Powerframes

Virtual Instrumentation Software Manual

60-070-VI

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Notes

Product Use

All users must familiarise themselves with the following information.

This product is marked as CE compliant. This means that it complies with the relevant European Directives for this product. In particular the Directives cover Low Voltage, EMC, Machinery, Pressure and electronic waste disposal.

The equipment, when used in normal or prescribed applications and within the parameters set for its mechanical and electrical performance, should not cause any danger or hazard to health or safety.

If, in specific cases, circumstances exist in which a potential hazard may be brought about by careless or improper use, these will be pointed out and the necessary precautions emphasised.

This equipment is designed for use by students as part of the learning process who must be under the supervision of a suitably qualified and experienced person in a laboratory environment where safety precautions and good engineering practices are applied.

By the nature of its intrinsic teaching functionality, parts are visible and accessible that might normally be covered up or encased in an industrial or domestic product. For this reason students attention should be drawn to the need to operate the equipment only in the manner prescribed in the accompanying documentation and supervisors must make students aware of any particular risk. The equipment should not be operated by any person alone.

We are required to indicate on our equipment panels certain areas and warnings that require attention by the user. These have been indicated in the specified way by yellow labels with black printing. The meanings of any labels that may be fixed to the instrument are shown below:

CAUTION - RISK OF DANGER

CAUTION - RISK OF ELECTRIC SHOCK

CAUTION - ELECTROSTATIC SENSITIVE DEVICE

Compliance with the EMC Directive

This equipment has been designed to comply with the essential requirements of the Directive. However, because of the intrinsic teaching function it cannot be electromagnetically shielded to the same extent as equipment designed for industrial or domestic use. For this reason the equipment should only be operated in a teaching laboratory environment where electromagnetic emissions in the immediate area might not be expected to cause adverse effects. In the same way users should be aware that operating the equipment near to an electromagnetic source may cause the experimental results to be outside the range expected.

The Waste Electrical and Electronic Equipment Directive (WEEE)

If this equipment is disposed of it must be in accordance with the regulations regarding the safe disposal of electronic and electrical items and not placed with ordinary domestic or industrial waste.

Product Improvements

We maintain a policy of continuous product improvement by incorporating the latest developments and components into our equipment, even up to the time of dispatch.

All major changes are incorporated into up-dated editions of our manuals and this manual was believed to be correct at the time of printing. However, some product changes which do not affect the teaching capability of the equipment, may not be included until it is necessary to incorporate other significant changes.

Component Replacement

In order to maintain compliance with the Directives all replacement components must be identical to those originally supplied.

Operating Conditions

WARNING:

This equipment must not be used in conditions of condensing humidity.

This equipment is designed to operate under the following conditions:

Operating Temperature	10°C to 40°C (50°F to 104°F)
Humidity	10% to 90% (non-condensing)

ACKNOWLEDGEMENTS

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TABLE OF CONTENTS

Notes

1 System Description

1.1 Introduction

Note: If carrying out experiments from the 60-070 series of manuals, these manuals will refer to the virtual instrumentation which used the 68-500, 68-441 and 67-502 hardware. This hardware has now been replaced with the 68-600, 68-445 and 67-505 respectively.

The operation and physical appearance are different to the units they replace and so care must be taken when connecting up the hardware in configurations illustrated in these manuals.

The Espial based 60-070 Virtual Instrumentation system is intended for use in Electrical Systems where a number of measuring instruments is generally required to evaluate the system behaviour. Conventionally, this would be achieved using several separate bench meters, but now a personal computer (PC), a data acquisition device (68-600 Multi-Channel Power Sensor) and virtual instrumentation combines all these instrument functions. The virtual instrumentation software is used to reproduce the meter functions and provide a virtual instruments display.

The virtual instrumentation system can also be used in conjunction with a dynamometer (and controller) to form a Machines Testing System, which allows ac and dc motors and generators with power ratings up to 300 watts to be tested. Machine loading tests can be conducted manually or under software control.

The system finds many applications for its multi-measurement capability within the *Powerframes* range of machines and transformer systems, and can be used wherever several electrical parameters are required to be measured.

The Virtual Instrumentation software can be used with either or both the 68-600 Multi- Channel Power Sensor and 68-445 Machine Test system (with the 67-505 Dynamometer).

The 68-600 Multi- Channel Power Sensor captures voltage and current signals for analysis and the 68-445 (with 67-505) captures speed and torque values of machines under test. This data is displayed in the integrated 60-070 virtual instrumentation in Espial.

The instrumentation provides numerical, waveform, spectral and vector plots of both direct measurements, such as voltage and current as well as derived functions such as relative phase and power factor. This is available for both single phase and three phase systems.

In order to have clean and stable measurements extensive use is made of digital signal processing, in particular where signals have significant harmonic content or where unavoidable noise is present. It is also possible to examine the parameters associated with individual

harmonics. This is of interest in the analysis of non-linear loads and their contribution to system losses.

The direct measurements comprise three voltage and three current channels, each with their own reference so there is complete connection flexibility. Preconfigured displays are available that mean common measurements can be achieved quickly and simply.

The displays available are:

Real-time waveform of voltage and current, organised such that relevant traces may be overlaid
Three D vector display of voltage and current showing both amplitude and phase
Spectral data in both graphical form, as well as derived functions such as total harmonic distortion
Numerical data such as frequency

Data from different displays may be viewed concurrently

All instrumentation has built-in facilities for accurate parameter extraction and display export to stored images

68-600 Specification

Number of voltage channels	3
Voltage input resistance	>10k ohms
Number of current channels	3
Maximum differential peak voltage	600 volts, 320 volts with respect to local ground
Maximum current	14 amps
Current input resistance	<0.5 ohms
Computer Interface	USB2
Maximum sampling rate	512 kHz
Maximum sample length	1024
Resolution	12 bits

1.2 Software based Virtual Instrumentation System

The virtual instrumentation system comprises:

- Multichannel I/O Unit 68-600 with USB connection
- Espial based Instrumentation software 60-070 CD-ROM
- USB Interconnection Cable
- 93-420 Espial & Tools CD-ROM plus Activation Key (purchased separately)

The above may be purchased with Machines Testing equipment which includes a Machine Testing System Unit 68-445 and a Dynamometer 67-505.

The 68-600 and 68-445 are designed to be mounted into a 91-200 system frame. It is connected to mains power for the internal electronic circuits and, via a USB connection on the rear of the 68-

600 Unit and USB cable, to the PC with the 60-070 Instrumentation software installed.

1.2.1 Measurement Input

Up to three ac or dc voltages and currents can be measured using the 4 mm connections on the front panel of the 68-600 Multi-Channel Power Sensor Unit.

The software provides instrumentation for measuring and displaying a number of direct and derived values the instrumentation provided includes:

- Oscilloscope
- Vectorscope
- Spectrum Analyser
- Frequency Counter

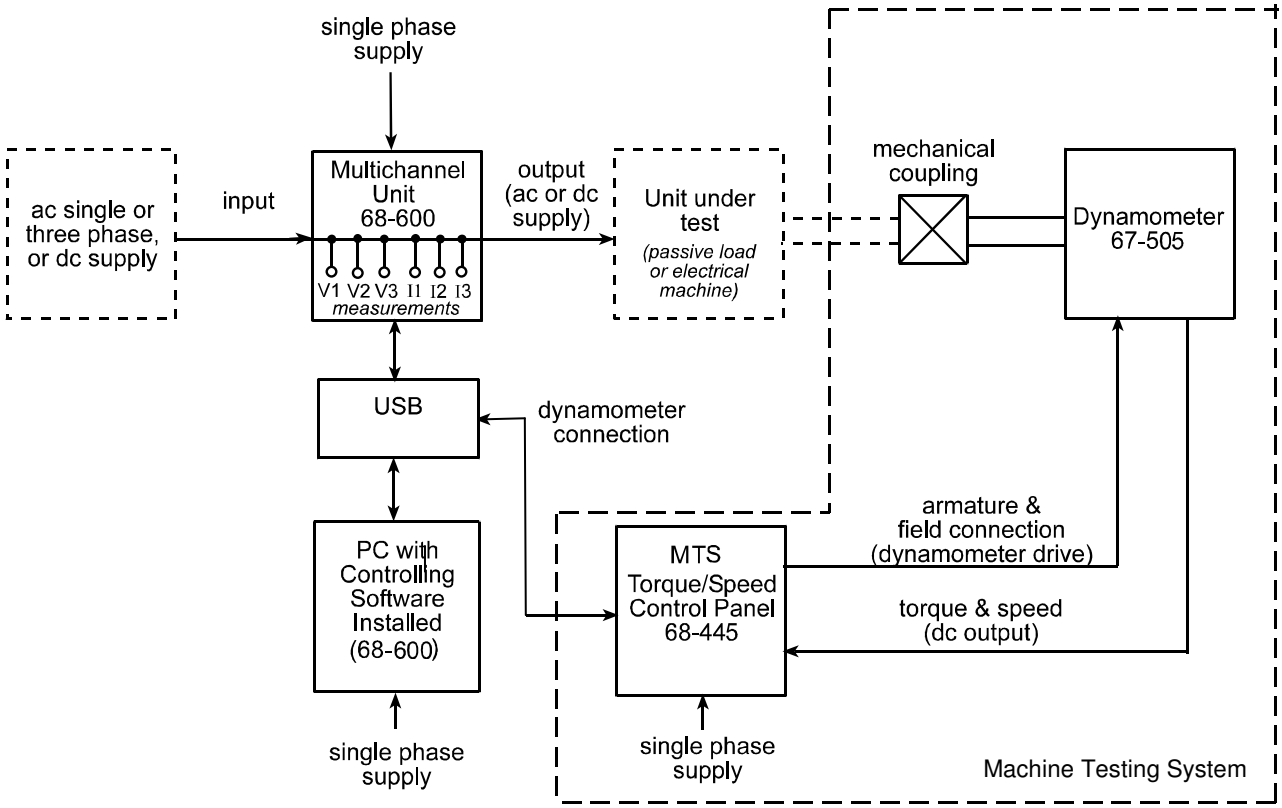
Using the above instruments it is possible to select and view the following measurements:

- Oscilloscope – 2 Channels either Voltage or Current.
- Vectorscope –Single phase (2 Channel) or 3 phase (6 Channel) displayed showing phase and magnitude. Derived values of Apparent Power (VA), Real Power (W) and Power factor displayed. DC values, Phi absolute and 2 wattmeter also selectable.
- Spectrum Analyser – 2 Channels displaying signal magnitude as a function of frequency.
- Frequency Count – Single Channel frequency display.

Each instrument within a practical is preconfigured, and these settings will be stated in the practical text.

