



OPERATING AND MAINTENANCE MANUAL

For Software Version 2.06 and later

Product: **3 Phase Secondary Injection Test Set**

Type: **200A-3PH mk3**



DESIGNED AND MANUFACTURED BY:

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GENERAL SAFETY STATEMENT



WARNING

The following safety precautions should be reviewed to avoid injury to the user and damage to the product (and other products connected to it). To avoid potential hazards only use this product as specified.

- **Only suitably qualified personnel should use this equipment.**
Servicing of this product should only be carried out by suitably qualified service personnel.

To Avoid Fire Hazards and Personal Injury

- Use the correct power supply lead. Only use a suitably rated and approved power supply lead for the country of use.
- Ensure that systems that the unit is to be connected to are dead.
- Do not connect and disconnect leads whilst outputs are switched on. Breaking the output circuit with current flowing may cause potentially fatal arcing.
- Ensure that the product is grounded. To avoid electric shock, it is essential that the grounding conductor is connected to the earth ground. An additional earth terminal is provided on the unit that should be connected to a local earth. Ensure that the unit is properly grounded before making any connections to inputs or outputs.
- Terminal ratings must be observed to prevent fire hazards and risk of injury to the operator. Consult the product manual for ratings information before making connections to any terminal.
- It is ESSENTIAL to consult the product manual for rating information before making any connection to a terminal or terminal group marked with a warning triangle.
- Only use fuses of a type and rating specified for this product.
- Do not operate the unit out of its case or with any covers or panels removed.
- Do not touch exposed connections and components when power is present.
- Do not operate the product if any damage is suspected. Refer the unit to qualified service personnel to be checked.
- Do not operate the unit in wet or damp conditions
- Do not operate the unit in an explosive atmosphere
- The 200A-3PH mk3 system has a high output current (up to 200A), and therefore generates large magnetic fields around the output leads. Care must be taken in siting the unit next to items sensitive to magnetic fields (such as computer monitors and other sensitive equipment).
- Warnings from cardiac pacemaker manufacturers state that strong magnetic fields may affect operation. Any high current unit such as the 200A-3PH mk3 should therefore not be operated by, or in the vicinity of persons fitted with cardiac pacemakers or any other electronic or electrical medical implants.

If any further queries occur regarding the usage and maintenance of the equipment detailed in this manual, please refer these to the supplier of the equipment in the first case or to the manufacturer, **T & R Test Equipment Limited**.

SAFETY TERMS AND SYMBOLS

The following safety symbols appear on the equipment:



CAUTION/WARNING – Refer to manual



Mains off



Mains on

The following safety symbols appear in this manual:



CAUTION

This action or procedure may be dangerous if not carried out correctly and may cause damage to the equipment or connected equipment.



WARNING

This action or procedure may be cause injury or death to the operator or other personnel if not carried out correctly using applicable safety procedures.

CONVENTIONS USED IN THIS MANUAL

Text shown in CAPITALS refers directly to labels of controls on the front panel of the unit (e.g. ADJUST refers to the auxiliary ac adjustment knob).

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1. DESCRIPTION OF EQUIPMENT

The 200A-3PH mk3 is a flexible 3 phase current injection system capable of supplying currents of up to 200A ac per phase into a variety of loads. The unit is designed for testing devices used for power system protection but can be used wherever a 3-phase high current AC source is required. The outputs may also be used to supply voltages of up to 5Vac.

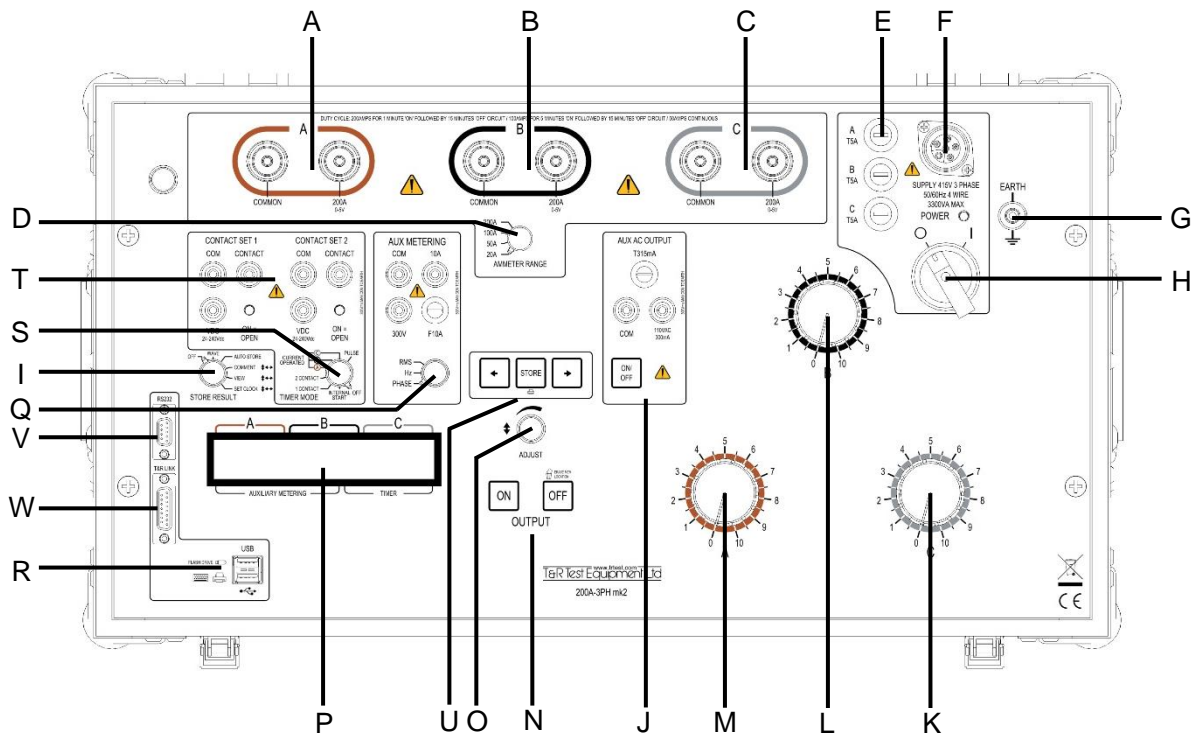
An independently isolated output is provided for each phase, allowing a wide range of output configurations to be selected.

A single phase isolated auxiliary AC output of 110Vac is also available.

The unit also has an auxiliary metering input with a fast capture time, allowing the measurement of voltage, current, frequency, and phase.

The 200A-3PH mk3 requires a 3 phase 4 wire 400V \pm 10% supply (50/60 Hz.)

The 200A-3PH mk3 is designed to be used on 'dead' systems (i.e. no externally supplied voltages are present on the test object. Under no conditions connect the 200A-3PH mk3 to a live system. Always check that the power to the device under test is off and the circuit is isolated before making any connections.



1.1 Front Panel Layout

Ref	Item	Function
A	Main output – phase A	Phase A current output
B	Main output – phase B	Phase B current output
C	Main output – phase C	Phase C current output
D	Ammeter range switch	Selects ammeter range for main outputs
E	Mains input fuses	
F	Mains input connector	
G	Earth terminal	Connect to local ground for safety
H	Mains on/off switch	
I	Store results control	Set comment, set clock, view stored results, select auto results store mode
J	Auxiliary ac voltage output	Single phase 110V isolated output
K-M	Main output controls	Control main current output level
N	Main output on/off controls	Switches the main outputs on & off
O	Adjust Knob	Access results, and clock settings
P	Display	Shows current, time, aux input & status
Q	Auxiliary metering selects	Selects auxiliary input function
R	USB sockets	Upper USB socket for connection of USB memory key. Lower USB socket for connection of keyboard
S	Timer mode switch	Selects timer mode
T	Timer contact sockets	Contact inputs for timer
U	Data storage Buttons	Select results to store
V	RS232 connector	Serial data output for printer
W	T&R link connector	Contact & phase lock outputs to DVS3

1.2 Installation

1.2.1 Environment

The 200A-3PH mk3 is designed for use in indoor industrial and electrical substation environments.

Maximum altitude: 2000m

Temperature: 0°C to 45°C operating
-20°C to 60°C storage

Relative humidity: 90% non-condensing

Protection rating: IP40 lid closed
IP20 in use



WARNING

In substation environments the earth terminal on the front panel of the unit should be connected to a low impedance local earth.



WARNING

Ensure that the unit is connected to an appropriate supply by a suitably rated connector.

1.2.2 Supply Requirements

The 200A-3PH mk3 requires a three phase 4 wire 50/60Hz supply of 400V \pm 10%. The maximum power requirement of the unit is 1100VA per phase.

Other supply voltages may be catered for by using the optional 200A-DSU Delta-Star converter. This allows the unit to operate from 3 wire supplies of 115V, 230V, 400V or 440V (see section 5).

1.2.3 Supply Voltage Connections

The 200A-3PH mk3 is supplied with a five-core supply cable with a CEE 400V 16A 3P+N+E 5 pin plug fitted. If this connector is not correct for the supply environment an adaptor will be required.

If necessary, the supply plug can be changed. Ensure that the plug is connected correctly. The cores of the supply cable are marked to ensure correct phase rotation. The mains input lead is marked as follows:

L1	Brown
L2	Black
L3	Grey
Neutral	Blue
Earth	Green and yellow

The unit requires a neutral connection (4 wire supply) and will not operate from a three-wire supply without the optional 200A-DSU delta-star converter.

It is essential that this unit is earthed.

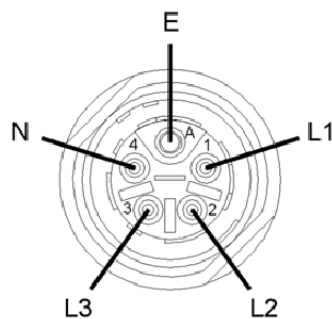


Figure 1.1 Connections for mains input socket

1.2.3.1 Operation from a Single-Phase Supply

If no three-phase supply is available, it is possible to operate the 200A-3PH mk3 from a single-phase supply with reduced functionality. To connect the set to operate from a one phase supply, connect L1, L2 and L3 to live, and N to neutral. When operating from a single-phase supply, all three outputs will be in phase.

1.3 Functions

1.3.1 Main Current Outputs

The main output on the 200A-3PH mk3 is used to inject current into test object to determine operating (setting) levels and trip times. The outputs are taken from the 'main output' terminal groups, and are switched on and off using the "OUTPUT ON" and "OUTPUT OFF" pushbuttons, and the voltages of each phase (and hence current) are set using the "A", "B", and "C" control knobs.

The main current output of the unit consists of three independent, isolated outputs derived from the three phase mains supply. The phase difference between the outputs is therefore fixed.

Each of the main outputs allows voltage output of 0-5 Vac. The ratings are shown in the table below.

Voltage range	Current rating		
	Continuous	5min on/15 off	1min on/15 off
0-5V	50A	100A	200A

A true RMS ammeter with 20, 50, 100 and 200A ranges meters the output current. The meter range is totally independent of the output tap, allowing any metering range to be used with either of the output taps. It is always best to start by connecting the device under test (as shown in Figure 1.2) and select the lowest current metering range that includes the desired test current.

