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APPLICATION NOTE 25

Performing PWM Motor Drive Ramp Testing with the PPA45/5500 Power Analyzers

Introduction

Ramp testing of PWM/Inverter Motor drives is a demanding application for any power analyzer, however the PPA4500 and PPA5500 series of power analyzers are ideally suited to such an application. They both feature very high speed FPGA architecture, excellent common mode rejection, sophisticated parallel filtering and frequency tracking algorithms which provide true wideband measurements of dynamically changing loads.

This application note will discuss how to set up the power analyzer for a ramp test of a PWM motor drive in which both the load and the fundamental/motor frequency is expected to rapidly change.

Setting Up the PPA (Fig 1)

We must first enter "PWM Motor Drive Mode" which is found in the "APP" menu.

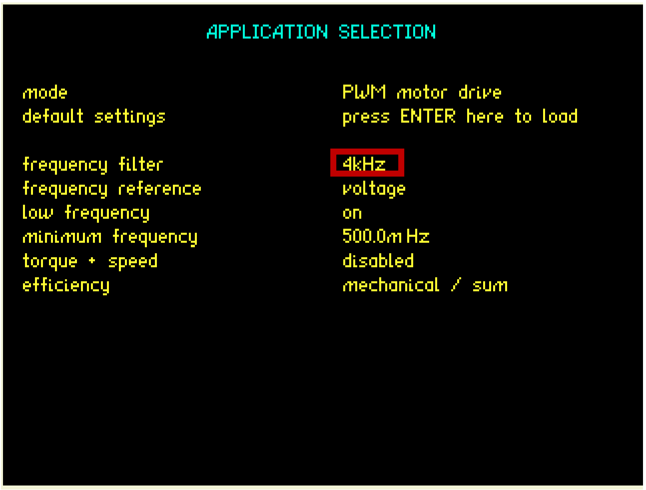

Fig 1

The most influential setting here is the "frequency filter", this is a parallel digital filter intended to filter out the switching/carrier frequency of the inverter drive for frequency detection **ONLY**. It is important to remember that the data used for power analysis is not filtered and you will always obtain **wideband** power measurements, it is often overlooked that many power analysers on the market filter such data resulting in incorrect measurements, particularly the Voltage RMS parameter with often significant wideband content as a result of the switching edges.

The frequency at which this filter is set is very important, the principle to use when setting this parameter is to use a filter that is slightly higher in frequency than the maximum motor frequency and lower than the switching/carrier frequency.

Example filter selections are illustrated in the table below;

Max Motor/Fundamental Freq	Switching Freq	Filter Selection
100Hz	5kHz	250Hz
1kHz	25kHz	4kHz

Speed (Fig 2)

As we intend to perform a very fast measurement we have the option to carry out "cycle-by-cycle" analysis, this is essentially the ability to output the RMS value on a cycle-by-cycle basis which requires the analyzer to output data after every cycle. We will set the instrument in "Very Fast" mode, very fast mode will provide a minimum window size of 1/80s which will clearly provide cycle-by-cycle analysis up to 80Hz.

When cycle-by-cycle analysis of higher fundamental frequencies than the 80Hz possible in *very fast* mode is required, it is recommended to use a speed setting of "window" and then select the window size as required (minimum 2ms direct to internal RAM/ minimum 5ms direct to Software).

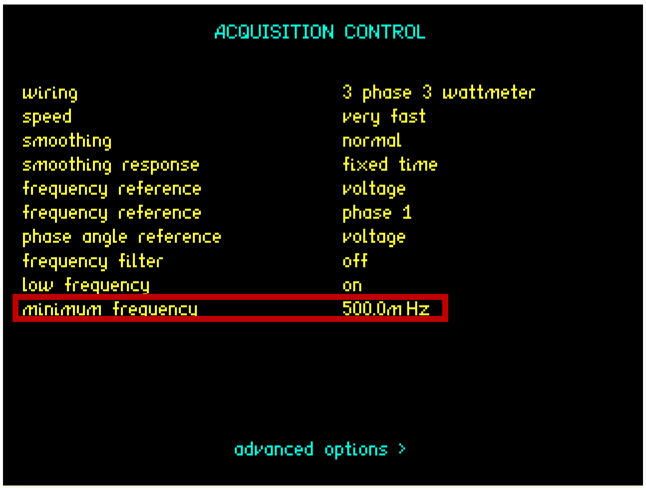

Fig 2

Note that low frequency mode is set to *ON,* this mode provides a very useful feature. Low frequency mode ensures that as the fundamental frequency time period becomes longer (as frequency decreases) the window will automatically extend down to the frequency specified in the PWM Application/Acquisition menu as the *minimum frequency*.