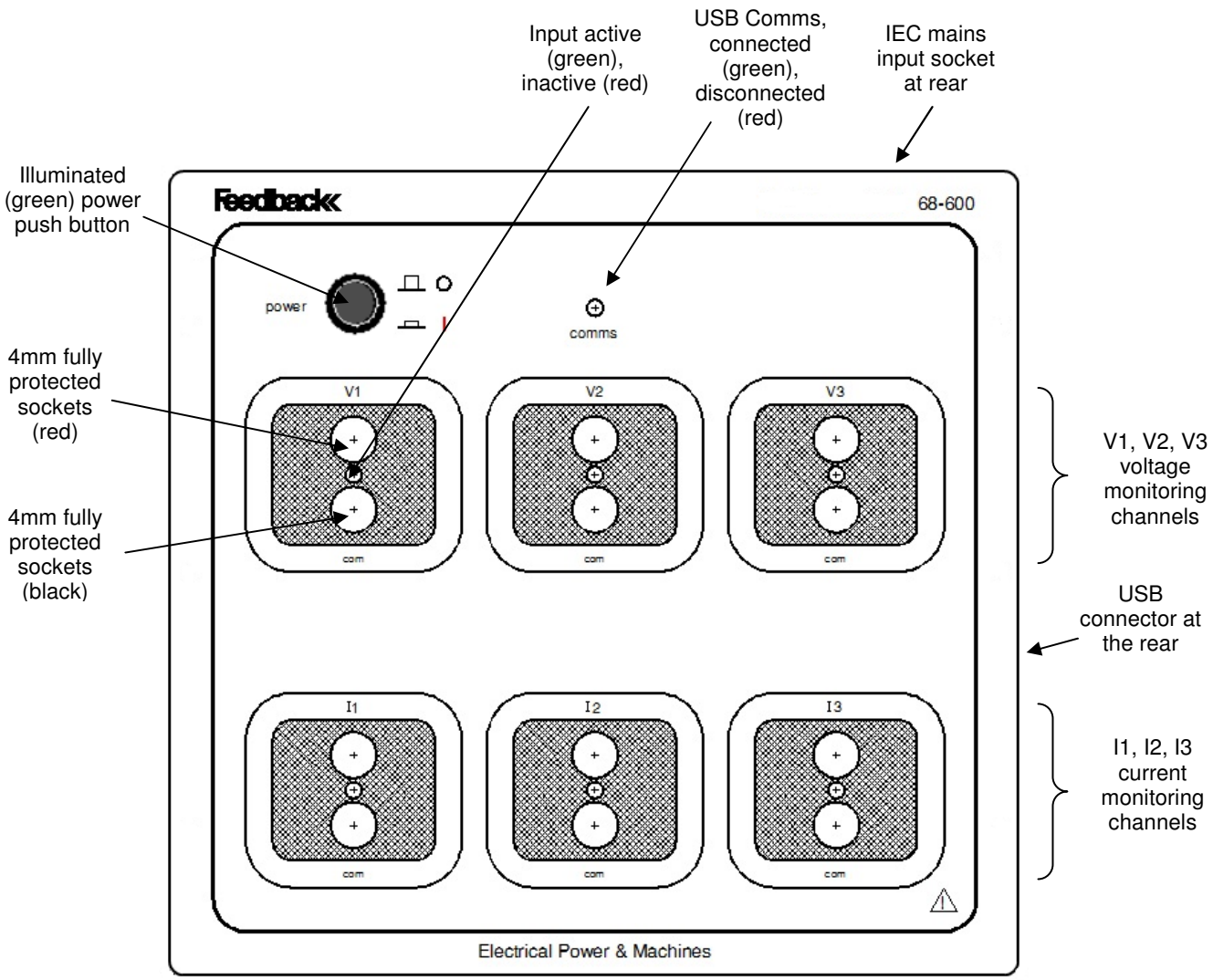
Instrument configurations can be changed and altered using the Espial Tools supplied on the Espial & Tools CD-ROM

The system may be used in conjunction with the 67-505 Dynamometer and 68-445 MTS unit to form a complete Machines Testing System, shown as a block diagram below.



Complete Machines Testing System

1.2.2 Multi-Channel Power Sensor Unit



Multi-Channel Power Sensor Unit Front Panel

1.2.2.1 Front Panel

The diagram above shows the front panel layout of the Multi-Channel Power Sensor Unit.

There are six sets of sockets for independent measurements of three ac or dc voltages, and three ac or dc currents.

An LED is provided for each voltage and current channel to indicate channel activity. If an LED is lit up red then the channel is inactive, if green then the channel is active and gathering data.

1.2.2.2 Rear Panel

The rear panel of the 68-600 has the power supply input to the unit and a USB connector for connection via the supplied cable to the PC.

1.3 Machine Testing System

The computer based Virtual Instrumentation System operation is extended with the addition of the Machine Test System Panel 68-445 and Dynamometer 67-505. This addition to the Instrumentation System forms a complete Machines Testing System as shown in the diagram above.

The complete system comprises:

- Machine Test System 68-445
- Dynamometer 67-505
- Interconnecting Cables for 67-505 Dynamometer to 68-445 MTS – 7pin & 25 pin cables
- Multi-Channel Power Sensor 68-600
- Software Pack 93-420 Espial & Tools CD-ROM (purchased separately)
- 60-070 Virtual Instrumentation software CD-ROM.
- 2 x USB Interconnection Cable

The machine testing system is controlled by the Espial based 60-070 Virtual Instrumentation software. The system software allows motor loading, as a torque quantity (Nm), to be set and varied from the computer, or a speed quantity (rpm) set and varied if the dynamometer is operated in speed mode.

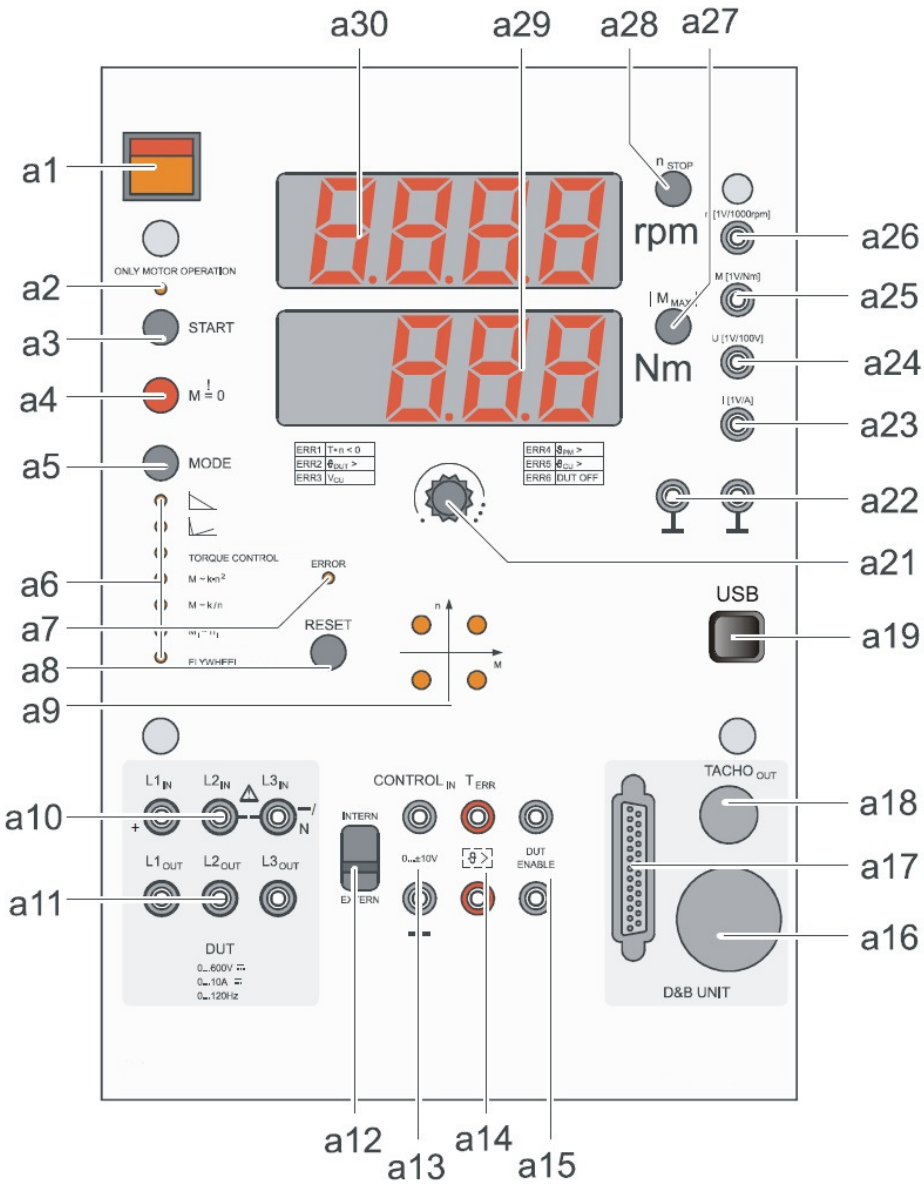
Electrical input quantities and machine output parameters are monitored or measured using the Multi-Channel Power Sensor 68-600. Measurements of incoming supplies which consist of up to three voltages and three currents, these are shown on virtual instrumentation displays on the computer screen. Additionally, the system can compute and display power, phase angles, power factors, volt-amperes and frequencies.

1.3.1 Machine Test System 68-445 (with 67-505)

The 68-445 Machine Test system control unit is a microcontroller-controlled device with integrated frequency converter for the power supply and control of the three-phase pendulum machine and display of the speed and torque measured values. Different operating modes permit manual and automatic recording of characteristics. Furthermore, the machines can approach unstable operating points, like when the squirrel-cage machines are set to lower speeds than the pull-out speeds, which are then maintained exactly by digital control loops.

The front panel is shown below and includes operational controls and connectors for the various external equipment.

Multiway connectors are provided for connection of the dynamometer machine and its tacho-generator. There is a round 7 pin connector and a 25 pin connector on both the 68-445 and 67-505 that need connecting together using the supplied cables. A USB connector provides a link to the PC with the instrumentation software installed so torque and speed functions can be controlled.



Torque & Speed Control Panel 68-445

68-445 Torque & Speed Panel description

a1 Main switch

ON / OFF switch for the control electronics and supply voltages for the pendulum torque & speed control panel.

a2 2- or 4-quadrant operation (ONLY MOTOR OPERATION)

If this LED lights up the control unit automatically switches off when the DUT is operating in the 2nd or 4th quadrants (generator operation). This is a function used to protect power sources which

are not energy recovery-proof, if the DUT is being supplied by such a source.

After the device is switched on at switch S, the LED lights up (only 2-quadrant operation possible). If the device is switched on by pressing the START button (directly below the LED), the LED does not light up (4-quadrant operation possible).

a3 Pushbutton to start automatic recording of the characteristics.

If the operating mode load characteristic or run-up characteristic is active, automatic recording of characteristics can be started by pressing the pushbutton.
In the case of the load characteristic the speed range, starting from the momentary speed value and automatically proceeding up to the stop speed. For the run-up characteristic the machine-generator set is rapidly braked to the stop speed in order to run up again to the speed applicable for start or recording. Before starting the characteristic recording the momentary speed can be changed using the incremental control knob . At the end of the characteristic recording the machine-generator set sheds its load and the stop speed flashes for approx. 5 seconds.

a4 The pushbutton M = 0 serves to interrupt any given operating state.

At the same time the torque display shows OFF. The 67-505 dynamometer no longer develops any torque, comes to a standstill or is set to its no-load speed by the machine under test. Consequently, the activation of the pushbutton M = 0 results at all times to the load shedding of the machine-generator set. Reactivation of the pushbutton M = 0 results in the reactivation of the control unit and there with the frequency converter.

a5 Operating mode switch (MODE)

Switchover to the next operating mode occurs each time this pushbutton is pressed. The current operating mode is displayed by an LED **(a6)**.

a6 Modes of operation:

a6.1 Load characteristic (Speed) 

The rotation speed, specified by the incremental control knob or externally, is kept constant. The load of the DUT is the product of its speed / torque characteristic. The recording of the characteristic is started by pressing the START button.

a6.2 Run-up characteristic

The speed, which is preset using the incremental control knob or externally, is kept constant. The load of the DUT is the product of its speed / torque characteristic. The recording of the characteristic is started by pressing the START button.

a6.3 Automatic torque control (TORQUE CONTROL)

The torque, which is set by means of the incremental control knob or externally, is kept constant. The DUT operates under constant load.

a6.4 Load simulation M ~ k n2

The 67-505 Unit simulates the load response of a fan (M ~ k * n2 with k = 1).

a6.5 Load simulation M ~ k / n

The 67-505 Unit simulates the load response of a winding drive (M ~ k / n with k = 1).
a6.6 Load simulation Mi ~ ni

The 67-505 Unit simulates the load response with arbitrary characteristic edited by the user.
a6.7 Load simulation flywheel

The 67-505 Unit simulates the load response of a flywheel.

Note only the Load characteristic and Torque modes can currently be used with the Espial software.

a7 Error message LED (ERROR)

A multicolored LED is situated with the following significance:

off:	normal operation
green:	An error has been eliminated and has to be acknowledged
red:	An error appears and is displayed as ERR n (n stands for 1 to 6)

Acknowledge by pressing RESET button **(a8)**.

a8 RESET

If an error message is displayed or switch off has been carried out because the torque limit has been exceeded, the control unit can be switched on using this button. However, this is only possible if the corresponding error has been eliminated. In the case of switch-off due to overheating this entails a cooling off of the corresponding components (LED lights green).

a9 Four-quadrant display

Display of the instantaneous load type of the DUT.

