Wayne Kerr Electronics

10A DC BIAS UNIT

6565 Series

User Manual

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Part No 9H6565

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ILLUSTRATIONS

1. SAFETY

1.1 General

This equipment has been designed to meet the requirements of EN61010-1 'Safety requirements for electrical equipment for measurement, control & laboratory use' and has left the factory in a safe condition.

The following definitions in EN61010-1 are applicable:

OPERATOR	Person operating equipment for its intended purpose. **Note: The OPERATOR should have received training appropriate for this purpose.**
RESPONSIBLE BODY	Individual or group responsible for the use and maintenance of equipment and for ensuring that operators are adequately trained.

The RESPONSIBLE BODY must ensure that this equipment is only used in the manner specified. If it is not used in such a manner, the protection provided by the equipment may be impaired.

This product is not intended for use in atmospheres which are explosive, corrosive or adversely polluted (e.g. containing conductive or excessive dust). It is not intended for use in safety critical or medical applications.

The equipment can cause hazards if not used in accordance with these instructions. Read them carefully and follow them in all respects.

Do not use the equipment if it is damaged. In such circumstances the equipment must be made inoperative and secured against any unintentional operation.

WARNING Back EMF!

Lethal back-emf potentials can be generated if an inductor under test is disconnected whilst current is still flowing in it. The energy is proportional to the square of the current and back-emfs can reach several kilovolts.

NEVER touch the test connections while the direct current is flowing.

USE the Safety Interlock, see section 5.2.4.

1.2 AC Power Supply

Power cable and connector requirements vary between countries. Always use a cable that conforms to local regulations, terminated in an IEC320 connector at the instrument end.

If it is necessary to fit a suitable AC power plug to the power cable, the user must observe the following colour codes:

WIRE	EUROPEAN	N. AMERICAN
LIVE	BROWN	BLACK
NEUTRAL	BLUE	WHITE
GROUND	GREEN/YELLOW	GREEN

The user must also ensure that the protective ground lead would be the last to break should the cable be subject to excessive strain.

If the plug is fused, a 13-amp fuse should be fitted.

If the power cable electrical connection to the AC power plug is through screw terminals then, to ensure reliable connections, any solder tinning of the cable wires must be removed before fitting the plug.

Before switching on the equipment, ensure that it is set to the voltage of the local AC power supply.

WARNING!

Any interruption of the protective ground conductor inside or outside the equipment or disconnection of the protective ground terminal is likely to make the equipment dangerous. Intentional interruption is prohibited.

1.3 Adjustment, Maintenance and Repair

WARNING!

The equipment must be disconnected from all voltage sources before it is opened for any adjustment, replacement, maintenance, or repair.

When the equipment is connected to the local AC power supply, internal terminals may be live and the opening of the covers or removal of parts (except those to which access can be gained by hand) is likely to expose live parts.

Capacitors inside the equipment may still be charged even if the equipment has been disconnected from all voltage sources.

Any adjustment, maintenance, or repair of the opened equipment, when it is connected to the power supply, must be carried out by a skilled person who is aware of the hazards involved.

Service personnel should be trained against unexpected hazards.

Ensure that only fuses with the required rated current and of the specified type are used for replacement. The use of makeshift fuses and short-circuiting of fuse holders is prohibited.

1.4 Static Electricity

The unit supplied uses static-sensitive devices. Service personnel should be alerted to components that require handling precautions to avoid damage by static electrical discharge.

Before handling circuit board assemblies containing these components, personnel should observe the following precautions:

1) The work surface should be a conductive grounded mat.
2) Soldering irons must be grounded and tools must be in contact with a conductive surface to ground when not in use.
3) Any person handling static-sensitive parts must wear a wrist strap which provides a leaky path to ground, impedance not greater than 1MΩ.
4) Components or circuit board assemblies must be stored in or on conductive foam or mat while work is in progress.
5) New components should be kept in the suppliers packaging until required for use.

WAYNE KERR ELECTRONICS and the associated sales organisations accept no responsibility for personal or material damage, or for any consequential damage that results from irresponsible or unspecified operation or misuse of this equipment.

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2. INTRODUCTION

Figure 2-1 6565/10A Bias Unit

2.1 6565

The 6565 series of DC bias units can be used on the bench-top or rack-mounted. Each model in the series is intended to be used in conjunction with one of the 6500 series of Impedance Analyzers, extending the DC bias capability from 1mA to 10A (6565/10A). Up to four 6565 series bias units, may be connected to a single 6565 LCR bridge to give a maximum DC bias current of 40A. The 6565 in combination with the 6500 may be used up to the full frequency bandwidth of the system up to a maximum of 120MHz. Either the 6500 or the 6565 could limit this maximum bandwidth according to the model type used.

Each 6565 has two sets of current input and output connectors that allow the connections to be cascaded. A maximum cascade current of 20A is permissible using 2 units. This may be fed into a single high current 20A fixture type 1026. For 40A current requirements the 1027 fixture should be used which has two sets of 20A current input ports. Please see the connection arrangement in section 3.4. It is essential that the 6565 be used with a Wayne Kerr fixture such as the 1026 or 1027 since this provides the necessary interface circuitry to the device under test. Additionally a 1031 adaptor may be used with either of these fixtures for testing surface mount components.

When enabling the 6565 in the 6500 menu system, the D1and D2 internal bias options are automatically disabled and switched off in the 6500 menu system.

Figure 2-2 6500B Impedance Analyzer, 6565 Bias Unit and 1026 Fixture

The host 6500 bridge has full control of the 6565, output current being set via a menu in the 6500 or by GPIB control. Warning messages and the status of the 6565 are displayed on the 6500 impedance bridge. A red warning LED on the 6565 indicates when DC bias is being applied. The 6565 will display a green power on lamp when the 6500 power is applied or an amber light when in standby mode. This is the case if the 6500 is not connected or its power is removed

Warning! Alternative fixtures must not be used in conjunction with the 6565 without prior consultation with Wayne Kerr electronics Ltd since this could cause damage to the internal electronics of the 6500 and may cause an operator safety issue. No fixture should be used without a protective safety cover attached and the safety interlock cable attached. In this case, bias current will only be applied when the contacts on the safety interlock socket are shorted together.

Please read section 1—Safety, before using the instrument.

Figure 2-3 1026 High Current Fixture

2.2 1026 20A fixture

The 1026 fixture allows connection of up to two 6565 units to test leaded components up to a maximum bias current of 20A and to the specified maximum test frequency of either 6565 or 6500 unit up to a maximum of 120MHz. Note: this fixture should not be operated above 20A since to do so will cause internal overheating of the components inside the 1026 and the 6565 coaxial current-carrying cables. Please consult the connection diagrams Figure 3-2 and Figure 3-4 before using this unit. The interlock cable 3.5mm jack connector should be connected between the 6500 rear panel and the rear of the 1026. This is mechanically connected to the translucent cover which, if lifted, will either switch off the bias current to the device under test or prevent it being applied. The 1026 also has temperature overload sensing on the jaws to prevent components overheating in situ. In such a case the bias current will be turned off.

Please read section 1—Safety, before using the instrument.

Figure 2-4 1027 High Current Fixture

2.3 1027 40A fixture

The 1027 high current fixture enables a DC bias current of up to 40A to be applied to an inductor during component test.

This fixture has been designed to work specifically with up to four 6565 units operating in conjunction with a 6500 series Impedanace Analyzer. There are two pairs of bias current input/output ports one at each side of the fixture. Please consult the connection diagram in Figure 3-5 and Figure 3-6 before using this unit. The interlock cable 3.5mm jack connector should be connected between the 6500 rear panel and the rear of the 1026. This is mechanically connected to the translucent cover which, if lifted, will either switch off the bias current to the device under test or prevent it being applied. The 1027 also has temperature overload sensing on the jaws to prevent components overheating in situ. In such a case the bias current will be turned off.

Please read section 1—Safety, before using the instrument.

3. INSTALLATION

3.1 AC Line Connections

The unit is provided with a power cable capable of carrying the input current for both 115V and 230V operation. This cable should be connected via a suitable connector to the local AC power supply. The colour code employed is as follows:

WIRE	EUROPEAN	N. AMERICAN
LIVE	BROWN	BLACK
NEUTRAL	BLUE	WHITE
GROUND	GREEN/YELLOW	GREEN

No adjustment is required for variation of supply frequency or supply voltage.

Before connecting the AC power, read the precautions listed under section 1.2—AC Power Supply.

The instrument is not suitable for battery operation.

The power switch is located on the right side of the front panel.

3.2 Safety Interlock

WARNING!

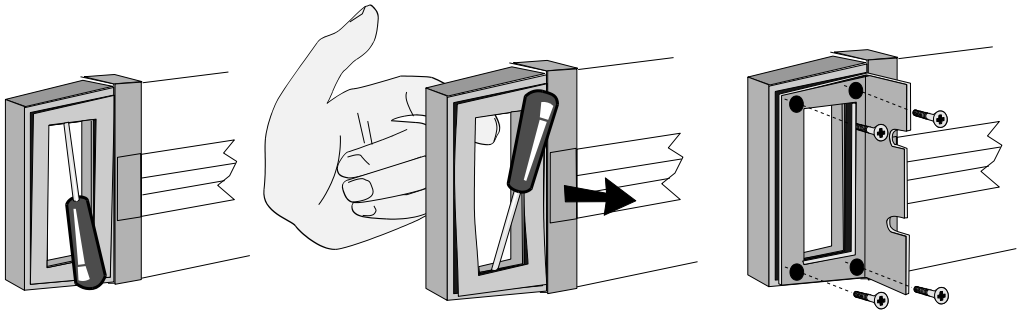
Improper use of this instrument could be fatal

To protect the user against lethal back-emf potentials, there is a facility to inhibit the operation of a DC bias current function by removing the 'BIAS SAFETY INTERLOCK' plug on the 6500 rear panel. Details of this feature can be found in section 5.2.4. The safety interlock cable is supplied with the unit and must be inserted to use the bias current feature.

3.3 Rack Mountings

This instrument is intended for use either on the bench or in a rack. The power modules are convection cooled and care must be taken not to restrict any of the air paths.

There is a rack mounting kit available as an optional extra to fit a standard 19" rack. This kit contains the mounting 'ears' and screws required for the conversion. To fit these 'ears' carefully remove the insert in the outer face of both front handles, see Figure 3-1 below. Fit each 'ear' into the recess formed by the removal of the insert and secure using the bolts provided (M4 x 10mm CSK). It is important that some provision is made to support the rear of the unit when using the rack mounting ears.



Insert small screwdriver into the gap between insert and handle body. Prise away one end slightly and hold in position with finger. Note operation of insert with styling cut-out opposite cut-out in handle.

Insert screwdriver into other end and repeat procedure. This will relieve the small tapered pins of the insert from the threaded holes in the handle. Remove insert in the direction of arrow.

Insert rack mounting bracket into recess in handle in attitude shown and secure firmly with 4 M4x10 C'SK HD screws supplied.

