43	32		A	23723
0222056	5,100.00	5	70AT	0.250	52.00	75.00	1.20	740		240	1.50	32		A	23723
0222038	5,600.00	5	70AT	0.250	55.00	73.00	1.10	740		240	1.50	32		A	23723
0492417	6,200.00	5	70AT	0.250	51.00	71.00	1.10	740		190	1.50	32		A	23723
0222039	6,800.00	5	70AT	0.250	62.00	68.00	1.00	740		240	1.50	32		A	23723
0222040	7,500.00	5	70AT	0.250	65.00	67.00	1.00	740		240	1.50	32		A	23723
0483301	8,000.00	10	75AT	0.250	62.70	100.00	.93	750		312	1.25	32		A	23723
0222041	8,200.00	5	70AT	0.250	67.00	66.00	.98	740		240	1.50	32		A	23723
0222042	9,100.00	5	70AT	0.250	70.00	64.00	.93	740		240	1.50	32		A	23723
0317346	10,000.00	5	79AT	0.079	29.70	50.00	.53	677		428	1.31	32		A	23723
0482153	10,000.00	5	70AT	0.250	70.00	64.00	.90	740		240	1.50	32		A	23723
0491291	10,000.00	5	60AT	0.150	80.00	50.00	.45	740		240	1.43	32		A	23723
0492595	10,000.00	5	70AT	0.250	66.00	75.00	.80	750		250	1.35	32		A	23723
0734454	10,000.00	6	3AT	0.001	20.00	50.00	.00	350		698	.40	25		A	23723
2145015	10,000.00	10	70AT	0.079	40.00	100.00	390.00	562		302	1.62	25		A	23723
0222043	11,000.00	5	50AT	0.250	80.00	64.00	.84	740		300	1.50	32		A	23723
0492418	12,000.00	5	50AT	0.079	84.00	62.00	.80	740		190	1.50	32		A	23723
0222044	13,000.00	5	50AT	0.079	88.00	61.00	.76	740		300	1.50	32		A	23723
0222045	15,000.00	5	55AT	0.079	95.00	59.00	.68	740		300	1.50	32		A	23723
0222046	18,000.00	5	55AT	0.079	105.00	56.00	.62	740		300	1.50	32		A	23723
1582642	18,000.00	25	N/A		.80	20.00	.00		1125	1500	.13	33		C	23721
0222047	20,000.00	5	60AT	0.079	115.00	53.00	.57	740		300	1.50	32		A	23723
0734455	20,000.00	6	2AT	0.001	45.00	36.00	.00	350		698	.40	25		A	23724
0482154	22,000.00	5	60AT	0.079	120.00	50.00	.50	740		24	1.50	32		A	23723
0483019	39,000.00	5	50AT	0.079	125.00	70.00	.15	740		305	1.31	32		A	23723
0483168	39,000.00	5	20AT	0.079	42.00	15.00	.16	740		312	1.50	32		C	23723
0813217	39,000.00	5	50AT	0.079	150.00	35.00	.25	740		300	1.50	32		A	23723
0483370	43,000.00	10	25AT	0.013	75.00	30.00	.15	740		300	1.50	32		A	23723
0813208	80,000.00	5	40AT	0.079	500.00	20.00	.30	750		300	1.25	32		A	23723
0483506	140,000.00	5	30AT	0.001	250.00	.00	.00	460		1073	.40	25		A	23723
0483507	300,000.00	5	14AT	0.001	109.00	.00	.00	460		1073	.40	25	188	A	23723

TOTAL RECORDS 228

AUDIO TRANSFORMERS AND INDUCTORS

COMPONENT DATA BANK - P/N CATALOG

DCS CODES

23731, 2 - Audio Frequency (AXF)

PG. 1 06/30/82 23:34 UR0206 *** IBM INTERNAL USE *** COMPONENT DATA BANK INTERNAL USE ONLY
CDB/AXF ALL/AXF AXF/PAR1 AXF/LP NE ' ' SEQ/LH AXF/LP NO/LIMIT.

PART NUMBER	NO OF WIND	TRA N1	NSFO RA N2	RMAT TIO N3	ION N4	LP PRIM IND MILLI-H	LP VOLTS VRMS	LP FREQ KHZ	DC ON PRIMARY MILLI-A	ADJ RANGE %	DCR N1 OHMS	DCR N2 OHMS	DCR N3 OHMS	DCR N4 OHMS	DCR N5 OHMS	WIND CAP PF	LEAK AGE MH	Q1 N Q 1 1	2 Q 2 2
1637625	3	4	1.0	3.0	.0	3	5.0	16.0	.00	.0	1.5	.1	.1	.0	.0		.04		
5615817	3	10	1.5	1.5	.0	3	5.0	16.0	.00	.0	1.5	.1	.1	.0	.0		.04		
4429634	6	10	10.0	2.5	2.5	1.6	5.0	16.0	.00	.0	.4	.4	.1	.1	.0		.18		
0737500	2	5	1.0	.0	.0	2300	.1	1.0	.00	.0	999.9	144.0	.0	.0	.0		.00		
1582918	3	2	.5	59.8	.0	0.400	.2	1.0	.00	.0	2.4	215.0	.8	.0	.0		.00		
1582756	2	1	1.0	.0	.0	3.000	1.0	1.0	.00	.0	136.0	235.0	.0	.0	.0		5.40		
1582641	2	1	1.0	.0	.0	1000000	1.0	1.0	12.00	.0	165.0	208.0	.0	.0	.0		.00		
2396958	1	3	10.0	.0	.0	20.00000	.0	30.0	.03	.0	550.0	.0	.0	.0	.0		.04		

TOTAL RECORDS 8

PG 1 06/30/82 23:34 UR0206 *** IBM INTERNAL USE *** COMPONENT DATA BANK INTERNAL USE ONLY
CDB/AYF ALL/AXF AXF/PAR2 AXF/LP NE ' ' SEQ/LH AXF/LP TECH DCS NO/LIMIT.

PART NUMBER	N R	SRF KHZ	MAX HGHT INCH	MAX WDTH INCH	PIN DIAM MILS	PIN GRID MILS	ELEC SHIELD	T U C	DCS CODE	LP PRIM IND MILLI-H
1637625		40	1.00	1.20	30	100	YES	C	23731	3
5615817			1.00	1.20	30	100	NO	C	23731	3
4429634			1.00	.80	30	100	YES	C	23731	1.6
0737500			.00	.00				A	23731	2300
1582918			.80	.60	32	100	NO	E	23732	0.400
1582756		40	.50	.71	46	100	YES	C	23731	3.000
1582641			.08	1.05	53	100	YES	C	23732	1000000
2396958			.00	.00				C	23731	20.00000

TOTAL RECORDS 8

PULSE AND WIDEBAND TRANSFORMERS

COMPONENT DATA BANK - P/N CATALOG

DCS CODES
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23733 - Pulse (PXF)
23734 - Wide Band (PXF)

PG. 1 06/30/82 23:34 UR0206 *** IBM INTERNAL USE *** COMPONENT DATA BANK INTERNAL USE ONLY
CDB/PXF TECH ALL/PXF PXF/PAR1 DCS SEQ/LH DCS NO/LIMIT.