Advanced Acquisition (Fig 3)

If we press the Right keypad arrow whilst in the Acquisition menu, we enter Acquisition-Advanced settings. We know that the fundamental/motor frequency will be rapidly changing therefore it is recommended to set frequency lock as *Dynamic* and high-speed mode to *Enabled*.

Note: High Speed mode disables some of the parameters computed in "normal mode", the instrument will now compute Vrms, Irms, Watts RMS for Channel 1, 2 and 3.

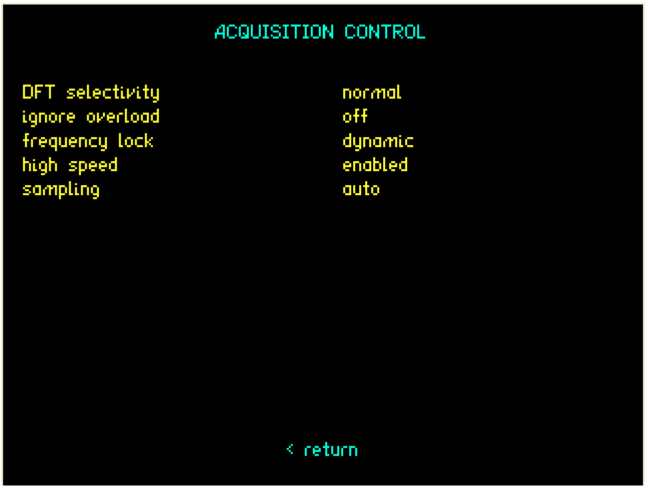

Fig 3

Ranging (Fig 4)

As the load will by dynamic and we wish to analyse the device on a cycle by cycle basis we should set the ranging to *manual* and set the range to a level at which we know the load will not exceed during the test.

Note: Setting the range to manual and accidentally exceeding this range level will **NOT** cause any damage to the PPA Voltage/Current inputs providing the Voltage/Current level does not exceed the maximum current for the particular model of PPA used. This is a result of the sophisticated "single shunt - single attenuator" design developed by N4L.

Example limits are as follows for the PPA45/5530:

Model	Voltage Limit	Current Limit
PPA45/5530 Standard Current	1000Vrms/3000Vpk	30Arms/300Apk
PPA45/5530 Low Current	1000Vrms/3000Vpk	10Arms/30Apk
PPA45/5530 High Current	1000Vrms/3000Vpk	50Arms/1000Apk

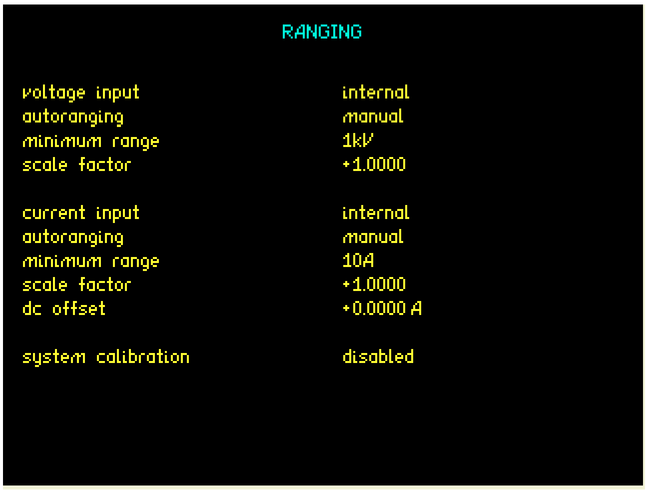

Fig 4

Analysis (Fig 5)

Using PPALoG, free software available via the N4L website, *high speed mode* is enabled and the PPA Datalogger was started.