Figure 3-1 Procedure for Attachment of Rack mounting brackets

3.4 6500 and 6565 Interconnection

To perform measurements with the 6500 impedance analyser and 6565 system, the units must be linked together.

1) Position the analyzer on top of the 6565.

Front Panel Connections

2) Link the analyzer BNCs to the top four BNCs on the 6565 using short coaxial leads.

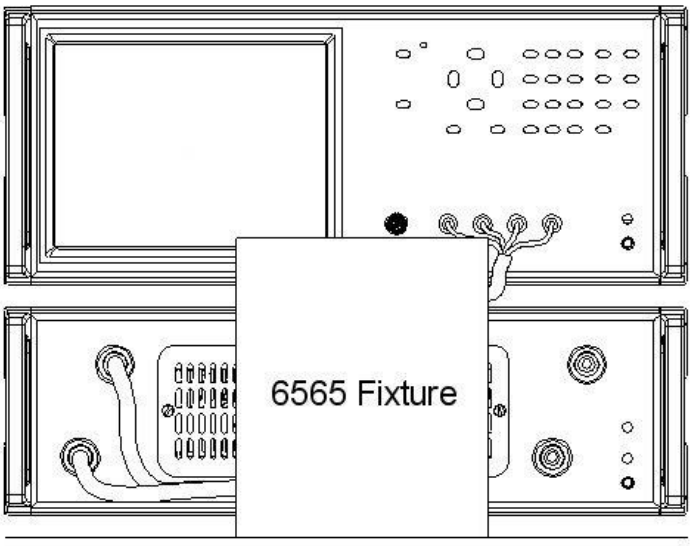


Figure 3-2 Front Panel Connections for 2-Terminal Measurement One 6565

3.5 Using Multiple 6565's

Up to four 6565 can be connected together in parallel as follows.

1) Position the 6500 impedance analyzer on top of two 6565 units. See Figure 3-4, Figure 3-5 and Figure 3-6.
2) Maximum Stacking Height).
3) Place the other (two) 6565 units on a separate stack to the right side of the first stack.

Figure 3-3 Front Panel Connections (1026 fixture)

1) Connect the high current coaxial cables (supplied) to the 1026 fixture and connect them to the left hand connector set of the lowest bias unit in the stack.
2) Link the lower bias unit to the upper bias unit by connecting the remaining pair of high current cables to the right hand 6565 sockets.
3) Connect the BNC cable adaptor from the 1026 to the 6500 impedance analyser ensuring that the cable adaptor is the correct way up. **Failure to observe this can damage the internals of the 6500**.

3.6 Front Panel Connections (1027 fixture)

1) Connect the high current coaxial cables (supplied) to the 1027 fixture and connect these to the lowest bias unit in the stack.
2) Link the lower bias unit to the upper bias unit by connecting the remaining pair of high current cables to the right hand 6565 sockets.
3) Connect the BNC cable adaptor from the 1027 to the 6500 impedance analyser ensuring that the cable adaptor is the correct way up. **Failure to observe this can damage the internals of the 6500**.

4) Make a similar stack of two 6565 units to the right side of the first stack and connect the left side terminals of the lowest 6565 in the second stack to the right hand input sockets of the 1027 fixture using the high current cables.

5) Next connect the lower 6565 in the right side stack to the upper 6565 again using the high current cables and the right hand connector pairs.

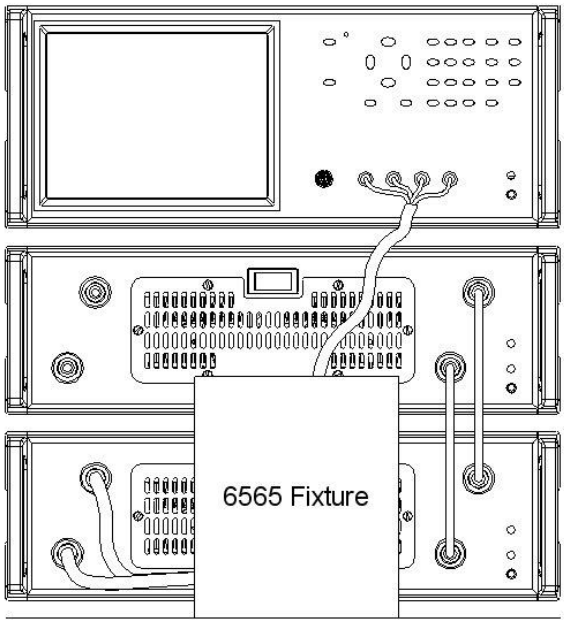


Figure 3-4 Two Stacked Bias Units with a 6500 Impedance Analyzer and a 1026 Fixture

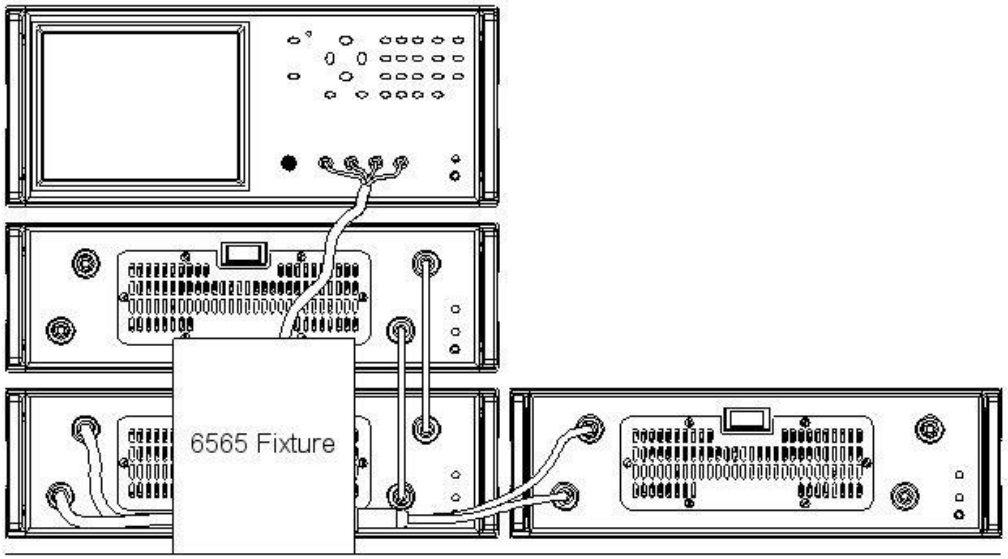
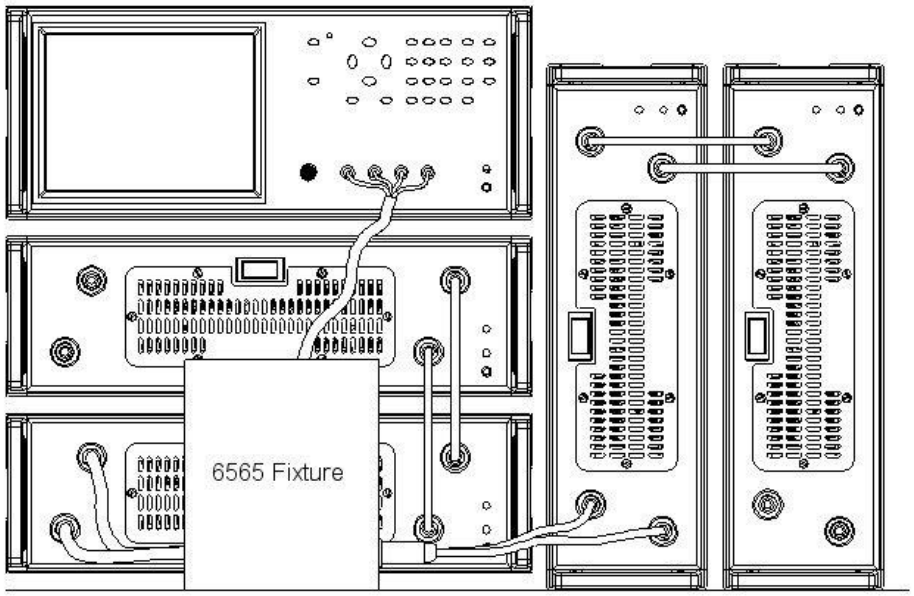
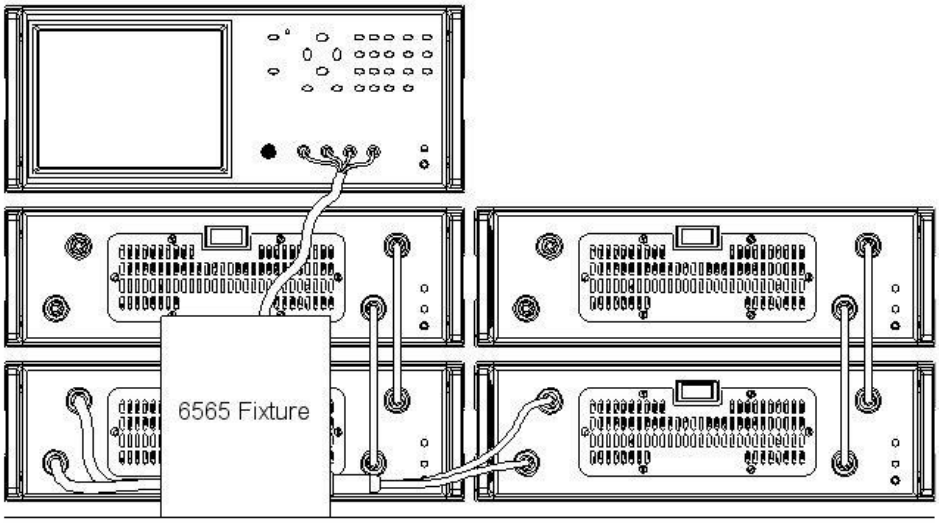


Figure 3-5 Front Panel Connections for 2-Terminal Measurement with Three Bias Units



Option 1



Option 2

Figure 3-6 Connection Options for Four Bias Units and the 1027 Fixture

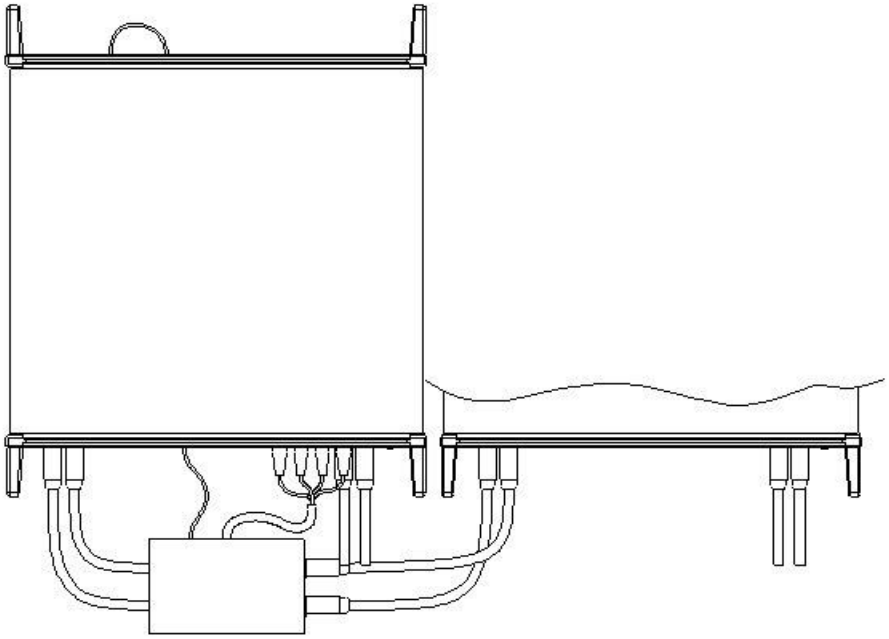


Figure 3-7 Top View of 1027 Fixture with Multiple Bias Units Connected

3.7 Rear Panel Connections

Connect the 6565 ‘Aux Out’ 9-way ‘D’ connector to the 6565 ‘Control In’ 9-way ‘D’ connector using the control link cable supplied. Multiple bias units are connected by daisy chaining connections from the 6565 ‘Control Out’ connector to the Control In connector on the next 6565 unit.

