Education and training in Electronic Design Realisation

Connecting to Printed Circuit Boards

written by Harwin plc

Electronic Design Realisation

www.edrcentre.org.uk

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Connecting to Printed Circuit Boards

1 The purpose of PCB connectors

Designers of electronic equipment (OEMs) use connectors for the following reasons:

- Connectors improve manufacturability by allowing the equipment to be manufactured in small sub-units and then finally plugged together
- Connectors allow for ease of servicing, repair, replacement and upgrading
- Connectors give design flexibility

2 Types of PCB connectors

There are two basic forms of PCB connector – those that connect board to board and those that connect board to cable. Connectors consist of male and female (plug and socket) types.

Board-to-board connectors can plug together perpendicular to each other, or in-line, or can be stacked. The main, or base board is called a mother board and the board which plugs into it is called a daughter board. Any subsequent add-on boards are called child or baby-boards. Very large mother board PCBs having multiple daughter boards are also called backplanes.

Board-to-board connectors can be single part (called edge connectors) or two part. Two part are generally more reliable than edge connectors, but are more expensive. Board mounted connectors can have through hole or surface mount terminations.

Board-to-cable connectors can be mounted at 90° or parallel to the board surface. They can again be single part where the connector is soldered permanently to the PCB, or more commonly, two part. These usually consist of a male header connector, which is soldered to the PCB. The female cable connector can then be plugged and unplugged as and when required. Board-to-cable connectors can also be Input/Output (I/O) connectors, such as 'D' connectors found on the back of personal computers (Figure 1).

Figure 1: D sub connector

Another type of PCB connector is the **IC socket** (Figure 2), into which integrated circuits can be plugged and unplugged. These allow for ease of repair or upgrade, without the need for any desoldering operations.

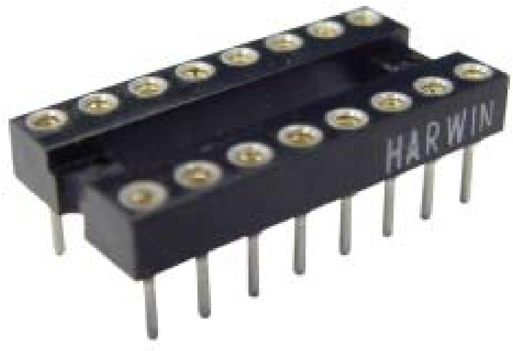

Figure 2: IC socket

3 Choosing a PCB connector

When choosing connectors for a PCB design, there are several important characteristics that should be considered. To a large extent, these characteristics will depend on the type of circuit, that is analogue, digital, power, RF, etc.

There are some requirements that apply to the connectors on all types of circuit, such as:

- Possible need to interface with known connectors, or industry/company standard connectors
- Lowest cost connectors, of suitable quality and performance
- Connectors supplied from an ISO 9000 approved manufacturer
- Suitable footprint, usually the smallest possible space taken up on the PCB surface
- Pad layouts to the LMPS internationally accepted standard
- Connector life, or the number of pluggings necessary to meet the market requirement
- Connector retention, in some form of latching for board to cable connectors
- Strain relief for cable connectors, to prevent cable failure

Digital and high-speed digital circuits

When designing PCB’s for digital or high-speed digital circuits, the choice and performance of the connector becomes critical. The additional characteristics, which are of most importance, are:

- **Contact impedance** – This must be known and consistent in order to allow the impedance of the PCB tracks to be matched to that of the connector.
- **Skew** – Need to know the total signal path length through the contact.

- **VSWR** – Especially important to know in high-speed circuit design.
- **Grounding/shielding** – Grounding between each track and each connector contact maintains the correct impedance matching and eliminates crosstalk. Other ways to shield circuits are by using ferrites in the signal path (to eliminate edge ringing), or by using metal shrouds or cans to continue the shielding across from PCB connectors on to cable connectors.

4 Connector materials and finishes

Connector moulding materials

There are three basic types of applications in connectors, which use different types of polymer.

- **RF/high frequency connectors –** using polyethylene, polypropylene and PTFE.
- **Standard board-to-board and board-to-cable** – using nylon, polyester, polycarbonate and polyacetal.
- **Micro-miniature, surface mount and special applications –** using liquid crystal polymer, polyphenylene sulphide, diallyl phthalate and high temperature nylon.

Plastic materials have lightweight, are easily moulded into complex shapes, have good resistance to corrosion and excellent dielectric properties.