TUC	PART NUMBER	TRANSFORMATION N1	RATIO N2	N3	N4	PRIMARY INDUCT MIL-HEN	L-MEASURE FREQ KHZ	MAGNET CURRENT MIL-AMP	N1 DCR OHMS	N2 DCR OHMS	N3 DCR OHMS	N4 DCR OHMS	WIND CAPAC PF	LEAKAGE INDUCT MIC-HEN	DCS CODE
A	0349431		.0	.0	.0		.00		.00	.00	.00	.00	.0	.0	23733
C	0483126	1	1.0	.0	.0	.194	.00		.72	.80	.00	.00	20.0	.5	23733
C	0483503	1	3.1	.0	.0	320.0	.30		30.00	550.00	.00	.00	.0	.0	23733
A	0483504	1	1.0	.0	.0	247.0	1.00		73.00	110.00	.00	.00	85.0	.0	23733
A	0483505	1	1.0	.0	.0	135.0	2.20		44.00	63.00	.00	.00	85.0	.0	23733
A	0492462	1	1.0	1.0	.0		.00		.00	.00	.00	.00	.0	.0	23733
C	0492689	1	2.0	2.0	.0		.00		120.00	200.00	200.00	.00	.0	.0	23733
C	0518436	1	9.0	9.0	.0		.00		.12	7.60	.00	.00	25.0	1.2	23733
A	0595451	1	1.0	.0	.0	NO DATA	.00		.00	.00	.00	.00	.0	.0	23733
L	0734452	1	1.0	.0	.0		.00		30.00	30.00	.00	.00	.0	.0	23733
C	0737512	1	1.0	.0	.0	25.0	40.00		8.00	8.00	.00	.00	100.0	40.0	23733
A	0813238	1	1.0	.0	.0	154.0	1.00		46.20	71.00	.00	.00	85.0	.0	23733
A	0813239	1	1.0	.0	.0	167.0	1.00		48.80	74.50	.00	.00	85.0	.0	23733
C	0814203	1	1.0	.0	.0		.00		440.00	440.00	.00	.00	.0	.0	23733
C	0814229	1	1.0	.0	.0	135.0	.82		60.00	98.00	.00	.00	85.0	.0	23733
C	0814230	1	1.0	.0	.0	262.0	.99		135.00	237.00	.00	.00	85.0	.0	23733
C	0814231	1	1.0	.0	.0	77.4	1.23		36.00	60.00	.00	.00	85.0	.0	23733
C	0814232	1	1.0	.0	.0	117.0	1.40		54.00	93.00	.00	.00	85.0	.0	23733
C	0814233	1	1.0	.0	.0	34.2	1.64		14.80	24.50	.00	.00	85.0	.0	23733
C	0814234	1	1.0	.0	.0	53.7	1.81		24.00	39.50	.00	.00	85.0	.0	23733
C	0814235	1	1.0	.0	.0	18.9	2.05		7.00	11.30	.00	.00	85.0	.0	23733
C	0814236	1	1.0	.0	.0	29.6	2.22		13.50	22.50	.00	.00	85.0	.0	23733
C	1582637	1	1.0	.0	.0	7.000	20.00		11.00	11.00	.00	.00	4.5	22.0	23733
C	1582679	1	4.8	.0	.0	1.8	1.00	800	3.00	.70	.00	.00	90.0	18.0	23733
C	1582680	4	1.0	.0	.0	14.000	100.00		4.00	1.50	.00	.00	20.0	1.0	23733
C	1582681	4	1.0	.0	.0	14.000	100.00		4.00	1.50	.00	.00	20.0	1.0	23733
C	1582812	1	1.0	.0	.0	4.000	.00		3.50	3.50	.00	.00	300.0	10.0	23733
C	1582917	2	.5	18.1	18.0	2.860	22.00		.30	.80	18.00	800.00	.0	.0	23733
C	1582943	1	3.1	.0	.0	.650	15.75		.20	.15	.00	.00	.0	10.0	23733
C	1582944	77	10.0	.0	.0	7.300	15.75		.60	.10	.00	.00	.0	180.0	23733
C	1589274	4	1.0	.0	.0	5200.000	10.00		64.00	17.00	.00	.00	.0	.0	23733
C	1589423	1	1.0	1.0	.0	7.5	1.00		50.00	40.00	4.00	.00	60.0	30.0	23733
C	1589457	1	3.0	3.0	1.0	4.500	20.00		3.00	21.00	24.00	9.00	40.0	.0	23733
C	2161075	2	1.0	.0	.0	76.000	.00	500	10.00	16.00	.00	.00	28.0	999.0	23733
A	2172534	1	1.0	.0	.0	11.0	1.00		8.00	9.00	.00	.00	6.0	24.0	23733
A	2183700	1	1.0	1.0	.0	.01	.00		.16	.31	.31	.00	14.0	.7	23733
C	2196865	1	2.0	.0	.0		.00	600	.40	.80	.00	.00	20.0	.8	23733
B	2390107	1	1.0	.0	.0	.007	.00		.20	.20	.00	.00	15.0	.2	23733
C	2390118	2	1.0	1.0	.0	5.0	100.00		6.00	3.00	.00	.00	40.0	10.0	23733
C	2391140	1	1.0	.0	.0	1.0	.00	320	.85	.85	.00	.00	30.0	.5	23733
B	2391146	2	1.0	.0	.0		.00	570	.80	.45	.00	.00	12.0	.7	23733
C	2391175	1	2.0	.0	.0	6.0	.00		10.00	20.00	.00	.00	50.0	10.0	23733
C	2391188	1	1.0	1.0	.0		.00	200	.75	.75	.75	.00	35.0	.3	23733
C	2391189	1	1.0	2.0	.0		.00	180	1.50	1.50	3.00	.00	8.0	.5	23733
C	2391203	1	1.0	1.0	.0	2.0	100.00		5.00	2.50	.00	.00	50.0	1.2	23733
C	2391215	1	1.0	2.0	.0		.00	460	.40	.40	.80	.00	20.0	.4	23733
A	2391235	1	1.0	1.0	.0	5.0	.00		5.00	4.00	4.00	.00	40.0	10.0	23733
C	2391270	1	1.0	1.0	.0	.026	.00		1.50	1.50	1.50	.00	28.0	.6	23733

PG. 2 06/30/82 23:34 UR0206 *** IBM INTERNAL USE *** COMPONENT DATA BANK INTERNAL USE ONLY
CDB/PXF TECH ALL/PXF PXF/PAR1 DCS SEQ/LH DCS NO/LIMIT.

