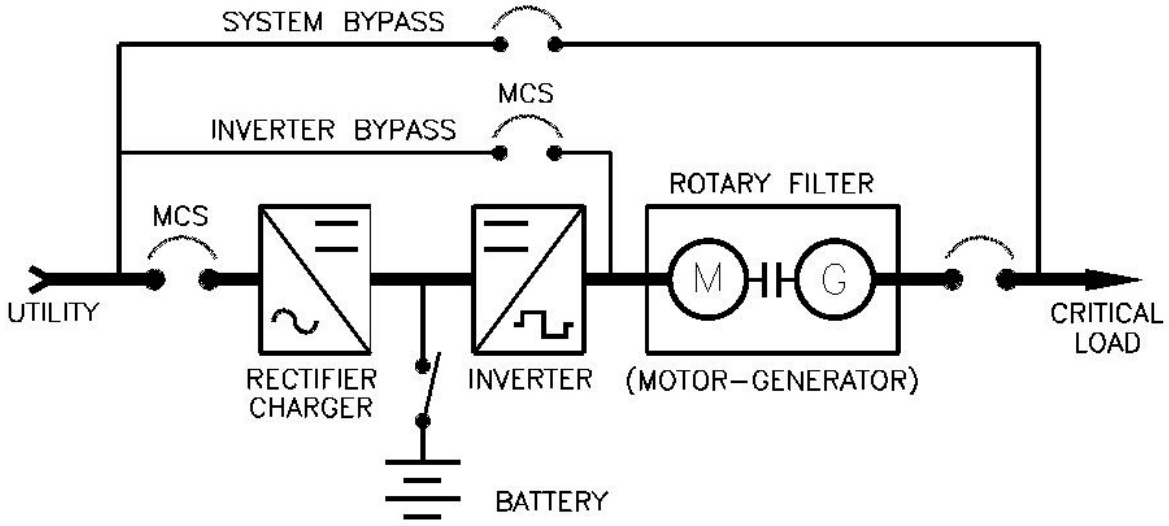
HYBRID ROTARY UPS

In the hybrid rotary UPS configuration, there are two modes of bypass. If there is a failure in the electronics, the utility is bypassed into the motor input and there is almost 100% protection against all power line problems except blackouts. There is still 100% lightning protection because of the isolation of the input and output and they have 100% transient and brownout protection. The second mode of the bypass in the hybrid system is complete system bypass from input to output, which is very much like the static units. The redundancy produces added reliability.



The input utility comes into a protective input circuit breaker, and from there, is fed to a transformer. This input transformer transforms the AC voltage to whatever is required by the rectifier, which converts AC to DC output. As mentioned above, the rectifier can be either a 6 or 12 pulse configuration. The higher the pulse numbers, the lower the input current distortion. The DC link is called a “link” because it joins the rectifier and battery to the inverter. The rectifier normally provides charging current to the battery and provides DC input to the inverter.

When there is a power failure, the rectifier shuts down and the battery supplies current to the DC link. Since both are supplying DC to the inverter, the inverter cannot differentiate between the DC coming from the rectifier or the DC coming from the battery bank. Many customers purchase 5 to 10 minute batteries and have a diesel generator back up that comes on to supply utility power to the input of the UPS. Batteries can be designed for almost anytime desired, usually dictated by economics. Some customers have purchased batteries which will last up to one hour. In general, the cost of battery time beyond 15 minutes is usually more expensive than adding a diesel auxiliary generator.

The inverter can be 6 or 12 pulse, depending on the size and configuration of the unit. Since the inverter is made up of SCR's the resulting output waveform is high in distortion. However, the frequency of the waveform is 60 cycle as controlled by the logic. The filtering of the waveform out of the inverter is performed by the dynamic filter made up of a motor alternator set. The filter, as mentioned above, is the difference between a static and a hybrid rotary UPS. The static UPS uses a static filter made up of transformers and tuned LC's. The synchronous motor in the input of the dynamic filter, if you remember, rotates at a speed determined by the fundamental input frequency of the waveform. The distortion on the waveform has no effect on the speed of the synchronous motor, since the speed is determined by the fundamental frequency. Again, this fundamental frequency is controlled by the stable oscillator in the logic. If the motor input voltage is reduced, the motor continues to turn at a speed determined by the input frequency and is not sensitive to input voltage variances until the voltage reaches a point where not enough power is being supplied the synchronous motor for it to turn. This point is generally designed to be around 40% of the rated voltage of the unit. The alternator output frequency and voltage are determined by the shaft speed again is determined by the motor shaft speed, since the two are coupled rigidly together. The regulator on the output of the alternator maintains the voltage regulation to 1%.

Why is this dynamic filter so much better than the static filters? The reason is the total isolation between the motor input voltage and the alternator output voltage. From the above discussion, the output voltage is not influenced at all by the magnitude of the input voltage, nor is it influenced by the magnitude of the input harmonics. The output voltage is simply a function of the input fundamental frequency to the motor and of the alternator voltage regulator loop. Since the motor and the alternator generally are in different frames, this means there is a steel frame separating the windings of the motor and the windings of the generator so there cannot be any EMI coupling between the two. Lightning strikes cannot arc across from input to output. Therefore, duplicate equipment is totally protected from EMI and lightning strikes.

The other advantage of the dynamic filter is in the bypassing schemes; all static UPS have a system bypass so that in case of a failure of the electronics in an all static system, the input is bypassed to the output without interruption. The load will not see this transient, but the load does not have any protection from all of the input utility power problems. In the hybrid rotary UPS, the first bypass that is initiated (due to an electronics failure) would be the bypass from the input to the motor of the dynamic filter. In this case, the load will get a high level of protection. There will be 100% protection against EMI problems, against transient problems, against all brownout problems and against all short outages, which will increase up time.

It is often asked why the dynamic filter is more reliable than the electronics. In general, component count is what determines reliability if all components have suitable derating. Since there are many more components in the inverter/rectifier path, including a large number of power capacitors that have a high failure rate, it is more likely to fail than the dynamic filter. Please note that many computer manufacturers offer motor-alternators for use as a power source for their CPU's. This demonstrates the faith of the computer manufacturers in the motor-alternator concept. If there is a failure in the dynamic filter, as with the static UPS, there will be a system bypass that will bypass the utility to the load without interruption. There will be no "blips" and transients due to this bypass, but there is no protection from input power problems.

There are two configurations for the UPS. One, as described above, is where the normal flow of power is from the input, to the rectifier, to the DC link, to the inverter, to the dynamic filter, and then to the load. If there is a fault in the electronics, there is a bypass around the electronics to the dynamic filter and if there is a failure in the dynamic filter, there is a system bypass mode. Another approach is that the unit normally runs in a bypass to the motor mode; i.e., the power flow is normally from the input to the motor and from the alternator to the load. If there is a power outage that last over one-half second, the inverter automatically cuts on and starts supplying power to the motor. In both cases, the concepts have advantages and disadvantages but both concepts are better than an all static concept. The major weakness of the offline inverter is that components tend to fail on initial start-up and thermal shock. The major advantage is cost. Sometimes the question of the system efficiency is brought up. If we talk about site efficiency, which includes all the power required by the site to run the UPS, you will find that the hybrid UPS is generally more efficient. The hybrid rotary is a very simple unit, is non-complex, and therefore, does not require an air conditioned environment. The units can run in 40º C ambient (104ºF) without any problem. In all cases, the battery must be maintained at 77ºF or less, but this only requires a small air conditioner as the battery itself does not give off very much heat. Therefore, the total site efficiency would be higher than that of a static unit that required air conditioning to maintain the console between 30º-40º C.