Quadrant	Load type	Rotation direction
1st quadrant	*Motor operation*	*clockwise*
2nd quadrant	*Generator operation*	*couterclockwise*
3rd quadrant	*Motor operation*	*counterclockwise*
4th quadrant	*Generator operation*	*clockwise*

a10 $L1_{IN}$, $L2_{IN}$, $L3_{IN}$ resp. (-)-pole or N (Neutral)

Input sockets to the internal DUT's measurement circuits for connection of external power supply:

Input ranges for	voltages:	0…600 V AC/DC
	currents:	0…10 A AC/DC
	frequency:	0…120 Hz

Note these inputs are not currently used with the Espial software.

a11 $L1_{OUT}$, $L2_{OUT}$, $L3_{OUT}$

Output sockets for connection of different DUT-machines
(DC, AC, 3~)

Note these outputs are not currently used with the Espial software.

a12 INTERN / EXTERN-switch

INTERN: Depending on the operating mode reference variable is set for speed, or torque via the incremental control knob.
When using the 68-445 Machine Test System with a PC make sure the switch is set to this position.
EXTERN: Depending on the operating mode the reference variable is set for speed or torque via the external input CONTROLIN (a13).

a13 External control input CONTROLIN

This input is active if the INTERN / EXTERN-switch is set to EXTERN. For external operation the setpoint value for the control loop selected by the MODE button is supplied via this socket. Here the following linear relationships apply to some extent:

Automatic torque control (TORQUE CONTROL):
±10 V corresponds to ±10 N
Automatic speed control (SPEED CONTROL):
±10 V corresponds to ±5000 rpm

The setpoint value is supplied to the selected controller via a run-up generator. This means that setpoint step changes are possible and lead to a slight overshoot of the controller in question.

a14 Temperature monitoring of the Device Under Test (DUT): TERR

This input is connected to the thermal contact of the DUT. This connection is always established as otherwise there would be no overload protection for the DUT.

NOTE: Some device that are to be put under test may not be fitted with thermal protection output and so the TERR sockets on the 68-445 will need connecting together with a short lead in order for the 68-445 not to show an error (pressing reset will clear the error after the short lead has been added). Where a device to be tested has a thermal protection output it must be connected to the 68-445.

a15 DUT ENABLE-sockets

a16 Connection socket to supply the 67-505 Unit.

a17 Control connection input

Multifunction Input for the connection of the 67-505 unit's build-in incremental tacho-generator, torque measurement- and protection circuits.

a18 Digital speed output (TACHOOUT)

The signals of the tacho-generator are automatically forwarded.

a19 USB interface (USB)

This interface is electrically isolated and outputs the speed and torque of the 67-505 Unit. Control of the control unit can also be carried out using the Espial and 68-600 software.

a21 Incremental control knob to change the reference variable and the limit

The reference variable to be changed depends on the operating mode set and thus on the control loop currently activated. The speed setpoint is varied in the operating modes load characteristic and run-up characteristic.

Setting range: -5000 rpm...0 rpm...5000 rpm

In the automatic torque control mode (TORQUE CONTROL) the setpoint value for the torque control loop is varied.

Setting range: -9.99 Nm...0 Nm...+9.99 Nm

In the case of external operation the incremental control knob cannot induce a change in the setpoint.
If the stop speed or the torque limit is displayed (by pressing or, the incremental control knob can be used to vary the value currently being displayed.

Setting range stop speed: 0 rpm…+/-5000 rpm
Setting range torque limit: 0 Nm…+/-9.99 Nm

The load simulation operating modes only permit an effective setting of the torque limit, for load simulation of a winding drive (M ~ k/n) the maximum adjustable torque limit is at 5 Nm (this torque has to be overcome during start up).

a22 Auxiliary ground sockets

a23 Analog DUT's current output (I [1 V / A])
The voltage is proportional to the DUT's supply current when connected to DUT socket field (1 V corresponds to 1 A).

a24 Analog DUT's voltage output (U [1 V / 100 V])
The voltage is proportional to the DUT's supply voltage when connected to DUT socket field (1 V corresponds to 100 V).

a25 Analog torque output (M [1 V / Nm])
The voltage is proportional to the instantaneous torque of the 67-505 Unit (1 V corresponds to 1 Nm).

a26 Analog speed output (n [1 V / 1000 rpm])

The voltage is proportional to the momentary speed of the machine-generator set (1 V corresponds to 1000 rpm).

a27 Pushbutton to display torque limit (|MMAX|)

When operated switchover occurs between the torque limit and the momentary torque. If the torque limit is being displayed, the display flashes. This value can now be changed using the incremental control knob.

If the display flashes, max. limit switch off (machine torque > set torque limit) is performed at the value now shown in the display. The DUT sheds its load: M = 0.

a28 Pushbutton to display speed limit nSTOP

When operated switchover occurs between stop speed and current speed. If the stop speed is displayed, the display flashes. This value can now be changed using the incremental control knob.

a29 3-digit 7-segment display to indicate the torque

a30 4-digit 7-segment display for the indication of the speed and error codes.

To acknowledge error see RESET (a8)

1.3.2 67-505 Dynamometer

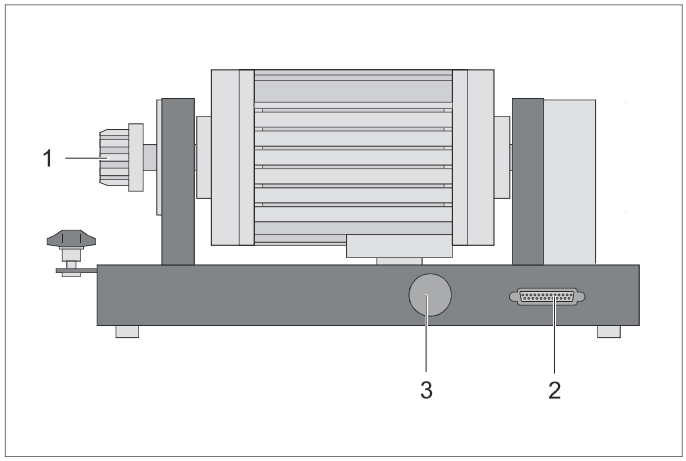
67-505 Dynamometer

The control 68-445 is used in conjunction with the 67-505 as a testing system in the electrical machine laboratory.

The 67-505 is a cradle-type three-phase asynchronous machine with integrated torque pick-up for connection to the control unit. This machine is equipped with sufficient power and torque reserves to brake to standstill or drive any of the machines contained in the electrical machine system up to

0.3 kW. Torque pick-up is performed with strain-gauges mounted to a durable, highly elastic stainless steel bending bar and includes integrated electronics.

67-505 Dynamometer description



1. Shaft with coupling - Mechanical connection between the 67-505 Dynamometer and the Device Under Test (DUT) using flexible rubber coupling.

2. 25 pole data connector to be connected to the 68-445 control unit

3. 7 pole connector to connect the power cord to the 68-445 control unit

68-445 and 67-505 Specification

- Power supply 230 V, 47…63 Hz, 2 kW, supplied via connection cable with earthing-pin connector
- Automatic digital speed control: (-5000 rpm ...0...+5000 rpm)
- Automatic digital torque control: (±9.99 Nm)
- Reference variable and limiting value can be set via incremental control knob
- Automatic run-up and load characteristics
- Load simulations: Load start-up ($M \sim n^2$), Heavy load start-up ($M \sim 1/n$), arbitrary load characteristic $M_i \sim n_i$, Flywheel
- External control: -10 V...+10 V
- Switchover between two / four quadrant operation
- 26 mm seven-segment display; speed 4 digit, torque 3 digit
- Temperature monitoring: device under test (DUT[1]), 67-505 Unit, control unit

[1] DUT = **D**evice **u**nder **t**est – machine to be tested

- Four-quadrant display for load type of DUT
- Adjustable torque limiting (overload protection) and stop speed (for automatic recording of characteristics)
- Direct measurement of DUT's voltage and current without the need of isolation amplifier
- USB interface for measured value transmission and remote control
- Restart inhibit can be reset after fault induced switch-off
- Analog outputs for connection of an XY recorder or display meters
- Highest safety standard: leakage current < 5 mA

Furthermore the device is equipped with an error recognition using six codes as well as protective functions. The following parameters are continuously monitored:

- Generator operation (ERR 1)
- Temperature of the DUT (ERR 2)
- Overvoltage in the link circuit of the control unit (ERR 3)
- Temperature of the D & B Unit (ERR 4)
- Temperature of the control unit (ERR 5)
- DUT is switched off via the output DUT ENABLE by removing the coupling guard or the shaft end guard (ERR 6)

1.4 Related Software Packages

1.4.1 Espial & Tools 93-420

Espial and Espial Tools software 93-420 (purchased separately) is provided on a CD-ROM and provides the environment in which the instrumentation software is installed.

1.4.2 The 60-070 Instrumentation Software

The 60-070 virtual instrumentation software is provided on a CD-ROM and controls the operation of the Espial based Instrumentation, including the dynamometer system if connected. It provides the ability to monitor the three voltages and three currents and various status signals from the Multi-Channel Power Sensor Unit. Its primary task is to provide the instrumentation for voltage and current measurements, and to display power, phase angles, power factors and frequencies.

If the 68-445 and 67-505 dynamometer is available then this forms a machine testing system, the virtual instrumentation software allows a motor loading to be specified as a torque, or a speed to be specified in rpm depending on the mode the dynamometer is operated in.

The Instrumentation displays voltages, currents, ac single and three phase power, phase, single and three phase power factor, and signal frequency.

Each instrument within a practical is preconfigured, and these settings will be stated in the practical text.

Instrument configurations can be changed and altered using the Espial Tools supplied on the Espial & Tools CD-ROM.

When using the 68-445 Machine Test System with a PC make sure the switch Extern/Intern switch (a12) is set to the Intern position.

2 Safety Instructions

The device is designed according to protection class 1 and corresponds to the safety stipulations laid out in VDE 0411. When the device is used according to the stipulations the safety of both the operator as well as the device is guaranteed. However, safety cannot be guaranteed if the device is used improperly or handled carelessly.

For that reason it is imperative that these instructions be read thoroughly and carefully before putting the 68-445 control unit for the 67-505 into operation and that all of the points listed below be adhered to.

This device may not be operated by persons who are unable to recognize contact hazards and incapable of meeting safety measures.

In general only work with safety connecting leads so that contact hazards with dangerous voltages can be excluded.

Modifications to the experiment set up may only be performed when the system is switched off (zero current / zero voltage). For this turn off the three-phase mains and the control unit for the 67-505 with switch a1.

Before switch off operate the 67-505 at no load by actuating pushbutton M = 0.

Always use coupling and shaftend guards to protect against contact to rotating parts.

Normally it is not necessary to open the device's housing. However, should this prove necessary, this may only be performed by a technician and only under the condition that the mains plug and all connecting leads have been disconnected.

Only apply safety extra-low voltages to the CONTROL IN sockets.

Never connect external voltage sources to the outputs.

Warning: This operating equipment defined class A, group 1 as set forth in the EN55011 standard and may cause radio interference in residential areas. In this case it may be required of the person operating the equipment to take necessary preventative measures and to bear the expenses. However, when the equipment is operated in the appropriate technical setting or lab of a general education or vocational institution or other training center it is assumed that no radio interference will arise in residential areas as long as a safety zone of at least 30m exists and the operating equipment is operated only intermittently.

3 Installation

3.1 Instrumentation Software and Hardware Installation

This chapter details the installation of the Instrumentation Software 68-600 and then the hardware installation of the computer (PC) to Multi-Channel Power Sensor via a USB communications link.

The installation stages are as follows:

1. Espial & Espial Tools 93-420.
2. Virtual Instrumentation Software 60-070 Installation.
3. Hardware Installation.

3.2 Virtual Instrumentation Software 60-070 Installation

Installing the software will take several minutes on each computer. There should be two software CD's with the system.

One CD contains Espial & Tools (purchased separately) and the other contains the 60-070 Virtual Instrumentation for the Espial Environment.

Espial is necessary to be able to use any of the Espial products (Espial & Tools CD).