Figure 3-8 Rear Panel Connections

3.8 Maximum Stacking Height

If more than two 6565's are being used, the instruments can be positioned in accordance with the various descriptions in section 3-5 but should ideally be rack-mounted in a suitably ventilated environment.

4. OPERATING INSTRUCTIONS

4.1 Basic Features

The 6565 10A bias unit extends the range of DC bias current available when measuring inductance with the 6500 impedance analyser and its associated D1 option.

One 6565 can provide a bias current in the range 1mA to 10A. Up to four 6565 units can be connected in parallel, to give a maximum bias current of up to 40A, and a minimum current of 4mA provided that the maximum voltage drop across the device under test does not exceed the maximum compliance voltage.

Operation of the 6565 is via the 6500 impedance analyser. The 6500 measurement modes may be used to the full, except the internal 100mA or 50V dc bias supply that are provided by the D1 and D2 options. These are automatically switched out when the 6565 is enabled for use.

The safety interlock system on the 6500 impedance analyser is designed for use with enclosed fixtures that reduces the risks associated with high currents and large inductors. It is essential for operator safety that this be used with the 6565 and its fixtures. See sections 2.2, 2.3 and 5.2.2.

4.2 Operation

4.2.1 Enabling the 6565 in Analysis Mode

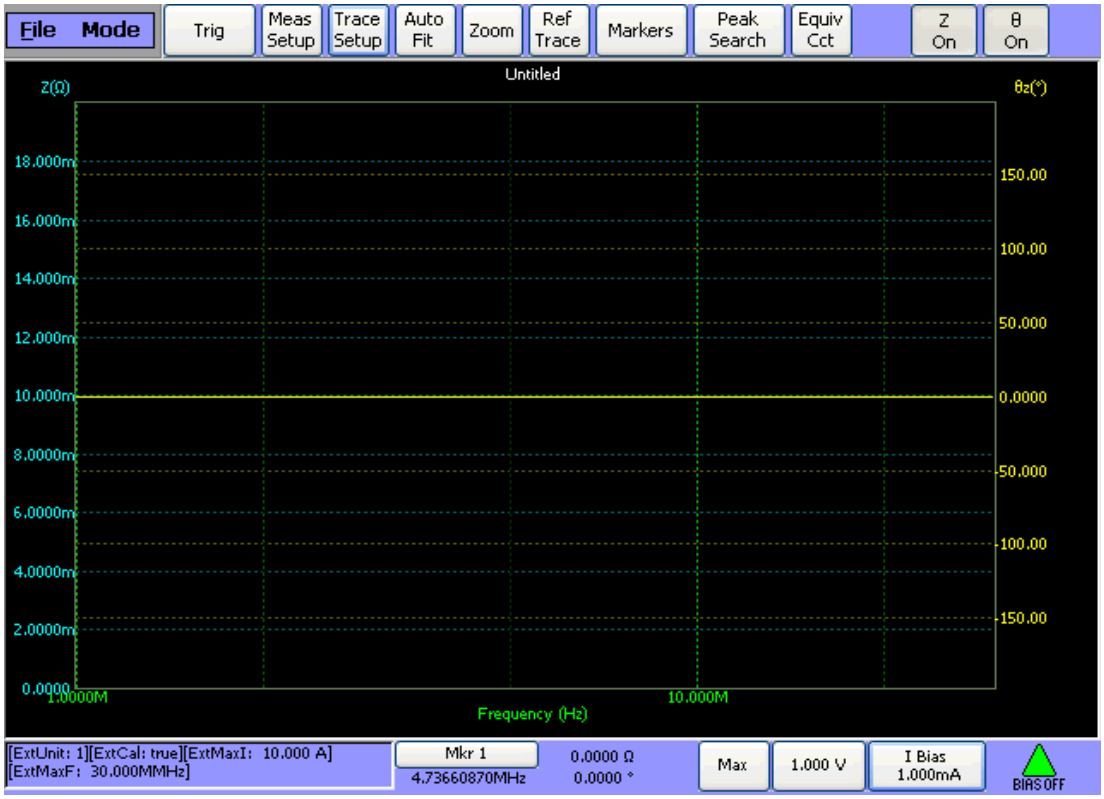


Figure 4-1 6500 in Analyzer Mode Showing the Bias Unit Statistics in the Lower Toolbar

The 6565 operation is mainly controlled by the on screen menu system. The 6500 numerical keypad is used for entry of the bias current values and the control of bias on or bias off. In

Figure 4-1 the 6500 is shown operating in analysis mode. The lower toolbar shows that the 6500 has recognised the presence of one 6565 during boot up and it displays the maximum available bias current and the maximum measurement frequency that the setup can be operated at. (The maximum measurement frequency may be limited by any 6565 or the 6500 itself.) In the right side of the bottom toolbar is shown the selected bias current which defaults to 1mA. Bias is shown to be OFF by the lower right hand green triangle. Multiple 6565's are similarly automatically enabled. When first powering up the system always ensure that the 6565's are either turned on first or at the same time as the 6500.

4.2.2 Manually Enabling the 6565

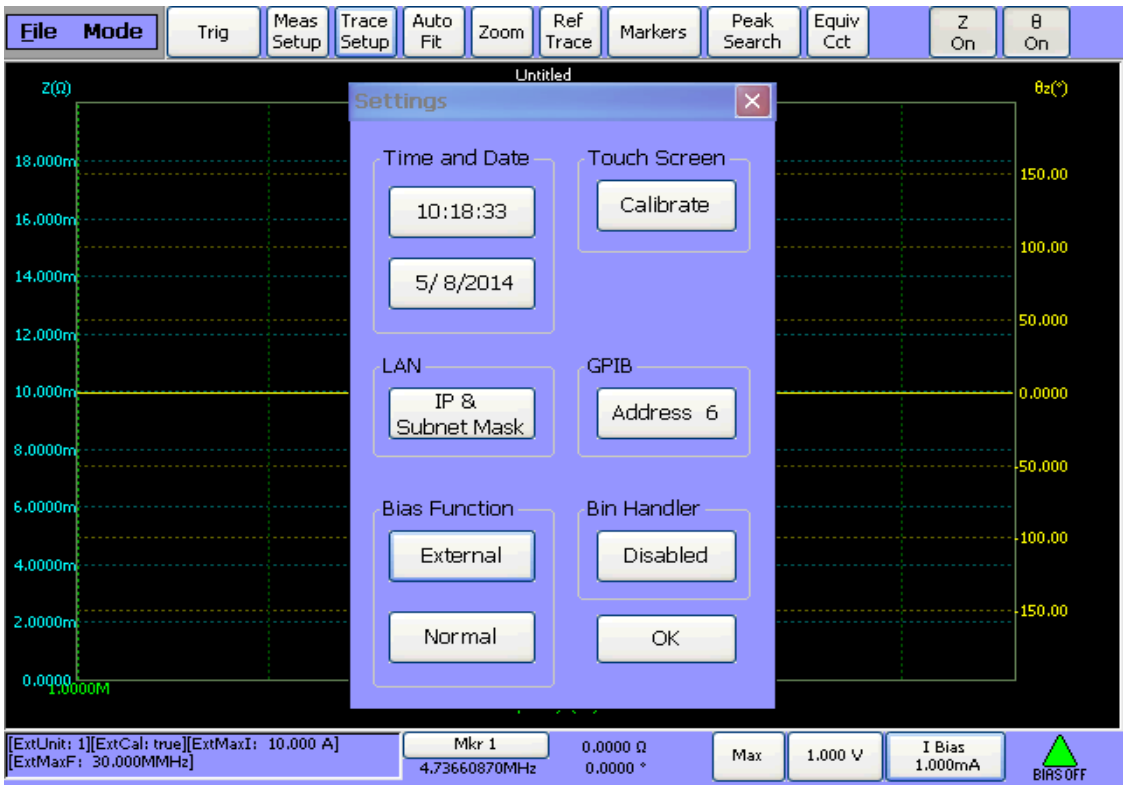


Figure 4-2 6500 Analyzer Mode Bias Unit Enable

In Figure 4-2, the 6500 can enable the 6565 by first selecting the settings menu in 'Mode' (top left corner). In the bias function menu, the bias will probably show 'Disabled'. Push this box and 'External' should come on. Then select 'OK'. The menu system should then enable the 6565. If 'External' does no come on then check the power and control cable to the 6565. Note that if a further 6565 bias unit is added to the rest of the system while in a powered up state then the manual setup routine will have to be repeated.

