UK PowerTech Ltd

Specialists in Connector Technology

- Minimise Formation Energy
- Reduce Battery Damage / Scrap
- Improve Circuit Efficiency
- Ergonomic Designs
- Improve Battery Performance

Make the Right Connection

Contents

About Us

UK PowerTech Ltd has been involved in the industrial battery industry for over 25 years supplying solutions and products for all aspects of battery uses, from traction to stationary applications. We work with the best companies and technicians in Europe to develop our knowledge and expertise in both manufacturing and technical skills as well as the use of up-to-date materials and manufacturing techniques.

Our major area of product development over the past 10 years has been connectors for linking batteries together for charging in the formation areas of battery production. Time, effort and safety are now crucial to this sector of manufacturing and battery connectors supplied by UK Powertech excel in all areas.

UK PowerTech Ltd manufactures and stocks a wide range of battery component products and accessories including forklift truck battery accessories, formation connectors, plug and socket accessories, battery watering components and water deionisers.

Effects of bad connections

What can create a bad connection?

Incorrect/lose fitting of the connector by the operator, deformed battery terminal from a previous manufacturing operation (spine to bushing weld), build-up of a $PbSO_4$ corrosion layer, which results from the acid environment and DC rectifier voltage as the connector ages.

Energy losses occur

Bad connections create a high resistance which creates excess heat at the battery/connector joint. This heat, created by the high resistance, is waste energy

Damaged battery terminals, connectors and scrap batteries

Loose fitting connectors or contaminated contact surfaces allow arcing to occur which damages both the battery terminal and the connector. This creates the need for rework on the battery terminal and damages the connectors' contact surface, leading to increased potential for arcing in the future.

Heat generation tracking into battery

High resistance connections create extra heat which in turn is transmitted into the battery.

Higher heat generated inside the battery

Higher heat inside the battery leads to a lower gas evolution voltage. This leads to more gassing which also leads to higher water losses.

Slower formation times on temperature controlled systems

Heat created from high resistance connections means that the internals of the battery heat up faster than normal. On formation systems that are temperature limited, this means that the maximum temperature is reached sooner. The current is then reduced which slows down the programme, meaning that the accumulation of Ah is slower. This lengthens the overall formation time reducing the battery output capacity of the formation equipment.

Fire Risk from arcing

Arcing from bad connections is the biggest cause of fire or explosions

Therefore accumulated losses – High resistance connection, terminal rework and premature connector failure, heat generation, gassing, water loss, slower formation times all add up to significant, and mostly hidden $/€ losses.

Effects of Good connections

What creates a good connection?
Loose fitting connectors or contaminated contact surfaces allow arcing to occur which damages both the battery terminal and the connector. This creates the need for rework on the battery terminal and damages the connectors' contact surface, leading to increased potential for arcing in the future.

Efficient energy continuity
It's important to have as efficient a circuit as possible to achieve good formation of the battery.

Save Energy
Efficient connections save 3%-7% of energy during the formation process.

Reduces re-work of damaged terminals and scrap batteries
Arcing damaged to the battery terminals is a significant cost of rework and scrap batteries.

Lower internal battery temperatures
No additional heat is generated at the battery terminal meaning that a maximum value, in a temperature limited formation programme is reached later, or in some cases, not at all. This means shorter formation times and increased throughput capacity. A good efficient connection should be the same temperature as the battery itself.

Fire Risk
Drastically reduced.