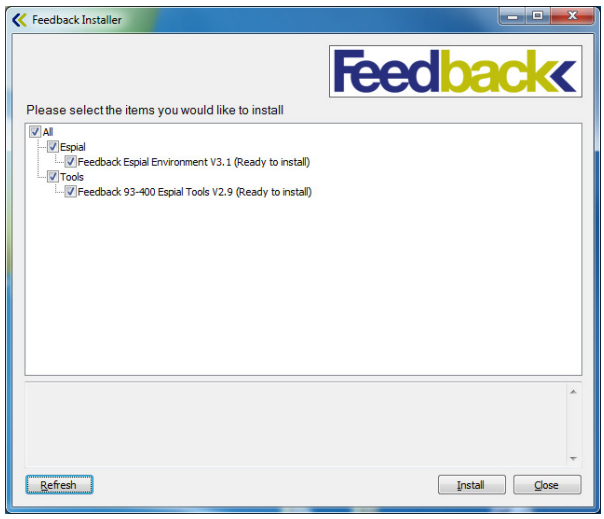
The Espial Tools are for editing and producing course material (Espial & Tools CD).

The 60-070 Instrumentation CD contains the instrumentation software for the Espial Environment.

When you are ready to begin, insert the 93-420 Espial & Tools installation CD into the CD-ROM drive of your computer and follow the on-screen instructions.

The Espial Tools software must be installed on the computer that a tutor will use to manage the Espial courseware. To protect the authenticity of the training material, it should not be installed on any client machines that are used by students in a network.

The installer will give you the option of installing the Espial and the Tools as shown.



Once you have finished installing Espial and the Tools remove the CD from the drive.

Next insert the 60-070 Content CD into the CD-ROM drive of your computer and follow the on-screen instructions.

The installer will give you the option of installing the 60-070 Instrumentation software.

Once you have finished installing the 60-070 Instrumentation remove the CD from the drive.

Drivers for both the 68-600 Multi-Channel Power Sensor and 68-445 MTS are not provided on the CD's this is because these use a Human Interface Device (HID) driver and should be automatically recognised by the Windows operating system.

3.3 Hardware Installation

The hardware requires the use of a single USB port for 68-600 Multi-Channel Power Sensor or two USB ports for operation using the 68-600 and 68-445 as a machine testing system. You can identify a USB port on the back your computer as a narrow rectangular socket that is usually located close to an existing keyboard connector.

The 68-600 Multi-Channel Power Sensor has a USB connector located on the rear of the unit. If you have 68-445 Machine Test System this has a USB connector located on the front of the panel. Both Connections should be connected via USB cable to the PC.

When connecting the 68-600 or 68-445 to a PC ensure they are switched off.

The 68-600 and 68-445 use HID drivers so there is no need to install a driver before connecting them to the PC.

Plug one end of the USB cable to the 68-600 and 68-445 (if available), then plug in the other end of each cable to the PC.

Switch on the 68-600, the Microsoft Windows operating system should automatically detect it and install the driver. Then do the same for the 68-445 if present.

Once your computer has completed the installation, your USB device is ready for use.

Notes

4 Using the Espial Virtual Instrumentation Software

This section looks at the use of the Espial based Instrumentation and provides instructions for powering up, setting up the instruments and general system control and operation. This section also provides information on using the system to perform software controlled machine testing with the dynamometer control and monitoring facilities.

Machines testing operations use instrumentation software to control all loading operations and to monitor torque and speed data obtained from the machine under test. Additionally, further measurements of voltage, current, power, etc. can be used to calculate, analyse and produce graphical results.

When using the 68-445 Machine Test System with a PC make sure the switch Extern/Intern switch (a12) is set to the Intern position.

4.1 Patching

For familiarisation purposes, Figure 4-1 shows the connections for a three phase supply and load. The three voltmeters are connected across L_1/L_2, L_1/L_3, L_2/L_3, and the three ammeters are measuring the currents in each of the 3 wires to the 3-phase load.

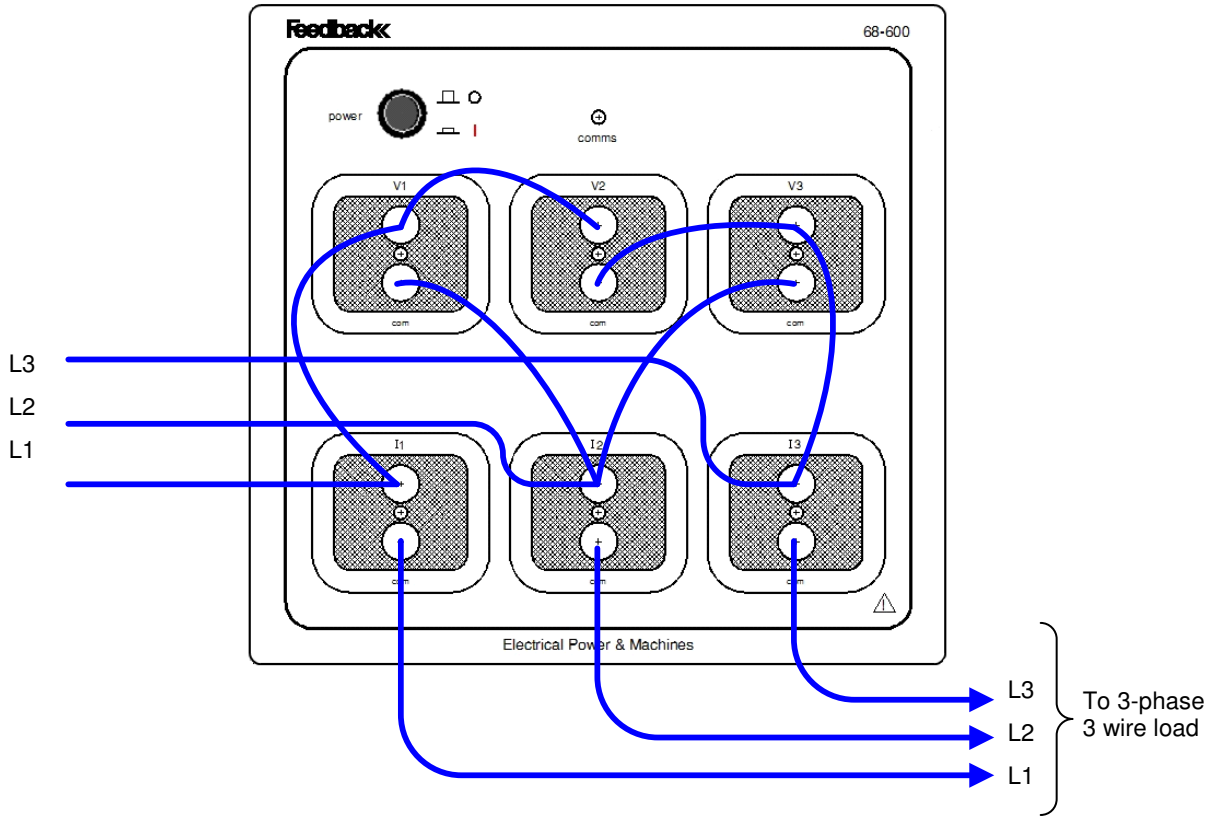
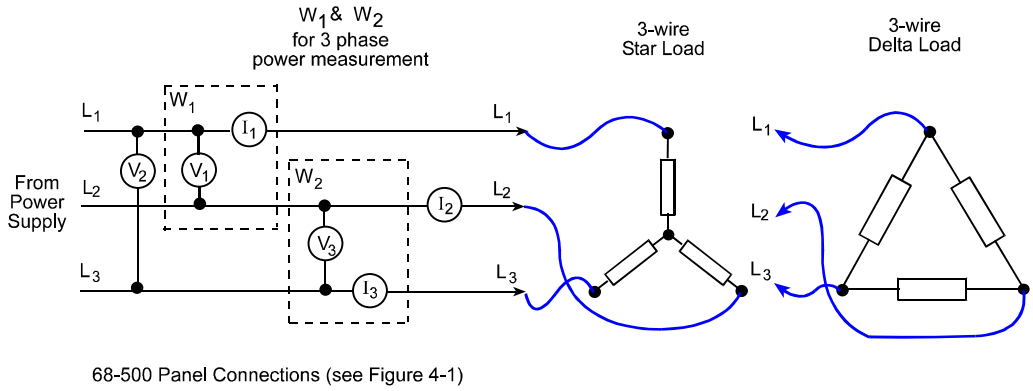


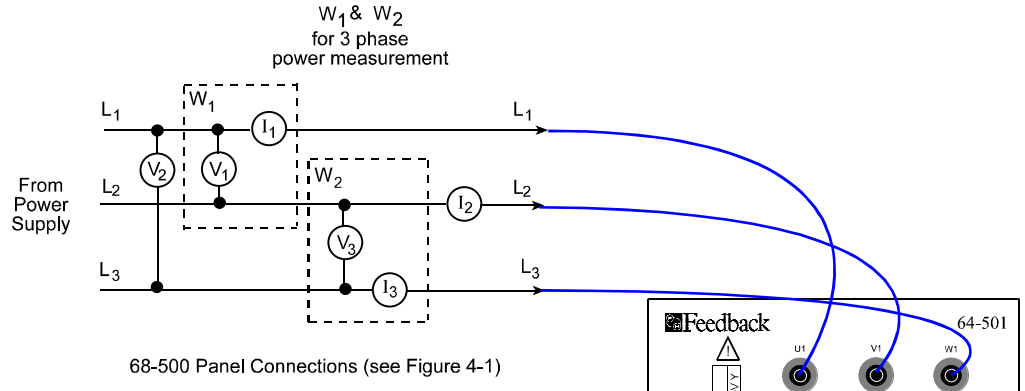
Figure 4-1: Multichannel I/O Unit Patching Diagram

Figure 4-2 shows the connections of Figure 4-1 in the form of a circuit diagram and patching from the Multi-Channel Power Sensor Unit to resistive and motor loads.



68-500 Panel Connections (see Figure 4-1)

(a) Resistive Load Connections



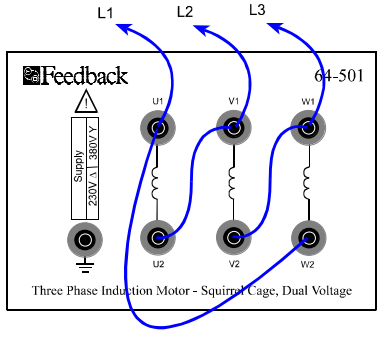
68-500 Panel Connections (see Figure 4-1)

Star Connection

WARNING:

High Voltages are present at the connections. Ensure that you only use the fully shrouded safety connectors provided, for all power connections.

When performing armature current dynamometer tests in speed mode, do not make power connections to the machine under test such that it runs as a motor.



Delta Connection

(b) Typical Motor Load Connections

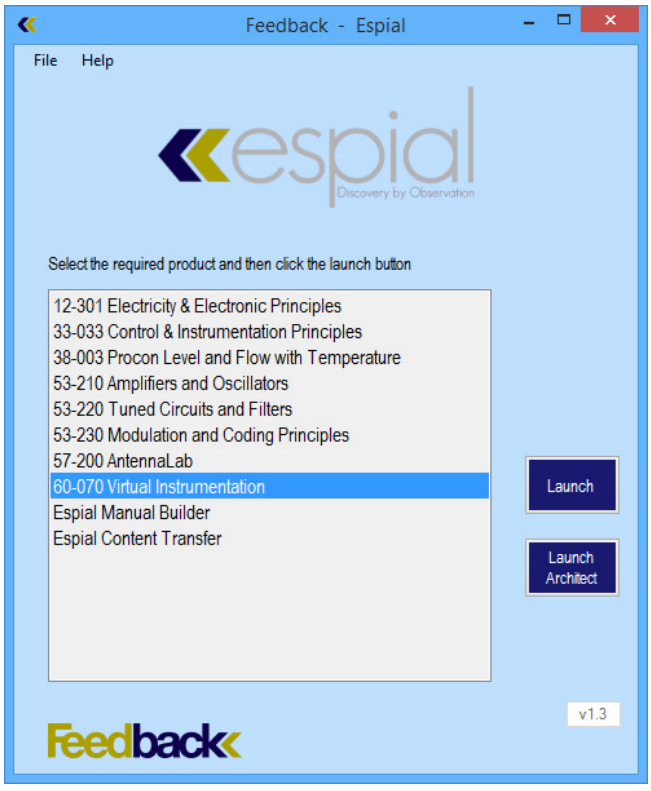
Figure 4-2: Load Patching Diagram

4.2 Power Up

Ensure that the Multi-Channel Power Sensor unit and if available the Machine Test System unit are correctly connected to the PC are properly connected. Ensure connections and the power up procedure are performed as detailed in the appropriate assignment in the 60-070 Student's Manual or the 60-070 Installation and Commissioning Manual.