4.2.3 Enabling the 6565 in Meter Mode

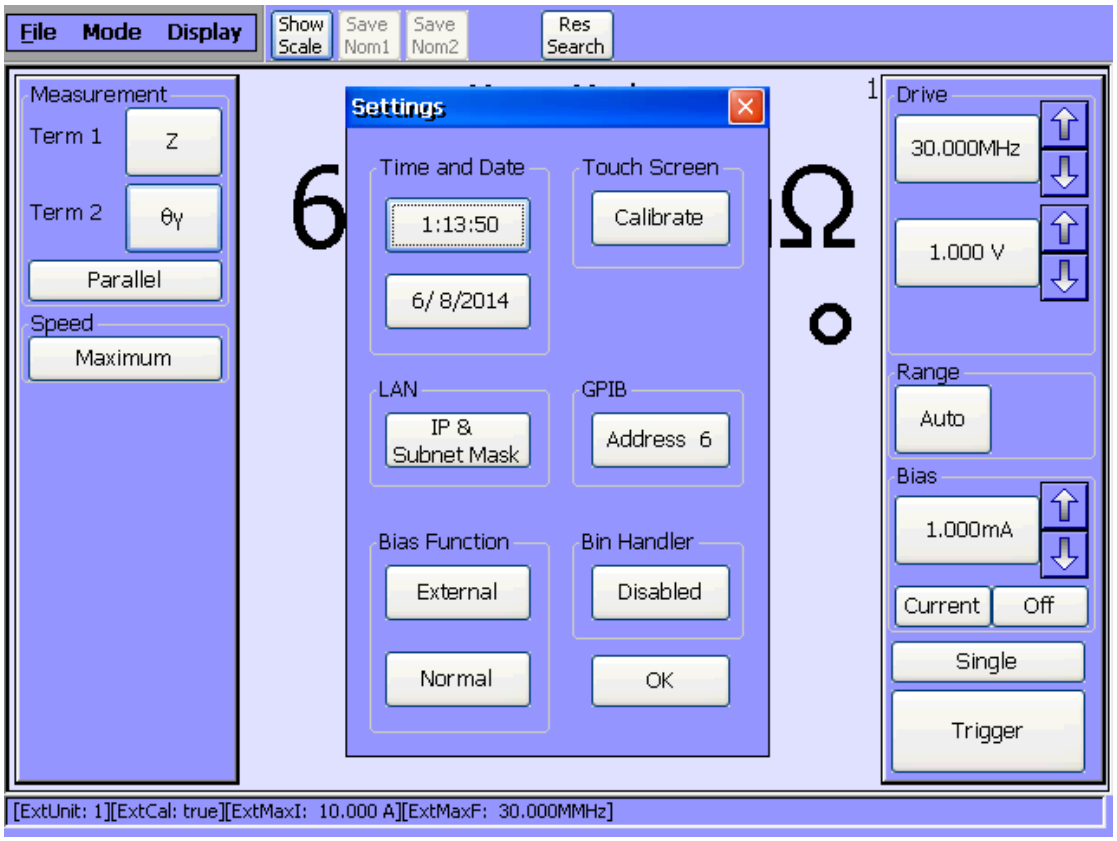


Figure 4-3 6500 Meter Mode Bias Unit Enable

In Meter mode or where the controller is a 6500P series model the manual operation is performed similarly. The 6500 should normally boot up and enable the 6565's in the process thus requiring no operator intervention. However, to manually enable the 6565, first select the 'Mode' menu on the top toolbar and then select 'Settings'. This brings up the settings menu and the bias function can then be changed from 'Disabled' to External. Then select 'OK'. This will boot up the 6565 combination.

4.2.4 Setting up the bias current in Analysis Mode

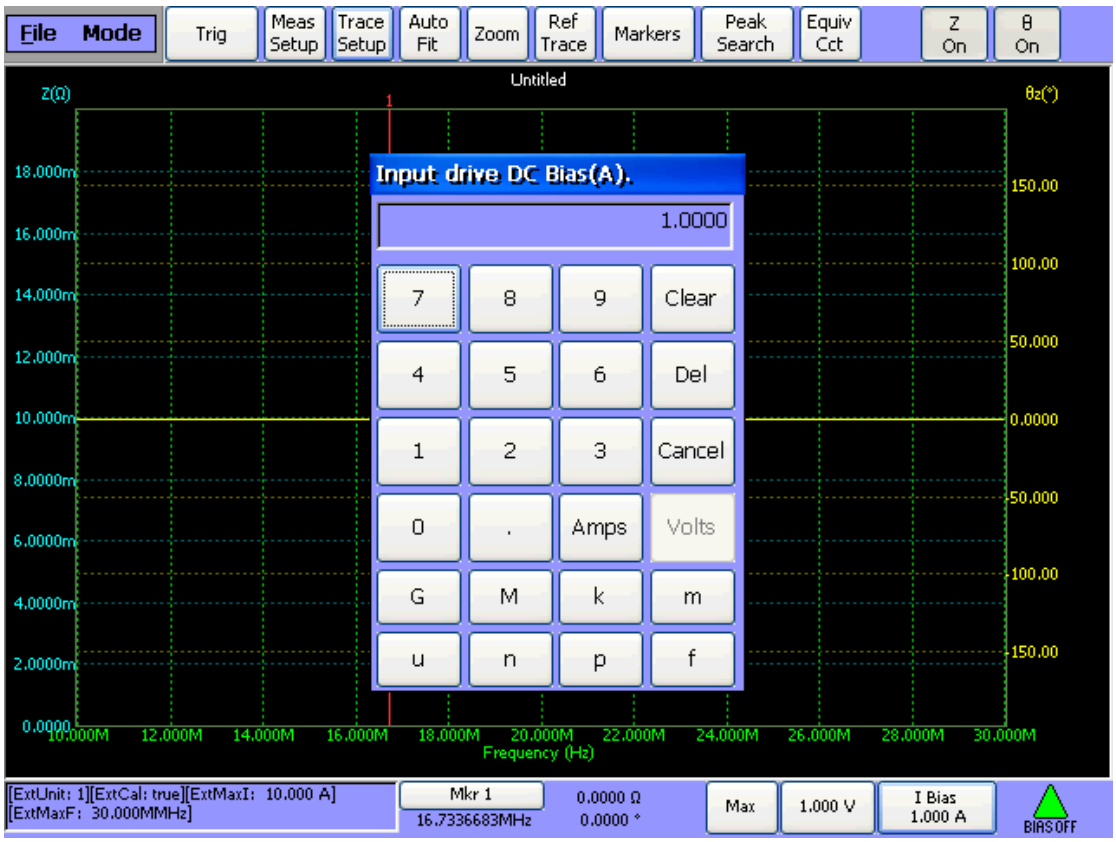


Figure 4-4 Bias Current Setup in 6500 Analyzer Mode

In order to set up the current press the ‘I Bias’ dialog box on the bottom right hand corner. This will bring up the bias current setting menu. Bias current may be entered with a resolution of 1mA for currents ≤ 1A and 10mA for bias currents ≥ 1.01A to 10A. When two or more 6565 bias units are used these values will be automatically multiplied by the number of bias units employed. To enter the current enter the value with the decimal point as appropriate and then press either ‘Amps’ or ‘m’ and then ‘Amps’ for milliamp size currents. For example, a current of 12mA may be set either by entering 0.012A or 12mA and so on.

4.2.5 Setting up the bias current in Meter Mode

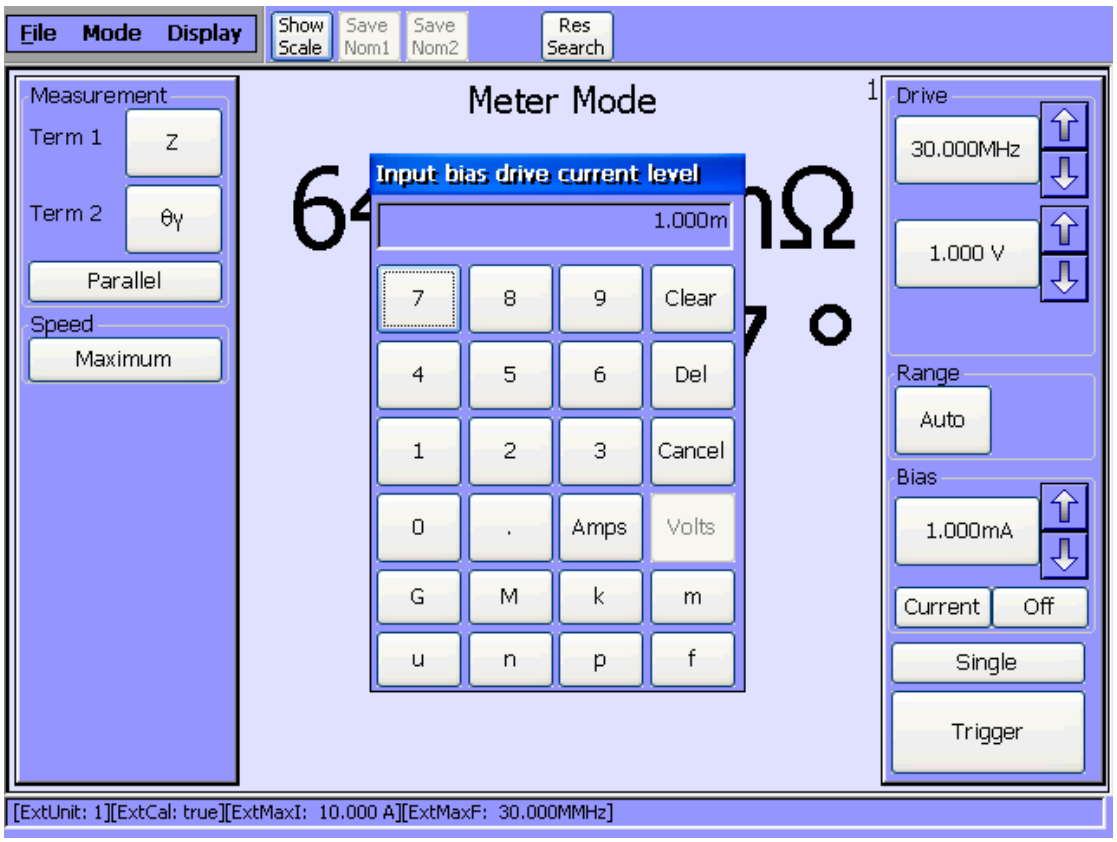


Figure 4-5 Bias Current Setup in 6500 Meter Mode

The setup of the bias current in Meter Mode is done in exactly the same manner as in Analysis mode (Section 4.2.5). To gain access to the current setup dialogue box press the box on the right hand side showing current just below 'Bias'.

4.2.6 Applying the bias current

After setting up the bias current as described in the previous sections firstly check the following:

- Ensure that the high current coaxial leads from the 6565 are suitably connected to the 1026 or 1027 fixture in use.
- Ensure also that the interlock cable is connected between the fixture and the rear panel socket of the 6500 marked 'SAFETY INTERLOCK'. **Never under any circumstances attempt to link out or bypass the interlock cable as it is there for your safety.**
- Make sure that there is a device in the fixture and that its DC resistance is such that the maximum compliance voltage of the 6565 will not be exceeded when the chosen current is applied.
- Ensure that the top cover of the fixture is closed over the device under test.
- Make sure that the power rating of the device under test is within the power that you will be applying to it since excessive power may cause the device to become extremely hot, possibly catch fire or even explode.

If satisfied that the above conditions have been met then the bias current can be applied by pressing the 'Bias' button on the front panel of the 6500. At the same time you should see the BIAS indicators show red on the 6565 and its display show the current that was set. When there are multiple 6565's used, this current shown will be ½, 1/3 or ¼ of the total current according to the number of 6565's used.

WARNINGS !