TUC	PART NUMBER	TRA N1	NSFO RAT N2	RMAT IO N3	ION N4	PRIMARY INDUCT MIL-HEN	L-MEASURE FREQ KHZ	MAGNET CURRENT MIL-AMP	N1 DCR OHMS	N2 DCR OHMS	N3 DCR OHMS	N4 DCR OHMS	WIND CAPAC PF	LEAKAGE INDUCT MIC-HEN	DCS CODE
C	2391376	2	1.0	.0	.0		.00	270	.60	.30	.00	.00	15.0	.4	23733
C	2391709	1	4.0	.0	.0	.8	.00		2.50	9.00	.00	.00	15.0	10.0	23733
C	2396597	1	2.0	2.0	.0		.00	200	20.00	30.00	30.00	.00	50.0	80.0	23733
C	2396648	1	1.0	1.0	.0		.00	180	.75	.75	.75	.00	35.0	.3	23733
C	2397098	2	1.0	.0	.0	0	.00	1000	.90	.60	.00	.00	60.0	20.0	23733
C	2397099	2	1.0	1.0	.0	.340	100.00		1.50	.30	.30	.00	33.0	1.7	23733
A	2410050	1	.6	3.9	.0	7.	20.00	600	1.70	1.00	7.45	.00	50.0	20.0	23733
C	2410100	1	4.0	.0	.0	14.000	100.00	90	1.00	4.00	.00	.00	20.0	1.0	23733
C	2410174	1	4.0	.0	.0	.800	100.00		2.50	9.00	.00	.00	15.0	10.0	23733
C	2414930	1	1.5	.0	.0		.00		50.00	112.00	.00	.00	10.0	.0	23733
C	2414932	1	2.2	.0	.0		.00		50.00	140.00	.00	.00	.0	.0	23733
C	2414942	1	1.0	.0	.0	.730	.00		1.80	1.80	.00	.00	.0	.7	23733
C	2414943	1	1.0	1.0	.0	.025	.00		1.50	1.50	1.50	.00	28.0	.6	23733
C	4429605	4	1.0	2.0	.0	5.000	100.00		9.30	.60	4.90	.00	60.0	10.0	23733
C	4429742	1	1.0	1.0	.0		.00	16	15.00	15.00	15.00	.00	30.0	300.0	23733
C	4430080	2	1.0	4.0	.0	.530	500.00		1.50	.50	3.00	.00	30.0	10.0	23733
C	4481470	1	3.0	.0	.0	0.500	1.00		.60	4.50	.00	.00	350.0	10.0	23733
L	5130431	1	1.0	.0	.0	12.000	.00		10.00	10.00	.00	.00	5.0	15.0	23733
C	5130490	1	1.0	.0	.0	0.075	1,000.00		.20	.20	.00	.00	25.0	.1	23733
E	5261836		.0	.0	.0		.00		.00	.00	.00	.00	.0	.0	23733
C	5616102	1	1.0	1.0	.0	0.350	.00		.15	.15	.15	.00	30.0	80.0	23733
C	5617053	1	1.0	.0	.0	5.000	1.00	38	4.50	4.50	.00	.00	450.0	10.0	23733
C	5713581		.0	.0	.0		.00		.00	.00	.00	.00	.0	250.0	23733
C	8272102	2	5.5	.5	.0	2.620	.00		.10	.15	.10	.00	.0	.0	23733
C	8493711	1	1.0	.0	.0		.00		.85	.85	.00	.00	30.0	.5	23733
C	0222784	1	2.0	.0	.0	1.0	19.50		3.70	10.50	.00	.00	.0	10.5	23734
C	0353635	1	1.0	.0	.0		.00		15.00	15.00	.00	.00	.0	10.5	23734
C	0483125	1	12.5	12.5	.0		.00		5.20	11.50	11.50	.00	.0	.6	23734
C	0483226	1	1.3	1.3	.0		.00		1.50	3.00	.00	.00	.0	1.5	23734
A	0492546		.0	.0	.0	0.2	1.00		1.55	1.70	.00	.00	.0	4.0	23734
C	0492547	1	12.5	12.5	.0		.00		1.30	13.00	.00	.00	.0	.3	23734
C	0492575	1	10.0	.0	.0		.00		4.50	97.00	.00	.00	.0	18.0	23734
C	0492604	1	2.5	2.5	.0		.00		62.50	353.50	.00	.00	.0	999.9	23734
C	0492628	2	1.0	.0	.0		.00		.63	.35	.00	.00	.0	.0	23734
A	2174242	1	1.2	.0	.0	1500.0	.40		175.00	450.00	.00	.00	40.0	.0	23734
C	2396623	1	4.0	.0	.0	.8	.00		2.50	9.00	.00	.00	15.0	10.0	23734
A	2410087	1	1.0	1.0	.0	.350	100.00		.15	.15	.15	.00	.0	.3	23734

TOTAL RECORDS 85

PG. 1 06/30/82 23:34 UR0206 *** IBM INTERNAL USE *** COMPONENT DATA BANK INTERNAL USE ONLY
CDB/PXF TECH ALL/PXF PXF/PAR2 DCS SEQ/LH DCS NO/LIMIT.

T U C	PART NUMBER	INPUT VOLTAGE VOLTS	PULSE WIDTH MIC-SEC	HI-MIN FREQ KHZ	HI-MAX FREQ KHZ	LO-MIN FREQ KHZ	LO-MAX FREQ KHZ	MID BAND GAIN	MID-B FREQ KHZ	PRIMARY MATCH OHMS	SECONDARY MATCH OHMS	DCS CODE
A	0349431	.00	.0	.00	.00	.00	.00	.00	.00	.0	.0	23733
C	0483126	.00	.0	.00	.00	.00	.00	.00	.00	.0	.0	23733
C	0483503	.04	.0	5.00	3.00	.00	.50	.00	.80	50.0	5,000.0	23733
A	0483504	6.36	.0	.00	.00	.00	1.00	.00	.00	.0	.0	23733
A	0483505	6.36	.0	.00	.00	2.20	.00	.00	.00	.0	.0	23733
A	0492462	.00	.0	.00	.00	.00	.00	.00	.00	.0	.0	23733
C	0492689	.28	.0	800.00	.00	.00	1.00	.97	15.00	2,000.0	8,200.0	23733
C	0518436	.00	.0	.00	.00	1.00	.00	.00	.00	30.0	.0	23733
A	0595451	.10	.0	.00	2,700.00	.00	260.00	.42	600.00	5,000.0	5,000.0	23733
L	0734452	1.50	.0	.00	.00	1.40	.00	.00	.00	.0	30.0	23733
C	0737512	6.00	62.5	.00	.00	.00	.00	.00	.00	.0	.0	23733
A	0813238	6.36	.0	.00	.00	.00	.00	.00	.00	.0	.0	23733
A	0813239	6.36	.0	.00	.00	.00	.00	.00	.00	.0	.0	23733
C	0814203	.35	.0	7.50	7.50	.00	.20	.89	1.00	3,000.0	3,500.0	23733
C	0814229	6.36	.0	.00	.00	.00	.00	.00	.00	.0	.0	23733
C	0814230	6.36	.0	.00	.00	.99	.00	.00	.00	.0	.0	23733
C	0814231	6.36	.0	.00	.00	1.23	.00	.00	.00	.0	.0	23733
C	0814232	6.36	.0	.00	.00	1.40	.00	.00	.00	.0	.0	23733
C	0814233	6.36	.0	.00	.00	1.64	.00	.00	.00	.0	.0	23733
C	0814234	6.36	.0	.00	.00	1.81	.00	.00	.00	.0	.0	23733
C	0814235	6.36	.0	.00	.00	2.05	.00	.00	.00	.0	.0	23733
C	0814236	6.36	.0	.00	.00	2.22	.00	.00	.00	.0	.0	23733
C	1582637	5.00	40.0	.00	.00	.00	.00	.00	.00	.0	.0	23733
C	1582679	.00	5.0	.00	.00	.00	.00	.00	.00	.0	.0	23733
C	1582680	3.00	1.0	.00	.00	.00	.00	.00	.00	.0	100.0	23733
C	1582681	3.00	1.0	.00	.00	.00	.00	.00	.00	.0	100.0	23733
C	1582812	4.00	25.0	.00	.00	.00	.00	.00	.00	.0	.0	23733
C	1582917	.00	.0	.00	.09	1,100.03	.00	.00	.00	.0	.0	23733
C	1582943	24.00	41.7	.00	.00	.00	.00	.00	.00	.0	.0	23733
C	1582944	24.00	21.0	.00	.00	.00	.00	.00	.00	.0	.0	23733
C	1589274	2.00	104.0	.00	.00	.00	.00	.00	.00	800.0	.0	23733
C	1589423	15.00	6.0	.00	.00	.00	.00	.00	.00	.0	.0	23733
C	1589457	24.00	9.0	.00	.00	.00	.00	.00	.00	.0	.0	23733
C	2161075	.10	.0	.00	.00	.00	.00	.00	.00	.0	.0	23733
A	2172534	.20	.0	.00	.00	.00	.00	.00	.00	.0	.0	23733
A	2183700	.00	.0	.00	.00	.00	.00	.00	.00	.0	.0	23733
C	2196865	30.00	3.0	.00	.00	.00	.00	.00	.00	300.0	100.0	23733
B	2390107	.02	.0	.00	.00	.00	.00	.00	.00	.0	.0	23733
C	2390118	.50	.0	.00	.00	.00	.00	.00	.00	.0	.0	23733
C	2391140	4.00	4.0	.00	.00	.00	.00	.00	.00	.0	.0	23733
B	2391146	1.10	.3	.00	.00	.00	.00	.00	.00	.0	.0	23733
C	2391175	.50	.0	.00	.00	.00	.00	.00	.00	.0	.0	23733
C	2391188	8.00	.7	.00	.00	.00	.00	.00	.00	.0	.0	23733
C	2391189	1.10	1.0	.00	.00	.00	.00	.00	.00	.0	.0	23733
C	2391203	.00	.0	.00	.00	.00	.00	.00	.00	.0	.0	23733
C	2391215	.95	.2	.00	.00	.00	.00	.00	.00	.0	.0	23733
A	2391235	.00	.0	.00	.00	.00	.00	.00	.00	.0	.0	23733
C	2391270	.00	.0	.00	.00	.00	.00	.00	.00	.0	.0	23733