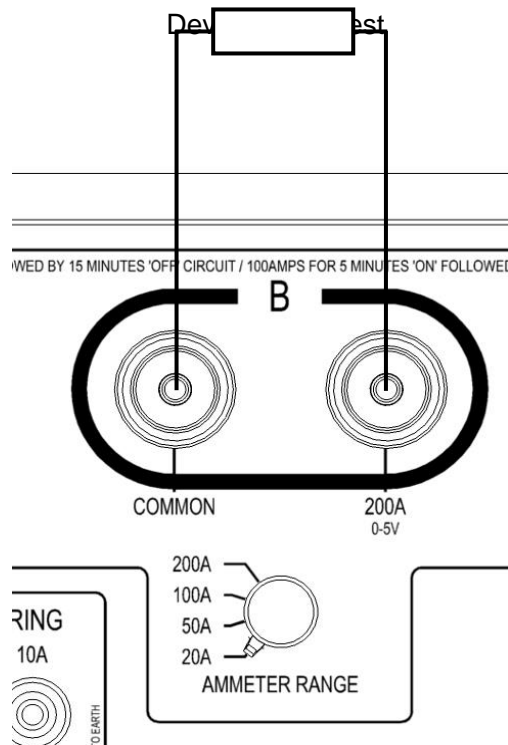


Figure 1.2 Example connection

Each output is rated for a continuous current, and for higher intermittent currents. The maximum 'on' time for intermittent currents is enforced by the unit, and the output will be switched off if the

rating is exceeded. The display will then show the following message until the green 'OFF' button is pressed to clear the trip condition:



The outputs are rated for a maximum of four times the rated continuous current for 1 minute on / 15 minutes off. The complete curve for intermittent current ratings is shown in figure 1.3.

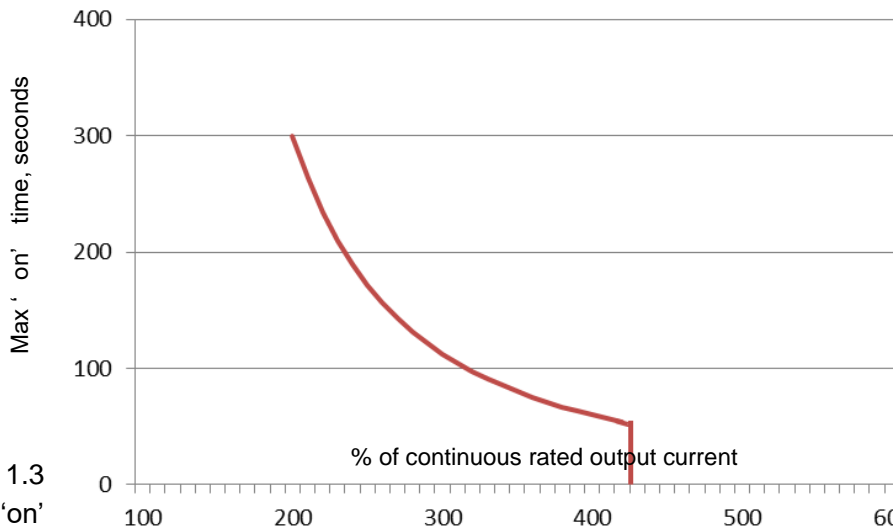


Figure 1.3 maximum 'on'

200A-3PH mk3 times

1.3.2 Output Phase Relationships

The phase relationship between the supply voltages and the output voltages are shown below. The phase relationship between the output voltage and output current is determined by the impedance of the load.

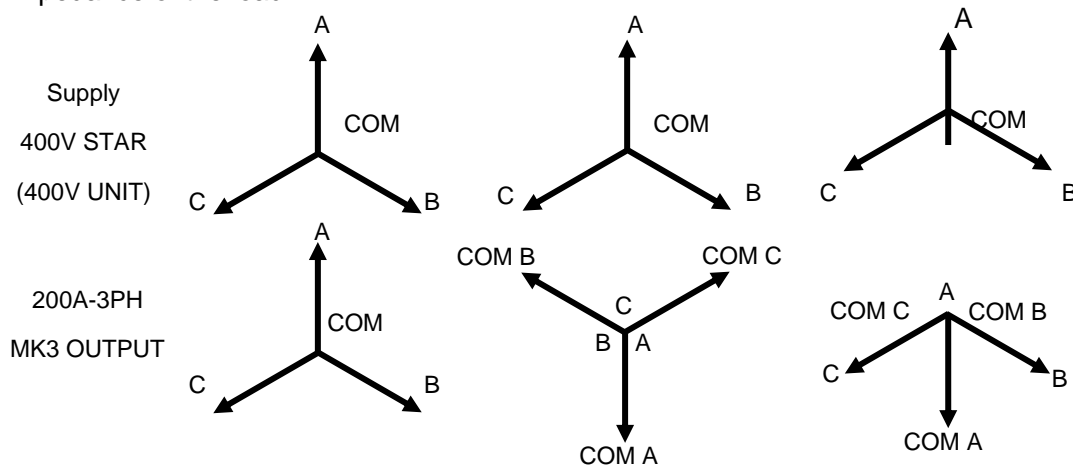


Figure 1.4 Supply and output phase relationships

Note that any phase can be shifted by 180° by reversing the connections for that phase. Equal currents are shown in the phasor diagrams overleaf, but unequal currents are equally valid.

Delta output connections are not valid.

1.3.3 Star-connected loads

The configuration and interconnection of the outputs depends on the configuration of the load. The configuration for injecting current into a three-phase star-connected load is shown in figure 1.5

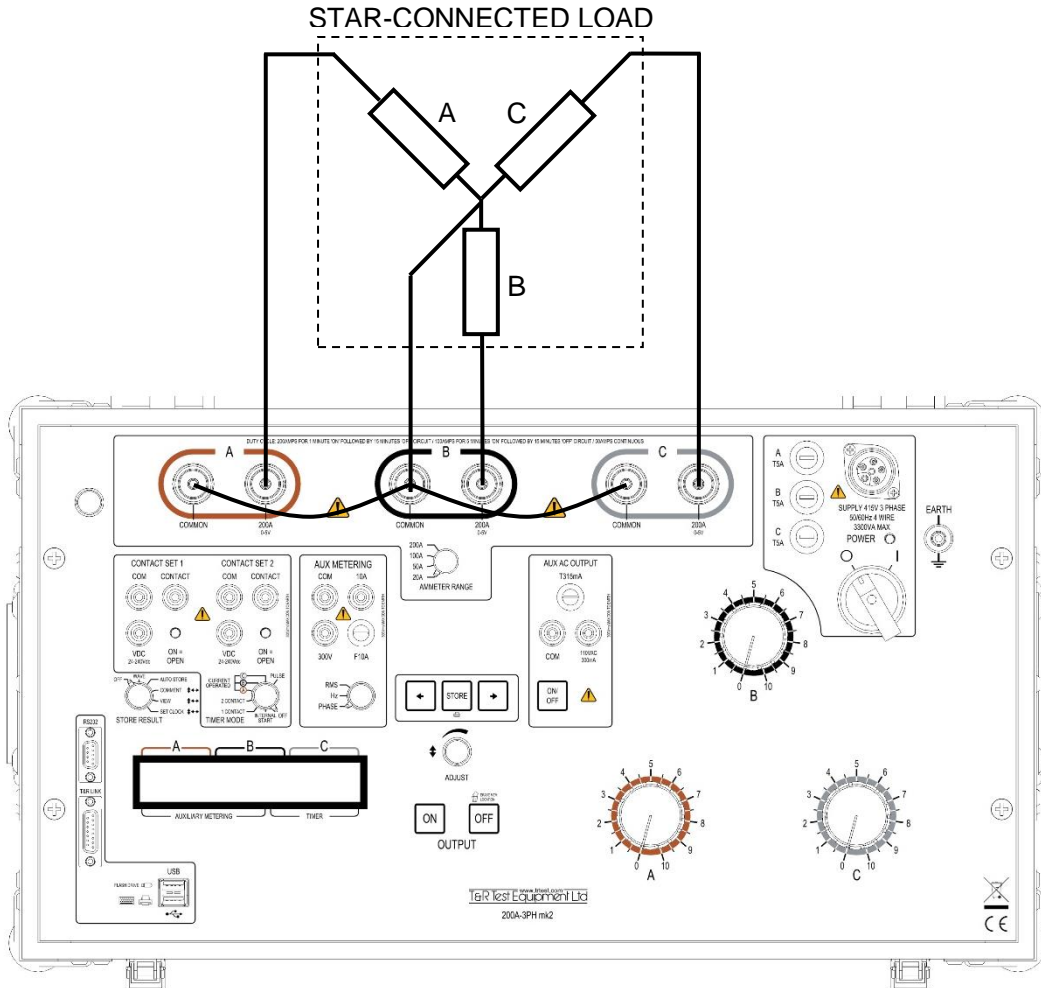


Figure 1.5 Connections for star-connected load

1.3.4 Three phase loads with isolated elements

It is also possible to inject current into three isolated loads, as occurs on some three phase relays and MCBs. See figure 1.6.

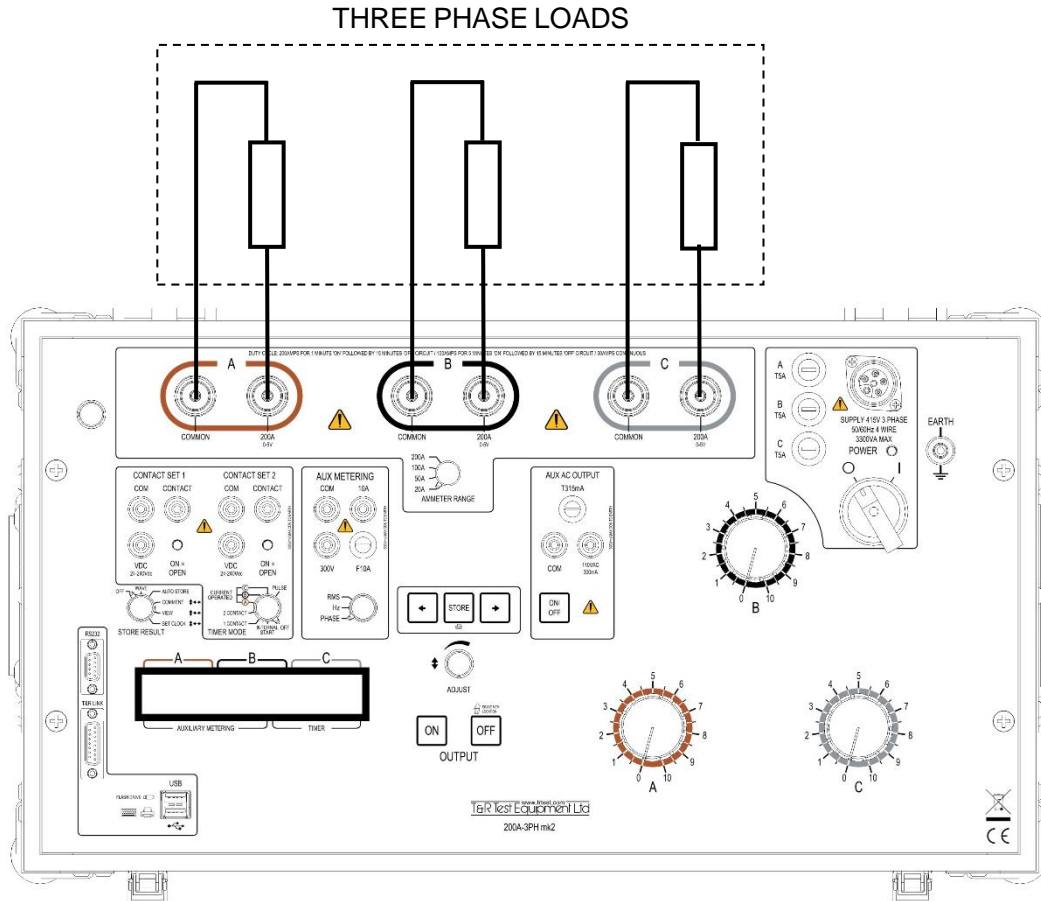


Figure 1.6 Connections for load with isolated elements

1.3.5 Current Metering

The main output currents are metered by a true RMS reading digital memory ammeter. The following ranges are available:

Range	Resolution	Accuracy	Trip current
20 A	0.01A	±0.6% rdg ±5d	21.0A
50 A	0.01A	±0.6% rdg ±5d	52.5A
100A	0.1A	±0.6% rdg ±5d	105.0A
200A	0.1A	±0.6% rdg ±5d	210A

The ammeter range is independent of the current output and is therefore possible to meter low currents very accurately from the lower voltage range, giving the best control of the output current.

The unit has an electronic trip circuit that monitors the output current and switches the output off if the trip value exceeds 105% of full scale of the metering range selected.

1.3.6 Auxiliary AC Voltage Output

The auxiliary AC voltage output is fixed at 110 Vac with a maximum output current of 300mA, duty cycle 5 min on, 15 min off. The output is switched independently of the main output. The voltage and current from this output may be metered using the auxiliary metering input.

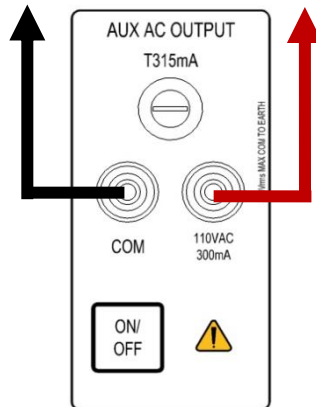


Figure 1.7 Auxiliary AC output

1.3.7 Auxiliary Metering Input

The 200A-3PH mk3 has an auxiliary metering input which can be used to measure AC voltage or current, frequency, and the phase between the main output and the auxiliary input. The unit may measure either voltage or current derived quantities by selecting the appropriate input on the front panel.

Two inputs are provided, one for voltages up to 300V and the other for currents up to 10A. The input in use is automatically selected by the unit. Do not connect to both inputs simultaneously.



WARNING

Do not exceed the input ratings

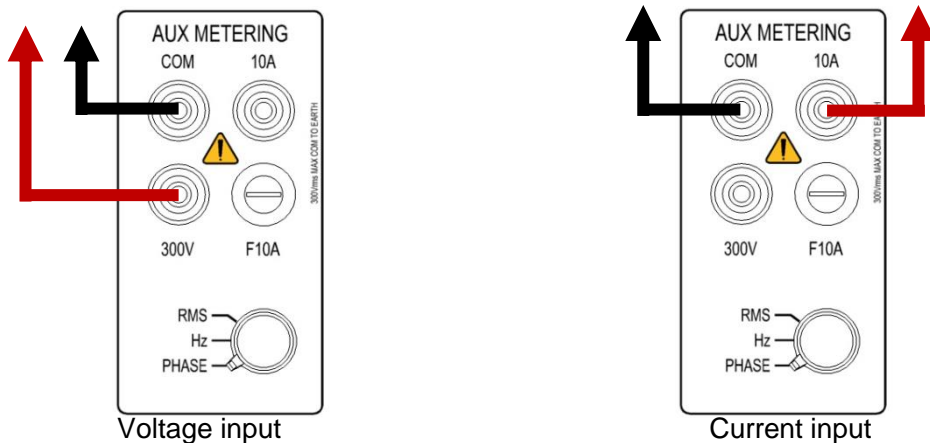


Figure 1.8 Auxiliary inputs

1.3.7.1 Auxiliary input ranges

The following ranges are provided:

	Range	Resolution	Accuracy
Frequency (V)	40.00-99.99Hz	0.01Hz	±0.2% rdg ±2d
Frequency (I)	40.00-99.99Hz	0.01Hz	±0.2% rdg ±2d
Phase (V)	±180.0°	0.1°	±3 degrees
Phase (I)	±180.0°	0.1°	±3 degrees
AC Voltage	0-300.0Vac rms	0.1V	±0.7% rdg ±5d
AC Current	0-10.000Aac rms	0.001A	±0.7% rdg ±5d

1.3.8 Voltage Measurement

To measure external voltages, connect the signal to the aux metering terminals marked 'COM' and '300V'. Ensure that the voltage to be measured is switched OFF when connecting the leads.

The type of reading to be taken should then be selected using the aux metering rotary selection switch. The frequency of the signal and phase relative to the main output current may also be measured.

When measuring voltages, ensure that 300V ac is not exceeded on the 300V terminal.

1.3.9 Current Measurement

To measure current, connect to the 'COM' and '10A' aux metering sockets. The aux metering rotary switch selects the reading type.

1.3.10 Frequency Measurement

The frequency of the input signal may be measured for either a voltage or current input. To measure frequency, the voltage or current must be greater than 1.6V or 0.03A respectively.

1.3.11 Phase Measurement

Switch to phase mode to measure the phase between the main current output selected by the phase select switch and either the voltage or current input. In each case, the current or voltage must be greater than 5% of the full scale of the range for the phase to be displayed and more than 10% for the stated accuracy to be guaranteed.

1.3.12 Timing System Specification

The 200A-3PH mk3 is fitted with an integrated timing system that is linked to the main output and two sets of contact inputs. The system is highly flexible and allows for the timing of all common protection devices and trips. The timer may also be used to time external events not linked to the output of the set.

Timer information

Timer range	0-999.999s/9999.99s/99999.9s auto-ranging	
Resolution	1ms/10ms/100ms	
Accuracy	$\pm 0.01\%$ rdg $\pm 2d$ $\pm 0.01\%$ rdg $\pm 4d$	All modes except current operated Current operated mode
Contact o/c voltage	24V	
Contact s/c current	20mA	
Contact indication	LED on – contact open LED off – contact closed	

Timer Modes

Timer Mode	Timer Start Condition	Timer Stop Condition	Automatic output off	Example application
Off	-	-	-	Set current
Internal Start	Main output on	C1 change	When timer stops	IDMT relay
1 Contact using Contact 1	C1 1 st change	C1 2 nd change	C1 1 st change (timer start)	Auto-reclose relay
1 Contact using Contact 2	C2 1 st change	C2 2 nd change	C2 2 nd change (timer stop)	Drop-off timing
2 Contacts 1st change C1	C1 change	C2 change	C2 change (timer stop)	
2 Contacts 1st change C2	C2 change	C1 change	Output cycles on and off	Multiple auto re-close timing
Current Operated Phase Select*	Current >20% of range	Current <20% of range	Current <20% Timer stop	Miniature circuit breakers
Pulse	Main output on	500ms	500ms	Set current for thermal devices

* results obtained with test currents below 20% of range will give a lower accuracy than specified.

The timer is automatically reset in every mode when the output is switched on. In each mode that the timer is active, the output of the unit must be switched on to arm the timer.

Each contact channel has a contact input for volt-free contacts and a Vdc input for dc voltages. The Vdc input may be used to trigger the timer from a dc voltage and will trigger from either the voltage switching from zero to 24-240Vdc or 24-240Vdc to zero. The voltage must be connected with positive to the red "VDC" terminal and negative to the blue "COM" terminal.

1.3.12.1 General Procedure for Timing Tests

To time the operation of any device a basic procedure needs to be followed to set the desired test current and to carry out the timing test.

- Connect the device under test to the output of the unit and to the contact inputs as required. For details of connection configurations, see the applications notes section.
- Set the timer to 'off' mode and the output control to zero. Switch on the output of the unit and increase the current or voltage to the desired level.
- Switch off the output of the unit and select the desired timer mode.
- Switch on the output of the unit. The timer will reset and then start when the start condition is met. Any change to the timer switch setting will be ignored once the output is switched on.
- The timer will stop when the stop condition is met.

1.3.12.2 Timer mode: OFF

In the 'off' mode, the timer has no effect on the operation of the set, and the timer does not run. This mode is used to set the required current through the test object before a timing test.

1.3.12.3 Timer mode: INTERNAL START

The internal start mode starts the timer when the main output is switched on and stops the timer on the first change of contact set 1. When the timer is stopped, the output of the unit is automatically switched off.

1.3.12.4 Timer mode: 1 CONTACT

In single contact mode, the timer starts on the first change of state of CONTACT SET 1 after the output is switched on and stops on the second change on CONTACT SET 1. CONTACT SET 1 or CONTACT SET 2 can be used in 1 contact mode. If C1 (CONTACT SET 1) is used, the output is switched off when the timer is started, and if C2 (CONTACT SET 2) is used the output is switched off when the timer stops.

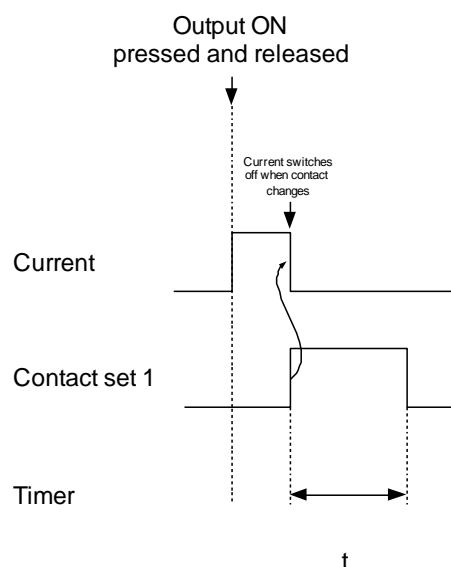


Figure 1.9 1 contact mode using CONTACT SET 1 (C1)

1 CONTACT mode using C1 is used to time auto-reclose relays (connected to a breaker auxiliary contact). The time recorded is the time between the breaker opening and the first re-closing of the breaker.