Glass-filled materials

Most connectors (except RF) have a percentage of glass fibres mixed in with the basic polymer. This can vary between 15% and 40% glass content. The more glass, the stronger the moulding and the better it withstands heat.

Flammability

In connectors, it is mandatory to use, and declare, an Underwriters Laboratories (UL) approved material, which will self-extinguish. That is to say that if the material catches fire, the moment the flame is taken away, the moulding will extinguish itself virtually immediately. This is achieved by including flame retardant additives in the moulding powder.

The norm for connectors is the UL94V-0 UL rating. This relates to instant self-extinguishing. Many terminal blocks and other electrical components are made from nylon having a UL94V-2 rating, which will take longer to self-extinguish. Underwriters issue a ‘Yellow Card’ for each material that they have approved.

Resistance to soldering heat

In normal wave soldering processes, the PCB protects the connector moulding from the solder wave: normal materials like nylon, polyester, etc, can therefore be used.

In surface mount soldering processes, the connector moulding has to withstand the full soldering temperature, which requires high temperature materials such as Liquid Crystal Polymer, Nylon 46, etc. Normal nylon/polyester materials would melt under these temperatures.

> In choosing a material it is important to know the intended assembly process. During wave soldering, the board shields the components from the molten solder, although some heat is conducted by the leads. The process is also relative fast, with immersion times rarely as much as five seconds. However, with reflow soldering, the whole connector has to withstand high temperatures (typically 235°C peak), and stay above the solder melting temperature for possibly as long as 120 seconds. Materials used in SM components must therefore have a substantially higher temperature rating.

Connector contact materials

Electrical contacts in connectors are usually made from a non-ferrous material so as to give good electrical conductivity (that is low resistance, which allows electrical current to flow more easily).

Male contacts are usually of a solid, non-flexing design and use brass or phosphor bronze material.

Female contacts are usually designed to flex and therefore have to withstand stresses. These normally require stronger materials such as phosphor bronze or beryllium copper (the strongest available). The normal rule is that the smaller the contact, the higher the stress, the greater the need to use beryllium copper material.

Contact plating finishes

An electro-plated deposit normally of gold or tin covers most contacts in connectors. Without this covering, the base material would oxidise and corrode, and therefore give high contact resistances.

The best material for contact resistance is gold. This is a ‘noble’ metal and remains clean under severe environments. However, it is expensive and can cause problems of solderability. Gold plated contacts are therefore often selectively gold/tin plated, having tin on the areas that are to be soldered.

Lower cost, lower performance connectors have tin-plating all over.

Plating finishes

On brass components it is essential to have an absolute minimum of 1 micron of nickel as an undercoat. This is to form a barrier to prevent zinc from migrating through into the tin plating. Zinc will cause de-wetting.

The standard minimum thickness for tin plating is 3 microns. Plating adhesion is important because if the plating lifts-off, de-wetting will occur. It is therefore very important to thoroughly clean the components before plating, and to ensure that the nickel undercoat does not become 'passive' during the plating process.

Tin plating (actually 98% tin, 2% lead) is now the preferred finish for most connector applications. This gives better wear properties than 90/10 or 60/40 tin lead, and solderability is acceptable, except in surface mount applications. Pure tin can grow crystals at low temperatures (-40°), 10% of lead eliminates this phenomenon. Environmental issues means that it is desirable to remove as much lead as possible from the process which also explains the move towards 98/2 tin/lead solutions. Some tin solutions also contain fluoroborates and formaldehyde and these are being phased out.

Connector assembly

In order to be cost competitive, most connectors are assembled using automatic machinery. The fastest method of contact assembly is called **gang insertion**, where an entire row of contacts is assembled into the connector housing in one operation. As many as 100 contacts can be gang inserted in 4 seconds.

Another automatic assembly method is called **terminal stitching**, which, as the name implies, fits one contact at a time into the housing, at high speed (Figure 3). This technique is particularly useful when contact patterns change within a housing. In some instances, a secondary operation is needed after insertion of the contacts into the housing. This can be some form of locking in of the contacts or bending the terminations through 90°, etc. On gang insertion machines, this is normally carried out on the same machine, followed by automatic testing and inspection, and even packing.

Figure 3: Automatic assembly machine

5 Soldering and cable assembly

There are many ways of attaching electrical cables to connector contacts:

Solder tail connectors

Electrical cables can have their ends stripped of insulation, and then the internal conductor can be soldered into the back of the connector contact. This is normally called a solder cup. In most applications, this is a one at a time operation. However, in sub-miniature connectors, all cables can sometimes be soldered to the contacts simultaneously by use of a hot bar soldering technique. After soldering, it is usual to fit an insulating rubber sleeve over the soldered joint. This sleeve can be a heat-shrink sleeve, which is fitted over the cable and shrinks tightly around it when heat is applied.