- **Never under any circumstances, attempt to remove the device under test without turning off the bias current first.**
- **Never under any circumstances, attempt to lift the protective cover on the fixture with the bias current still flowing. Although to do so will immediately turn off the bias current, there could still be a high voltage across the device (inductor) under test and it also could be very hot.**
- **Always wait until the red lights have gone off on all of the 6565 bias units and that the Bias 'ON' indicator on the 6500 has gone out (or the green on screen triangle appears) showing safe mode. Remember that a large inductor will take time for its charge to dissipate fully and it may be able to supply a dangerous voltage if disconnected prematurely.**

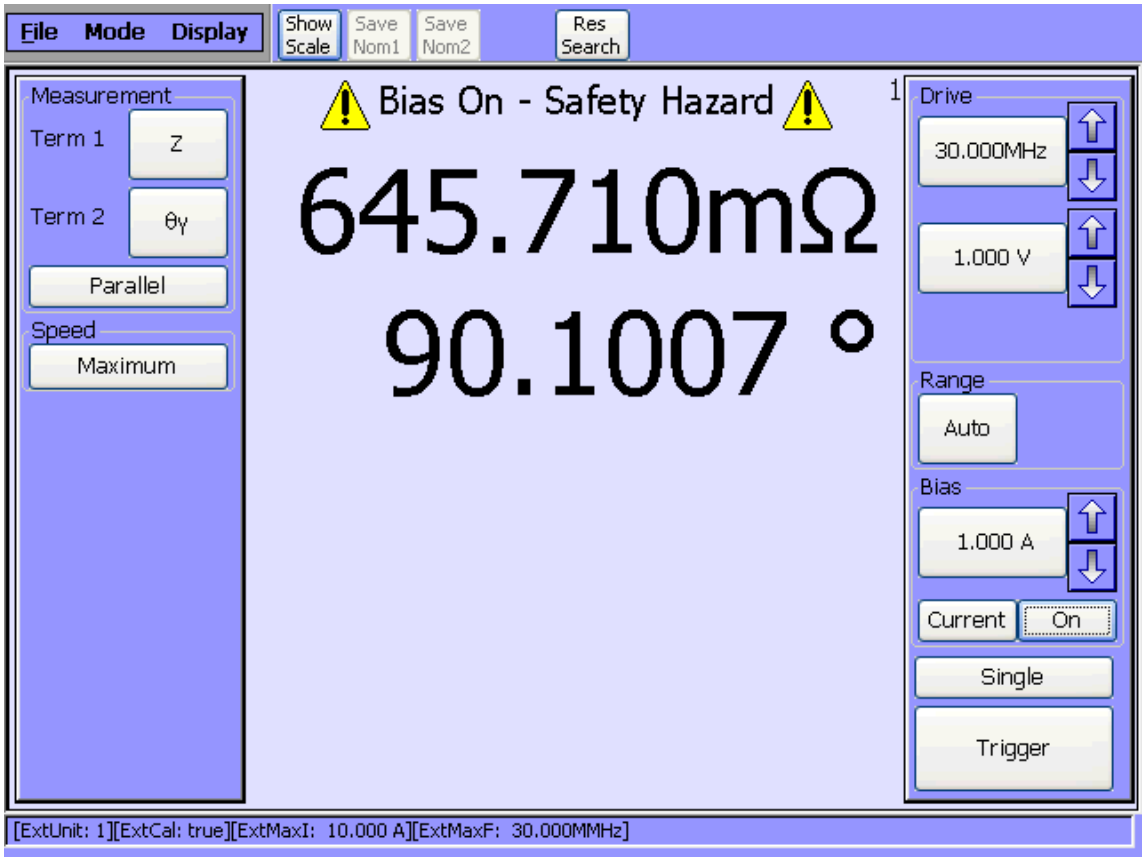


Figure 4-6 Safety Warnings in Meter Mode

4.2.7 Calibration and Trims

The 6500 trims would normally be expected to change with the addition of a 1026 or 1027 fixture and the associated 6565 units. When the setup has been connected up the 6500 trim procedure should be employed (See 6500 user manual). The 6565 units must be in the bias off

condition for the entire trimming procedure. If the user wishes to perform an HF compensation then the model 7010 Transfer Standard kit option will be required. *Whether performing open and short circuit trims or high frequency fixture compensation it is vital that the 6565 unit be enabled in the* 6500 **Settings** menu *beforehand*. Failure to do this will result in incorrect trims.

4.2.7.1 Performing Short Circuit and Open Circuit trims.

Firstly, in either Meter mode or Analysis mode, press the MODE box in the upper screen menu, then select the calibration menu as shown.

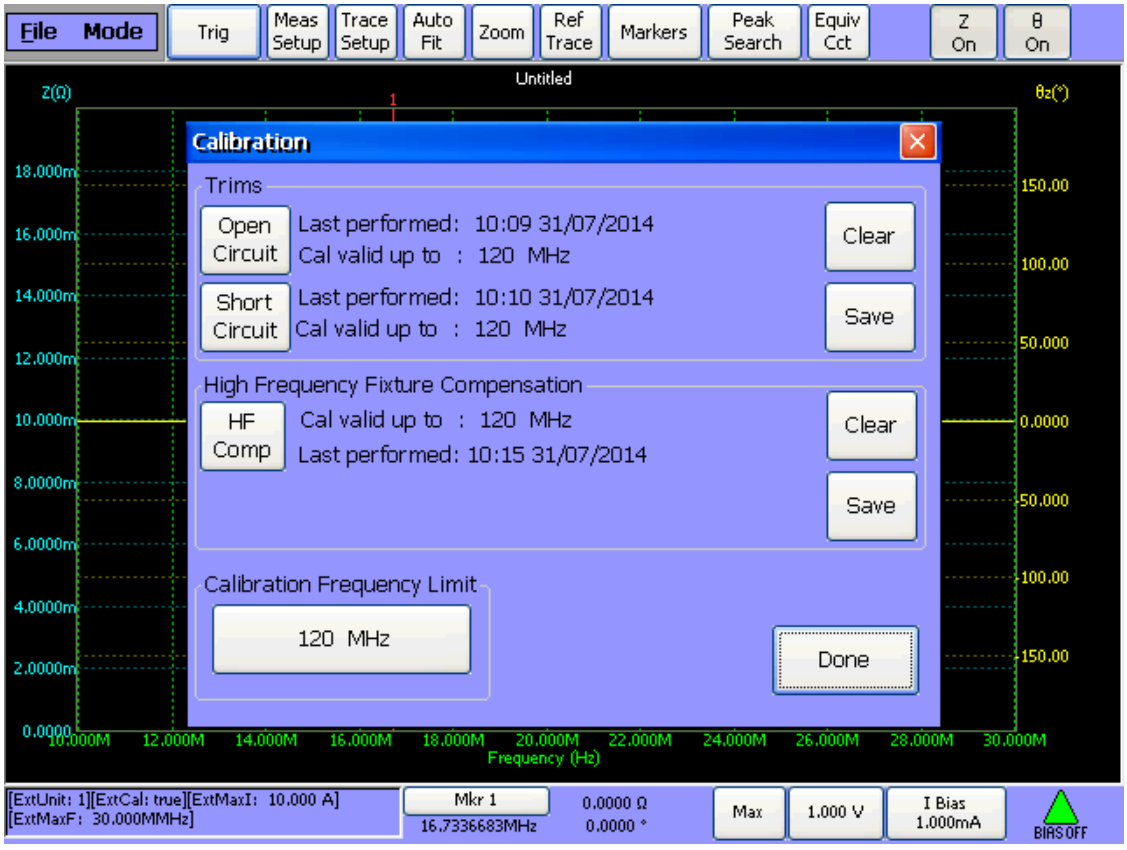


Figure 4-7 Calibration Menu

Clear the box marked trims. **DO NOT CLEAR** the High Frequency Compensation box yet. Close the jaws of the 1026 or 1027 fixture with no component fitted and then select the open circuit trim box. This will initiate the open circuit trim sequence which runs for a few minutes. If the 7010 Transfer Standards Kit is not to hand then a short thick piece of tinned copper wire will be needed for the short circuit trim. Make this into a 'U' shape and connect across the jaws of the fixture. Then select the short circuit trim box. The short circuit trim routine will then run through. If the 7010 Transfer Standards are available, then the supplied short circuit must be used since it provides a closer match when setting up the High Frequency Compensation. After completion of both trims these can then be saved and the date and time of the trim will appear in the dialogue box. Attempting to save the trims if only one trim type has been completed will negate the process and the procedure will have to be repeated.

Note that clearing the open circuit and short circuit trims will not clear the factory default trims set up for the 6500. **Never attempt to apply bias to the 7010 short circuit trim standard as this may destroy it.**

4.2.7.2 Performing High frequency Fixture Compensation

In order to perform this trim it is essential that the operator have access to the 7010 Transfer Standards Kit. Also it is vital that the open and short circuit trims be completed beforehand using the short circuit standard provided in the kit.

Assuming that this has been done correctly firstly press the 'Clear' box in the High Frequency Compensation area to remove the current trims. Next press the 'HF Comp' box and follow the on-screen guidance to complete the new trims. For this you will need up to three transfer standards (depending on 6500 and 6565 models). These are 100Ω, 100pF and 10pF. (The 10pF standard will not be called for if either the 6500 or the 6565 is rated for less than 15MHz.)

After completion of the high frequency compensation, press the save box to store the trims. It is recommended that the short circuit trim be repeated after HF compensation to get best performance. Do not clear the open and short circuit trims in this case. The existing open circuit trim performed earlier is still valid and can be retained.

4.2.8 Making Measurements

The 6565 contains a high degree of isolation internally and when used with the 6500 and 1026 or 1027 fixtures should have very little effect on inductance measurements being taken from low frequency (20Hz) up to the maximum available test frequency of 120MHz. This is also true whether the bias current is turned on or not. The 6500 series do not allow for Rdc measurements and so this feature is not available.

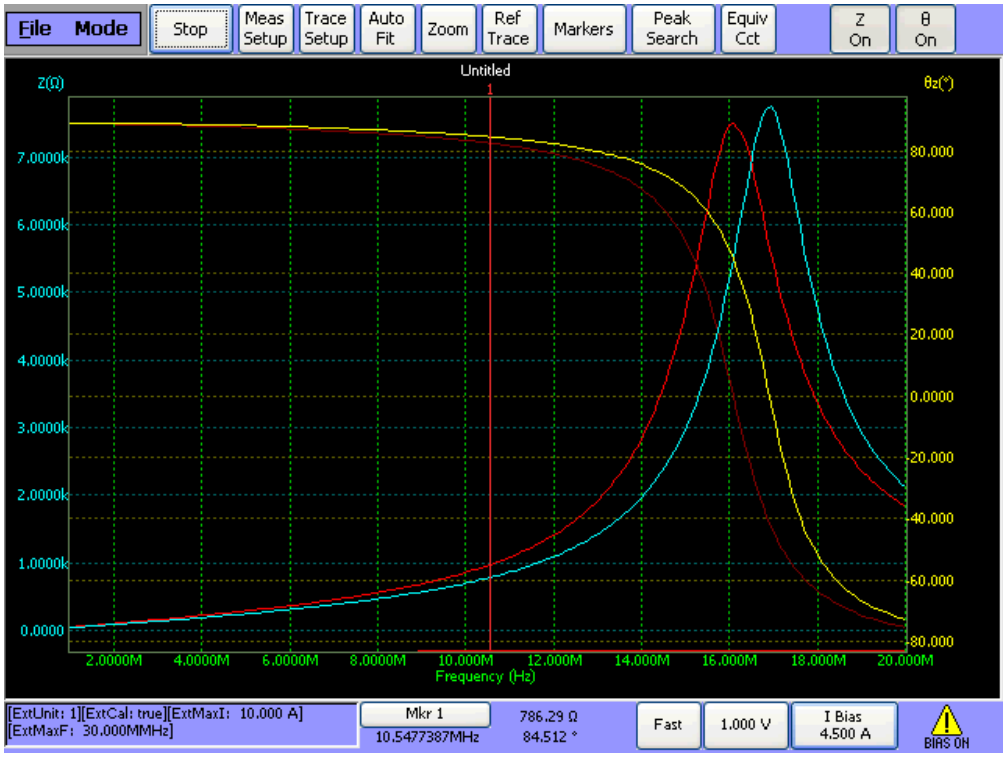


Figure 4-8 Example 10uH Inductor - Zero Bias (Red & Brown), 4.5A (Blue & Yellow)

Ensure that Bias is switched OFF. Insert an inductor to be measured into the jaws of the fixture and close the jaws tightly. Ensure that the dc resistance of the inductor under test is such that the maximum compliance voltage of the 6565 will not be exceeded when the specified bias current is applied.