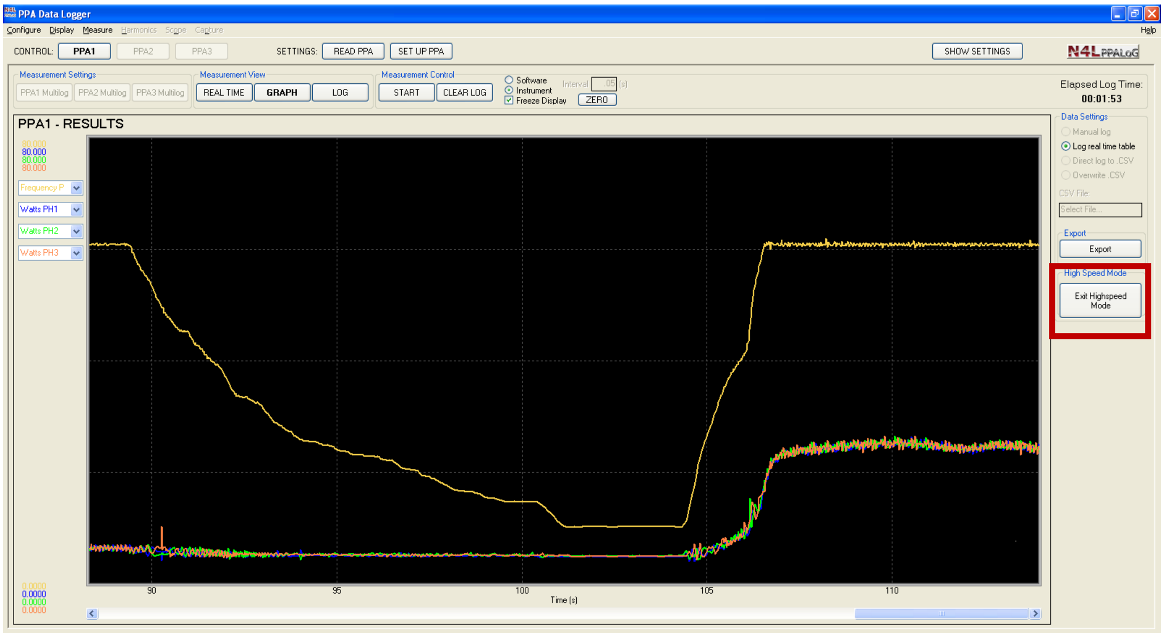

Fig 5

Fig 5 illustrates the speed at which the PPA45/5500 combined with N4L software is able to synchronise with a rapidly changing fundamental frequency whilst simultaneously analysing the Voltage, Current and Power.

In line with N4L's philosophy of true real time no-gap analysis, this mode is no different and the measurement is taken with no gap.

At 15:50:17 the load on the motor was removed, during ramp up at 15:50:32 the load increased, an excel graphical plot (fig 6) is also shown below.

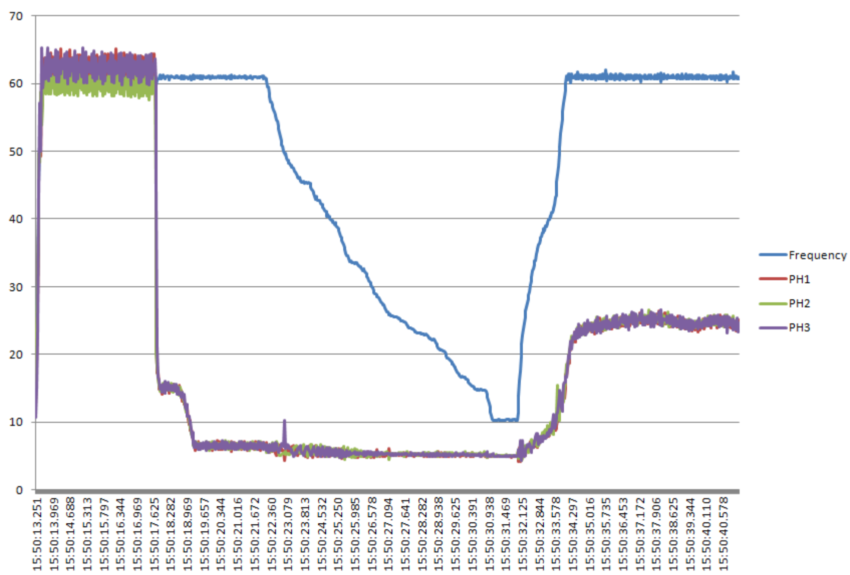

Fig 6