Covers

Often called 'hoods': can be fitted to many cable connectors and this has the advantage of tidying up all the cables and clamping them as a strain relief (Figure 4). In this way, if someone pulls on the cables, it does not strain the soldered joints. Some of these hoods are made of metal, or metallised plastic. This is for users who need EMI shielding. Cables and connectors emit stray electrical fields, which can affect nearby equipment, or be affected by other incoming electrical fields. Covering the cable/connector with a metal case collects these stray fields. Legislation on EMI shielding is now quite severe.

Figure 4: Cable assembly with cover

Crimp connectors

Crimp connections offer a more reliable cable joint than soldering, which is difficult to inspect. Once a crimping tool is set, it reproduces a consistent joint, which can be easily measured and inspected.

There are two forms of crimp connection, circular and F crimp. Circular crimps are used with high reliability precision turned circular contacts. F crimps are used with stamped and formed flat strip contacts. In both instances, the electrical cable has to have its insulation stripped off at the cable end. In circular crimps, the crimping tool has four indenters positioned at 90° to each other. The crimp barrel on the contact is placed in a positioner, which is fitted to the crimping tool. Operation of the tool brings in the four indenters which crush the crimp barrel onto the electrical conductor and welds it in a gas tight joint. (Gas tight means that after crimping; the electrical joint will not deteriorate in a severe industrial environment). The completed contact/cable joint is then removed from the tool and can be fitted into the appropriate position in the cable connector.

These types are called crimp, poke-home contacts. They are always poked-home from the rear face of the connector, and are pushed fully in until they latch into position. The latching feature varies from connector to connector. Also, these poke-home contacts can be removed from the connector should replacement be necessary. These are called replaceable contacts and the de-latching can be front releasable, side releasable or rear releasable (less usual). A small special tool or miniature screwdriver is the normal way to release contacts.

In the case of F crimps, contacts are normally supplied for volume use on reels, where the contacts are joined together by a metal bandolier. Crimping machines, typically called applicators, feed the reel of contacts into position between a crimping die set. The stripped cable is inserted into the crimp section of the contact and the top and bottom die is closed to again wrap the contact around the conductor in a cold, gas tight weld. Usually, another section of the contact is crimped around the cable insulation, to act as a strain relief. The F crimp operation is much quicker and lower cost than circular crimping, and is therefore much more widely used. It can be fully automated as a production process.

IDC connectors

Another popular cable connection system uses insulation displacement connectors (IDC), sometimes called IDT (insulation displacement terminations). These use ribbon cables, which have normal circular conductors bonded into a flat cable insulation. The cables are positioned at the same pitch (centre to centre distance between conductors and contacts) as the connector contacts. The contacts are shaped like a tuning fork, with a precise gap. The cable is positioned above the contacts and forced down through the contacts, which pierce (displace) the insulation and make permanent electrical contact between the cable and the connector contacts. This can happen at all positions simultaneously (mass termination). The connection system is very easy to use, requiring only simple bench presses with location nests.

There is another type of ribbon cable called flat flexible cable (FFC). This has flat, rather than circular conductors inside the insulation. Connection to this cable is very difficult and very few connector manufacturers have products suitable for its use, except with cable pre-stripped of insulation on one side.

Wire-wrap connectors

Wire-wrap connectors are mainly used on large backplanes, and are therefore a relatively limited market. To make a wire-wrap joint, approximately 25 mm of insulation is stripped off a 30 AWG cable (AWG = American Wire Gauge) and relates to 0.3 mm diameter. The uninsulated cable, and a short length of insulated cable are positioned into a wire-wrap tool (these can be electrically, pneumatically or hand operated). The tool is then used to tightly wrap the cable around a square post (usually of 0.635 mm size). During wrapping, the cable is stretched tightly around each of the four corners of the post, over a length corresponding to at least 7 complete turns, plus 1½ turns insulated. This results in 4 x 7 = 28 gas tight joints per complete wire-wrap. This method is therefore very reliable, but uses space behind the connector. One other advantage is that wire wrapping can be automated using a CNC (computer controlled) machine.

6 Connector accessories

Coding keys: Normally made of plastic, and which fit into or around the mating faces of connectors, to prevent the wrong connectors being plugged together, or to the wrong PCB. (Similar to polarising keys).