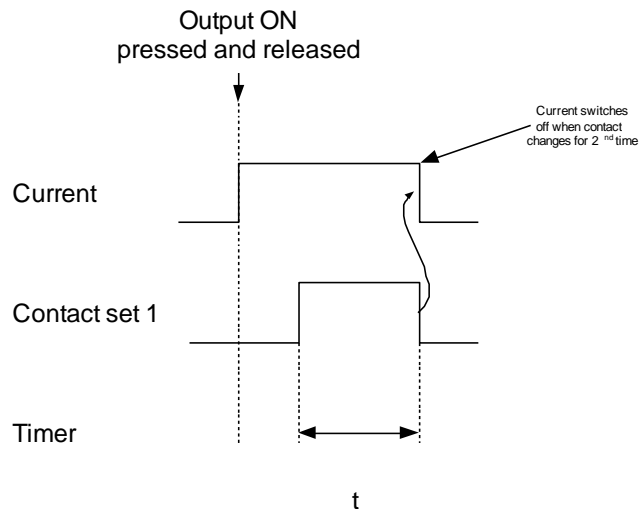


Figure 1.10 1 contact mode using contact set 2 (C2)

1 CONTACT mode using C2 is suited to drop-off tests.

1.3.12.5 Timer mode: 2 CONTACT (contact 1 changes first)

Dual contact mode uses both contact set 1 and contact set 2. The timer starts on the first change of contact set 1 after the output is switched on and stops on the first change of contact set 2. The output of the unit is automatically switched off when the timer stops.

1.3.12.6 Timer mode: 2 CONTACT MART (Multiple Auto-Reclose Timing)

This mode is used to time multiple re-close actions on an auto re-closing relay. 100 time results can be stored and logged to the USB memory key.

The auto re-close relay breaker trip contacts are connected to contact set C2 and the breaker closed contact connected to contact set C1. If a breaker state signal is required, this can be obtained from the contact on the T&R link connector.

MART mode is triggered by contact set 2 changing state before contact set 1 in 2 contact mode.

- Start the test by pressing the ON pushbutton. The timer starts when the output is switched on.
- On the 1st change of C2 the timer result is stored as t0. The timer resets and restarts, and the output is switched off.
- On the 1st change of C1 the timer result is stored as t1. The output switches back on automatically, and the timer resets and restarts.
- On the 2nd change of C2 the timer result is stored as t2. The timer resets and restarts, and the output is switched off.
- On the 2nd change of C1 the timer result is stored as t3. The output switches back on automatically, and the timer resets and restarts.

- This cycle continues until the OFF pushbutton is pressed. The display is left showing the last timer value. If auto-store mode is selected, all the results for the test are written to the USB memory key, up to 100 times can be recorded. After t99 is stored the test ends and the output switches off automatically.

At the end of the test the ADJUST knob is automatically put into timer result selection mode (both LEDs off). The ADJUST knob scrolls through the timer results. The timer results are cleared when the output is switched on for another test.

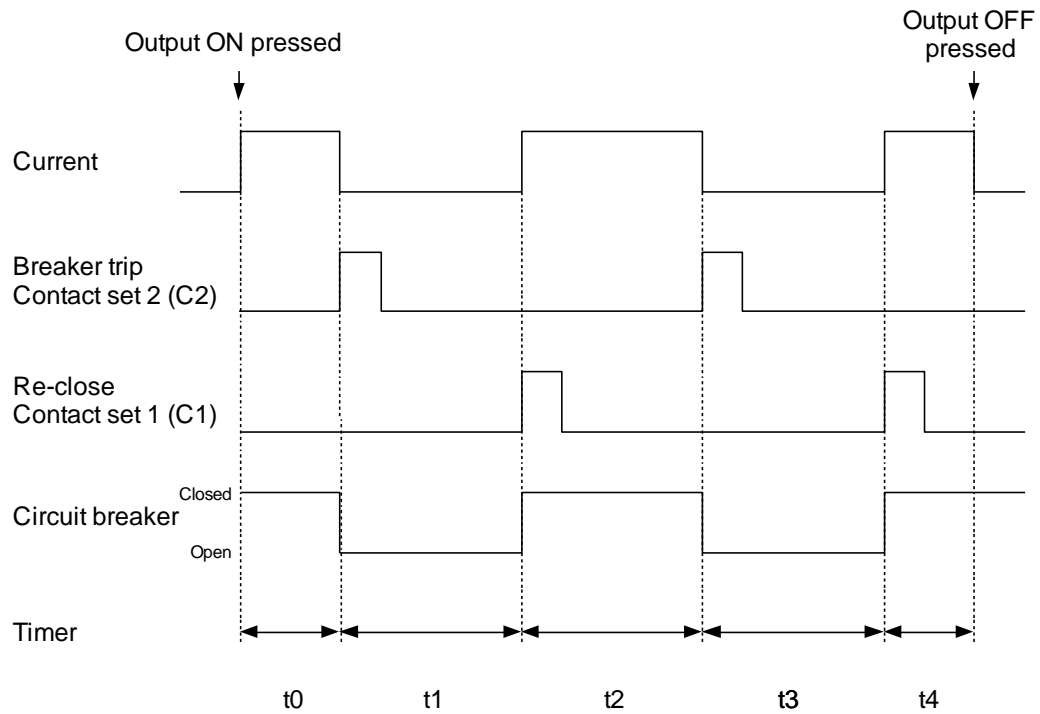


Figure 1.11 Multiple auto-reclose timing

To view the timing results, press the left button to scroll through the stored time values.

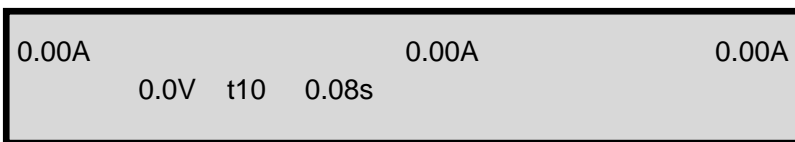
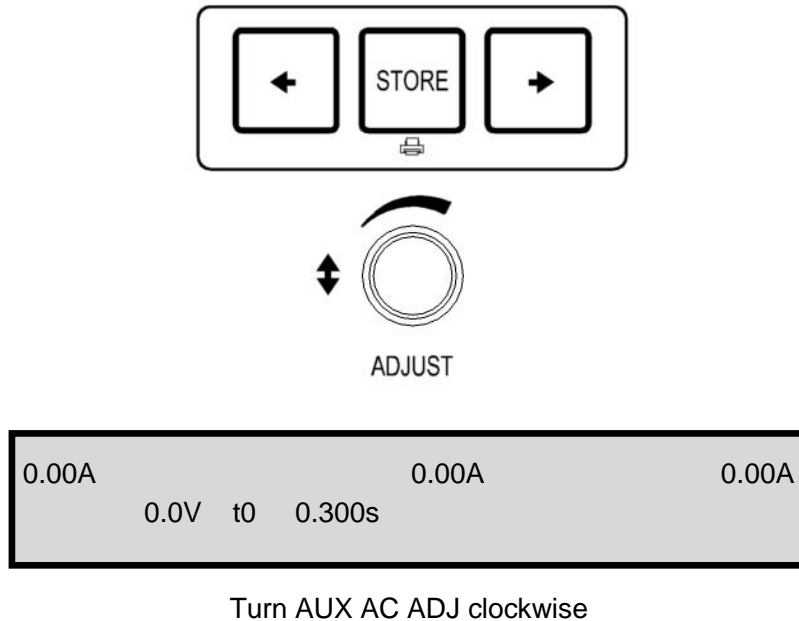


Figure 1.12 Displaying results for multiple auto-reclose timing

Note: The auxiliary metering value displayed is dependent upon the position of the auxiliary metering mode select knob. For example, when the knob is set to PHASE, change in the ADJUST knob will refresh the display to show the selected metered value.

1.3.13.7 *Timer mode: CURRENT OPERATED*

Current operated mode is used to time devices that have contacts in series with the current sense element. This includes miniature circuit breakers and MCCBs.

The timer is started when the output current exceeds 20% of full scale of the selected metering range and stops when the current falls below this threshold.

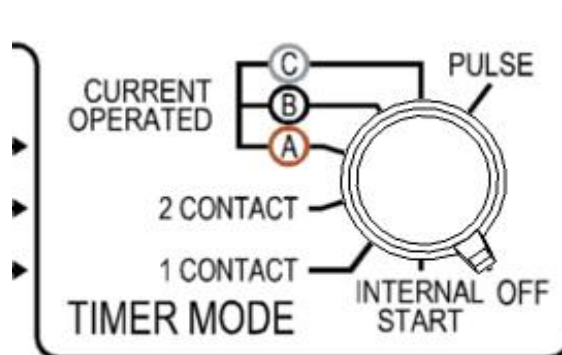


Figure 1.13 Current operation knob selections

1.3.13.8 Timer mode: PULSE

Pulse mode is used to set the current in devices that are sensitive to heating due to the test current (thermal relays and circuit breakers and instantaneous trips). In this mode current is injected for 500ms when the ON switch is pressed. The current is captured and displayed.

1.4 Displayed Values and Messages

1.4.1 Displayed Values

The 200A-3PH mk3 display simultaneously shows the three injected test currents, the timer result, the selected auxiliary input value and unit, onto the liquid crystal display. It also displays warning and error messages, detailed in section 1.4.2.

0.00A 0.00A 0.00A

0.0V RMS 60.000s

Figure 1.14 Normal values displayed on screen

1.4.2 Warning Messages

In addition to the normal display screens, the 200A-3PH mk3 can display a range of warning messages if the unit trips on over-current or duty cycle or is too hot internally. If an over current or duty cycle trip occurs, the green 'OFF' pushbutton must be pressed to clear the trip condition. If the unit trips on over temperature, the unit will automatically reset when the temperature falls to an acceptable level. If the unit is over temperature, switching the unit off and back on will not clear the message – the unit must be allowed to cool.

Output Tripped
Press Green to Reset

Figure 1.15 Over-current trip warning message

Duty Cycle Trip
Press Green to Reset

Figure 1.16 Duty cycle trip warning message

Over Temperature
Output Disabled

Figure 1.17 Unit over temperature warning message

1.5 Overload Protection

The 200A-3PH mk3 is fitted with a range of over protection devices, listed in the table below.

Location	Protection
Mains supply	T5A fuses on each phase
Auxiliary ac output	T315mA fuse

Contact circuits	Auto-resetting semiconductor fuses
Main output	Electronic over-current trip Electronic duty cycle trip Thermal protection
Auxiliary metering current input	F10A fuse

1.5.1 **Storage of results**

The 200A-3PH mk3 can store all displayed values to a CSV spreadsheet file whenever the timer stops, or the output is switched off. This is useful for recording all results, plotting relay curves and plotting transformer magnetisation curves.

Files are stored on the USB key in the folder \TRTEST. A folder is then created in this using the day's date, and results files are named with the time of the test.

A comment can be entered to be stored with the results using a USB keyboard.

The following values are stored:

- Time
- Date
- Main output current for each phase
- Timer result
- Auxiliary current/voltage input value
- Auxiliary metering phase & frequency
- Comment

Macros are provided with the unit to format results and plot graphs for IDMT overcurrent relays.

1.5.1.1 USB key

A standard USB flash memory key is used to store the results files. The unit has been tested with keys up to 8Gb in size.

Insert the USB key into the upper USB socket on the unit before starting to test. Most USB memory devices have an LED that indicates when the device is accessed. This will flash when a result is written.