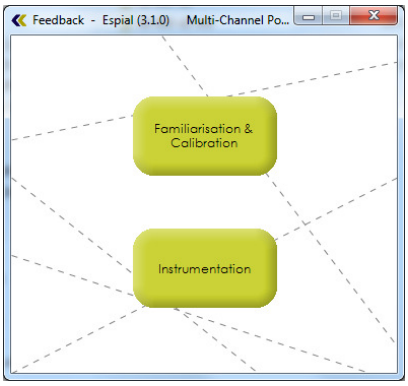
Before opening the Espial virtual instrumentation software, power the Multi-Channel Power Sensor unit and the Machine Test System unit (if available) by using the green pushbutton at the top left of the front panel.

Open the Espial environment by double clicking the Espial Environment icon. The Espial launcher window will open as shown below.



Select 60-070 Virtual instrumentation and click Launch.

Next an assignment window will open as shown below.



Familiarisation & Calibration Assignment – This assignment consists of 3 practicals. The first describes how to navigate the Espial environment. The second describes how to connect the 68-600 & 68-445 hardware to the PC and determine that they are functioning correctly. The third details the steps needed to calibrate the 3 current channels of the 68-600.

Calibration/zeroing of the 68-600 current channels should take place at the beginning of each laboratory session.

There are three red warning indicators within the side bar. These are marked ‘F’, ‘H’ and ‘A’. These are warning indicators. If any one of them is visible on your screen then you have a fault condition, as follows:

- F indicates that there is a firmware communications error;
- H indicates that the hardware is incorrectly connected.
- A indicates that there is a data acquisition error.

If both the 68-600 and the 68-445 are not connected or powered the Espial Instrumentation software will run in demonstration mode and the warning indicators will indicate there is a data acquisition error in this case. This mode will allow you to navigate the Espial environment but the instrumentation will be disabled (greyed out).

If you do not see any of these warning indicators on your screen then your set-up is correct and you may perform any of the practical’s in the assignment.

You can still open a practical when a fault condition exists, but you will not be able to use any test equipment that may be required to perform that practical.

The hardware must be correctly connected before starting an assignment in order to use the instrumentation in any of the practical’s within that assignment.

If either the 68-600 or the 68-445 are connected and powered correctly then the instrumentation software will run as normal.

4.3 Instrumentation

The Instrumentation assignment contains 3 practicals. Each practical contains the same instrumentation but each instrument is configured differently to enable to range of measurements to be taken for the range of different systems that can be under test.

If you have a 68-600 only then use practical 1.

Use practical 2 if only the 68-445 and 67-505 are to be used. Only torque/speed plots are possible.

Use practical 3 when the 68-600, 68-445 & 67-505 are available.

Practical 1

Instruments available:

Oscilloscope – Initial setting of Y1 = 1000v ac pk-pk Y2 = 5Amp pk-pk, 10ms/division

Vectorscope - Initial setting of Ch1 = 500v ac rms, Ch2 = 5 Amp ac rms

Spectrum Analyser – Initial setting of Max frequency 500Hz, Ref dB 0, 100Hz/division

Frequency Counter

Practical 2

Instruments available:

1 x plotter – default setting of Y = 4Nm torque X = RPM 4000 Max

Practical 3

Instruments available:

Oscilloscope – Initial setting of Y1 = 1000v ac pk-pk Y2 = 5Amp pk-pk, 10ms/division

Vectorscope - Initial setting of Ch1 = 500v ac rms, Ch2 = 5 Amp ac rms

Spectrum Analyser – Initial setting of Max frequency 1000Hz, Ref dB 0, 100Hz/division

Frequency Counter

Plotter 1 – default setting of Y = 4Nm torque X = RPM 4000 Max

Plotter 2 - default setting of Y = 4Nm torque X = Apparent Power (Single Phase) 500w Max

Plotter 3 - default setting of Y = Apparent Power (3 Phase) 500w Max X = Power Factor (3 Phase)

4.4 Input Ranges

The Multi-Channel Power Sensor unit has six signal input channels. Each channel has one common socket and one signal input socket.

When a signal is applied to a channel the hardware auto ranges to a suitable range setting for the input signal on that channel.

Voltage signal input sockets have ranges of 250v, 100v, 30v, 10v, 3v 1v, 0.3v, 0.1v RMS.

Current signal input sockets have ranges of 30A, 10A, 3A and 1A. These RMS values represent the maximum sine wave signal that can be measured by using the socket.

4.4.1 Calculated values

The software calculates other values from measured input signals. For these calculated values to be correct the input signals need to be connected to the correct input sockets.

Calculated values include:

Single Phase Apparent power – Channels V1 & I1, V2 & I2, V3 & I3

Single Real Power – Channels V1 & I1, V2 & I2, V3 & I3

Single Power Factor – Channels V1 & I1, V2 & I2, V3 & I3

3 Phase Apparent Power – Channels V1, V2, V3, I1, I2, I3

3 Phase Real Power - Channels V1, V2, V3, I1, I2, I3

3 Phase Power Factor Channels V1, V2, V3, I1, I2, I3

Note: The voltage and current of a phase must be connected as a pair to the input sockets. The input pairs are V1 & I1, V2 & I2, V3 & I3.

4.5 Instruments

General Instrument Notes

Any of the instruments can be resized and moved at any time using conventional ‘drag-and-drop’ mouse techniques. If you make an instrument small enough then only the display area will be shown; you must increase its size again in order to restore the controls. If you close any of the instruments and open them again they will return to their default settings. Each instrument has a Defaults button which returns the equipment to its default settings (equivalent to closing and re-opening the instrument). If you want to return all the instruments (and any other resource windows) to their default size and position simply click the Auto Position button in the assignment side bar.

Some instruments allow you to place a cursor (by clicking the mouse) at any position on their display; the cursor reveals information regarding the point at which it is located. You will have to reactivate this cursor each time you change the settings, size or position of the instrument.

There are 5 instruments available in the Espial software for the 68-600, 68-445 & 67-505. These instruments are an Oscilloscope, Vectorscope, Frequency Counter, Plotter and Spectrum Analyser.

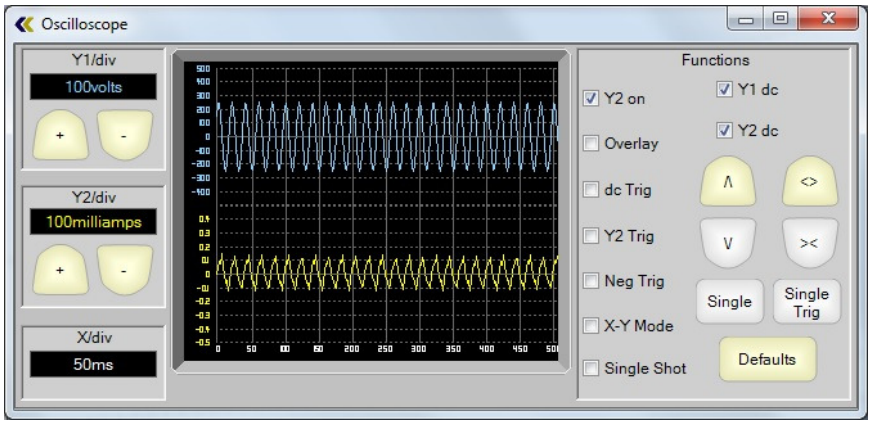
If you have a 68-600 only then it is not possible to use the plotter for Torque/Speed plots.

If only the 68-445 and 67-505 are to be used then it is only possible to carry out torque/speed plots using the plotter.

However when the 68-600, 68-445 & 67-505 are available all instruments can be used.

4.5.1 Types of Instrument

4.5.1.1 Oscilloscope



The Y (voltage) axis is set to a default value by the practical for each channel, but you may change it by using the + button for more volts/div and the - button for less volts/div.
Either only one channel can be displayed or both channels. The Y2 Show tick box determines whether the second channel is shown. In two-channel mode, if the Overlay box is ticked, the two traces are superimposed on the same scale as for one trace. If Overlay is not ticked the display area is divided into two and each trace is displayed half-size. The Y1 dc and Y2 dc tick-boxes determine if the inputs are dc coupled or not (ac coupled). If the signal has a large dc offset then ac coupling can be useful.

The X (time) axis is set to a default value by the practical but you may change it by using the ^ button for a faster timebase and the v button for a slower timebase. The <> and >< buttons provide a means of further expanding the trace if the highest, or lowest, timebase is in use. If you have the X scale expanded and select a lower timebase speed then the X scale automatically returns to its default setting.

An anti-alias feature automatically switches the time-base speed up if you select a rate that may produce a misleading display due to aliasing. If this feature has increased the timebase rate then the ^ button is coloured red.

The oscilloscope can also be operated in X-Y mode, where data from channel 1 is in the vertical axis and data from channel 2 is in the horizontal axis. Because the oscilloscope is a digital sampling scope, in X-Y mode the time base settings are still relevant and determine the sampling rate for both channels. Also in X-Y mode the traces have persistence and stay on the screen longer than one trace refresh.

Note that you can switch off the anti-aliasing feature from the main laboratory screen.

Triggering takes place when the selected trace crosses the zero volt level. If the Y2 Trig box is ticked, then the trigger source is Channel 2. Otherwise, Channel 1 is used. The Neg trig box enables only negative transitions to trigger the scope. Normally only positive ones do.

If the signal has a large dc offset, ac triggering can be useful.

The oscilloscope can be used for data capture by selecting **Single Shot** using the tick-box. In this mode **Single** or **Single Trig** can be selected.
Single will take one buffer of samples at the moment the button is pressed. **Single Trig** differs from **Single** in that it waits for the input signal to trigger an acquisition of a signal waveform. This can be used to create a graph showing the inrush current produced when power is applied to an electrical machine for example.The trigger level is 1/20th of the Y axis full scale. If no trigger signal is input within 10 seconds then **Single Trig** is cancelled. When **Single Trig** has been selected and it is waiting for a trigger you will notice that the 68-600 LED's for the channels connected to the oscilloscope will turn red, which signifies no data acquisition is taking place, as soon a trigger is found they will turn green and the data will be recorded.

Using triggering, it is possible to start capturing data immediately after switching on power but not before.

You can return to the default settings by pressing the Default button. The Auto Position button on the Espial laboratory window moves **all** the test instruments back to their default positions and sizes on the screen but does not affect their settings.

A cursor is available to make more accurate measurements. Left click on the display area to activate it. The green cursor can be moved to anywhere on a waveform. Move the mouse away and back into it to allow a tool-tip window to open with the measurement data displayed for that point.

You have to reactivate the cursor if you change the settings, size or position of the oscilloscope.

By right clicking on the display an options box appears. The options available are:

Print Display – Sends image to the default printer.
Export Display to File – Opens a window enabling the name for the file you wish to use to be entered and the directory where to save the file can be selected.
Export Display to File (reverse colours) - Opens a window enabling the name for the file you wish to use to be entered and the directory where to save the file can be selected.

4.5.1.2 Vectorscope

The Vectorscope Instrument allows you to display two vectors (single phase) or six vectors (three phase) that represent the magnitude and phase relationships of your signals in real time.

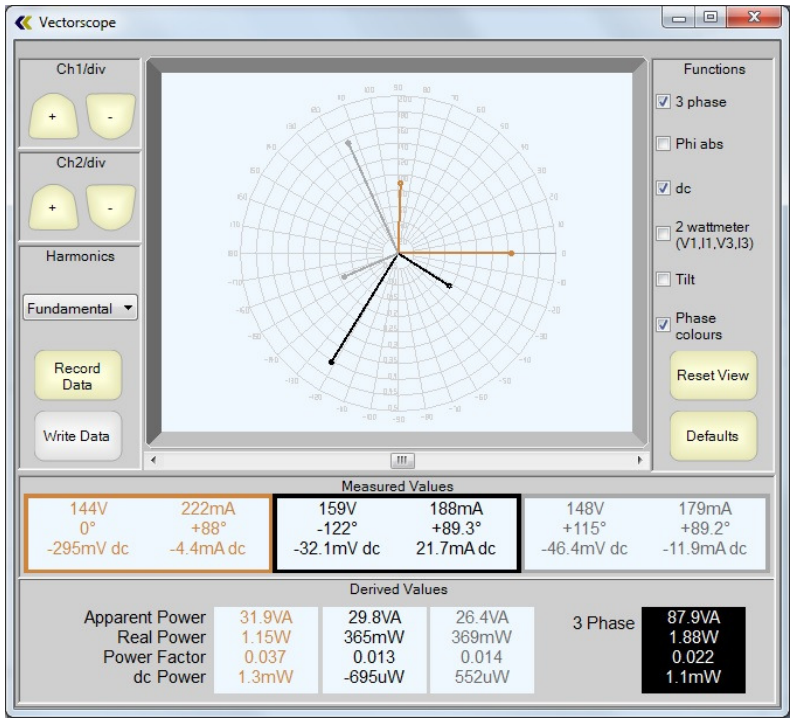
The reference signal to be displayed at the zero degrees position is the signal input to V1. Without a reference signal on V1 no other vectors will be displayed.