Measurements in Analysis mode and Meter mode using the 6500 impedance analyser are done in exactly the same way with current bias applied or not.

Figure 4-8 shows a 2525 size 10uH inductor which is swept over a frequency range of 1 to 20MHz at zero bias (red and brown traces) and then at its maximum (4.5A) current (blue and yellow traces). This shows how the self-resonant frequency increases as the inductor value drops with current and also how the phase transition frequency moves correspondingly. Note the yellow warning triangle on the right side of the bottom toolbar showing that bias current is flowing.

4.2.8.1 Making bias sweep measurements (available in Analysis Mode only)

In this mode, the frequency is fixed and the bias sweep is set to run between two fixed points.

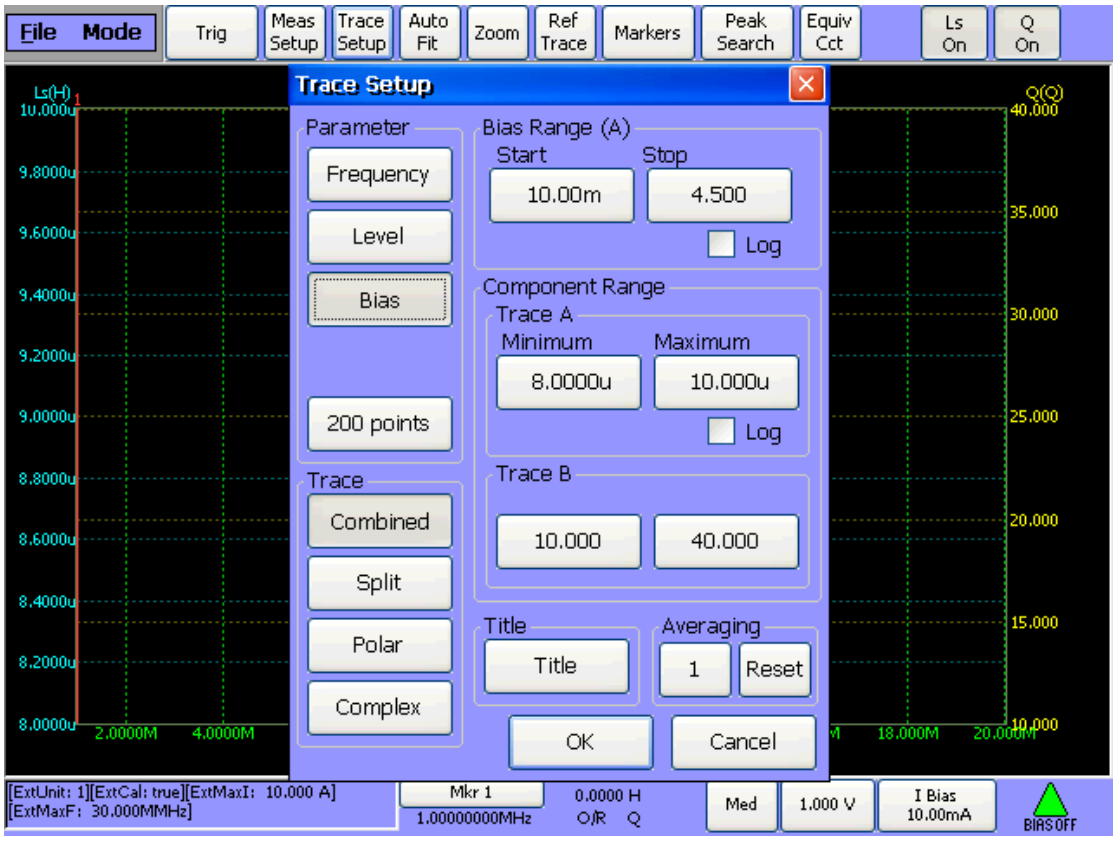


Figure 4-9 Menu System for Bias Sweep Selection

Firstly press the ‘Trace Setup’ box on the upper toolbar. Next press the ‘Bias’ box under the parameter section. The bias sweep range minimum current is entered in the ‘Start’ box and the maximum in the ‘Stop’ box. Note that if the maximum current exceeds 1A then the minimum starting current and step size is 10mA whereas if it is ≤ 1A then the starting current and step size can be as low as 1mA.

After entering the start and stop sweep currents and pressing OK, then the frequency of measurement must now be entered. This can be done simply via the dialogue box on the lower

right hand side toolbar of the Analysis display. Adjacent boxes also allow the operator to re-enter different sweep speeds and measurement signal levels. Please see Figure 4-9.

An alternative and more comprehensive method is to use the ‘Meas Setup’ box as shown in Figure 4-10.

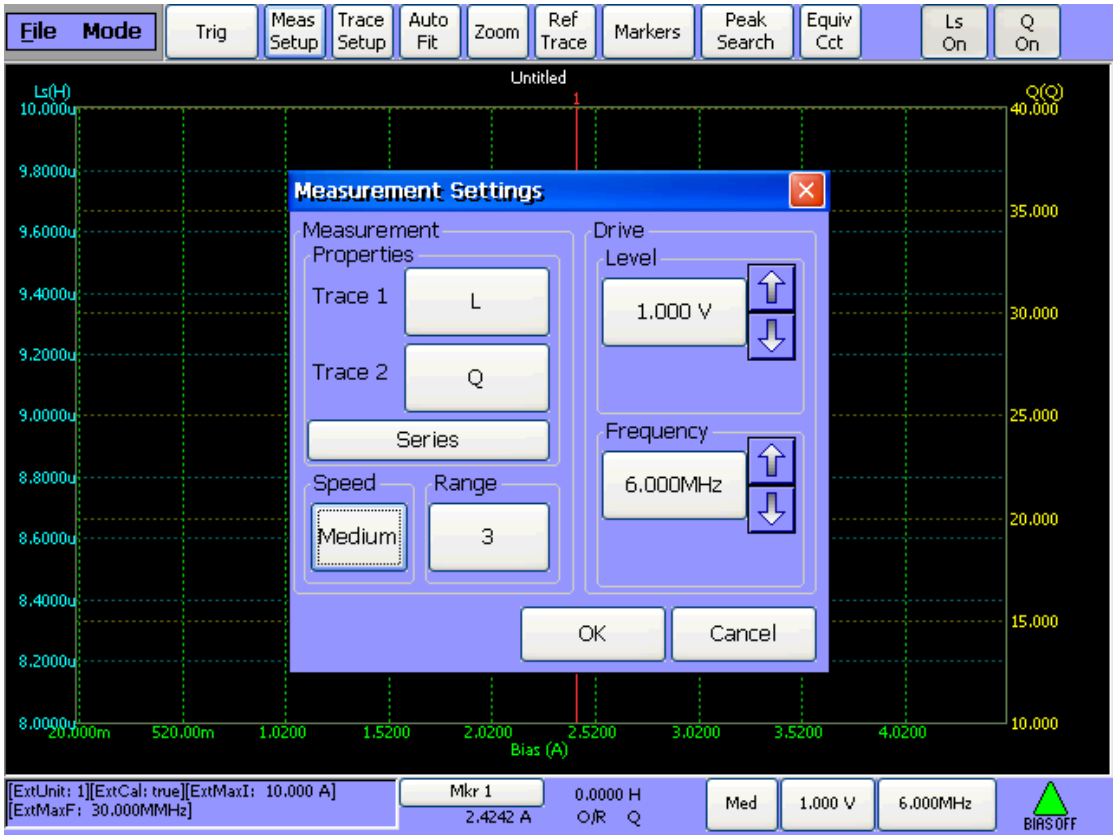


Figure 4-10 Measurement Settings Menu for Bias Sweep

This allows the operator to select the measurement parameters for Traces 1 & 2, the circuit configuration, drive level, test frequency and measurement range.

Figure 4-11 Example Bias Sweep for a 10uH Inductor at a Frequency of 6MHz

Figure 4-11 shows a typical display of an inductor of value 10uH where the bias current has been swept from 10mA to 4.5A, and the test frequency is 6MHz. The vertical graphical axes have been chosen to display L (left and blue trace) and Q (right and yellow trace). The bias current values are shown on the horizontal axis. The cursor may then be aligned to read the L an Q values at a selected bias current.

4.2.8.2 Fast Mode

In normal operation the 6565 is slew-rate limited in an attempt to reduce the amount of back-emf from large inductors, both when applying current bias and turning it off. Normally this slew-rate is about 50V/sec at 10A. When multiple 6565's are connected together the slew-rate reduces by the multiple of the number of units connected. Conversely, in the case of a single 6565 where the current is ≤ 1A the slew rate increases above the 50V/sec.

However, this time delay due to slew-rate limiting could be unwanted when testing low value inductors at large currents in automated machinery. The 6565 therefore has a fast mode where the slew rate is approximately 100V/sec and does not vary with the number of 6565's connected in the system. In order to access this facility, please refer to Figure 4-12. Whether in Meter mode or Analysis mode the setup is done in the same way. To begin, press the 'Mode' box on the upper toolbar. Then select 'Settings'. Under the 'Bias Function' heading the lowest box will usually display 'Normal'. Select this and the box will change to 'Fast'. This then gives the high speed slew-rate if required.