CAUTION Do not unplug the USB key whilst data is written – data loss will result.

1.5.1.2 Setting the clock

The output of the unit must be switched off to set the clock.

- Set the STORE RESULT switch to SET CLOCK.

hh:mm:ss dd-mm-yy
10:13:24 15-01-21

Figure 1.18 Clock setting screen

- Use the ← and → keys to select which digit to change.
- Use the AUX AC ADJ control to change the selected digit.
- Use the red ON button to save the changes to the clock.
- Use the green OFF button to cancel setting the clock.
- Set the STORE RESULT switch to OFF.

1.5.1.3 Entering a comment

Each result is tagged with a comment when it is stored. The comment is entered by setting the store result control to “comment” and typing the comment using the optional USB keyboard.

The same comment is tagged to each result until the comment is updated, and the comment is erased when the unit is switched off.

Any USB keyboard can be used with the 200A-3PH mk2.

The comment can be typed on the USB keyboard using the letters a-z, numbers 0-9 and punctuation marks. A maximum of 39 characters may be entered for the comment.

The following keys are also used:

Shift + a-z Enter capital letter.

←→ Move cursor left/right.

Ins Switch between overwrite and insert mode. By default, the unit will overwrite the character to the right of the cursor when a new character is typed.

	Switching to insert mode will shift characters of the right of the cursor right when a new character is typed.
Enter	Accept the current comment.
Esc	Lose the changes made to the comment since entering comment mode and revert to the last comment entered.
⇐ (backspace)	Delete the character to the left of the cursor.
Del	Delete the character under the cursor.
→ (cursor right)	Move cursor one character to the right.
← (cursor left)	Move cursor one character to the left.
Shift+→	Move cursor to end of comment.
Shift+←	Move cursor to start of comment.
End	Move cursor to end of comment.
Home	Move cursor to start of comment.

The following keys have no effect: caps lock, shift lock, alt, Windows key, tab, ↑, ↓, page up/down, F1-F12.

1.5.1.4 *Auto-store*

Set the STORE RESULTS switch to AUTO-STORE.

Set TIMER MODE to internal start, 1 contact, 2 contacts, current operated or aux ac.

A result record is added to the current result file whenever the timer stops (this includes when the output is switched off in internal start mode).

If results are to be stored not dependant on the timer, set the timer mode to internal start, and press the OFF button for the main output when a result is to be stored.

Results are not stored when the timer is set to OFF. This allows the output current to be set without storing any results to the output file.

The example below shows data stored when testing a relay.

```
"200A-3PH ", "V2.09 C03", "2.01", "P1", "A1"
"Time", "Date", "Main A", "Timer", "Aux A", "Aux V", "Phase", "Freq Hz", "Aux Range", "Comment"
"11:18:40", "27/01/21", "2.38", "7.961", "0.000", "0.0", "0.0", "0.00", "6", "CDG11 relay"
"11:18:49", "27/01/21", "3.73", "5.252", "0.000", "0.0", "0.0", "0.00", "6", "CDG11 relay"
```

1.5.1.5 *Waveform storage*

Waveform storage mode allows the main output current and auxiliary input waveform to the USB memory key as a CSV file.

Set the STORE RESULTS switch to WAVE.

Set TIMER MODE to internal start, 1 contact, 2 contacts or current operated.

The waveform is stored to the memory key whenever the timer stops, or the output is switched off. It takes several seconds to write the waveform data to the memory key. Please be patient while the unit finishes writing the data.

A spreadsheet program (e.g. Microsoft Excel or Libre Office Calc) can be used to show the waveform graphically. A macro is available for Excel to automatically format and plot waveform data.

1.5.1.6 File formats

Results file format

The results file is in CSV (comma separated value) format. The first line of the file details unit type, software version, and configuration information. The second line specifies column headings for the data, and the third line onwards is data.

```
"200A-3PH", "V2.09", "C00", "P1", "A1"  
"Time", "Date", "Main A", "Timer", "Aux A", "Aux V", "Phase", "Freq Hz", "Aux Range", "Comment"  
"11:18:40", "27/01/21", "0.00", "0.000", "0.000", "0.0", "0.0", "0.00", "6", "Comment - up to 39  
chars"
```

Double-clicking on a results file in MS Windows on a PC with a spreadsheet installed will open the file. Excel macros are provided on the supplied USB memory key. To use the macros, open the "200A-3PH mk3 tools" Excel spreadsheet before opening the results CSV file. This will install a toolbar in Excel with buttons for formatting overcurrent and waveform results files. Refer to the instructions in the "200A-3PH mk3" tools spreadsheet for further details.

Waveform file format

The waveform file is in CSV (comma separated value) format.

The first line lists the time, date, and time between samples in ms ($0.06=60\mu\text{s}$). The second line specifies column headings, and subsequent lines list one sample value for main output current in A and one sample value for the auxiliary input in A or V. 1024 samples are stored at $60\mu\text{s}$ intervals for a total sampling time of 61.44ms.

```
"11:57:34", "27/01/21", "", "", "", "Sample Time(ms)", "0.06"  
"Main", "Aux. I"  
"0.000", "0.000"  
"0.000", "0.000"  
"0.000", "0.000"  
"0.000", "0.000"  
"0.000", "0.000"  
"0.000", "0.000"  
.  
.  
.  
"0.000", "0.000"
```

Double-clicking on a results file in MS Windows on a PC with a spreadsheet installed will open the file.

1.5.1.7 Viewing results

The VIEW RESULTS setting allows the results to be displayed.

Ensure the main output is off. Set the STORE RESULTS switch to VIEW. The files to view can be scrolled through using ADJUST knob and the file to view opened using →. The results in the file can then be stepped through using ADJUST knob.

Press OFF to delete the current result. Changes are not saved after deleting a result until the → key is pressed.

1.5.3 Phase Measurement

The 200A-3PH mk3 auxiliary metering circuit may be used to measure the phase difference between one of the phases of the main output current and the auxiliary metering input.

1.5.3.1 Phase measurement between output current and an external voltage

Certain relays and transducers require the injection of a current and the application of a phase-shifted voltage (e.g. directional relays). In such situations, the auxiliary metering circuit may be used to measure the phase angle between the 200A-3PH mk3 output current and an externally generated phase-shifted voltage. The circuit configuration is shown below using a T&R Test Equipment DVS3 mk2 voltage source. The AUX METERING MODE switch should be set to "PHASE".

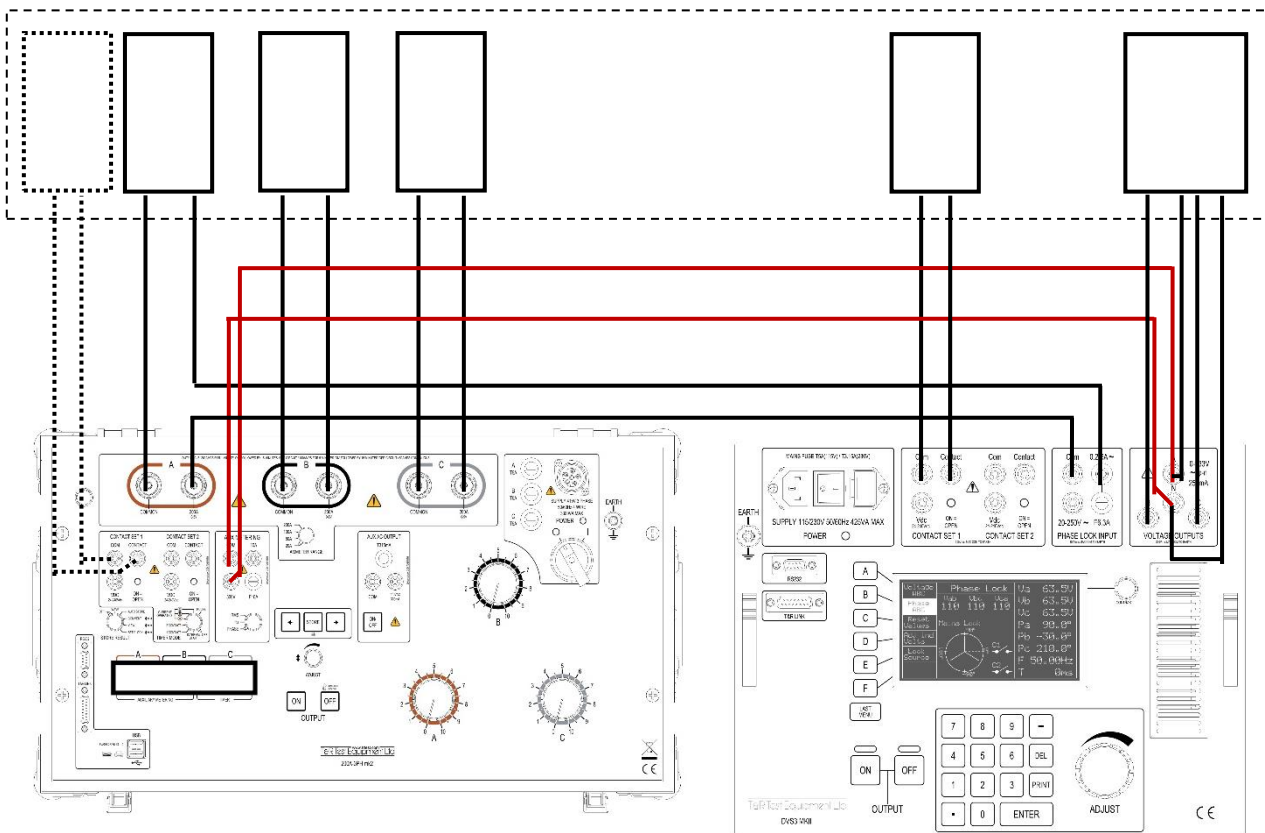


Figure 1.19 Phase measurement

When measuring the phase angle between the output current and an external voltage, the 200A-3PH mk3 defines the voltage generated across a resistive load in phase with the current. Connecting a resistor as shown in figure 1.19 will therefore result in a voltage in phase with the output current from phase A.