Earthing tabs or strips: Metal components, which surround contacts or connectors and which take any short circuit or stray electrical fields to earth on the PC board.

Hold-downs: Can be integral in a connector housing, or additional parts, which hold a connector firmly down onto the surface of a pc board. This prevents lifting of the connector during the soldering operation, and acts as a strain relief on the soldered joints during service.

Hoods (covers): Used on cable connectors to insulate and protect the cables as they leave the back of the connector housing. Will usually include some form of clamp to prevent any movement of the cables from affecting the termination joints. (that is crimp, solder, etc.)

Jackscrews: Devices which, when rotated by hand or hand tool, plug and unplug board to cable connectors in a controlled way. When fully tightened, they prevent the cable connector from ‘walking out’ of the board connector under vibration conditions.

Latches: A simple way to hold board to cable connectors together to prevent them ‘walking’ apart during service, usually comprising of a metal or plastic spring which latches over some feature moulded into the connector housings as they are plugged together. Deflection of the latches by hand or with a small hand tool, allows the connectors to be unplugged.

Pick-and-place-pads: Simple plastic or metal ‘throw-away’ components which are initially fitted to surface mount PCB connectors for the sole purpose of allowing them to be picked from some form of packaging, and placed onto a PCB automatically (Figure 5). After the subsequent soldering operation, the pick-and-place pads are discarded.

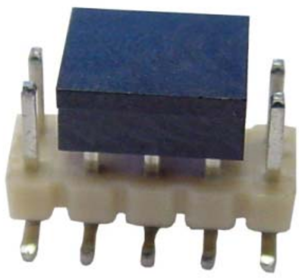

Figure 5: SMT connector with pick and place pad

Polarising features: Can be features moulded into a connector housing, or additional add-on components, which prevent connectors being plugged together 180 degrees from their intended orientation. (See also Polarising Keys and Coding Keys).

Polarising keys: Add-on components fitted to connectors to prevent two or more similar connectors being plugged together into the wrong mating half.

Shrouds: Plastic or metal shields which fit over connectors and protrude out from the mating face such that any exposed contacts are protected from mechanical damage. Can also incorporate a pre-alignment feature to assist in guiding connector together during plug-in.

Tape and reel packaging: Continuous reels of pre-formed plastic tape containing pockets into which connectors or components are housed (Figure 6). These reels are used on automatic pick and place assembly machines, which feed the tape under a tool head. This head picks the connector out of the pocket and places it on the surface of the PC board. Tape and reel is the most popular form of packaging for surface mount connectors and components.

Figure 6: Tape and reel packaging

7 Customised connectors

Often electronic designer engineers find that a 'standard' connector is not exactly what they need for a particular application. When that happens, connector suppliers who have in-house design and manufacturing capabilities are able to offer a customised connector.

Typical 'custom' connectors (Figure 7) can be:

- A standard connector, but with some contacts left out.
- A new design of housing, but using existing electrical contacts.
- A completely new design of both housing and contacts.

For the more simple changes from standard product, a relatively small tooling charge or minimum sales order is usually applied. For new custom designs requiring production tooling, tool charges are payable by the customer. The connector is then produced exclusively for that customer.