The Ch1/div is set to a default value by the practical for each channel, but you may change it by using the + button for more volts/div and the - button for less volts/div.
The Ch2/div is set to a default value by the practical for each channel, but you may change it by using the + button for more current/div and the - button for less current/div.

The slider below the vector display enables the display to be rotated about its vertical axis to enable the current voltage pairs to be observed in 3D. Selecting Tilt enables the display to be rotated about the horizontal axis.

Phase colours enables the vectors on the Vectorscope to be displayed in either CENELEC harmonised cable colours (L1 = Brown, L2 = Black and L3 = Grey) or the Espial channel colours. Note: By using Laboratory Architect provided with Espial tools it is possible to select the old cable colours (L1 = Red, L2 = Yellow and L3 = Blue) for the vector colours.

The Vectorscope can be switched between single phase (channels V1 & I1) or 3 phase (channels V1, I1, V2, I2, V3 & I3).



Below the phase diagram are the measured values. For each channel the RMS value for either voltage or current, phase (voltages relative to zero degrees, currents relative to the voltage that makes up the channel pair).

Phi abs when selected displays the current phase relative to zero degrees. If not ticked then the current phase is in relation to voltage that makes up the channel pair (V1, I1, V2, I2 and V3, I3).

The harmonics drop down enables harmonics other than the fundamental to be observed up to the 9th harmonic of the input signals.

Selecting the dc tick-box displays the measured dc for the voltage and current channels.

Below the measured values on the vectorscope are the derived values. These values are calculated from measured values and include:

Apparent Power, Real Power, Power factor and dc Power for each phase and for the 3 phases combined.

The Apparent Power displays the ac power in volts-amperes associated with the voltage and current channel (phase) pairs.

The 3 Phase Apparent power displays the apparent ac power in volts-amperes calculated from all three phases.

Real power single phase displays the real ac power in watts associated with the chosen voltage and current signal pair. This value is calculated using the equation:

$$P_{ac} = VI\cos\theta$$

where V is the voltage, I is the current and θ is the phase between them.

Real power three phase displays the real ac power in watts associated with all three phases, calculated from the three voltage and current signal pairs. A negative value indicates the current lags the voltage.

The dc power in watts is calculated from the voltage and current channel (phase) pairs. This value is calculated using the equation:

$$P_{dc} = VI$$

Power factor for each voltage and current channel pair (phase) is displayed. A negative value indicates that the power flow has reversed.

The 3 phase power factor displays the power factor associated with all three phases, calculated from the three voltage and current signal pairs. A negative value indicates the current lags the voltage.

The ‘two wattmeter’ mode can be selected to show the power absorbed by a 3-phase star or delta load. It can be shown (see Ref 1 in Chapter 5) that for either star or delta connected loads, the total power in the three loads can be measured by two wattmeters, by taking the algebraic sum of the instantaneous readings of the two wattmeters. It can be shown that this holds true even when the loads are not balanced. Channels V1, I1 & V3, I3 are used in this mode which means V2 & I2 can be used to measure other values.

Apparent power single phase displays the apparent ac power in volts-amperes associated with the chosen voltage and current signal pair.

Apparent power three phase displays the apparent ac power in volts-amperes calculated from all three phase pairs.

Data can be recorded from the Vectorscope to a file. To record to file select the **Record Data** button. A window will open where the location and name of the file to be saved can be selected, then the **Write Data** button will be enabled. Each time the **Write Data** button is pressed all the readings currently displayed on the vector scope will be written to the file so the number of measurements will depend on whether the Vectorscope is in single or three phase mode. When all the measurements have been taken that are required select **Stop Record** and this will

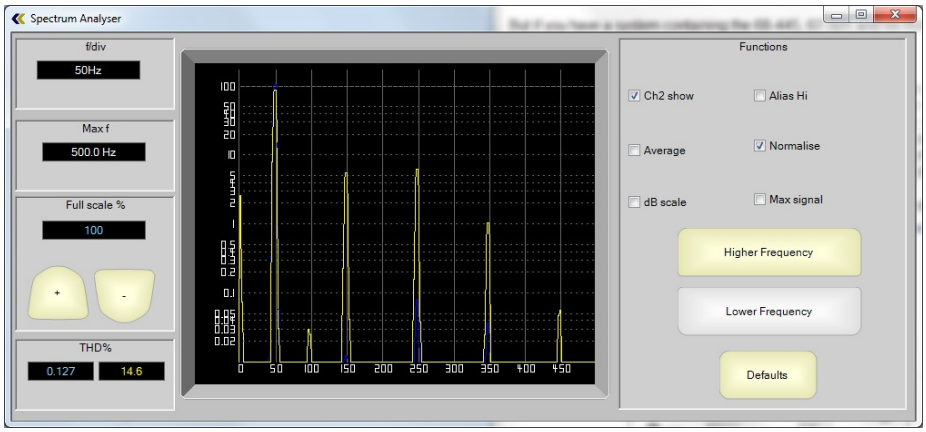
save and close the file.

Data can also be recorded in conjunction with the plotter as a plot is taking place. To do this the Vectorscope and plotter must be open. Select the **Record Data** button. A window will open where the location and name of the file to be saved can be selected. Now proceed with a plot as normal. While the plot is taking place the measured and derived values on the Vectorscope, and additionally the RPM and Torque form the 68-445 are being recorded to the file automatically. When the plot is finished select **Stop Record** and this will save and close the file.

By right clicking on the display an options box appears. The options available are:

Print Display – Sends image to the default printer.
Export Display to File – Opens a window enabling the name for the file you wish to use to be entered and the directory where to save the file can be selected.
Export Display to File (reverse colours) - Opens a window enabling the name for the file you wish to use to be entered and the directory where to save the file can be selected.

4.5.1.3 Spectrum Analyser



The Y (amplitude) scale is calibrated in Decibels relative to an arbitrary dotted line near to the top of the screen. The dB scale is linear and the number of dB per division is shown in the box. The Y (amplitude) axis is set to a default value by the practical, but you may change it by using the + button or the - button to change the Ref dB value higher or lower. The minimum level that you can see is determined by the assignment, and ultimately by the noise in the system.

The analyser has the capability of showing two channels at the same time. Click Ch2 Show button to show channel 2 as well as channel 1.

If the dB scale is disabled the Spectrum Analyser also displays Total Harmonic Distortion % (THD%) for each input.

The X (frequency) axis is calibrated in MHz, kHz or Hz per division, as appropriate. The default scale is set by the practical but you may change it by using the Higher Frequency and Lower Frequency buttons.

The anti-alias feature will operate if you try to set the frequency too low. The Higher Frequency button is shown red if this feature has increased the frequency. Note that if a new frequency component appears such as noise, the anti-alias feature may operate suddenly. The Alias Hi tick-box allows you to increase the threshold at which the anti-alias feature operates. This allows signals to be examined that have larger amounts of harmonic content. The default setting for this is off.

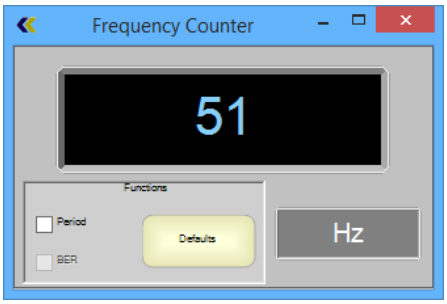
A cursor is available to make more accurate measurements. Left click on the display area to activate it. The green cursor can be moved to anywhere on a waveform. Move the mouse away and back into it to allow a tool-tip window to open with the measurement data displayed for that point.

You will have to reactivate the cursor if you change the settings, size or position of the spectrum analyser.

By right clicking on the display an options box appears. The options available are:

Print Display – Sends image to the default printer.
Export Display to File – Opens a window enabling the name for the file you wish to use to be entered and the directory where to save the file can be selected.
Export Display to File (reverse colours) - Opens a window enabling the name for the file you wish to use to be entered and the directory where to save the file can be selected.

4.5.1.4 Frequency counter



Displays the frequency or time of the input signal. Input signal is preset in the Espial software. If the input amplitude is too low a warning message will be displayed.

4.5.1.5 Plotter

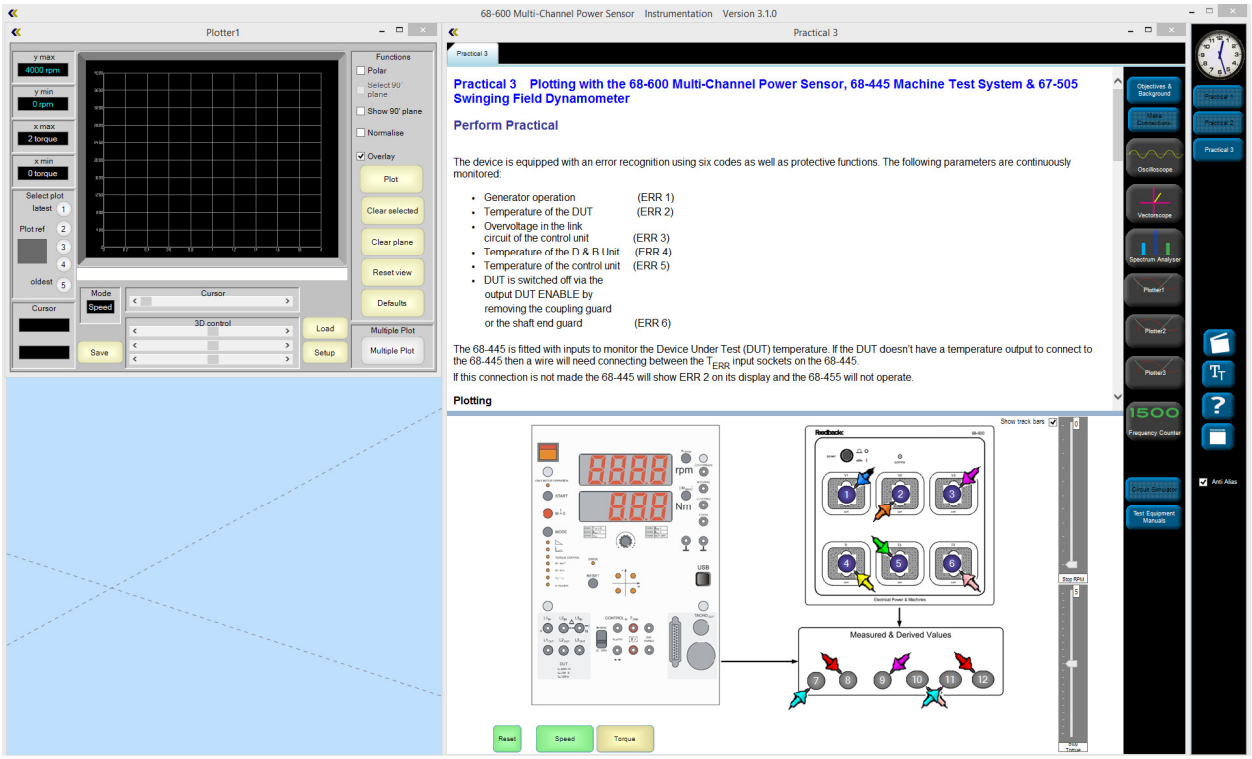
To use the plotter a 68-445 and 67-505 must be available.

The plotter provides the means to plot torque/speed patterns. Additionally it is possible to plot the measured and derived values that are displayed on the Vectorscope.