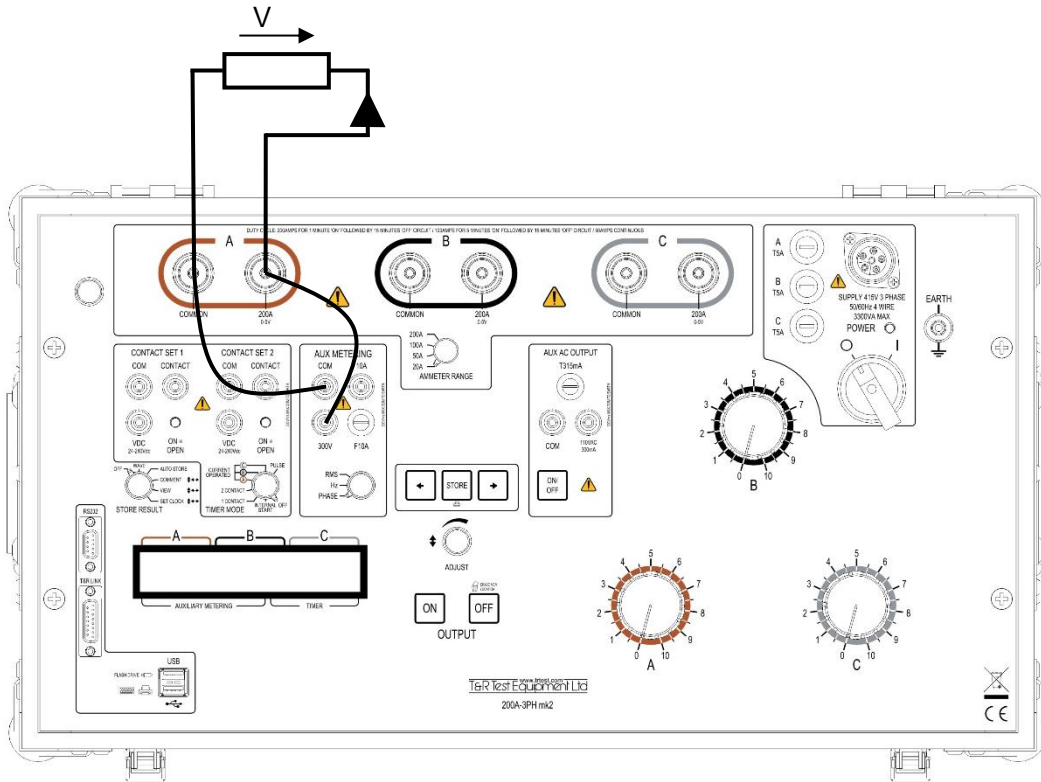


Figure 1.20 Zero phase between voltage and current

1.5.3.2 Phase measurement between output current and an external current

The auxiliary metering current input can be used to measure the phase of an external current (up to 10A) relative to the output current from phase A, B or C. To do this, connect the external current to the aux metering “com” and “10A” terminals, and switch the mode switch to “phase”. Select the desired reference phase output using the phase select switch.

The connection shown below will result in a measured angle of zero degrees. Note that the **TIMER MODE** switch is set to phase A.

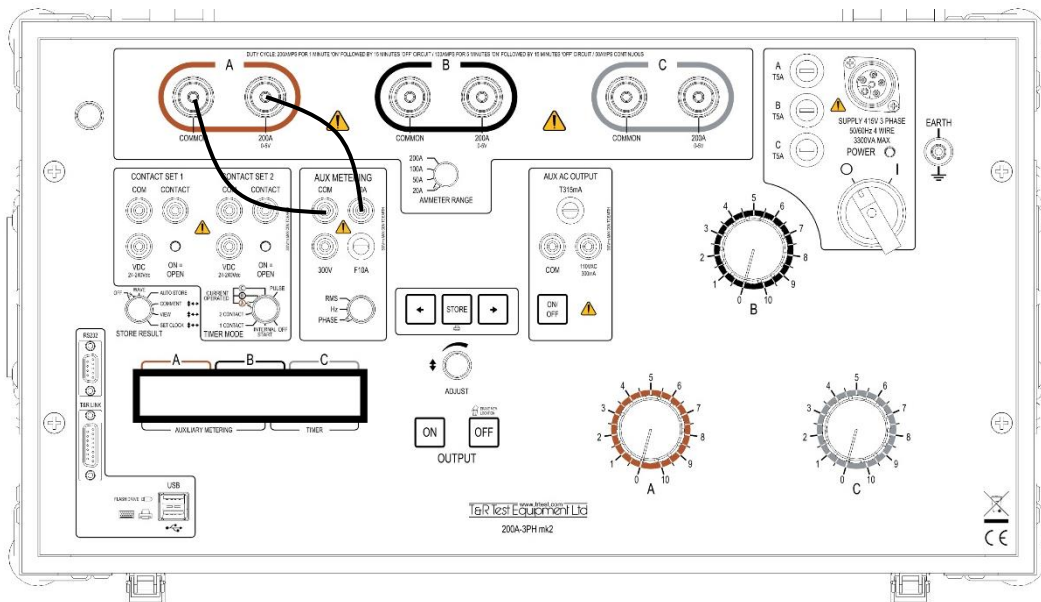


Figure 1.21 Zero phase between internal and external current

2 OPERATION

This chapter gives details of how to test many common types of protection device using the 200A-3PH mk3.

2.1 Three Phase Over Current Relays

The configuration shown in figure 2.1 is suitable for testing over-current relays and will measure the time delay between the time when the “on” pushbutton is pressed and the time the relay trips.

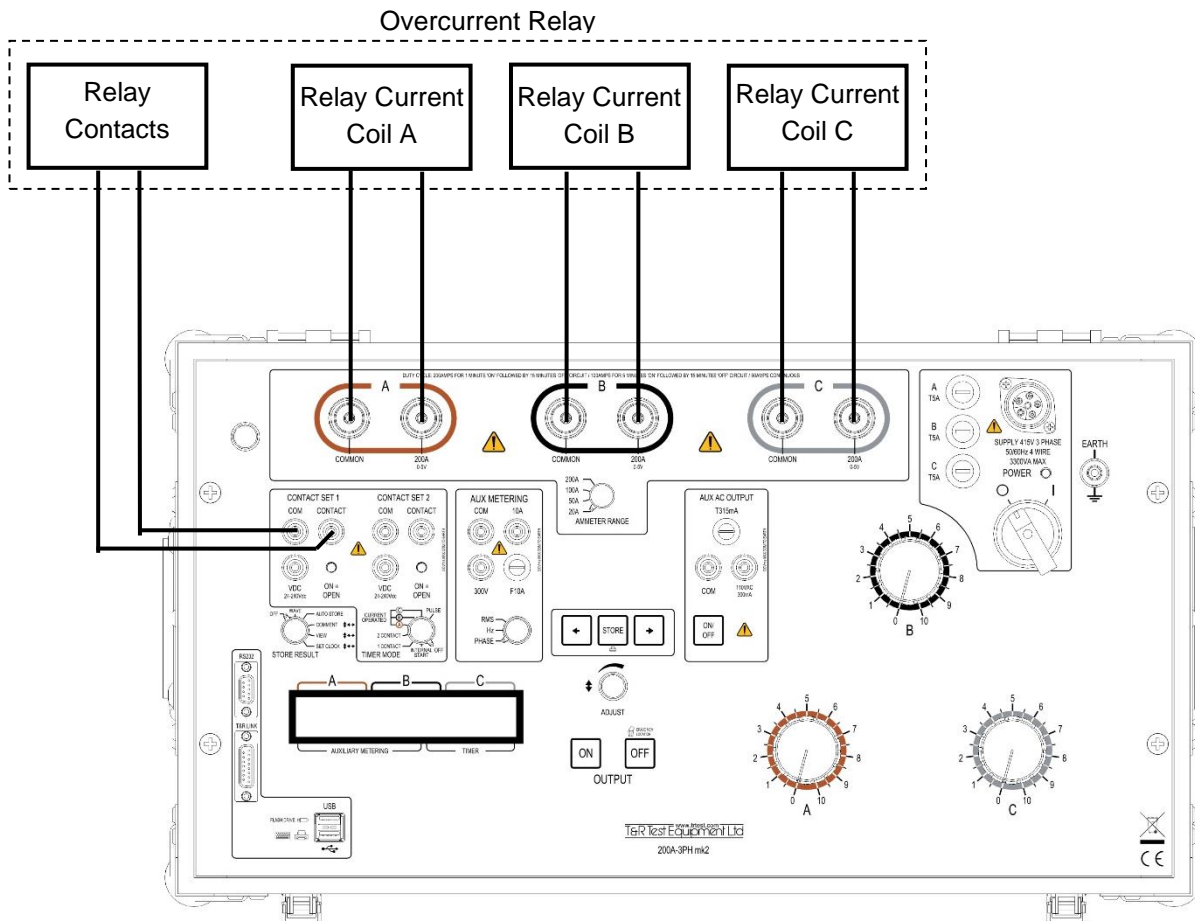


Figure 2.1 Connections for testing over-current relays

2.1.1 Connections

Ensure that the output is switched off and that the relay is isolated before making any connections.

Connect the relay contacts to CONTACT SET 1.

Connect the relay current coils to the 3 phase outputs, selecting suitable leads from the lead set depending on the current to be injected.

2.1.2 Test procedure

Set the output controls to zero (anti-clockwise) and the timer mode to “OFF”.

Select the desired ammeter range.

Press the “output on” pushbutton and increase the desired test current for each phase.

Switch the output off using the “OUTPUT OFF” pushbutton.

Select “INTERNAL START” timer mode and switch the output on. The unit now resets and starts the timer and starts injecting current into the relay. When the relay’s contacts change state, the timer will stop, and the output will be switched off automatically.

2.2 Timing of Auto-Reset/Reclosing Devices

Auto-reclosing devices require that the timer is started when power is removed from the device, and the timer stops when the contacts change state. This may be achieved using the single contact timer mode using CONTACT SET 1.

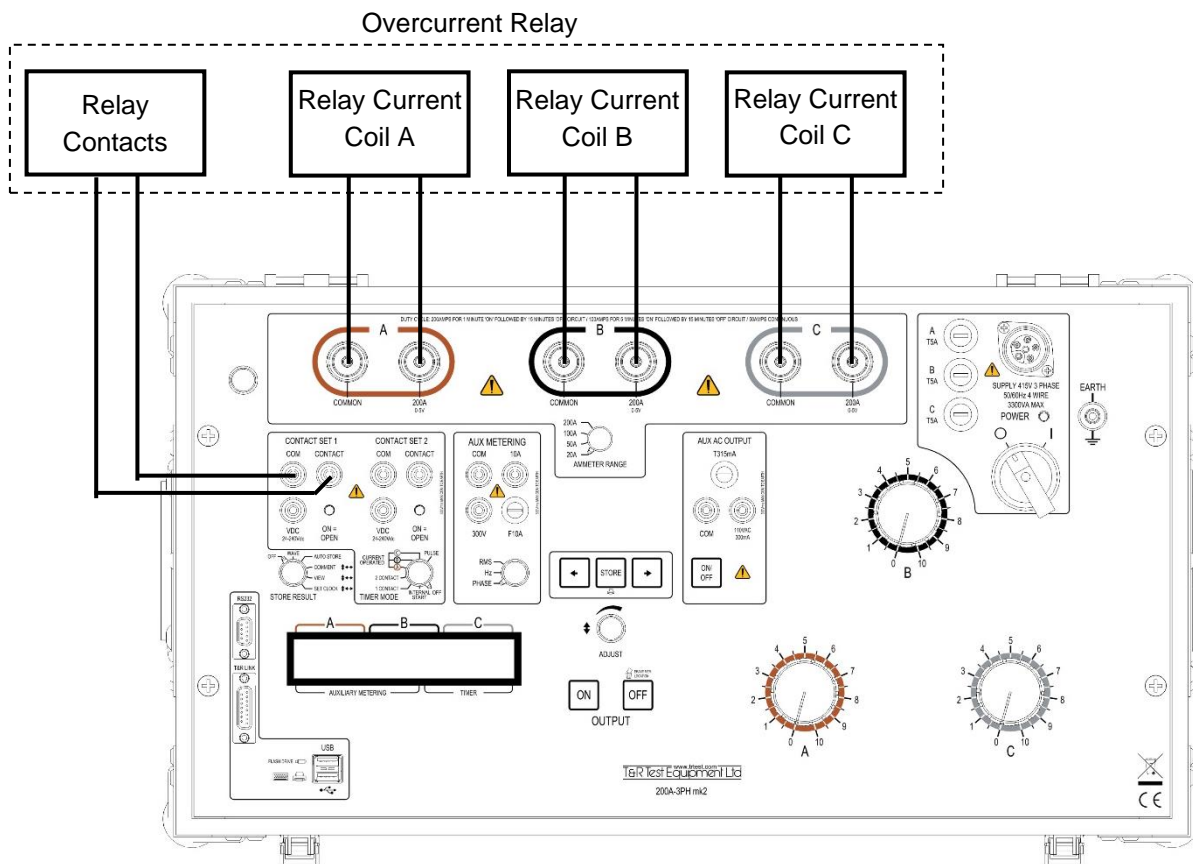


Figure 2.2 Connections for testing auto-reclose devices

2.2.1 Connections

Ensure that the outputs are switched off and that the relay is isolated before making any connections.