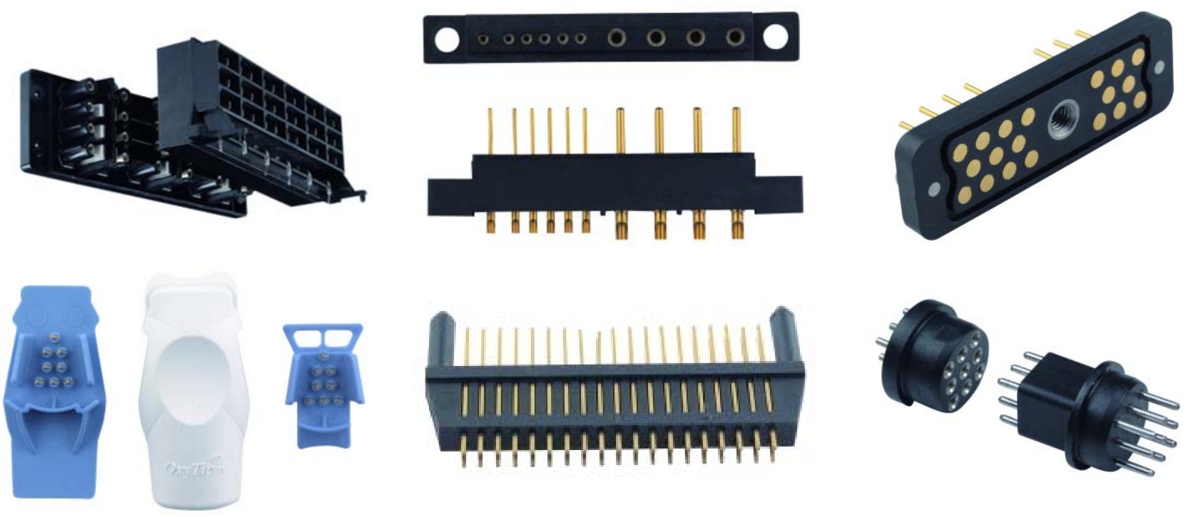

Figure 7: Application-specific connectors

8 IC sockets

IC sockets (Figure 8) are useful when the designer wishes to allow easy upgrade, reprogramming or repair, without the need to desolder, and are available for many of the larger standard package formats, in particular DIPs and PGAs.

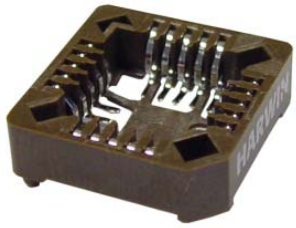

Figure 8: Leadless chip carrier socket

For parts with through-hole leads, such as DIPs, there are two distinct types of socket on the market – turned pin or stamped and formed contacts.

Turned pin

The turned pin type is for use in severe environments, or where utmost life and performance are required. Each contact is manufactured in two parts, an outer precision-turned brass shell (usually tin plated) and a four-finger beryllium copper inner contact (usually gold plated). This gives genuine selective plating, and no chance of solder wicking up into the contact area. The four-point contact is obviously very reliable (four chances not to fail) and the socket can be re-used many times.

Stamped and formed contacts

Stamped and formed contacts can have single or double-sided contacts, and are used where lowest cost is required, and probably only two pluggings will ever take place.

Pin Grid Array sockets

The vast majority of these socketsare either the precision-turned type (as in the DIL sockets) or have zero-insertion force stamped and formed contacts. Pin Grid Array packages may have up to 320 contacts, which means that precision-turned contacts must have low forces. For this reason, PGA socket contacts usually have six-finger inner contacts. (Figure 9)

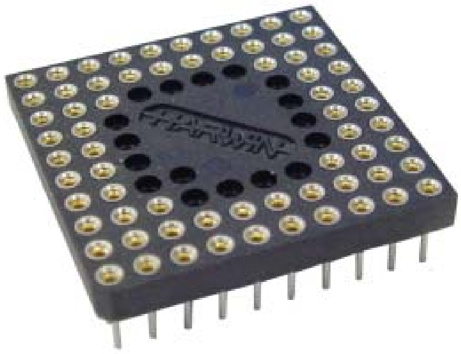

Figure 9: Pin Grid Array socket

This need for low insertion force also fuels a growing trend towards ZIF-PGA sockets. In their normal state, the contacts in a ZIF-PGA socket are wide open, allowing the PGA package to be placed inside without resistance. The contacts can then be operated by a lever, which closes them onto each leg of the package. Reversing the lever opens the contacts, allowing the package to be easily removed and replaced. This is particularly important in computer applications, where upgrades are common.

PLCC sockets

Sockets for PLCCs normally have beryllium-copper or perhaps phosphor-bronze spring contacts, positioned vertically in rows around each side of a square. The PLCC package is plugged into the socket from the top side and goes just ‘over-centre’ on the contacts, which helps to retain the package. Packages can be removed for replacement by levering them out, using a screwdriver, in a slot provided for the purpose. Legs from these sockets (sometimes called pin-outs) can be in-line, staggered or in surface mount format. Socket mouldings can be high or low profile (height above the PCB), and surface mount types will use high temperature plastic. Similar sockets are available for the smaller SOJs.

Board sockets

Individual PCB sockets are of similar construction to turned-pin IC sockets. Some have four-finger and some have six-finger internal contacts, and they will accept mating pin diameters of nominally 0.5 mm, 0.8 mm, 1.0 mm and 2.0 mm. The outer shells on some types have a knurl that acts as an interference fit in the PCB hole, and are referred to as ‘self-retaining’. Other types have the top aperture closed by a thick film of silicone rubber, which is called an RTV seal (RTV = Room Temperature Vulcanising). In production, the silicone rubber is dispensed onto the socket aperture, where it quickly forms a skin and then fully hardens, at room temperature.

