VOLTAGE DISTURBANCES (DIPS)

1.1.1.1 Voltage regulation

There is no such thing as steady state on the power system. Loads are continually changing and the power system is continually adjusting to these changes. All of these changes and adjustments result in voltage variations that are referred to as **long duration voltage variations**. These can be **under voltages or over voltages,** depending on the specific circuit conditions. Characteristics of the steady state voltage are best expressed with long duration profiles and statistics. Important characteristics include the voltage magnitude and unbalance. Harmonic distortion is also a characteristic of the steady state voltage but this characteristic is treated separately because of its dependence on the load characteristics.

Long Duration Voltage Variations

Long duration voltage variations include the normal daily variations of the voltage caused by load variations and the system voltage regulation equipment (tap changers, voltage regulators, capacitor banks, etc). These variations are typically characterized by plotting voltage profiles over extended periods of time, such as 24 hours (*Figure 1*).

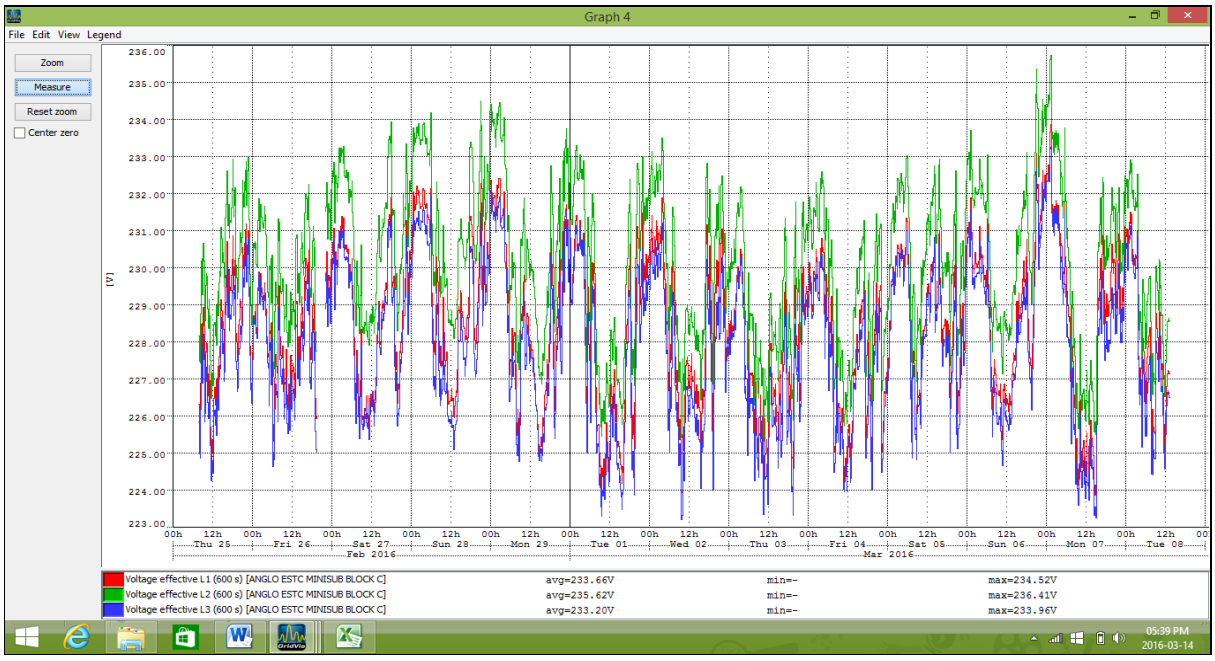

Figure 1: Voltage regulation profile

Over voltages

A momentary swell, or over voltage, is any change above the prescribed input voltage range for duration of one half cycles to 2 minutes (*Figure 2*). A sustained swell is an increase in the line voltage for a period greater than 2 minutes. Over voltages can be caused by incorrect transformer tap settings and improper application of power factor correction capacitors. They can cause overheating and reduced life of electrical equipment.