Connect the relay contacts to CONTACT SET 1.

Connect the main outputs as shown in figure 2.2.

2.2.2 Test procedure

Set the main output controls to zero (anti-clockwise) and the timer mode to “OFF”.

Switch on the main output and increase the currents for each phase to the desired level.

Switch off the main output.

Switch the timer to “single contact” mode and reset the relay.

Switch the main output on. The output will be switched off and the timer will start when the relay trips. The timer will stop when the relay auto-recloses.

2.3 Timing Circuit Breakers

Testing CBE's MCB's and other devices with no auxiliary contacts is possible using the current operated timer mode on the 200A-3PH mk3. This mode starts the timer when the output current on the selected phase exceeds 20% of the selected current range and stops the timer when the current on the selected phase falls below 20% of range. The phase on which to start and stop the timer is selected using the phase select switch.

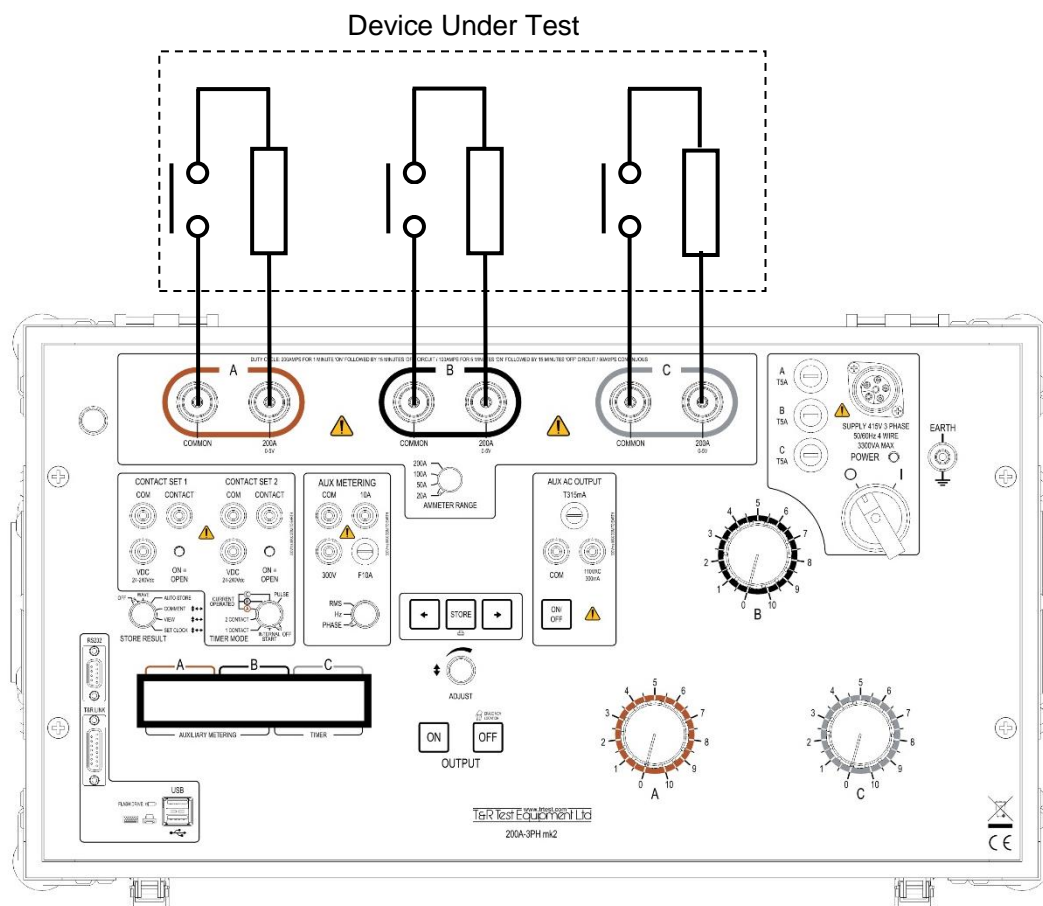


Figure 2.3 Connections for testing circuit breakers

2.3.1 Connections

Ensure that the outputs are switched off and that the device under test is isolated before making any connections.

Connect the main outputs as shown in figure 2.3, selecting the most appropriate ammeter range for the device under test.

Set the phase select switch to trigger the timer on the desired phase.

2.3.2 Test procedure

Set the output controls to zero (anti-clockwise) and the timer mode to "OFF".

Switch on the main output and increase the outputs to the desired level.

Switch off the main output.

Switch the timer to "CURRENT OPERATED" mode and reset the breaker if it has tripped.

Switch the main output on. The timer will start when current starts flowing in the device under test and will stop when the device trips.

2.3.3 Devices with short trip times

When testing devices with short trip times (such as thermal circuit breakers at high over-current factors), setting the current may cause the breaker to trip. In such circumstances, set the current using pulse mode. In this mode, current will be injected for 500ms and the current logged every time the "ON" button is pressed.

2.4 Directional relays (in conjunction with DVS3 mk2 voltage source)

Directional relays may be tested using the 200A-3PH mk3 in conjunction with a suitable voltage source (such as the T&R DVS3 mk2). This procedure will detail the test procedure using the DVS3 mk2 but may be adapted to other voltage sources.

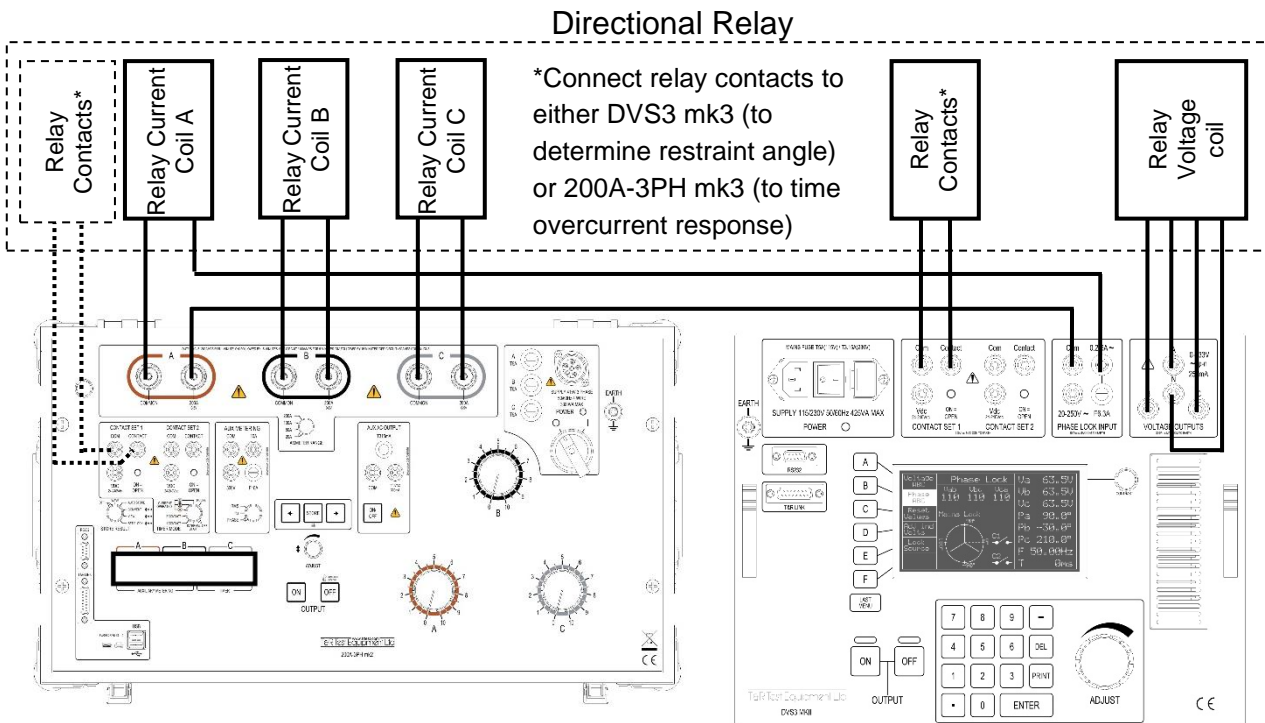


Figure 2.4 Connections for directional overcurrent relay

The phase locking between a 200A-3PH mk3 and a DVS3 mk2 may be simplified considerably using the T&R link phase locking lead as shown in figure 2.5.