Surface mount PCB sockets are basically square in section, and sit down onto pads on the board for reflow soldering. Some sizes of PCB sockets can be supplied to customers fitted onto metal combs, or in plastic (Mylar polyester) film tape. This enables them to be fitted in multiples, and so reduce assembly time and cost.

9 PCB components

Not to be forgotten within the connector family are a number of specialised pin-based products:

Power pins: Usually spade or circular format, used to take power onto boards. Various standard sizes and current/power ratings can be fitted into housings or directly into a PCB, and this operation can be automated.

Fuse holders: Stamped and formed from flat strip, and solderable into PCBs, these accommodate standard circular fuses.

Connector pins: Often used as an alternative to pin headers, especially when non-standard pin configurations, or longer/shorter pins are specified. Pin insertion into PCBs can be easily automated.

Test points: Designed-in to some PCBs in order to connect to Automatic Test Equipment (ATE). This equipment contains spring probes, which make electrical contact with the test pins.

10 Specialist PCB connectors

Coaxial connectors

Coaxial connectors are for use with Radio Frequency (RF) signal circuits, usually operating in the frequency range between 3 kHz and 300 GHz. This covers the range of radio and television transmissions. The connectors are constructed to have a centre contact, surrounded by an insulator (normally PTFE for its low dielectric constant), contained in a metal body. The centre conductor of the coaxial cable is terminated to the centre contact. The outer copper braid of the cable is terminated to the connector body, and the insulation remains in place. Most coaxial connectors are required to have an impedance of 50 ohms.

Fibre optic connectors

Fibre optic connectors are specialist connectors that allow light transmission via fibre optic cables. Connectors can transmit light from one cable to another, from one cable to a pair of cables, or to an electro-optic component. These connectors are used primarily in the telecommunications industry, or where light or laser systems are required.

Audio connectors

Audio connectors are often referred to as ‘jacks’ or ‘jack plugs and sockets’. These connectors work in the frequency range up to 20 kHz, and can be found on all types of recording and playing equipment.

11 Environmental and performance

The following parameters are important for design engineers to be able to assess whether a particular connector will meet their needs.

Contact resistance

Contact resistance is the electrical resistance measured from the back of the male connector through to the back of the female connector (measured in *milli*ohms, 1 mΩ = 0.001 Ω). This is sometimes called the total path resistance. The actual contact resistance is the resistance of the joint between the male and female contacts. This is also the only variable resistance. Normal maximum value for contact resistance variation, from initial to after use, is 5 mΩ.

Dielectric withstand (or proof) voltage

Dielectric withstand voltage, is a derated voltage, below breakdown voltage. It is specified as the minimum acceptable test voltage at which flashover must not occur, when the voltage is applied for one minute.

Environmental conditions

Refers to the range of climatic conditions and mechanical stress conditions, which the connector has been proved to be able to withstand. Ratings are normally shown as, for example, 55/105/21. This refers to -55°C, +105°C, and 21 days under standard damp heat conditions (+40°C, 95%RH)

Insertion and withdrawal force

Is the force measured in newtons required to plug or unplug a male and female connector (or pair of contacts) together. Connectors (or contacts) can be high force, low force or zero insertion force. Zero insertion force means that the connectors can be joined together without restriction, and subsequently the electrical contacts brought together by some integral mechanical mechanism.

Insulation resistance

Insulation resistance is the electrical resistance recorded between adjacent contacts (measured in MΩ). This measurement checks the design and quality of the mouldings.

Number of operations

Sometimes called life or durability. Refers to the number of times a male and female connector can be plugged together and still meet electrical and mechanical specifications.

Voltage breakdown

Voltage breakdown is a measurement of the minimum voltage at which flashover occurs due to the voltage jumping across from one contact to the next. This measurement checks the creepage distance across the moulded surfaces and the air gap between contacts.

Working voltage

Working voltage is the maximum voltage at which the connector can be used. Normally this figure is one third of the withstanding voltage.

Sample specifications

Typical connectors will be specified to withstand the following tests/conditions:

- **High temperature:** usually between +70°C and +125°C.
- **Low temperature:** usually between -10°C and -65°C.
- **Damp heat:** usually +40°C; 95% relative humidity.
- **Temperature cycling:** usually 10 cycles of maximum to minimum temperature.
- **Vibration:** usually 10g maximum.
- **Mechanical shock:** usually 100g.
- **Mechanical bump:** usually 40g.
- **Mechanical acceleration:** usually 25g.
- **Industrial atmosphere:** gas test.