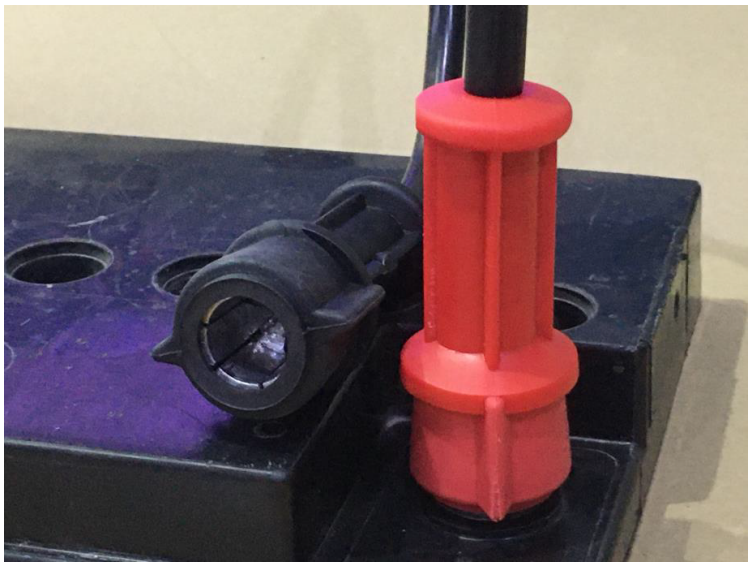
Battery Formation
An low resistance, energy efficient circuit, ensures better formation chemistry of the battery in the minimum possible time.

Therefore, creating an efficient system with good connections allows for minimal energy use, reduces the possibility of rework or scrap batteries, less gassing, less water loss, faster formation times (temperature limited), reduces the risk of fire and guarantee the best chemistry.

Battery Formation - This can only be performed once so it's important to get it right first time.

****See our published research articles on our website which identify how to save energy, unnecessary rework, water and time.**

New - TSC Type SAE/DIN Formation



Self Gripping Battery Formation Connector

Especially developed to automatically grip the battery terminal for better connectivity and better efficiency with seal against battery acid vapor ingress during the Formation Process. Easy for operators to fix correctly. Proved to save energy and reduce arcing. A much better connection for much longer.

Drastically reduces damaged battery terminals, rework and scrap batteries

Cable insulation – PVC as standard (or to suit customer specification)
Copper strand - Multistrand flexible HC copper wire
Terminal insulation – Specially developed compression material
High Antimony lead for extra life.
To suit standard SAE/DIN terminals.

Current carrying capacity:

16mm² = Up to 85 amps
25mm² = Up to 100 amps

***Maximum working Temperature 80 Degree Centigrade

Connectors and single ended Take - off leads
Standard lengths :
Connectors - Start at 300mm
Take-off's - Start at 500mm

Any length can be manufactured to customer order

Mk2 T Type SAE/DIN Formation Connector

Heavy Duty Inter Battery formation Connector

Now produced by Hot Pressure Die Casting for high precision terminals for greater precision.
To suit standard SAE/DIN

Cable insulation - PVC
Copper strand - Multistrand flexible HC copper wire
Terminal insulation - PVC
High Antimony lead for extra life.
Built in testing point for easy readings

Current carrying capacity:

10mm² = Up to 50amps
16mm² = Up to 85 amps
25mm² = Up to 100 amps

***Maximum working Temperature 80 Degree Centigrade

Connectors and single ended Take - off leads

Standard lengths :

Connectors - Start at 300mm
Take-off's - Start at 500mm

Any length can be manufactured to customer order

T Type JIS small terminal Formation Connect-

JIS small terminal Battery Formation Connector

Now produced by Hot Pressure Die Casting for high precision terminals for greater precision.
To suit JIS small terminal

Cable insulation - PVC
Copper strand - Multistrand flexible HC copper wire
Terminal insulation - PVC
High Antimony lead for extra life.
Built in testing point for easy readings

Current carrying capacity:

10mm² = Up to 50amps
16mm² = Up to 85 amps

***Maximum working Temperature 80 Degree Centigrade

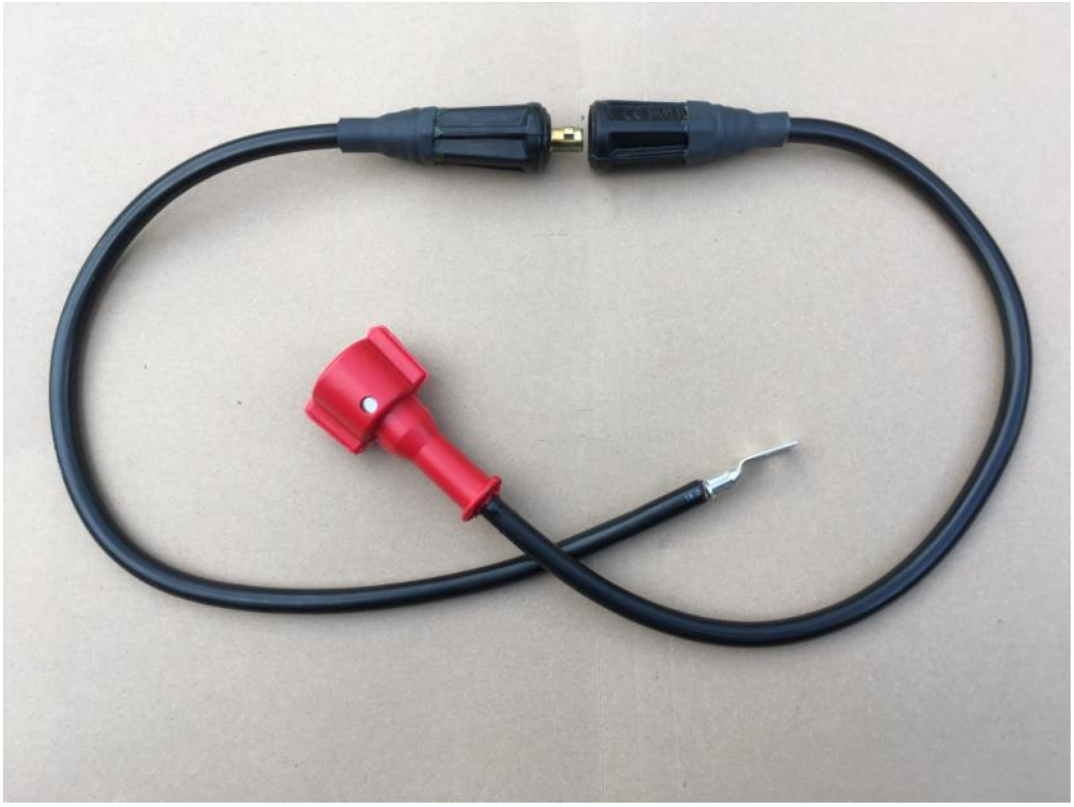
Connectors and single ended Take - off leads

Standard lengths :

Connectors - Start at 300mm
Take-off's - Start at 500mm

Any length can be manufactured to customer order

QR Quick Release Take off Connector System



QR Take off's System – No Down Time

The QR Take off System allows easy replacement of the Rectifier Connectors. A fixed part remains connected to the rectifier cabling system, meaning that the only part charged is the Terminal end allowing for easy quick changing of the termination cable.

Changed in seconds and doesn't need a skilled qualified person. Rectifier cabling is acknowledged as the highest risk of arcing and cause of fire because it remains in place to long because it's difficult to change.

Can also be used to change the circuit line for different types of battery pole types

Specifications:

Cable insulation - PVC
Copper strand – Multi-strand flexible HC copper wire
Insulation - PVC

Cable sizes 10/ 16 / 25mm2

Can be used with:

S Type
T Type
Quick Connect

S type Formation Connector

JIS small + ve

JIS

Inter Battery Formation Connector

To suit standard SAE/DIN, JIS (small taper post).

