Traditional drives employ large aluminum electrolytic capacitor banks to store energy, filter the output switching, and create a steady DC bus voltage for use by the output power stage. The front end of the drive consists of a diode bridge that coverts AC to DC. Because a diode only conducts in the forward direction when input voltage exceeds the DC bus, the input current becomes discontinuous and highly distorted. This is true for all VFD's that use traditional electrolytic capacitors, and is the inherent problem that utilities and consulting engineers are concerned with as these VFD's contribute heavily to the overall harmonic distortion in a system.

Aluminum electrolytic capacitors suffer excessive heating and a shorter lifespan than their counterpart capacitors composed of polyester film. Film capacitors last much longer and can handle a much higher ripple current, which makes them much more desirable in motor control applications. While the same basic process (AC to DC, DC to PWM) is employed in the Q-Link Drive, the R^3 Filtering topology utilizes polyester thin film capacitors in place of aluminum electrolytic capacitors. Due to the much higher ripple current carrying capacity, the DC bus is allowed to fluctuate much more, which means designs can utilize a greatly reduced capacitance, on the order of $1/100^{th}$. Not only does the film capacitor approach offer much less heating, longer lifespan and smaller footprint, but it also significantly improves the input current distortion.

Due to the reduced capacitance, the DC bus voltage now more closely follows the input voltage with little energy stored. Since the DC bus voltage is allowed to dip much lower, the diodes are in the forward conducting region much longer. The result is an input current more closely resembling that of a sine wave (<35% distortion) as opposed to the highly distorted input current of the traditional topology.

Peak current levels are also much lower, because the diodes are conducting for a much larger percent of each cycle. Imagine an application with several drives in parallel. The excess peak current will occur at the same time for all drives and result in a much higher current at the source, leading to larger breaker/fuse requirements (higher cost) and the potential for nuisance trips.

Drives utilizing a reduced capacitance technology solve these issues on the input, but without the proper intelligence (such as R^3 Filtering) the fluctuating DC Bus could present distortion on the output of the drive that would affect motor longevity and overall system performance. Traditional drives generate a switching frequency based on an assumption of stable DC bus voltage to produce the proper output voltage. Since the R^3 Filtering technology employs a greatly reduced capacitance and thus a more varying DC bus voltage, proper corrections must be made to ensure this fluctuation does not appear at the output of the drive. If the output voltage contained a 360Hz residual ripple, this would in turn create a ripple on the output voltage. As torque is a function of speed and voltage, this could cause a 360Hz torque ripple in the motor, which could create excessive motor heating and application issues. R^3 Filtering technology employs a highly sophisticated algorithm that monitors the DC bus voltage in real-time and compensates for any fluctuation, ensuring a pure sine wave at the output of the drive.

Traditional techniques to mitigate input current distortion included AC line reactors, DC bus chokes, and active front-end approaches. All of these solutions address the problem, but at the expense of larger panel sizes, higher packaged solution cost, and decreased efficiency. R^3 Filtering prevents harmonic distortion at the onset, addressing the root cause of the issue rather than mitigating it.

Figure 1 & 2 illustrates test data for a traditional aluminum electrolytic drive (Figure 1) alongside a Q-Link drive with R^3 Filtering (Figure 2).

Figure 1: Normal Electrolytic Capacitance 820uF

Vdc - DC Bus Voltage
V13 - Line to Line Voltage
V32 - Line to Line Voltage
V21 - Line to Line Voltage
I1 - Phase 1 input Current

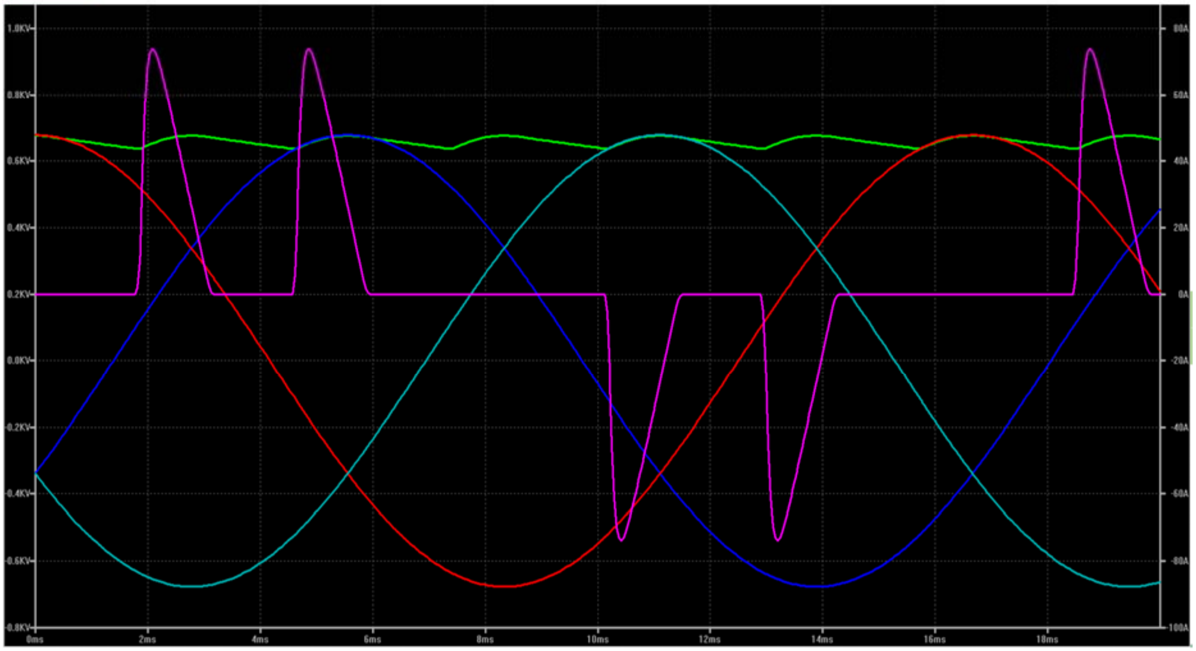

Figure 2: R3FILTERING 10uF

Vdc - DC Bus Voltage
V13 - Line to Line Voltage
V32 - Line to Line Voltage
V21 - Line to Line Voltage
I1 - Phase 1 input Current