PG. 2 06/30/82 23:34 UR0206 *** IBM INTERNAL USE *** COMPONENT DATA BANK INTERNAL USE ONLY
CDB/PXF TECH ALL/PXF PXF/PAR2 DCS SEQ/LH DCS NO/LIMIT.

TUC	PART NUMBER	INPUT VOLTAGE VOLTS	PULSE WIDTH MIC-SEC	HI-MIN FREQ KHZ	HI-MAX FREQ KHZ	LO-MIN FREQ KHZ	LO-MAX FREQ KHZ	MID BAND GAIN	MID-B FREQ KHZ	PRIMARY MATCH OHMS	SECONDARY MATCH OHMS	DCS CODE
C	2391376	1.07	.5	.00	.00	.00	.00	.00	.00	.0	.0	23733
C	2391709	.10	.0	3,000.00	.00	.00	5.00	.00	.00	100.0	1,690.0	23733
C	2396597	3.00	110.0	.00	.00	.00	.00	.00	.00	.0	.0	23733
C	2396648	3.00	3.0	.00	.00	.00	.00	.00	.00	.0	.0	23733
C	2397098	5.00	40.0	.00	.00	.00	.00	.00	.00	.0	.0	23733
C	2397099	4.00	10.0	.00	.00	.00	.00	.00	.00	.0	.0	23733
A	2410050	20.00	20.0	.00	.00	.00	.00	.00	.00	.0	.0	23733
C	2410100	3.00	1.0	.00	.00	.00	.00	.00	.00	.0	100.0	23733
C	2410174	1.00	.0	3,000.00	.00	.00	5.00	.00	.00	100.0	1,690.0	23733
C	2414930	.00	.5	.00	.00	.00	.00	.00	.00	50.0	112.0	23733
C	2414932	.00	.5	.00	.00	.00	.00	.00	.00	50.0	140.0	23733
C	2414942	.25	.0	.00	.00	.00	.00	.00	.00	.0	.0	23733
C	2414943	.03	.0	.00	.00	.00	.00	.00	.00	.0	.0	23733
C	4429605	10.00	30.0	.00	.00	.00	.00	.00	.00	.0	.0	23733
C	4429742	2.40	104.0	2.50	.00	.00	.00	.00	.00	.0	.0	23733
C	4430080	.00	.0	.00	.00	.00	.00	.00	.00	.0	.0	23733
C	4481470	10.00	150.0	.00	.00	.00	.00	.00	.00	.0	.0	23733
L	5130431	.00	.0	.00	.00	.00	.00	.00	15.81	.0	.0	23733
C	5130490	.00	.0	.00	.00	.00	.00	.00	.00	.0	.0	23733
E	5261836	11.00	.0	.00	.00	.00	.00	.00	.00	.0	.0	23733
C	5616102	.00	.0	.00	.00	.00	.00	.00	.00	.0	.0	23733
C	5617053	16.50	18.0	.00	.00	.00	.00	.00	.00	.0	.0	23733
C	5713581	.00	.0	.00	.00	.00	.00	.00	.00	.0	.0	23733
C	8272102	24.00	.2	.00	.00	.00	.00	.00	.00	.0	.0	23733
C	8493711	4.00	.0	.00	.00	.00	.00	.00	.00	.0	.0	23733
C	0222784	1.75	.0	3,000.00	.00	13.00	18.60	1.18	150.00	162.0	1,000.0	23734
C	0353635	.50	.0	1,500.00	2,300.00	125.00	185.00	.48	600.00	5,000.0	5,000.0	23734
C	0483125	.07	.0	840.00	1,260.00	40.00	60.00	5.70	200.00	100.0	15,000.0	23734
C	0483226	.98	.0	8,000.00	.00	240.00	360.00	.77	3,000.00	600.0	2,000.0	23734
A	0492546	10.00	.0	.00	.00	.00	.00	.00	.00	.0	.0	23734
C	0492547	.07	.0	950.00	1,300.00	90.00	130.00	5.80	350.00	100.0	15,000.0	23734
C	0492575	.18	.0	50.00	50.00	1.00	1.00	3.90	20.00	50.0	3,500.0	23734
C	0492604	.70	.0	150.00	300.00	.00	.06	2.35	5.00	65.0	15,000.0	23734
C	0492628	1.40	.0	3,500.00	.00	1.80	2.60	.33	15.00	100.0	50.0	23734
A	2174242	10.00	.0	.00	.00	.00	.00	.00	.00	.0	.0	23734
C	2396623	1.00	.0	3,000.00	.00	.00	5.00	.00	.00	100.0	1,690.0	23734
A	2410087	5.00	.0	500.00	.00	.00	30.00	.33	123.00	50.0	50.0	23734

TOTAL RECORDS 85

PG. 1 06/30/82 23:34 UR0206 *** IBM INTERNAL USE *** COMPONENT DATA BANK INTERNAL USE ONLY
CDB/PXF TECH ALL/PXF PXF/PAR3 DCS SEQ/LH DCS NO/LIMIT.