Cable insulation - PVC
Copper strand – Multi-strand flexible HC copper wire
Terminal insulation - PVC
High Antimony lead for extra life

Current carrying capacity:

10mm² = Up to 50amps
16mm² = Up to 85 amps
25mm² = Up to 100 amps

*** Maximum working temperature 80 Degrees Centegrade

Connectors and single ended Take - off leads

Standard lengths :

Connectors - Start at 300mm Centres
Take-off's - Start at 500mm

Any length can be manufactured to customer order

Quick Connect Formation Connectors

Replacement spring foils for all sizes except M5

Quick Connect Plug in and Plug on formation connectors are designed for speedy connect/disconnect of screw threaded battery terminals, saving valuable assembly time.

Manufactured from electrically conductive materials allowing for low resistance connections. Integral Insulations shrouds seal the terminal to post connection to prevent ingress of acid vapours which can damage connecting surface or internals of the screw thread.

Available in M5, M6, M8 & M10 for female connection.
M6, M8, & M10 for male connection for metric thread sizes.

Also in ¼", 5/16" & 3/8" for male and female connection for imperial thread sizes
Specifications:

M5 cable sizes to 4sq.mm (11awg)
M6, M8, M10, ¼", 5/16", 3/8" cables sizes 10, 16 & 25sq.mm

Current carrying recommendations for use:

M6 & ¼"up to 70amps –16sq.mm cabl

M8, M10, 5/16" & 3/8" up to 100 amps –16sq.mm cable (5awg)

up to 125 amps –25sq.mm cable (3awg)

Cable – High conductivity fine wire copper with rubberised insulation for flexibility.
Available in any length to suit your production requirements.

Customised designs to meet your requirements are our specialty

Quick Connect Connector – Group 31

Quick Connect Plug on Group 31 formation connectors are designed for speedy connect/disconnect of male screw threaded battery terminals, saving valuable assembly time, increasing the capacity of your equipment.

Manufactured from electrically conductive materials allowing for low resistance connections. Integral Insulations shrouds seal the terminal to post connection to prevent ingress of acid vapors which can damage the internals of the connector.

Especially designed for US Group 31 battery design 3/8" male stud terminals and is also available 5/16" version.
Specifications:

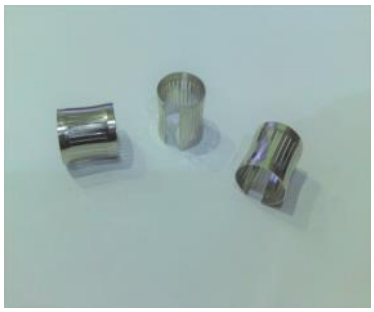
Cables sizes 10mm2 – 16mm2 (approx AWG # 7 – 5)

Current carrying recommendations for use:

Customer tests approve these connectors at 50 amps

Connectors come with terminal protected by Wurth Battery Terminal Protector – Regular applications extends life expectancy

Important – Terminals should be dry and free from acid before connecting otherwise damage to the internals of the connector and contact spring will occur.



Replacement spring contacts

How Important is Battery Formation?

Introduction

The ability of the lead acid battery to provide a voltage and current is due to the chemical structure of the positive and negative electrodes. It is the difference in potential between the positive plate (PbO_2) and the negative plate (Pb) in dilute sulphuric acid which creates the lead acid battery. It is the formation process which turns these complex lead compounds into electrochemical machines, capable of storing and providing electrical energy. This process is so called, as this is the first time the material has been converted (formed) into the electrodes.

The formation process is the last opportunity in the manufacturing process to ensure that the structures obtained from the previous processes will be converted into suitable and appropriate active material with the best possible properties for the battery application. For this reason, the parameters and conditions necessary for the successful conversion of dry cured paste masses for flooded batteries using pasted plates have to be very carefully controlled

Formation chemistry

The basis of all batteries is to create a potential difference between plates immersed in electrolyte. This basically means a different state of energy to allow electrons to flow from one plate to another until both plates have similar chemical energies, much like two containers with different amounts of water and each joined by a valve. When the valve opens the potential energy in the higher level causes the water to flow into the second container until the levels (and therefore the potential energies) are the same. In the case of the lead acid battery we have to create that imbalance by forming two different chemical species for the positive and the negative plate, i.e. PbO_2 for the positive and Pb for the negative.