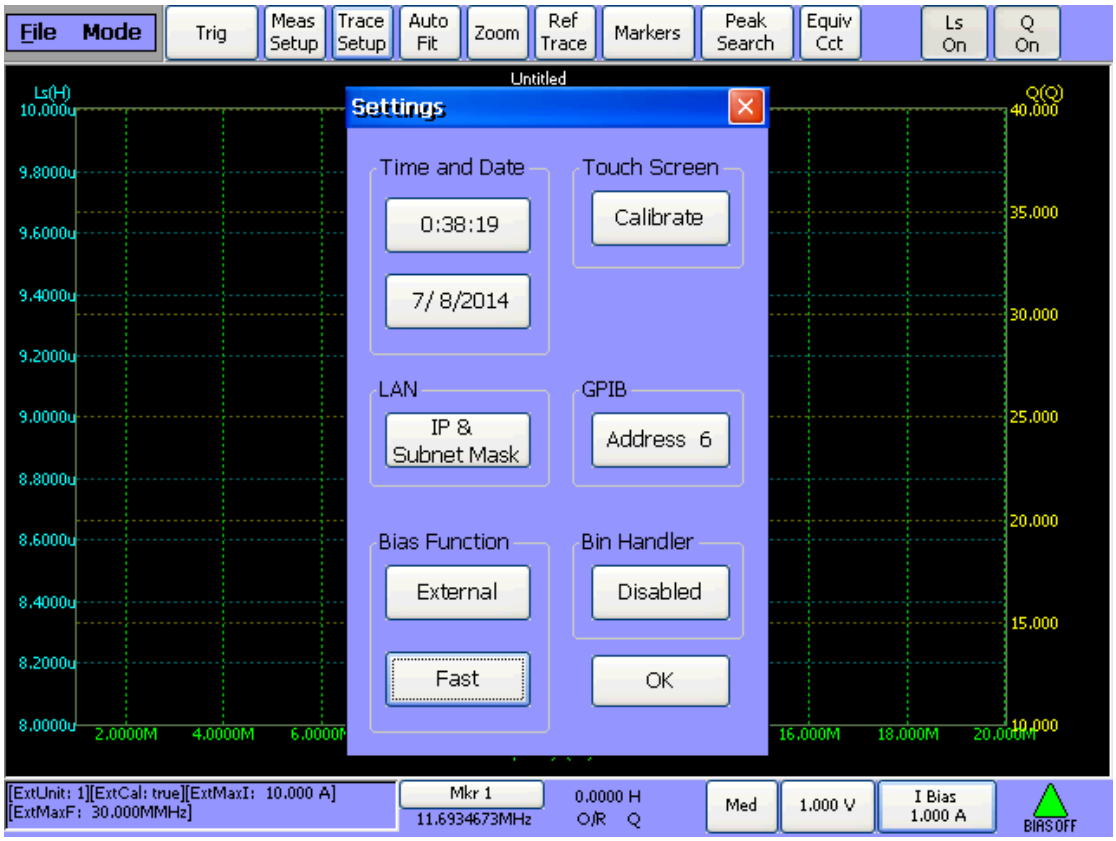


Figure 4-12 Setting the Bias Slew Rate

4.2.9 Messages

Message	Condition
External Device Interlock!	An attempt has been made either to switch on the bias without closing the safety interlock switch or the switch has been opened while the bias current was flowing.
Excess Bias Problem **Excessive Volts across DUT**	Too much bias current is flowing across the dc resistance of the DUT so the maximum compliance voltage has been exceeded. This may be avoided by reducing the bias current. The bias current will be turned off after a few seconds.
Load Disconnected	The DUT load has been disconnected while the bias current is flowing or the DUT has not been connected when the bias current was enabled. The bias current is removed immediately.
Fan Failure	One or both of the main cooling fans in the instrument has stopped working correctly. The dc bias current will be turned off.
Power Supply Failure	The main power supply has generated a fail flag or the voltage being supplied is incorrect. The dc bias current will be turned off.
Bias Current Error	This means that the bias current is not being supplied correctly. if the error is grossly incorrect the bias current will be shut off.

Message	Condition
Current Balance Error	This means that the bias source current and the bias sink current do not match correctly. A minor error will allow the system to be rectified within a few seconds and maintain the current while a major error will cause immediate shutdown.
Over Temperature Error!	This means that the 6565 has seriously started to overheat for some reason. On detection of this error, bias current will be shut down immediately. The situation is only recoverable when the instrument has cooled down sufficiently.

Figure 4-13 Warning Messages

4.3 GPIB and LAN commands

(Please also see section 11 on Remote Control in the 6500 handbook.)

The following section lists additional commands that are necessary for the 6565 control and also restates the relevant commands for setting bias that are applicable both to the 6565 and the internal D1 or D2 bias options. Note that it is not possible to simultaneously operate a 6565 with a D1 or D2 module active at the same time.

4.3.1 6500 / 6565 Bias System Setup Commands

***SYSBIAS** Sets the bias mode to internal, external or off. **Parameter** **'BIAS INT'** for internal bias. **'BIAS EXT'** for external bias. **'BIAS NONE'** To disable bias. **Example** To set the bias to external *SYSBIAS 'BIAS EXT' **Response** None.	***SYSBIAS?** Query the bias setting state. **Parameter** None. **Response** **BIAS INT** for internal bias **BIAS EXT** for external bias **BIAS NONE** for bias off Data is returned in text format.
***EXTBIASRAMP** Sets the slew rate that the bias increases or decreases to the new setting. This may be either fast or normal. **Parameter** **'RAMP NORM'** for normal speed **'RAMP FAST'** for speed up **Example** *EXTBIASRAMP 'RAMP FAST' **Response** None.	***EXTBIASRAMP?** Query the bias setting speed. **Parameter** None. **Response** **RAMP NORM** for normal speed. **RAMP FAST** for fast speed. Data is returned in text format.
	***BIASFITINT?** Query if an internal bias unit is fitted or not. **Response** Integer 0 for false and 1 for true.

	***BIASFITEXT?** Query if an external bias unit is fitted or not. **Parameter** None. **Response** Integer 0 for false and 1 for true.
***GPRBIASTYPE** Sets the bias type as voltage or current. (Note that the 6565 will only respond to current bias and a voltage bias command will be ignored.) **'CURRENT'** Sets current bias **'VOLTAGE'** Sets voltage bias **Example** *GPRBIASTYPE 'CURRENT' **Response** None.	***GPRBIASTYPE?** Queries the bias type as voltage or current. **Parameter** None. **Response** **CURRENT** for current bias. **VOLTAGE** for voltage bias. Data is returned in text format.
	***EXTBIASUNIT?** Query the number of 6565 bias units connected in the chain. **Parameter** None. **Response** The number of bias units is returned as an integer.
	***EXTBIASSRN?** Query the serial number of the 6565 bias unit. (Only applicable when one 6565 unit is connected.) **Parameter** None. **Response** The serial number is returned in text format. **Example** 1587124

	***EXTBIASBAND?** Query bandwidth of the bias unit connected. When multiple bias units are connected the lowest bandwidth is displayed **Parameter** None. **Response** The bandwidth is returned in floating point format (in Hz). **Example** 1.200000E+08 (= 120MHz)
	***EXTBIASMAX?** Query maximum current of the bias unit. When multiple bias units are connected the maximum current of the total setup is displayed. **Parameter** None. **Response** The current is displayed in floating point format. **Example** 1.000000E+01 (= 10A)
	***EXTBIASMIN?** Query minimum current of the bias unit. When multiple bias units are connected the minimum current of the total setup is displayed. **Parameter** None. **Response** The current is displayed in floating point format. **Example** 1.000000E-03 (= 1.0 mA)

	***EXTBIASBOARD?** Query the control board issue. (Only applicable when one bias unit is connected.) **Parameter** None. **Response** The board issue is displayed in numeric format. **Example** 03 (= Version 3)
	***EXTBIASSWNUM?** Query the software issue. (Only applicable when one bias unit is connected.) **Parameter** None. **Response** The software issue is displayed in numeric format. **Example** 1.20 (= version 1.20)

4.3.2 Common commands applicable for both internal and external bias units.

(See also section 11 in the 6500 main manual where these commands are restated here for completeness.)

4.3.2.1 Meter mode commands (:METER)

BIAS-TYPE Sets up the selected bias source. **Parameter** **VOLtage** Voltage bias **CUR rent** Current bias **Response** None. **Example** :METER:BIAS-TYPE CUR Note that this has the same effect as the *GPRBIASTYPE command.	**BIAS-TYPE?** Query the selected bias source. **Parameter** None. **Response** The bias type is returned as an integer **0** Current Bias **1** Voltage Bias **Example** :METER:BIAS-TYPE?
BIAS-STATe Change the state of the selected bias source. **Parameter** **ON** Turn the bias on. **OFF** Turn the bias off. **Response** None. **Example** :METER:BIAS-STAT ON	**BIAS-STATe?** Query the state of the selected bias source **Parameter** None. **Response** The bias state is returned as an integer **0** For bias Off **1** For bias On **Example** :METER:BIAS-STAT?
BIAS Sets the output level of the selected bias source. **Parameter** The required output level as a real **Response** None. **Example** To set 1.5A bias current. :METER:BIAS 1.5	**BIAS?** Query the bias source level. **Parameter** None. **Response** The bias source output level is given as a number **Example** :METER:BIAS?

4.3.2.2 Analysis mode commands (:ANAlysis)

BIAS-TYPE Sets up the selected bias source. **Parameter** **VOLtage** Voltage bias **CUR rent** Current bias **Response** None. **Example** :ANA:BIAS-TYPE CUR Note that this has the same effect as the *GPRBIASTYPE command.	**BIAS-TYPE?** Query the selected bias source. **Parameter** None. **Response** The bias type is returned as an integer **0** For Current bias **1** For Voltage bias **Example** :ANA:BIAS-TYPE?
BIAS-STATe Change the state of the selected bias source. **Parameter** **ON** Turn the bias on. **OFF** Turn the bias off. **Response** None. **Example** :ANA:BIAS-STAT ON	**BIAS-STATe?** Query the state of the selected bias source **Parameter** None. **Response** The bias state is returned as an integer **0** For bias Off **1** For bias On **Example** :ANA:BIAS-STAT?
BIAS Sets the output level of the selected bias source. **Parameter** The required output level as a real **Response** None. **Example** To set 1.5A bias current. :ANA:BIAS 1.5	**BIAS?** Query the bias source level. **Parameter** None. **Response** The bias source output level is given as a number. **Example** :ANA:BIAS?

4.3.3 Performing a bias sweep (Analysis mode only :ANAlysis)

This makes use of some additional commands together with the existing commands listed in section 11 of the 6500 main manual some of which are repeated here for completeness.