TUC	PART NUMBER	DC CURRENT MIL-AMP	PRIME WIND Q	NO. OF WIND	HGHT MILS	WIDTH MILS	LGTH MILS	PIN DIAM MILS	PRIME CENTER TAP	SECOND CENTER TAP	DCS CODE
A	0349431	.00	.0								23733
C	0483126	.00	.0	2	375	586	886				23733
C	0483503	.00	.0	2	460	687	687	45		YES	23733
A	0483504	.00	18.3	2	470	1073	1073	25			23733
A	0483505	.00	17.5	2	470	1073	1073	25			23733
A	0492462	.20	.0	3	350	600	600	32	NO	YES	23733
C	0492689	4.00	.0	2	860	1000	1200	32		YES	23733
C	0518436	.00	.0	2	375	938	1000			YES	23733
A	0595451	.00	.0	2	350	425	640	25	YES	YES	23733
L	0734452	6.00	.0	2	2380	1630	1630	40			23733
C	0737512	.00	.0	2	350	625	625	33			23733
A	0813238	.00	18.4	2	470	1073	1073	25			23733
A	0813239	.00	18.9	2	470	1073	1073	25			23733
C	0814203	5.00	.0	2	460	500	530	20			23733
C	0814229	.00	13.0	2	700	1125	1125	25			23733
C	0814230	.00	11.0	2	700	1125	1125	25			23733
C	0814231	.00	12.3	2	700	1125	1125	25			23733
C	0814232	.00	12.4	2	700	1125	1125	25			23733
C	0814233	.00	13.0	2	700	1125	1125	25			23733
C	0814234	.00	12.8	2	700	1125	1125	25			23733
C	0814235	.00	14.3	2	700	1125	1125	25			23733
C	0814236	.00	12.5	2	700	1125	1125	25			23733
C	1582637	.00	.0	2	400	443	650	20	NO	NO	23733
C	1582679	.00	.0	9	750	600	800	32	NO	NO	23733
C	1582680	.00	.0	4	400	500	750	20	NO	NO	23733
C	1582681	.00	.0	8	400	500	1550	20	NO	NO	23733
C	1582812	.00	.0	2	625	480		32			23733
C	1582917	.00	.0		900	1100	1100	32			23733
C	1582943	.00	.0	2	1100	1325	1325				23733
C	1582944	.00	.0	2	875	1075	1075				23733
C	1589274	.00	.0	2	370	500	500	20	YES	YES	23733
C	1589423	.00	.0	3	365	470	470	23			23733
C	1589457	.00	.0	3	750	500	500	20			23733
C	2161075	.00	.0	2	360	438	625	25	YES	NO	23733
A	2172534	.00	.0	3	590	750	870	25			23733
A	2183700	.00	.0	3	250	375	375	20			23733
C	2196865	.00	.0	2	365	225	350	20	YES	YES	23733
B	2390107	.00	.0	2	370	115	478	20			23733
C	2390118	.00	.0	3	370	484	484	20			23733
C	2391140	.00	.0	4	350	470	470	20			23733
B	2391146	.00	.0	2	370	115	478	20			23733
C	2391175	15.00	.0	2	220	350	480	20	NO	YES	23733
C	2391188	.00	.0	3	350	350	480	20			23733
C	2391189	.00	.0	3	350	350	480	20			23733
C	2391203	.00	.0	2	250	350	500	20	YES		23733
C	2391215	.00	.0	3	300	350	480	20			23733
A	2391235	.00	.0	3	370	480	480	20			23733
C	2391270	.00	30.0	3	350	350	480	20			23733

PG. 2 06/30/82 23:34 UR0206 *** IBM INTERNAL USE *** COMPONENT DATA BANK INTERNAL USE ONLY
CDB/PXF TECH ALL/PXF PXF/PAR3 DCS SEQ/LH DCS NO/LIMIT.

TUC	PART NUMBER	DC CURRENT MIL-AMP	PRIME WIND Q	NO. OF WIND	HGHT MILS	WIDTH MILS	LGTH MILS	PIN DIAM MILS	PRIME CENTER TAP	SECOND CENTER TAP	DCS CODE
C	2391376	.00	.0	2	370	115	478	20			23733
C	2391709	.00	.0	2	370	484	484	20		YES	23733
C	2396597	.00	.0	3	370	470	470	20			23733
C	2396648	.00	.0	3	350	350	480	20			23733
C	2397098	.00	.0	2	750	600	800	32			23733
C	2397099	.00	.0	3	400	443	650	26			23733
A	2410050	.00	.0	3	635	1000	1000	20		YES	23733
C	2410100	.00	.0	2	370	484	484	20	YES	YES	23733
C	2410174	.00	.0	2	370	490	490	20		YES	23733
C	2414930	100.00	.0	2	370	484	484	20			23733
C	2414932	200.00	.0	2	370	484	484	20			23733
C	2414942	.00	.0	2	350	350	480	20			23733
C	2414943	.00	.0	3	350	350	480	20			23733
C	4429605	.00	.0	3	440	650	443	26			23733
C	4429742	.00	.0	3	37	470	470	20			23733
C	4430080	.00	.0	3	400	443	650	13	NO	NO	23733
C	4481470	.00	.0	2	655	1000	1000	20	NO	NO	23733
L	5130431	.00	.0		500	500	1000	26	YES	YES	23733
C	5130490	.00	.0	2	250	300	400	20			23733
E	5261836	120.00	.0								23733
C	5616102	.00	.0	3	350	500	350	20			23733
C	5617053	38.00	.0		650	480		32			23733
C	5713581	.00	.0								23733
C	8272102	.00	.0	3	750	1000	1000	32	YES	YES	23733
C	8493711	.00	.0	4	350	470	470	20	NO	NO	23733
C	0222784	.00	.0	2	850	976	1176	32			23734
C	0353635	.00	.0	2	350	440	660		YES	YES	23734
C	0483125	.00	.0	2	350	430	660			YES	23734
C	0483226	.00	.0	2	350	445	660	25		YES	23734
A	0492546	.00	.0	2	318	700	400	32			23734
C	0492547	.00	.0	2	375	586	886	32		YES	23734
C	0492575	.00	.0	2	350	600	900	32			23734
C	0492604	.00	.0	2	870	1062	1062	32		YES	23734
C	0492628	.00	.0	2	850	1176	1176	32			23734
A	2174242	.00	.0	2	635	635	635	25			23734
C	2396623	.00	.0	2	370	484	484	20	YES	YES	23734
A	2410087	.00	.0	3	350	350	480	20	NO	NO	23734

TOTAL RECORDS 85

SATURABLE TRANSFORMERS

COMPONENT DATA BANK - P/N CATALOG

DCS CODE
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23735 - Saturable (SXF)

PG. 1 06/30/82 23:35 UR0206 *** IBM INTERNAL USE *** COMPONENT DATA BANK INTERNAL USE ONLY
CDB/SXF PN TECH DCS EQ 23735 SXF/PAR1 NO/LIMIT.

PART NUMBER	TUC	MAXWELL TURNS MIN	MAXWELL TURNS MAX	N1 DCR MIL-O	N2 DCR MIL-O	N3 DCR MIL-O	N4 DCR MIL-O	N5 DCR MIL-O	N6 DCR MIL-O	N7 DCR MIL-O	N8 DCR MIL-O	N9 DCR MIL-O	N10 DCR MIL-O	CAPAC PFD	LEAK INDUCT UH	DCS CODE
5213454	C	7100	7900	170	170	86	86	25	25					25.0	.0	23735
5261444	C	92300	102800	395	395	125	125	230	230	135	135	135	135	60.0	.8	23735

TOTAL RECORDS 2

PG. 1 06/30/82 23:35 UR0206 *** IBM INTERNAL USE *** COMPONENT DATA BANK INTERNAL USE ONLY
CDB/SXF PN TECH DCS EQ 23735 SXF/PAR2 NO/LIMIT.

PART NUMBER	TUC	RATED FREQ KHZ	TEST FREQ KHZ	INPUT VI MIL-V	INPUT VO MIL-V	INPUT(MIN) CURRENT MIL-AMPS	INPUT(MAX) CURRENT MIL-AMPS	RATED(MAX) CURRENT MIL-AMP	DCS CODE
5213454	C	20.00	.40	556.0	89.0	20.80	34.80	.00	23735
5261444	C	2.50	.40	314.0	576.5	23.50	39.20	195.00	23735

TOTAL RECORDS 2

PG. 1 06/30/82 23:35 UR0206 *** IBM INTERNAL USE *** COMPONENT DATA BANK INTERNAL USE ONLY
CDB/SXF PN TECH DCS EQ 23735 SXF/PAR3 NO/LIMIT.

PART NUMBER	TUC	MAX HGHT MILS	MAX WDTH MILS	MAX LGTH MILS	PIN DIAM MILS	TR N1	TR N2	TR N3	TR N4	TR N5	TR N6	TR N7	TR N8	TR N9	TR N10	DCS CODE
5213454	C	500	1000	1000	35	6.67	6.67	3.34	3.34	1.00	1.00	.00	.00	.00	.00	23735
5261444	C	780	1800	1800	31	3.00	3.00	.00	.00	.00	.00	1.00	.00	.00	1.00	23735

TOTAL RECORDS 2

DELAY LINE

COMPONENT DATA BANK - P/N CATALOG

DCS CODES
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23781
23782

PG. 1 06/30/82 23:36 UR0206 *** IBM INTERNAL USE *** COMPONENT DATA BANK INTERNAL USE ONLY
CDB/NPL ALL/NPL TECH NPL/PAR1 NPL/TAB SEQ/LH NPL/DELAY NO/LIMIT.