Formation charging

Assuming the active material is correctly processed and the battery properly filled at the point of formation, then the critical aspects affecting the process will become:

- Temperature of the batteries
- Total ampere hours input into the battery
- Total circuit resistance
- Loss of current through tracking

There are consequences to the under formation of batteries through insufficient ampere hours input due to high resistance or tracking. Equally the formation temperature can create conditions which are unsuitable to obtain the desired crystal structure and hence properties for the type of battery being formed, e.g. SLI compared to deep cycle applications. Table 1 gives the conditions necessary for the successful formation of various lead acid battery designs.

TABLE 1 – Comparison of acid filling parameters for different processes and applications

Process	Acid SG	Soak time	Maximum temperature	Battery types
Tank plate formation (all battery types)	1.05	1 – 2 hours	45C	All
Container formation single shot (automotive)	1.240	0.5 – 2 hours	55C	Automotive, semi traction, monobloc
Container formation two shot (automotive)	1.15	0.5 – 2 hours	55C	Automotive, monobloc
2V Container formation (tubular pickled plate)	1.15	1 – 2 hours	65C	2V traction cells
2V Container formation (flat plate standby power)	1,240	2-4 hours	55C	Standby power, UPS

It is quite clear that the effect of temperature increases and losses of coulombic input (ampere hours) through increased resistance and tracking can affect the performance of the battery. The reasons for the loss of coulombic input and higher temperatures are often down to the connectors used to join the batteries in series in the formation bath (or the connection between connector and battery terminal). The integrity and design of the connector and the quality of the connection is vital in assuring that there is no tracking and that the resistance of the series string is uniformly distributed. A high resistance connection will have two effects:

1. To generate heat and to raise the voltage of the battery it is connected to. The higher temperature is easily transmitted to the rest of the battery through the terminal to the grids.

2. The higher resistance will create a higher voltage for a particular battery in a series string which will induce a faster rate of dry-out which increases the battery's SG and alters the structure of the active material usually reducing the life of the battery.

Typical defects and their causes are listed in Table 2.

Note – The Connector to Battery Terminal must be tight and secure (not loose) with the connector surfaces clean from Oxide residue to allow for the least resistance to prevent the above situations from occurring

TABLE 2– Common formation defects

Defect	Cause	In service consequences
High SG	Incorrect acid filling SG Excessive formation ampere hours Poor final adjustment	Low CCA in automotive Undercharging due to higher on charge voltages, particularly in voltage controlled charging Increased positive corrosion and grid growth in non-voltage regulated charging
Low SG	Incorrect acid filling SG insufficient formation ampere hours Poor final adjustment	Low capacity, serious for 2 volt traction and semi traction applications
Low CCA (automotive)	High formation temperatures leading to large PbO_2 crystals High internal resistance due to low conversion of sulphate to AM	Poor starting characteristics, particularly in cold weather. Early failure under warranty conditions
Low charge acceptance	High SG see above	Battery performance reduces with time Early failure under warranty conditions
Reduced life	SG imbalance between cells due to poor acid adjustment. Low capacity due to voltage differences between string connected batteries (connectors). Corrosion of positive due to high formation temperature caused by high resistance connections.	For traction series connected cells it is a common cause of poor cycle life Batteries on float charge fail from positive corrosion. High corrosion in the formation stage will reduce the time to positive failure Low capacity in service will reduce the cycle life
Low capacity	Batteries under-formed due to insufficient current (tracking problems) or time on charge or too low formation temperature Low SG	Reduced cycle life for traction batteries. Unable to meet performance requirements and fail under warranty terms.
Short shelf life	Insufficient formation due to unconverted active material. High residual free lead in the positive.	Poor performance after storage at customers or manufacturers warehouse. Common cause of warranty returns in automotive markets

** Information courtesy of Dr Michael McDonagh BSc. PhD

How Important is Battery Formation?