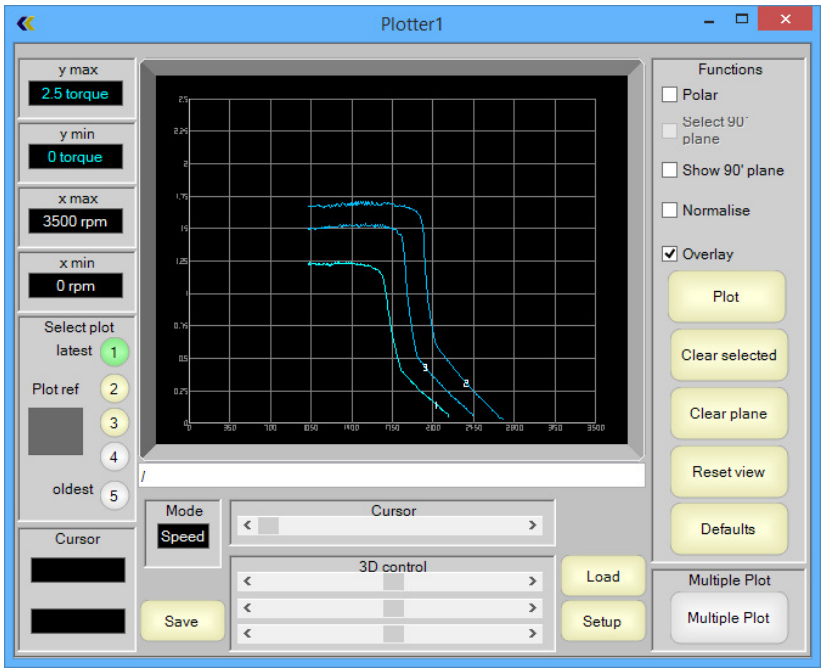
Before plotting the type of plot needs to be selected. Two modes are available from Espial which are Speed or Torque. The mode can be set by selecting either the Speed or Torque button in the practical diagram window or manually by pressing the button on the 68-445 unit.

The plotter displays the mode in which the 68-445 will perform the plot. When in speed (load characteristic)  mode the 68-445 controls the speed taking readings of the torque and RPM at 200 hundred points between the start speed (RPM of DUT at beginning of the plot) and the set stop speed. In torque mode the 68-445 applies torque in steps of 0.01, 0.02 or 0.04 Nm (this is determined by the range over which the plot is taken) to the DUT until either the stop speed or stop torque is reached.

Before plotting the Stop RPM and Stop Torque values should be set. These are set by using the trackbars in the practical diagram window as shown in the image below.



To abort a plot select the reset button in the practical diagram window as shown in the image above. This resets the 68-445 back to its default/switch On settings.



The functions are as follows:

If the **Overlay** check-box is ticked, then successive plots are superimposed up to a maximum of five. Each plot is numbered from 1 to 5, plot 1 is always the newest. The newest plot is highlighted at the end of data acquisition. Other plots may be highlighted by using the **Select Plot** buttons. The selected plot is highlighted. The current plot is displayed in realtime as the plot is taking place.

If the overlay tick-box is not checked then the display is cleared before each new plot.

The currently selected plot may be removed by using the **Clear Selected Plot** button. All the plots may be removed by using the **Clear Plane** button.

There are two planes, displayed at 90 degrees. Data is loaded into either, determined by the state of the **Select 90 plane** tick-box. In order to select the 90 degree plane the **Show 90 Plane tick-box** must be enabled. The display can be rotated in x, y and z using the **3D Control scroll** bars. The view can be reset at any time by using the **Reset View** button.

Plots can be normalised by checking the **Normalise** check-box. This means that all the plots are scaled such that their maximum values are at zero dB. Their relative maximum values are displayed in the Plot Ref box when they are selected.

The scales used to display the data are shown in the **Y max, Y min, X max and X min** displays as well as in the plots.

A cursor is provided that moves along the currently selected plot, controlled by the **Cursor** scroll-bar. The x and y values are displayed in the cursor box.

The display may be changed from polar to Cartesian by using the **Polar** tick-box.

Just below the display is a line of text that described the plot. You may edit this by clicking the text to place the cursor in the text to either change or add information.

Plots may be saved to a file using the **Save** button. You can accept an automatically generated filename or enter one manually. The file format is a comma delimited file which is compatible with a number of external analysis systems. Any plot information you have added will be stored with the plot.

Files may be loaded into the plotter using the **Load** button. Note that the axis units must be compatible or an error message will result.

Additionally measured & derived values from the 68-600 can be record to file at the same time as a plot it in progress. This can be done in conjunction with the Vectorscope **Record Data** feature. Please see the Vectorscope description for more detail.

The display may also be either printed or saved as an image file by right clicking the display and selecting the required function.

Print Display – Sends image to the default printer.
Export Display to File – Opens a window enabling the name for the file you wish to use to be entered and the directory where to save the file can be selected.
Export Display to File (reverse colours) - Opens a window enabling the name for the file you wish to use to be entered and the directory where to save the file can be selected.

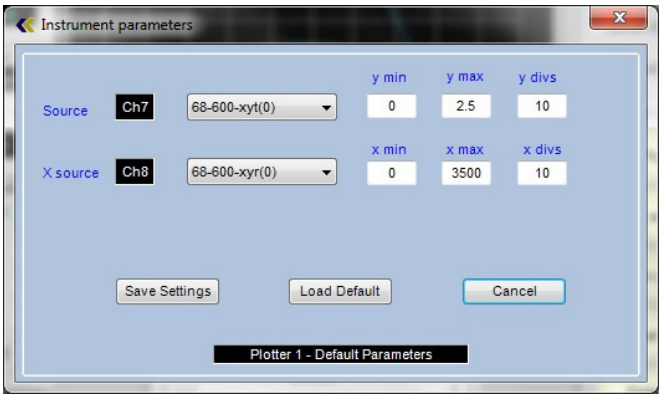
The **Default** button returns all settings to their default values.

4.5.1.5.1 Plotter Settings

To change the values plotted on the x and y axis you must be running Espial as an administrator. Assuming you have the correct user rights on the PC to do this you must close Espial then right click on the Espial environment icon on the desktop and select “Run as Administrator”, then return to the assignment/practical you want to change the plotter setting for.

Open the plotter and click the **Setup** button.

The instrument parameters panel will open as shown below.



The instrument panel enables you to change the values plotted on each axis by selecting from a drop down list. The maxmimum and minimum for each axis can be changed so that they can scaled according to the tests being carried out. To use the new settings the **Save Setting** button must be clicked, and the new settings will take effect. If you do not want to save the settings then click **Cancel** or the **X** in the top right corner. The default parameters can be loaded by clicking the **Load Default** button. If Espial, the assignment or the practical is closed on reopening them the default settings will be reloaded.

The values that can be plotted on each axis are show below.

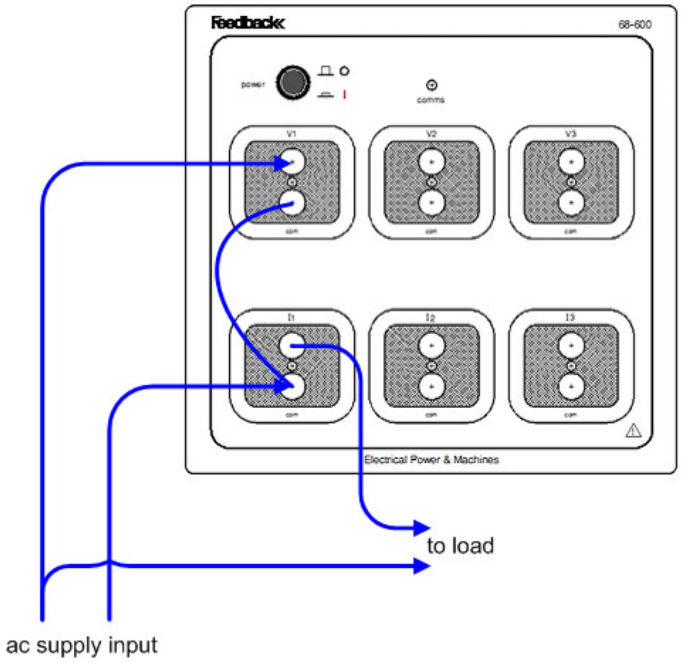
68-600-xyr(0)	RPM
68-600-xyt(0)	Torque
68-600-ap(0)	Single phase (V1 & I1) Apparent Power
68-600-rp(0)	Single phase (V1 & I1) Real Power
68-600-pf(0)	Single phase (V1 & I1) Power Factor
68-600-3p-ap(0)	Three phase (V1, V2, V3, I1, I2 & I3) Apparent Power
68-600-3p-rp(0)	Three phase (V1, V2, V3, I1, I2 & I3) Real Power
68-600-3p-pf(0)	Three phase (V1, V2, V3, I1, I2 & I3) Power Factor
68-600-out-p(0)	Output Power
68-600-dc-p(0)	Single phase (V1 & I1) DC Power
68-600-3p-dc-p(0)	Three Phase (V1, V2, V3, I1, I2 & I3) DC Power
68-600-v1-ac(0)	AC Voltage (V1)
68-600-v2-ac(0)	AC Voltage (V2)
68-600-v3-ac(0)	AC Voltage (V3)
68-600-i1-ac(0)	AC Current (I1)
68-600-i2-ac(0)	AC Current (I2)
68-600-i3-ac(0)	AC Current (I3)
68-600-v1-dc(0)	DC Voltage (V1)
68-600-v2-dc(0)	DC Voltage (V2)
68-600-v3-dc(0)	DC Voltage (V3)
68-600-i1-dc(0)	DC Current (I1)
68-600-i2-dc(0)	DC Current (I2)
68-600-i3-dc(0)	DC Current (I3)

4.6 Phase Analysis

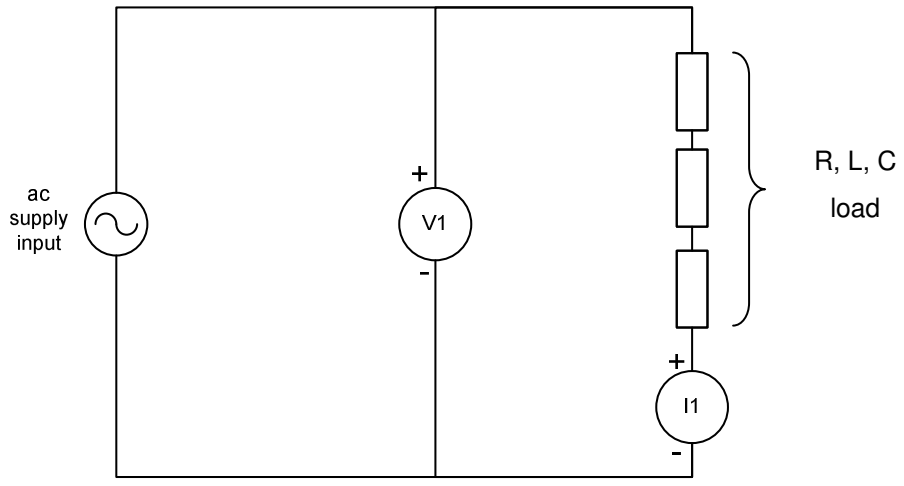
The vectorscope allows you to display two vectors (single phase) or six vectors (three phase) that represent the magnitude and phase relationships of your signals in real time.

4.6.1 Patching for Single Phase Analysis

A typical patching diagram for single phase analysis is shown below.