PART NUMBER	TUC	TOTAL DELAY NSEC	NO. OF TAPS	OUTPUT RISE NSEC	OUTPUT FALL NSEC	IMPEDANCE OHMS	DCR OHMS	DIEL STRENGTH VDC	BODY LENGTH MILS	BODY HEIGHT MILS	BODY WIDTH MILS	LEAD DIAM MILS	PIN SPACE MILS	LEAD LENGTH MILS	TAB DRAW NUM.
0454832	A	.00		.00	.00	.00	.00	.00							
4429952	C	.00		3.00	.00	93.00	.75	25.00	484	370	120	20	100	90	
4429965	C	.00	1	2.50	.00	80.00	.20	25.00	1000	250	190	20	100	50	4429965
5616850	C	.00	1	3.00	.00	93.00	.20	25.00	490	175	190	20	100	125	5616850
5617807	C	.00		3.00	.00	93.00	.20	25.00	500	175	250	20	125	110	5617807
8519622	B	.00	1	2.00	.00	80.00	2.00	25.00	1000	190	190	20	100	50	8519622
4430085	C	.50	1	2.50	.00	80.00	.75	25.00	1000	250	190	20	100	50	4430085
5616851	C	.50	1	3.00	.00	93.00	.75	25.00	490	175	190	20	100	125	5616850
5617808	C	.50		3.00	.00	93.00	.75	25.00	500	175	250	20	125	110	5617807
8519623	B	.50	1	2.00	.00	80.00	2.00	25.00	1000	190	190	20	100	50	8519622
2396652	C	1.00		3.00	.00	93.00	.75	25.00	484	370	120	20	125	90	
4429953	C	1.00		3.00	.00	93.00	.75	25.00	484	370	120	20	100	90	
4430086	C	1.00	1	2.50	.00	80.00	.75	25.00	1000	250	190	20	100	50	4430085
5616852	C	1.00	1	3.00	.00	93.00	.75	25.00	490	175	190	20	100	125	5616850
5617809	C	1.00		3.00	.00	93.00	.75	25.00	500	175	250	20	125	110	5617807
8519624	B	1.00	1	2.00	.00	80.00	2.00	25.00	1000	190	190	20	100	50	8519622
4430087	C	1.50	1	2.50	.00	80.00	1.00	25.00	1000	250	190	20	100	50	4430085
5616853	C	1.50	1	3.00	.00	93.00	1.00	25.00	490	175	190	20	100	125	5616850
5617810	C	1.50		3.00	.00	93.00	1.00	25.00	500	175	250	20	125	110	5617807
8519625	B	1.50	1	2.00	.00	80.00	2.00	25.00	1000	190	190	20	100	50	8519622
2391935	C	2.00		3.00	.00	93.00	1.00	25.00	484	370	120	20	125	90	
4429954	C	2.00		3.00	.00	93.00	1.00	25.00	484	370	120	20	100	90	
4429966	C	2.00	1	2.50	.00	80.00	1.00	25.00	1000	250	190	20	100	50	4429965
5616854	C	2.00	1	3.00	.00	93.00	1.00	25.00	490	175	190	20	100	125	5616850
5617811	C	2.00		3.00	.00	93.00	1.00	25.00	500	175	250	20	125	110	5617807
8519626	B	2.00	1	2.00	.00	80.00	2.00	25.00	1000	190	190	20	100	50	8519622
4429967	C	2.50	1	2.50	.00	80.00	1.00	25.00	1000	250	190	20	100	50	4429965
5616855	C	2.50	1	3.00	.00	93.00	1.00	25.00	490	175	190	20	100	125	5616850
5617812	C	2.50		3.00	.00	93.00	1.00	25.00	500	175	250	20	125	110	5617807
8519627	B	2.50	1	2.00	.00	80.00	2.00	25.00	1000	190	190	20	100	50	8519622
4429955	C	3.00		3.00	.00	93.00	1.00	25.00	484	370	120	20	100	90	
4429968	C	3.00	1	2.50	.00	80.00	1.00	25.00	1000	250	190	20	100	50	4429965
5616856	C	3.00	1	3.00	.00	93.00	1.00	25.00	490	175	190	20	100	125	5616850
5617813	C	3.00		3.00	.00	93.00	1.00	25.00	500	175	250	20	125	110	5617807
8519628	B	3.00	1	2.00	.00	80.00	2.00	25.00	1000	190	190	20	100	50	8519622
4429969	C	3.50	1	2.50	.00	80.00	1.00	25.00	1000	250	190	20	100	50	4429965
5616857	C	3.50	1	3.00	.00	93.00	1.00	25.00	490	175	190	20	100	125	5616850
5617814	C	3.50		3.00	.00	93.00	1.00	25.00	500	175	250	20	125	110	5617807
8519629	B	3.50	1	2.00	.00	80.00	2.00	25.00	1000	190	190	20	100	50	8519622
2391936	C	4.00		3.00	.00	93.00	1.00	25.00	484	370	120	20	125	90	
4429956	C	4.00		3.00	.00	93.00	1.00	25.00	484	370	120	20	100	90	
4429970	C	4.00	1	2.50	.00	80.00	1.00	25.00	1000	250	190	20	100	50	4429965
5616803	C	4.00	10	3.00	.00	120.00	.00	25.00	1450	250	190	25	100	100	
5616858	C	4.00	1	3.00	.00	93.00	1.00	25.00	490	175	190	20	100	125	5616850
5617815	C	4.00		3.00	.00	93.00	1.00	25.00	500	175	250	20	125	110	5617807
8519630	B	4.00	1	2.00	.00	80.00	2.00	25.00	1000	190	190	20	100	50	8519622
4429971	C	4.50	1	2.50	.00	80.00	1.00	25.00	1000	250	190	20	100	50	4429965
5616859	C	4.50	1	3.00	.00	93.00	1.00	25.00	490	175	190	20	100	125	5616850

PG. 2 06/30/82 23:36 UR0206 *** IBM INTERNAL USE *** COMPONENT DATA BANK INTERNAL USE ONLY
CDB/NPL ALL/NPL TECH NPL/PAR1 NPL/TAB SEQ/LH NPL/DELAY NO/LIMIT.