What causes tracking and heat generation on the battery/string

To reduce the risk of tracking and heat generation caused from the terminal/connector joint it is important that the connector and terminal connect as efficiently as possible. UK Powertech's automotive connectors (S & T Type) terminals are manufactured to exactly the same angle (1:9 taper) as the DIN/SAE standards. Before the moulded battery terminal is welded to the internal pillar insert of the battery, the connector is an exact fit. However, following the automatic battery post burning operation this is often not the case. Defective welds can range in severity from slight irregularities to major lead runs, burrs or spatter affecting the contact surface of the battery terminal.

Unfortunately, defects in the battery terminal can prevent the connectors used in the formation process from being correctly fitted. This creates the following problems:

The first and most obvious issue is that any space created in the connector/terminal joint will allow the ingress of acid as vapour or spray during the formation process. Over time, this creates a lead corrosion layer on the connectors contact surface. This layer has a high resistance, which creates heat and a voltage drop. This can induce arcing which damages both the connector and the battery terminal post. The subsequent voltage change in a battery string due to the high resistance can also affect the formation process. This will almost certainly lead to under-formed batteries. If there is acid on the surface of the battery then this creates tracking and heat which combined with arcing can easily result in a fire.

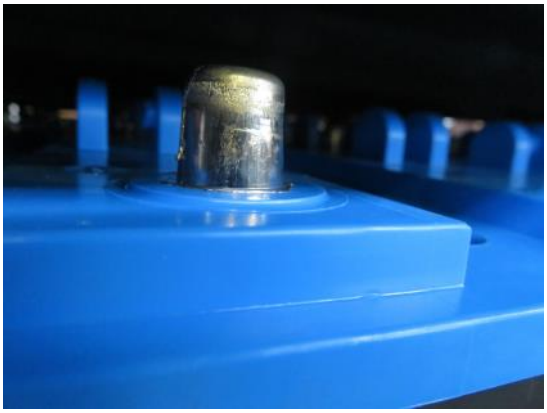
If one connector suffers these issues the voltage drop is carried throughout the complete string.

How Important is Battery Formation?

Cleaning the connectors to remove this oxide residue will allow for better connections and reduce electrical resistance and tracking. A poor connection also creates heat which, in turn is transmitted into the battery which increases the temperature of the acid

Other issues preventing good connections:

The process of welding the pillar inserts to the battery lid terminal creates heat which can distort the surface regularity of the precise conical shape of the terminal lid insert. Spatter from the welding process can attach to the conical contact area of the terminal or a mushroom shape can form over the top of the terminal. The top 2-3 mm of the post can become misshaped or irregular. All of which pre-vent the connector from efficiently contacting with the battery terminal. ALL will create voltage drop, heat generation and tracking.



Other causes of bad connection can be operator error in fitting the connectors prior to formation. Loose connectors, incorrect angle of fixing of the connectors to the battery terminals will also create high resistance joints. Obviously, this procedure is very intensive for the employee carrying out this operation, but it is important that the connector is fitted tightly, is clean and adequate for the charge currents being applied. The ergonomics and time requirements of the operator to carry out this operation correctly cannot be over-emphasised. High resistance joints caused by this method will be just as severe as defective battery terminals.

In conclusion – The Formation Process is a critical procedure. It is important that all aspects of the terminal manufacture and pre formation procedures are controlled very carefully with adequate quality standards. It is also crucial to make sure that your product is finished to the highest possible tolerances. These should be embedded in the quality standards and procedures of those processes which are vital to the assurance of high quality low resistance connector joints during formation.

Technical information taken from Papers written by Dr Michael McDonagh BSc. PhD
A full copy is available on request.

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