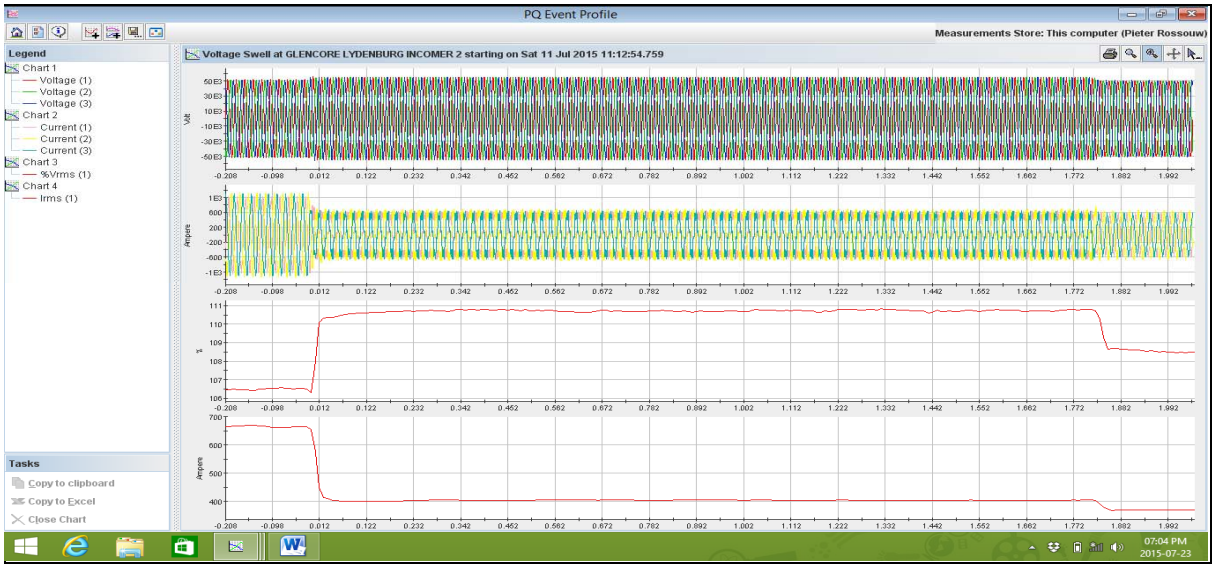

Figure 2: *Over voltage condition* - RMS trend of disturbance event – showing that the voltage increased as soon as load is reduced.

Under voltages

An under voltage is any change below the prescribed input voltage range for a given piece of equipment (*Figure 3*). Under voltages can be caused by overloaded distribution systems or customer wiring, incorrect transformer tap setting, faulty connections or wiring, loose or corroded connections, or unbalanced phase loading conditions. They cause a range of problems from errors in sensitive equipment to hardware damage, low efficiency, and reduced life of electrical equipment (e.g., some motors and heaters).

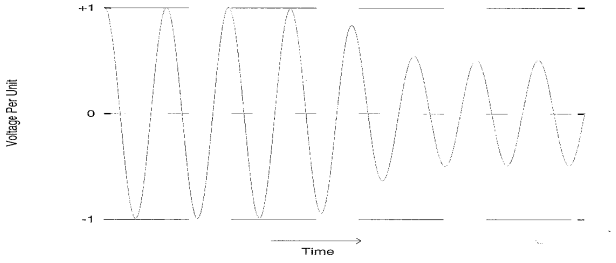

Figure 3: *Under voltage condition*

Voltage Disturbances (dip)