PART NUMBER	TUC	TOTAL DELAY NSEC	NO. OF TAPS	OUTPUT RISE NSEC	OUTPUT FALL NSEC	IMPEDANCE OHMS	DCR OHMS	DIEL STRENGTH VDC	BODY LENGTH MILS	BODY HEIGHT MILS	BODY WIDTH MILS	LEAD DIAM MILS	PIN SPACE MILS	LEAD LENGTH MILS	TAB DRAW NUM.
5617816	C	4.50		3.00	.00	93.00	1.00	25.00	500	175	250	20	125	110	5617807
8519631	B	4.50	1	2.00	.00	80.00	2.00	25.00	1000	190	190	20	100	50	8519622
4429761	C	5.00		3.00	.00	93.00	1.00	25.00	484	370	110	20	100	80	
4429972	C	5.00	1	2.50	.00	80.00	1.00	25.00	1000	250	190	20	100	50	4429965
5616860	C	5.00	1	3.00	.00	93.00	1.00	25.00	490	175	190	20	100	125	5616850
5617817	C	5.00		3.00	.00	93.00	1.00	25.00	500	175	250	20	125	110	5617807
8519632	B	5.00	1	2.00	.00	80.00	2.00	25.00	1000	190	190	20	100	50	8519622
4429973	C	5.50	1	2.50	.00	80.00	1.00	25.00	1000	250	190	20	100	50	4429965
5616861	C	5.50	1	3.00	.00	93.00	1.00	25.00	490	175	190	20	100	125	5616850
5617818	C	5.50		3.00	.00	93.00	1.00	25.00	500	175	250	20	125	110	5617807
8519633	B	5.50	1	2.00	.00	80.00	2.00	25.00	1000	190	190	20	100	50	8519622
2391937	C	6.00		3.50	.00	93.00	1.50	25.00	484	370	120	20	125	90	
4429957	C	6.00		3.50	.00	93.00	1.50	25.00	484	370	120	20	100	90	
4429974	C	6.00	1	2.50	.00	80.00	1.00	25.00	1000	250	190	20	100	50	4429965
5616862	C	6.00	1	3.50	.00	93.00	2.00	25.00	490	175	190	20	100	125	5616850
5617819	C	6.00		3.50	.00	93.00	2.00	25.00	500	175	250	20	125	110	5617807
8519634	B	6.00	1	2.00	.00	80.00	2.00	25.00	1000	190	190	20	100	50	8519622
4429975	C	6.50	1	2.50	.00	80.00	2.00	25.00	1000	250	190	20	100	50	4429965
5616863	C	6.50	1	3.50	.00	93.00	2.00	25.00	490	175	190	20	100	125	5616850
5617820	C	6.50		3.50	.00	93.00	2.00	25.00	500	175	250	20	125	110	5617807
8519635	B	6.50	1	2.00	.00	80.00	2.00	25.00	1000	190	190	20	100	50	8519622
2391190	A	7.00	3	4.00	.00	50.00	.70	25.00	470	350	470	20	125	90	
2396085	C	7.00		3.50	.00	93.00	2.00	25.00	484	370	120	20	125	90	
4429958	C	7.00		3.50	.00	93.00	2.00	25.00	484	370	120	20	100	90	
4429976	C	7.00	1	2.50	.00	80.00	2.00	25.00	1000	250	190	20	100	50	4429965
5616864	C	7.00	1	3.50	.00	93.00	2.00	25.00	490	175	190	20	100	125	5616850
5617821	C	7.00		3.50	.00	93.00	2.00	25.00	500	175	250	20	125	110	5617807
8519636	B	7.00	1	2.00	.00	80.00	2.00	25.00	1000	190	190	20	100	50	8519622
2391280	C	7.20		5.00	.00	90.00	1.00	50.00	460	350	330	20	125	90	
4429977	C	7.50	1	2.50	.00	80.00	2.00	25.00	1000	250	190	20	100	50	4429965
5616865	C	7.50	1	4.00	.00	93.00	2.00	25.00	490	175	190	20	100	125	5616850
5617822	C	7.50		4.00	.00	93.00	2.00	25.00	500	175	250	20	125	110	5617807
8519637	B	7.50	1	2.00	.00	80.00	2.00	25.00	1000	190	190	20	100	50	8519622
2391191	A	8.00		4.50	.00	50.00	.80	25.00	470	350	470	20	125	90	
2391938	C	8.00		4.00	.00	93.00	2.00	25.00	484	370	120	20	125	90	
4429959	C	8.00		4.00	.00	93.00	2.00	25.00	484	370	120	20	100	90	
4429978	C	8.00	1	2.50	.00	80.00	2.00	25.00	1000	250	190	20	100	50	4429965
5616866	C	8.00	1	4.00	.00	93.00	2.00	25.00	490	175	190	20	100	125	5616850
5617823	C	8.00		4.00	.00	93.00	2.00	25.00	500	175	250	20	125	110	5617807
8519638	B	8.00	1	2.00	.00	80.00	2.00	25.00	1000	190	190	20	100	50	8519622
4429979	C	8.50	1	2.50	.00	80.00	2.00	25.00	1000	250	190	20	100	50	4429965
5616983	C	8.50	1	4.00	.00	93.00	2.00	25.00	490	175	190	20	100	125	5616850
8519639	B	8.50	1	2.00	.00	80.00	2.00	25.00	1000	190	190	20	100	50	8519622
4429960	C	9.00		4.50	.00	93.00	2.50	25.00	484	370	120	20	100	90	
4429980	C	9.00	1	2.50	.00	80.00	2.00	25.00	1000	250	190	20	100	50	4429965
5616984	C	9.00	1	4.00	.00	93.00	2.00	25.00	490	175	190	20	100	125	5616850
8519640	B	9.00	1	2.00	.00	80.00	2.00	25.00	1000	190	190	20	100	50	8519622
4429981	C	9.50	1	2.50	.00	80.00	2.00	25.00	1000	250	190	20	100	50	4429965

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CDB/NPL ALL/NPL TECH NPL/PAR1 NPL/TAB SEQ/LH NPL/DELAY NO/LIMIT.