12 Quality standards

In your researches into connectors, you will meet references to a number of common standards:

ISO 9000: An internationally accepted quality standard. It is recognised in virtually all markets across the world. It specifies how a business should control its processes in order to ensure its customers a quality product or service. Third Party Accreditation is used to monitor the adherence of businesses to the ISO 9000 standard.

UL: Underwriters Laboratories approvals are often required, especially when product safety, and use by the general public are involved. The approvals cover topics such as flammability of plastics, electrical safety, etc.

CE: European standard ensuring safety on all types of electrical and electronic equipment. CE marking is applied to show that approval has been granted.

FCC: American standard to control electrical interference from and to equipment. (EMI).

CSA: Canadian standard, similar to FCC/CE.

TUV: German standard for products, mainly invoking safety requirements.

Acknowledgement

The course team are very grateful to Harwin plc for creating this material especially for EDR Centre courses, and for their kind permission to reproduce the figures it contains. We would encourage you to visit the company web site at www.harwin.com. Associated web sites cover Component Assembly Systems and Application Specific Connectors, and there is a wealth of information on connector products of all kinds.

Glossary of terms

A

Above-board profile – The height the connector stands above the top surface of the PCB

Anti-wicking contacts – Those that prevent entry of either flux or solder up into the contacts during the process, which solders the contacts and connector to the PCB.

B

Bifurcated contacts – Stamped and formed contacts, which are split into a pair of springs so giving two independent spring movements.

Board-to-board stacking height – The distance between the two inside faces of parallel mounted PCBs.

C

Closed bottom contact – The back of the contact is closed to prevent solder ingress, usually this applies to PCB and solder tail contacts.

Closed entry socket – The entry for the mating plug contact is such as to prevent damage to the socket contact on insertion.

Coding keys – Moulded or metallic pieces that prevent the wrong two connectors, or connector and printed circuit board, from plugging together. Moulded types can additionally be colour coded.

Compliant press-fit terminations – are contacts in a connector where the tails are formed to have a compliant section. This section deforms as the tail is pressed down into the plated through hole of the printed circuit board. The inherent spring force in the compliant section retains contact during the life of the equipment without the need for a soldering operation.

Connector mating and un-mating force – The total force required to plug and unplug connectors, made up of the sum of the individual contact forces plus any friction due to housing misalignment.

Contact bounce – Movement causing an open circuit between a male and female connector contact. This can occur during the plugging together operation, or due to vibration conditions during service.

Contact carrying capacity – The maximum current a mating pair of contacts, or all contacts in a connector simultaneously, can pass without causing degradation due to overheating and thermal stress. This is usually specified at room temperature and at maximum operating temperature, with a de-rating curve in between.

Contact rating – The maximum and minimum voltage, current and power that a contact pair can be guaranteed to operate with under specified environmental conditions.

Contact retention – The specified force at which contacts will start to receive damage or pull out of a connector housing.

Contact size – Defines the maximum wire size that can be used with a contact in a cable connector. This determines the contact diameter and current rating.

Covers (or hoods) – Used on cable connectors to protect and insulate the terminations.

D

Daisy chain – Two or more connectors joined together in parallel.

Discrete wire – a single cable or wire, to be terminated on to a connector contact.

F

Female connectors – Consist of an insulated plastic moulding fitted with socket contacts that allow male and female connectors to be plugged together. (In the USA female connectors can be called receptacles).

Footprint – The space a connector takes up on the surface of a printed circuit board, together with its termination layout.

G

Gas-tight joint – The joint between male and female contacts, or a termination to a cable, which excludes air. This results in the connector maintaining good electrical continuity even under severe industrial atmospheric conditions.

Grounding – Sends current flow to earth in the case of a short circuit.

Gull wing – The shape of the terminations on some connectors, primarily for surface mounting.

H

Hermaphroditic connectors – Contacts and mouldings, which can be used as both male and female types (that is, they will plug into each other).

High Insertion Force – Refers to contacts, which, due to their design and function, require a high force to plug together. Used mainly in high current or low cost connectors.

Hoods – (see Covers)

Hot plugging – Adding or removing components or sub-assemblies to a system whilst it is powered up (hot). This needs to happen without causing damage to any of the circuitry and without significantly interrupting the system. Hot plugging is also called line insertion or live line Connection.

Housing – The insulating body, usually a plastic moulding which holds the electrical contacts. Also called insulators, dielectrics or shells.