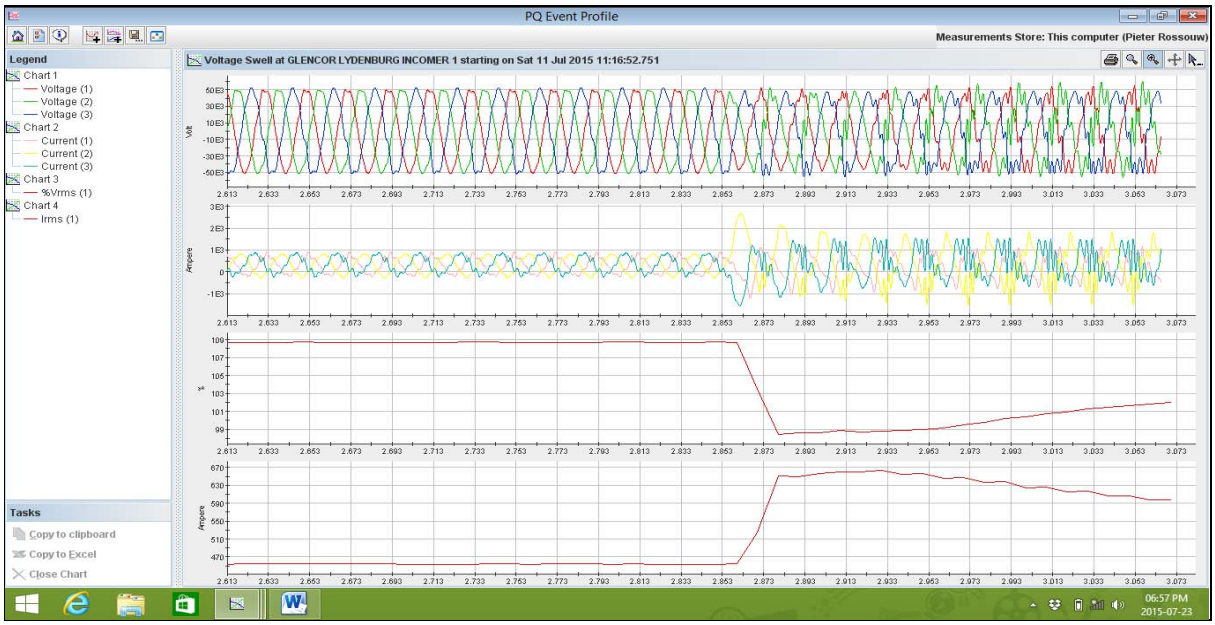

Figure 4: RMS trend of disturbance event – showing voltage dropped as soon as load is increased, which is what one would expect when a large load is added to the network. Figure shows that when network is lightly loaded the voltage is high and as soon as load is added it is within the specification of 5% regulation.

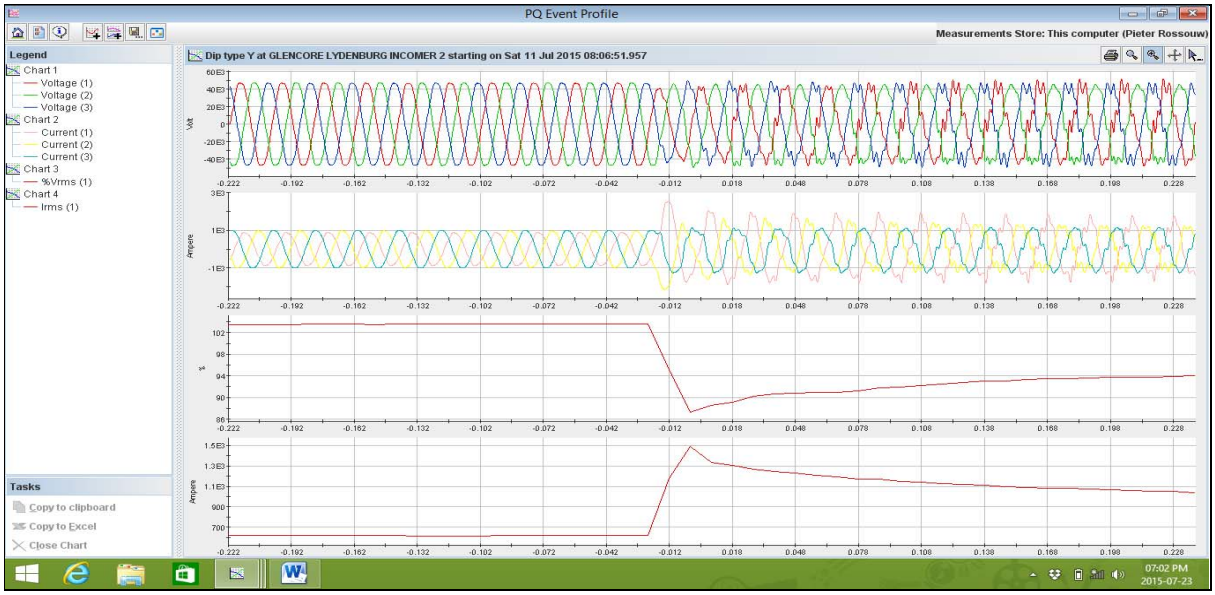

Figure 5: A very similar event than Figure 4. RMS trend of disturbance event – showing voltage dropped as soon as load is increased, which is what one would expect when a large load is added to the network. Figure shows that when network is lightly loaded the voltage is high and as soon as load is added it is within the specification of 5% regulation.