PART NUMBER	TUC	TOTAL DELAY NSEC	NO. OF TAPS	OUTPUT RISE NSEC	OUTPUT FALL NSEC	IMPEDANCE OHMS	DCR OHMS	DIEL STRENGTH VDC	BODY LENGTH MILS	BODY HEIGHT MILS	BODY WIDTH MILS	LEAD DIAM MILS	PIN SPACE MILS	LEAD LENGTH MILS	TAB DRAW NUM.
5616985	C	9.50	1	4.00	.00	93.00	2.00	25.00	490	175	190	20	100	125	5616850
8519641	B	9.50	1	2.00	.00	80.00	2.00	25.00	1000	190	190	20	100	50	8519622
2391192	A	10.00		5.00	.00	50.00	1.00	25.00	470	350	470	20	125	90	
4429901	C	10.00		2.50	.00	93.00	.00	25.00	1450	250	190	20	100	105	
4429961	C	10.00		4.50	.00	93.00	2.50	25.00	484	370	120	20	100	90	
4429982	C	10.00	1	2.50	.00	80.00	2.00	25.00	1000	250	190	20	100	50	4429965
5616986	C	10.00	1	4.00	.00	93.00	2.00	25.00	490	175	190	20	100	125	5616850
8519642	B	10.00	1	2.00	.00	80.00	2.00	25.00	1000	190	190	20	100	50	8519622
4429983	C	10.50	1	2.50	.00	80.00	2.00	25.00	1000	250	190	20	100	50	4429965
8519643	B	10.50	1	2.70	.00	80.00	3.00	25.00	1000	190	190	20	100	50	8519622
4429984	C	11.00	1	2.50	.00	80.00	3.00	25.00	1000	250	190	20	100	50	4429965
8519644	B	11.00	1	2.70	.00	80.00	3.00	25.00	1000	190	190	20	100	50	8519622
4429985	C	11.50	1	2.50	.00	80.00	3.00	25.00	1000	250	190	20	100	50	4429965
8519645	B	11.50	1	2.70	.00	80.00	3.00	25.00	1000	190	190	20	100	50	8519622
4429986	C	12.00	1	2.50	.00	80.00	3.00	25.00	1000	250	190	20	100	50	4429965
8519646	B	12.00	1	2.70	.00	80.00	3.00	25.00	1000	190	190	20	100	50	8519622
4429987	C	12.50	1	2.50	.00	80.00	3.00	25.00	1000	250	190	20	100	50	4429965
8519647	B	12.50	1	2.70	.00	80.00	3.00	25.00	1000	190	190	20	100	50	8519622
4429988	C	13.00	1	2.50	.00	80.00	3.00	25.00	1000	250	190	20	100	50	4429965
8519648	B	13.00	1	2.70	.00	80.00	3.00	25.00	1000	190	190	20	100	50	8519622
4429989	C	13.50	1	2.50	.00	80.00	3.00	25.00	1000	250	190	20	100	50	4429965
8519649	B	13.50	1	2.70	.00	80.00	3.00	25.00	1000	190	190	20	100	50	8519622
2391325	C	14.00	3	8.00	.00	93.00	1.00	50.00	720	350	470	20	125	90	
4429990	C	14.00	1	2.70	.00	80.00	3.00	25.00	1000	250	190	20	100	50	4429965
8519650	B	14.00	1	2.70	.00	80.00	3.00	25.00	1000	190	190	20	100	50	8519622
4429991	C	14.50	1	2.70	.00	80.00	3.00	25.00	1000	250	190	20	100	50	4429965
8519651	B	14.50	1	2.70	.00	80.00	3.00	25.00	1000	190	190	20	100	50	8519622
4429992	C	15.00	1	2.70	.00	80.00	3.00	25.00	1000	250	190	20	100	50	4429965
8519652	B	15.00	1	2.70	.00	80.00	3.00	25.00	1000	190	190	20	100	50	8519622
4429993	C	15.50	1	2.70	.00	80.00	3.00	25.00	1000	250	190	20	100	50	4429965
8519653	B	15.50	1	2.70	.00	80.00	3.00	25.00	1000	190	190	20	100	50	8519622
4429994	C	16.00	1	2.70	.00	80.00	3.00	25.00	1000	250	190	20	100	50	4429965
8519654	B	16.00	1	2.70	.00	80.00	3.00	25.00	1000	190	190	20	100	50	8519622
4429995	C	16.50	1	2.70	.00	80.00	3.00	25.00	1000	250	190	20	100	50	4429965
8519655	B	16.50	1	2.70	.00	80.00	3.00	25.00	1000	190	190	20	100	50	8519622
4429996	C	17.00	1	2.70	.00	80.00	3.00	25.00	1000	250	190	20	100	50	4429965
5616228	C	17.00	10	4.00	.00	100.00	.00	25.00	1450	250	190	9	100	100	
8519656	B	17.00	1	2.70	.00	80.00	3.00	25.00	1000	190	190	20	100	50	8519622
5616204	C	20.00	10	5.00	.00	120.00	.00	25.00	1450	250	190	27	100	100	
8519332	B	25.00	5	.00	.00	.00	.00	.00	800	300	400	18	100	65	000000
2391292	C	35.00	6	6.00	.00	50.00	1.50	25.00	1970	350	470	20	125	90	
2391275	C	45.00	8	17.00	.00	93.00	2.50	50.00	1470	350	845	20	125	90	
2391715	C	45.00	8	17.00	.00	93.00	2.50	50.00	1480	370	865	20	125	90	
1582991	L	50.00	5	4.00	.00	.00	.00	.00	1020	300	400	20	100	250	
1590168	C	50.00	10	12.00	.00	200.00	.00	50.00	1450	250	190	280	100	100	
2396630	C	50.00	1	18.00	.00	103.00	2.50	50.00	800	348	486	20	125	90	
6832314	C	50.00	10	12.00	.00	50.00	.00	25.00	1450	250	190	20	100	100	
8493466	C	50.00	10	7.50	.00	50.00	.00	25.00	1450	250	190	22	100	100	

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PART NUMBER	TUC	TOTAL DELAY NSEC	NO. OF TAPS	OUTPUT RISE NSEC	OUTPUT FALL NSEC	IMPEDANCE OHMS	DCR OHMS	DIEL STRENGTH VDC	BODY LENGTH MILS	BODY HEIGHT MILS	BODY WIDTH MILS	LEAD DIAM MILS	PIN SPACE MILS	LEAD LENGTH MILS	TAB DRAW NUM.
1590169	C	71.00		12.00	.00	200.00	.00	50.00	1450	250	190	280	100	100	
8493179	C	74.00	10	15.00	.00	93.00	.00	25.00	1450	250	190	22	100	115	
8493840	C	80.00	1	20.00	.00	93.00	.00	25.00	1450	250	190	20	100	115	
1582992	L	100.00	5	4.00	.00	.00	.00	.00	1020	300	400	20	100	250	
2396857	C	100.00		19.00	.00	103.00	4.00	50.00	800	345	486	20	125	90	
2414940	A	100.00	19	15.00	.00	93.00	4.00	50.00	3220	350	845	20	125	90	
5617147	C	100.00	10	9.00	.00	200.00	.00	25.00	1450	250	190	26	100	100	
4429741	C	120.00	4	22.50	.00	200.00	8.00	25.00	1450	250	190	22	100	115	000000
2391035	C	125.00		30.00	.00	93.00	2.50	50.00	1480	350	470	20	125	90	
2391777	C	125.00	5	20.00	.00	93.00	3.20	50.00	1540	370	865	20	125	90	
2414873	A	125.00	4	20.00	.00	93.00	3.20	50.00	1500	350	845	20	125	90	
4481345	C	130.00	10	26.00	.00	93.00	.00	25.00	1450	250	190	22	100	100	
4430088	C	150.00	10	30.00	.00	93.00	.00	25.00	1450	250	190	22	100	100	
0483156	A	155.00	5	50.00	.00	93.00	3.50	.00	2300	350	420	25	200	150	000000
2391277	C	180.00	10	35.00	.00	93.00	5.00	50.00	3220	350	845	20	125	90	
2391276	C	200.00	40	35.00	.00	93.00	5.00	50.00	3220	350	845	20	125	90	
5616712	C	220.00	4	38.00	.00	80.00	.00	25.00	880	250	190	9	100	100	
2391274	C	225.00	9	35.00	.00	93.00	5.00	50.00	3220	350	845	20	125	90	
4481886	C	225.00	10	45.00	.00	93.00	.00	25.00	1440	250	190	22	100	100	
1589116	L	250.00	5	4.00	.00	.00	.00	.00	1020	300	400	20	100	250	
2391285	A	250.00	9	68.00	.00	100.00	4.50	50.00	3220	350	845	20	125	90	
2391708	A	250.00	9	68.00	.00	100.00	4.50	50.00	3220	370	845	20	125	90	
2414941	C	250.00	9	68.00	.00	100.00	4.50	50.00	3240	360	865	20	500	90	
2391343	C	270.00	32	40.00	.00	93.00	6.00	50.00	3220	370	845	20	125	90	
0483040	A	280.00		60.00	.00	560.00	35.00	15.00	3400	350	1375	32	350	150	
8493839	C	300.00	4	60.00	.00	93.00	.00	25.00	1450	250	190	20	100	115	
2391036	C	350.00		50.00	.00	93.00	2.50	50.00	1500	370	875	20	125	90	
2391157	C	350.00	9	40.00	.00	93.00	4.00	50.00	3220	350	845	20	125	90	
2391714	C	350.00		50.00	.00	93.00	2.50	50.00	1500	370	875	20	125	90	
0483304	A	370.00	5	55.00	.00	1,000.00	100.00	15.00	3400	350	1375	32	350	150	000000
0483039	A	425.00		75.00	.00	560.00	53.00	15.00	3400	350	1375	32	350	150	000000
2414948	C	500.00	9	88.00	.00	100.00	8.50	50.00	3240	360	865	20	500	90	
0483038	A	525.00		85.00	.00	560.00	62.00	15.00	3400	350	1375	32	350	150	000000
2391116	C	1,000.00	9	105.00	.00	100.00	4.00	50.00	3220	350	845	20	125	90	
0483036	A	1,200.00		150.00	.00	560.00	78.00	15.00	3400	350	1375	32	350	150	

TOTAL RECORDS 179