PARameter Sets up the type of sweep **Parameter** **FREQuency** For a frequency sweep **LEVEL** For a drive level sweep at fixed frequency **BIAS** For a current bias sweep at fixed frequency **Response** None. **Example** To set up a bias sweep :ANA:PAR BIAS	**PARameter?** Query the type of sweep **Parameter** None. **Response** Data is returned in numeric format **Example** :ANA:PAR? **0** For Frequency **1** For Level **2** For Bias
LOG-X **LOG-Y** Select X or Y axis as a log or linear scale **Parameter** **ON** Log scale **OFF** Linear scale **Response** None. **Example** To set up a log sweep :ANA: LOG_X	**LOG-X?** **LOG-Y?** Query the X or Y axis log scale setting **Parameter** None. **Response** **0** Linear Scale **1** Log Scale **Example** :ANA:LOG-X?
START **STOP** Sets the start or stop point on the chosen scale **Parameter** Enter the number as a real (in Amperes) **Response** None. **Example** To start a sweep at 100mA :ANA:START 0.1	**START?** **STOP?** Query the value of the chosen start or stop point. **Parameter** None. **Response** Returns a real number e.g. 0.1 (as amps)

***SW-ABORT** Root command to abort a sweep while in progress **Parameter** None. **Response** None. **Example** *SW-ABORT	
	***SW-STATUS?** Query status of current sweep **Parameter** None. **Response** Returns a value of the percentage of the trace covered so far.
TRIGger Triggers the start of a sweep **Parameter** None. **Response** None. **Example** To trigger a sweep :ANA:TRIG	
TRIG2 Triggers the start of a sweep **TRIG2** differs from **TRIG** in that TRIG2 can be aborted during a sweep by using *SW-ABORT whereas **TRIG** cannot. This can be important for high current sweeps. **Parameter** None. **Response** None. **Example** To trigger a sweep :ANA:TRIG2	

4.3.3.1 Example code to perform a bias sweep.

*SYSBIAS 'EXT'	Selects External bias mode. Options 'INT', 'EXT' and 'NONE' (it needs the single quote i.e 'EXT' not just EXT)
*SYSBIAS?	Reads the BIAS setting
:ANA	Ensures that the system is put into Analysis mode at the start.
:ANA:PAR BIAS	Selects BIAS sweep . (Options FREQ , BIAS, LEVEL)
:ANA:BIAS 0.01	Sets up the bias current initial condition (pre-sweep) as 10mA (If this is not done then the bias can start up at a random value)
:ANA:START 0.01	Selects 10 milliAmp as the starting current
:ANA:STOP 10.0	Selects 10.0 Amp as the final current
:ANA:BIAS-STAT ON	Turn on bias before sweep trigger is applied
:ANA:TRIG2	Use TRIG2 so that the sweep can be aborted if required
*SW-STATUS?	Used as required to inspect the percentage of sweep covered so far.
:ANA:BIAS-STAT OFF	Turn off bias after trigger (end of sweep)

4.4 Software Updates

The 6565 bias software has a bootloader section in it that allows new software updates to be added. When updating software in cases where a multiple of 6565 units are employed it is recommended that all units be updated to the same software issue. Note that updates can be supplied through the internet as an e-mail as the files are generally small. If using this method, the update pack should be copied into the root directory of a USB Memory stick.

4.4.1 To perform a software update to the 6565.

1) Connect the USB Memory Stick to one of the USB ports on the rear panel of the 6500.
2) For this operation the interlock cable **must** be connected between the test fixture and the 6500 and the fixture cover closed. It is also recommended that the test fixture (e.g. 1026 or 1027) be connected to the 6500 and the bias current output cables be connected to the 6565.
3) **Only one 6565 unit can be updated at a time**. Connect the 6565 to the 6500 via the supplied control cable and power up both units. Note that it is not necessary to enable the 6565 unit in the 6500 **Settings** menu for this operation.
4) On the 6500 now enter the number 6565 on the keypad and press the **File** icon on the top left side of the upper taskbar. If done correctly **Ext-Device Update** should appear as one of the options in the column. Select this option and then follow the on-screen instructions. These may ask you to cycle the power to the 6565 if it has already been enabled.
5) When the process has been started correctly, the 6565 **Bias On** LED will flash about once per second as the data is being uploaded. This process takes about 3 minutes.
6) Upon completion of the software upload a message should appear that the software has been correctly installed. When this has been done it is important to cycle the power in the 6565 and it will then start up with the new software installed. It merely remains to re-enable the 6565 in the 6500 **Settings** menu and it should be ready to go.

5. SPECIFICATION

5.1 Facilities

Output DC Bias Current	0 (Off) to 10A
Resolution	From 1mA to 1A in 999 steps of 1mA From 1.01A to 10A in 899 steps of 10mA Up to four 6565 units can be connected in parallel, to give a maximum bias current of up to four times a single bias unit (40A), provided that the maximum voltage drop does not exceed the compliance voltage.
DC Bias Current Accuracy	±1% of set bias current ± 1mA from 1mA to 1A
Current Drive Readback	±1% of set bias current ± 10mA from 1.01A to 10A ±1% of set bias current, ±1 digit
Compliance Voltage	9V max at 1V ac drive level. 10V max at 0.25V ac drive level
Max Signal Drive Level	1V ac rms 20Hz to 49.9MHz 0.5V rms 50MHz to 120MHz
Frequency Range	20Hz – 5MHz for 6565-05 20Hz – 30MHz for 6565-30 20Hz – 120MHz for 6565-120
Measurement Protection Modes	Over-voltage trip, safety interlock, fan failure, excess temperature and circuit diagnostic checks.
Stored Energy Protection	10J (e.g. from inductor)
Current Supply to Fixture	65A Lemo FFA connectors and high current 50Ω coaxial cable e.g. RG8, Belden 89913 or Belden 89880
Number of Cascadable Units	Up to 4 to provide 40A
Control Method	via serial communication bus with 6500 series LCR meter
Suitable High Current Fixtures	1J1026 (20A) or 1J1027 (40A)

5.2 General Data

5.2.1 Input Specification

Input Voltage	85 to 265V AC
Frequency	47 to 63Hz
Input Current	4.2A RMS max
Power Factor	Meets EN61000-3-2
Input Fuse Rating	6.3A 'T' type, 5 x 20mm HRC (2 off required). The input fuses are in the fuse holder drawer integral to the IEC input connector.
Power-up	6565 powers up automatically when connected to a powered 6500 Impedance Analyser Isolating switch provided.

5.2.2 Measurement Connections

4 BNC Cable adaptor as supplied with the 1026 or 1027 to connect to the fixture and to the 6500 Impedance Impedanace Analyzer.

1 Pair of high current coaxial cables (1 off male – male, 1 off female – female) terminated with Lemo FFA series connectors.;

5.2.3 Control Connections

I^2C bus link controls application of DC current and monitors status of 6565. Status data includes 'Excessive Voltage Drop' and 'Over temperature'.

5.2.4 1026 and 1027 High Current Fixtures

The 1026 high current fixture enables a DC bias current of up to 20A to be applied to an inductor during component test, while the 1027 fixture allows bias current of up to 40A to be applied to an inductor under test. Both units have a 3.5mm jack socket at the rear for interlock connection to the 6500 rear panel. Lifting the lid of the 1026 or 1027 both prevents bias current being switched on and disconnects the bias current if the lid is inadvertently lifted while bias current is flowing.

5.2.5 Environmental Conditions

Altitude	Altitude up to 2000m
Relative Humidity	up to 80% non conducting.
Installation Category	II (in accordance with IEC664)
Pollution Degree	2 (mainly non-conductive)

This equipment is intended for indoor use only in a non-explosive, non-corrosive atmosphere.

5.2.5.1 Temperature

Storage	-40°C to +70°C (-40°F to +158°F)
Operation	0°C to +40°C
Full Accuracy	+15°C to +30°C (59°F to +86°F) (10A max)

5.2.6 Safety

Bias safety interlock on rear panel of Analyzer provides door lock and closed control lines.

Designed to meet the requirements of EN61010-1.

5.2.7 EMC

Complies with EN50081-1, EN50082-1 generic emissions and immunity standards by meeting with the requirements of EN55022, EN61000-4-2, EN61000-4-3, EN61000-4-4.

Note:

When subjected to a significant electrostatic discharge (in accordance with EN61000-4-2), the analyser may reset itself. If a bias current is being applied (either from the 6565 or the analyser), this will be removed as part of the reset procedure. This ensures the safety of the operator under normal and test conditions. Please read section 1—Safety before using this instrument.

5.2.8 Mechanical

Height	132mm
Width	435mm
Depth	522mm
Weight	15kg (33lb)
Cooling	Fan cooled: intake front, exhaust rear.with filter access on front panel. Over temperature trip provided.

5.2.9 Panel Symbols Used

	Refer to handbook.
	Alternating current
	Earth (ground) terminal
	CAUTION - Risk of electric shock.
	On
	Off

6. MAINTENANCE, SUPPORT AND SERVICES

6.1 Guarantee

The equipment supplied by Wayne Kerr Electronics is guaranteed against defective material and faulty manufacture for a period of twelve months from the date of dispatch. In the case of materials or components employed in the equipment but not manufactured by us, we allow the customer the period of any guarantee extended to us.

The equipment has been carefully inspected and submitted to comprehensive tests at the factory prior to dispatch. If, within the guarantee period, any defect is discovered in the equipment in respect of material or workmanship and reasonably within our control, we undertake to make good the defect at our own expense subject to our standard conditions of sale. In exceptional circumstances and at the discretion of the service manager, a charge for labour and carriage costs incurred may be made.

Our responsibility is in all cases limited to the cost of making good the defect in the equipment itself. The guarantee does not extend to third parties, nor does it apply to defects caused by abnormal conditions of working, accident, misuse, neglect or wear and tear.

6.2 Maintenance

6.2.1 Cleaning

The body of the equipment can be cleaned with a damp lint-free cloth. Should it be required, weak detergents can be used. No water must enter the equipment. Do not attempt to wash down internal parts.

6.2.2 Safety Checks

Each year the equipment should be given a simple safety check.

6.2.2.1 Equipment required

25A ground bond tester (e.g. Megger PAT 2)

Insulation tester @ 500V DC (e.g. Megger BM 7)

6.2.2.2 Tests

1) **DISCONNECT THE INSTRUMENT FROM THE AC POWER SUPPLY!**
2) Inspect the unit and associated wiring for damage, e.g. dents or missing parts which might impair the safety or function of the equipment. Look for any signs of overheating or evidence that objects might have entered the unit.
3) **Ground Bond:** Ensure that 25A DC can flow from exposed metal parts of the unit (not BNC connector outers) to ground with an impedance of less than 100mΩ.
4) **Insulation Test:** Connect the Live and Neutral of the power cable together and test the insulation between this point and the ground at 500V DC. Readings greater than 1MΩ are acceptable.

6.3 Support and Service

In the event of difficulty, or apparent circuit malfunction, it is advisable to contact the service department or your local sales engineer or agent (if overseas) for advice before attempting repairs.

For repairs and re-calibration it is recommended that the complete instrument be returned to one of the following:

USA

Wayne Kerr Electronics Inc.
165L New Boston Street
Woburn MA 01801-1744

Tel: +781 938 8390
Fax: +781 933 9523
Email: sales@waynekerr.com
service@waynekerr.com

UK

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Unit 1a
Durban Road
Bognor Regis
West Sussex PO22 9QT
Tel: +44 (0)1243 792200
Fax: +44 (0)1243 792201
Email: sales@wayne-kerr.co.uk
service@wayne-kerr.co.uk

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58675 Hemer
Germany

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Fax: +49 (0)2372 5578790
Email: info@waynekerr.de
service@waynekerr.de

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Nanshan District,
Shenzhen, Guangdong
China
Tel: +86 130 66830676
Fax: +86 755 26523875
Email: sales@waynekerr.com
service@waynekerr.com

When returning the instrument please ensure adequate care is taken with packing and arrange insurance cover against transit damage or loss. If possible re-use the original packing box.