Multi-Channel Power Sensor connections

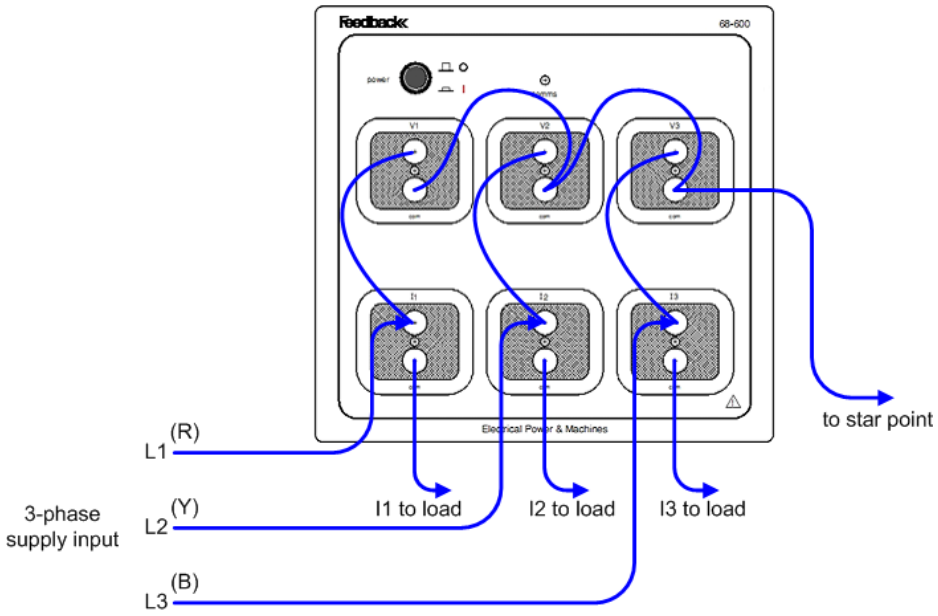


Circuit diagram

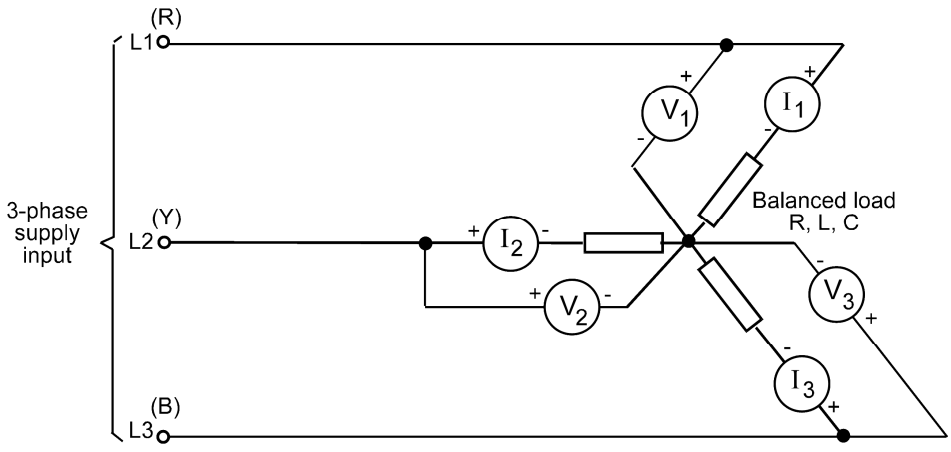
Single Phase Analyser - Typical Measurement

4.6.2 Patching for Three Phase Analysis

Before carrying out three phase analysis, ensure that the hardware is connected correctly. Three phase patching for a load connected in a 'Star' configuration is shown below, whilst three phase patching for a load connected in a 'Delta' configuration is shown in the following diagram.

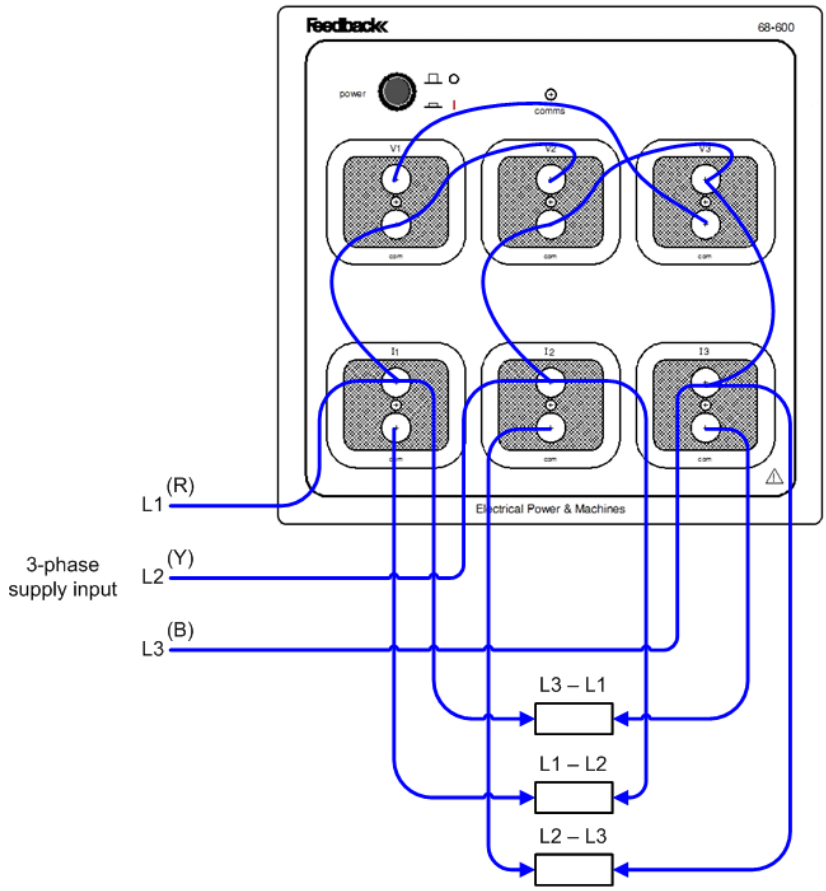


Multi-Channel Power Sensor connections

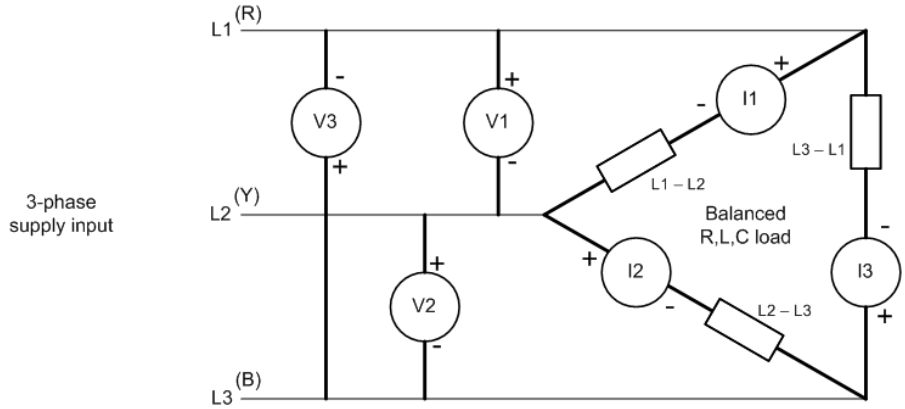


Circuit diagram

Three Phase Analyser for Direct Star Measurement



Multi-Channel Power Sensor connections



Circuit diagram

Three Phase Analyser for Direct Delta Measurement

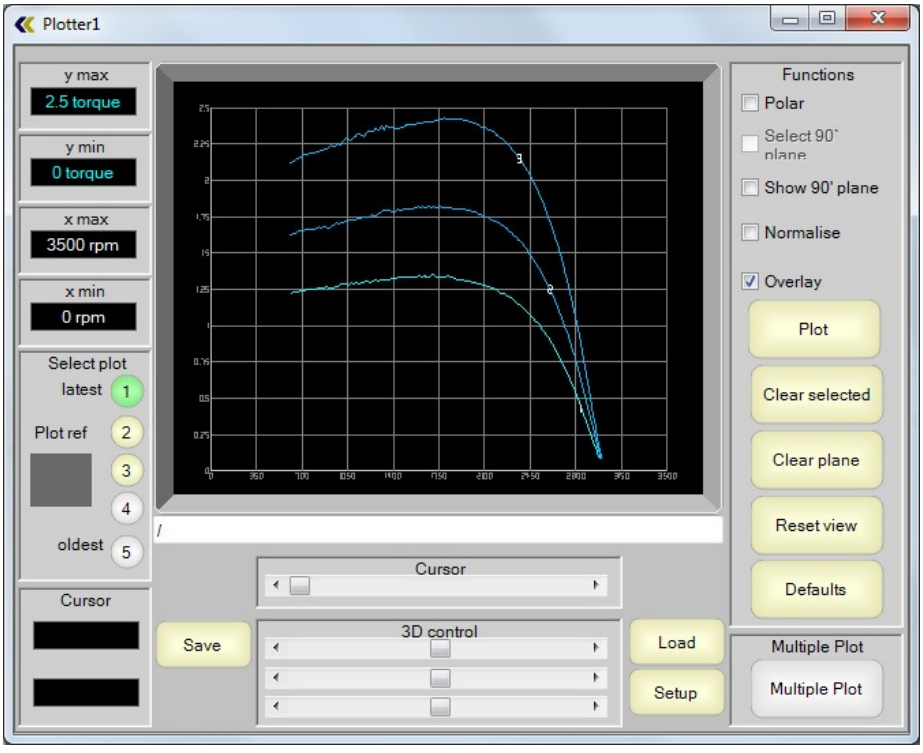
4.7 The Dynamometer

The torque and speed of machine systems can be measured and controlled using a dynamometer and the Torque and Speed Control Panel (68-445). A tachogenerator on the dynamometer provides direct measurement of the speed of the motor under test. Torque is measured by strain gauges mounted on a durable, highly elastic stainless steel bending bar.

The swinging field dynamometer 67-505 allows torque and speed to be measured in both torque and speed mode.

4.8 Torque Speed Plotting

The plotter provides you with the ability to automatically plot a graph of torque and speed along with other characteristics of the system. There can be up to 3 plotters available in the instrument panel. Each plotter will be setup to plot different values.



4.8.1 Creating a New Plot

To create a new torque speed plot:

1. Open a plotter.
2. Check that the X and Y axis are set to the required values in the case above they are RPM and Torque.

3. If required, select the setup button and select the settings required i.e. change the value plotted on the axis and the max and min for each. Save the changes or reset to default the setup.
4. Then select the type of plot to be carried out using the **Speed** or **Torque** buttons within the Espial software or manually pressing the mode button on the 68-445.
5. Before plotting the stop speed and stop torque must be set using the sliders in the Espial software.
6. Start the Device Under Test (DUT) motor.
7. Select **Plot** on the plotter. The plot will now take place in real-time.

Plotting will stop when the stop motor speed is reached. You may stop plotting at any time by pressing the **m=0** button on the 68-445.

4.8.2 Creating More Plots

To create further plots on the same graph axes, click the **plot** button.

4.8.3 Saving the plot

To save a highlighted plot:

1. Select **Save** on the plotter
2. Specify the location and filename that you want to use to save your test
3. Click **Save**.

4.8.4 Loading a Saved plot

To open a previously saved plot:

1. Select plot on the plotter
2. Select the test you want to open, then click **Open**.

4.8.5 Closing the Test

To close the test window, from the plotter's **File** menu, select **Close**.

4.8.6 Printing the plotter display

To print the plotter screen:

1. By right clicking on the display an options box appears. The options available are:

   Print Display – Sends image to the default printer.
   Export Display to File – Opens a window enabling the name for the file you wish to use to be entered and the directory where to save the file can be selected.

Export Display to File (reverse colours) - Opens a window enabling the name for the file you wish to use to be entered and the directory where to save the file can be selected.

4.9 Performing a Locked Rotor Test

WARNING:

The locked rotor test involves applying power to the motor while the shaft is held stationary. Leaving the system in this state for more than a few seconds can cause overheating and possible damage to the system.

The 67-505 does not have a mechanical device to lock the rotor, however it is possible to perform the test by using the procedure below.

1. Ensure the motor shaft is stationary, set the 68-445 to the Load Characteristic mode
2. Press the **m=0** button on the 68-445.
3. Apply power to the motor and take measurements, then switch off power to the motor immediately.

4.10 Zeroing the current channels

Sometimes you may want to remove any small offsets from the signal inputs.

To remove/zeroing of offsets on the 68-600 current channels follow the instructions in practical 3 of the Familiarisation & Calibration assignment.

The zeroing will remain each time the software is used. If however a different 68-600 is used with the PC the zeroing should be repeated.

Notes

5 References

Ref 1. Hughes Electrical and Electronic Technology 9th Ed p. 960
Published by Prentice Hall. December 2004
ISBN 0-13-114397-2

Ref 2 Principles of Electricity 5th Ed p. 528
Morley and Hughes
Published by Longman Group UK Ltd. 1994
ISBN 0-582-22874-3

Notes