J

Jackscrews – A means of controlling the plugging together of connectors and locking them in place. Rotation of the screws jacks the connectors together or apart. This is particularly useful for connectors having a large number of contacts and therefore a high insertion and withdrawal force.

L

Latching – A means of holding together a pair of mated connectors such that they will not walk apart under vibration or other physical forces. This usually only applies to board-to-cable or cable-to-cable connectors.

Location pegs/hold-downs/strain reliefs – Features moulded into connector housings which position the connector accurately onto the PCB, hold it down during soldering and act as a strain relief on the solder joints when plugging and unplugging mating connectors. This is particularly relevant to surface mount and 90° mounted connectors. Hold-down features can also be formed into the tails of contacts.

Low Insertion Force – Refers to contacts, which, due to their design and function, require very little force to plug together. Used mainly in miniature and high pin count connectors.

M

Make Before Break – Selected contacts in a connector that make an electrical circuit before breaking (open circuiting) other contacts.

Male connectors – Consist of an insulated plastic moulding (sometimes called housing) fitted with plug contacts.

Moulded-in contacts – Contacts that are encapsulated during the moulding process and cannot be removed. They are normally only used where a fully sealed connector is required.

N

Normal force – The force holding the contact faces together, and which determines how good the electrical performance of the contact is.

O

Open entry socket – One where the entry for the mating plug contact is open such that the socket contact is vulnerable to damage if not mated correctly.

P

Pin count – The number of electrical contacts in a connector housing also called ‘number of ways’.

Pitch – The dimension between adjacent contacts along the axis of the connector housing, also known as centre-to-centre distance.

Polarisation – is a means provided by the shape of the mating connectors, which ensures that:

a) The connector cannot be plugged together the wrong way round (that is,180° polarisation).

b) Two similar size and shape connectors cannot be plugged into the wrong mating half.

Precision turned contacts – Are manufactured by the screw machining process, and are basically therefore circular in format.

Press fit – Often called compliant contacts have a semi spring area on the contact tails, which, when pushed into holes in the PCB, will make and maintain electrical contact without the need for a subsequent soldering operation.

Pre-travel – The distance between the point where a connector starts to align when plugging together, and when electrical contact is made.

Priority contacts – in a connector make electrical contact before others in the same connector (usually earths or power).

R

Replaceable contacts – Can be replaced whilst in service by releasing them from their moulding and then the refitting of a new contact.

Ribbon cable – A multiple round conductor cable in flat ribbon format, which can be used in mass termination connectors. It is sometimes colour coded.

Row spacing – The dimension between rows of electrical contacts across the axis of a connector housing.

S

Selective plating (sometimes called duplex plating) – Contacts can be electroplated all over, usually with tin or gold. More common today are the selective plating processes whereby gold is plated onto the mating contact area for optimum electrical performance and tin is plated onto the tail for solderability performance.

Shielding – A device (normally metallic) attached to cables or connector housings to protect against electromagnetic interference (EMI) and mechanical damage.

Shrouded contacts – Contained within the outline of the moulding, so preventing contact damage. Un-shrouded contacts protrude beyond the outline of the moulding.

Spring contacts – can have one, two, three, four or six cantilever or beam contacts. These are usually called single beam, twin leaf or twin beam, three, four or six leaf or finger contacts. Two-part contacts comprise a precision turned outer shell with an integral stamped and formed inner spring contact.

Stack-ability – Where a connector has its length and/or breadth narrow enough to allow two connectors to be placed together, and maintain contact pitch centres. This can be side-to-side (side stackable) or end-to-end (end stackable).

Stamped and formed contacts – are made from originally flat strip (usually non ferrous materials) and are stamped out of the strip and formed up into spring contacts.

Stand-offs – Moulded pips or bars which allow cleaning fluids to pass between the connector housing and the top face of the PCB, this is necessary immediately after the soldering operation to clean out flux etc.

T

Top or bottom entry sockets – refer to the direction from which the connectors plug together (that is, bottom entry means that the plug connector has to pass through holes or slots in the PC board).

W

Wire pullout force – The force at which a cable will fracture or pull out of the termination at the back of a contact in a connector. The pull out force must be no less than the breaking strain of the plain wire.

Z

Zero Insertion Force (ZIF) – Refers to contacts or connectors which, when unplugged have electrical contacts which remain in an open position. The plug and socket connectors can be plugged together without any force being required. The contacts are then actuated by means of a mechanical lever, and come together to make electrical contact. This is particularly useful for very high pin count connectors, such as integrated circuit sockets.