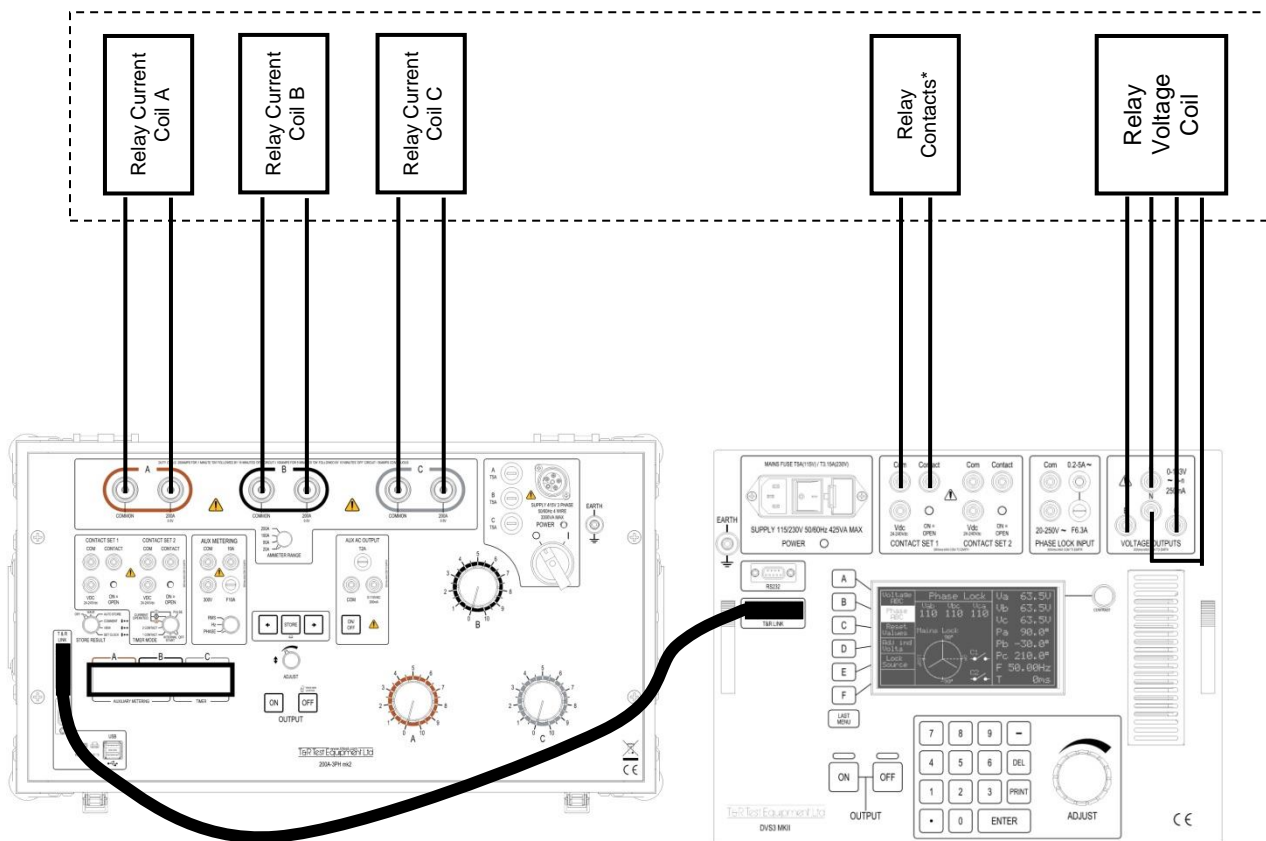


Figure 2.5 Connections for directional overcurrent relay using T&R Link phase locking

2.4.1 Connections

Ensure that the outputs are switched off and that the device under test is isolated before making any connections.

Connect the main outputs to the relay current coils as shown in figure 2.4. The output of phase A is looped into the DVS3 mk2 phase lock input to allow the DVS3 mk2 to phase lock to the current output of the 200A-3PH mk3.

Connect the output from the DVS3 mk2 to the relay voltage coils.

Set the AMMETER RANGE switch to 20A range, and the TIMER MODE switch to phase A.

Phase A of the DVS3 mk2 may be connected to the auxiliary input of the 200A-3PH mk3 as a double-check on the phase angle if required. Refer to figure 2.4 for connections.

Connect the relay contacts to contacts set 1 on the DVS3 mk2.

2.4.2 Test procedure – restraint angle

Set the output controls to zero (anti-clockwise) and the timer mode to “off”.

Switch on the main output and increase the output current for each phase to the setting current of the relay.

Select "Phase lock" mode on the DVS3 mk2 and select the lock source as "External lock". Set the DVS3 mk2 to the desired output voltage and switch the DVS3 mk2 output on. When phase A on the DVS3 mk2 is set to zero, the voltage from the DVS3 mk2 will be in phase with the current from the 200A-3PH mk3. The phase angle between the current and voltage may now be altered using the phase control on the DVS3 mk2. The contacts on the relay will now change state (indicated on the DVS3 mk2 screen) as the voltage phase is rotated through the restraint angle of the relay.

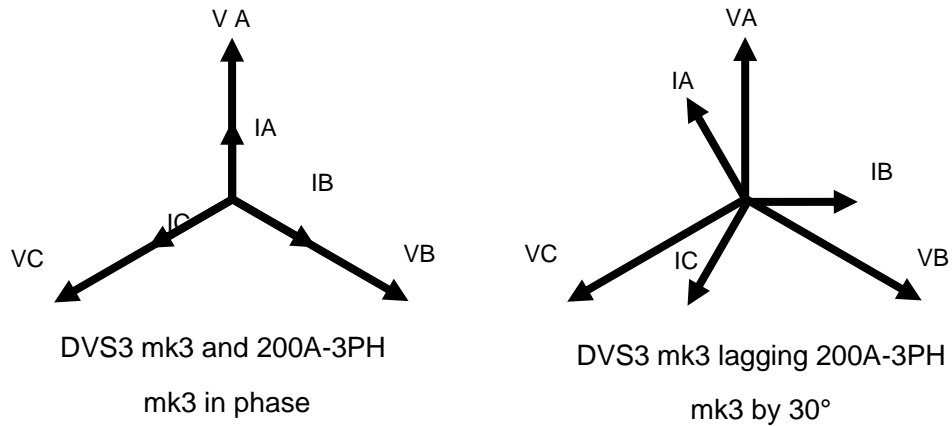


Figure 2.6 200A-3PH mk3 and DVS3 mk2 output phasors

2.4.3 Test procedure – overcurrent timing

Ensure that the outputs are switched off and that the device under test is isolated before making any connections.

Disconnect the relay contacts from the DVS3 mk2 and connect to contact set 1 on the 200A-3PH mk3 (see figure 2.7).

Disconnect the 200A-3PH mk3 phase A from the DVS3 mk2 (this may be left connected if the test current will not exceed 5A or if using the T&R Link phase lock connection between a 200A-3PH mk3 and DVS3 mk2.).

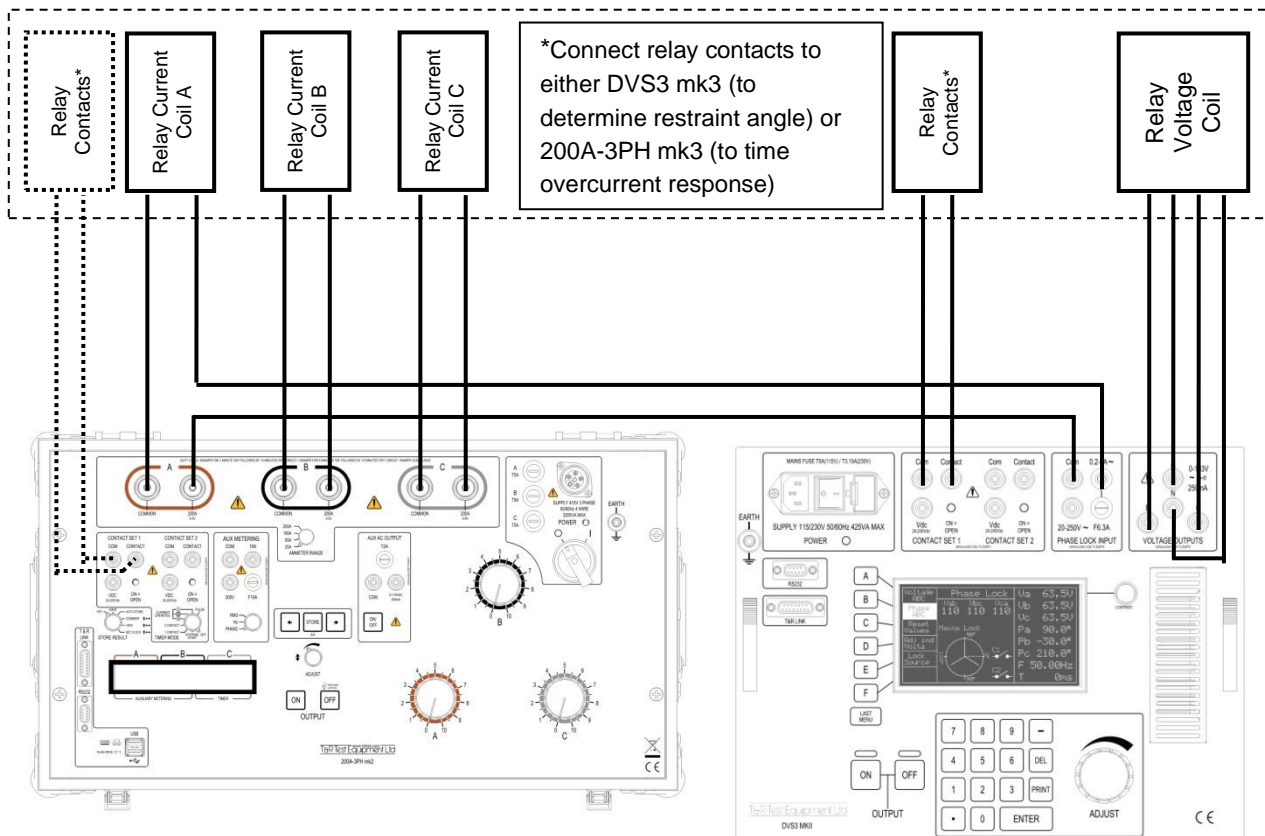


Figure 2.7 Connections for current injection into directional overcurrent relay

Set the phase angle so that the relay is not in restraint.

Set the 200A-3PH mk3 timer mode to “OFF”

Press the 200A-3PH mk3 “ON” pushbutton and increase the desired test current for each phase.

Switch the output off using the “OFF” pushbutton.

Select “INTERNAL START” timer mode and switch the output on. The unit now resets, starts the timer and begins injecting current into the relay. When the relay’s contacts change state, the timer will stop, and the output will be switched off automatically.

3. MAINTENANCE

WARNING Before removing the unit from its case, ensure that the unit is disconnected from the mains. Under no circumstances connect the unit to the mains whilst it is removed from its case.

3.1 Regulator Brushes

The regulator brushes should be examined and replaced if necessary. The interval between inspection and renewal of the brushes will depend upon the amount of usage. However, it should be remembered that damage to the regulator can result if the brushes are allowed to wear away to such an extent that a loss of brush pressure occurs.

3.2 Removal of the 200A-3PH mk3 from Case

To remove the instrument from its case, the following procedure should be used: -

1. Remove the lid from the case, and place the unit on its face, such that it is resting on the handles on the front panel.
2. Remove the four fixing screws from the base of the unit.
3. Lift the case from the unit, taking care not to damage the earth lead from the unit to the case.

4. STANDARD ACCESSORIES

4.1. Spares fuses supplied: -

- a. 3 off T5A 1¼ inch mains supply
- b. 1 off T315mA 20mm auxiliary supply
- c. 1 off F10A auxiliary current input

4.2. Standard Accessories Supplied

- a. Mains input lead.
- b. 3 off 5m 25mm² blue output leads
- c. 1 off 5m 25mm² grey output lead
- d. 1 off 5m 25mm² black output lead
- e. 1 off 5m 25mm² brown output lead
- f. 1 off 5m 2 core timer lead
- g. Operating & Maintenance Manual
- h. Lead set case
- i. USB keyboard
- j. USB key

4.3. Optional Accessories

- a. T&R link lead.

5. OPTIONAL DELTA-STAR TRANSFORMER

5.1 Description

The 200A-3PH mk3 Delta-Star transformer allows the 400V 200A-3PH mk3 to be used where only a three wire three phase supply is available. It also allows operation of the unit from 115V, 230V, and 400V line-line supplies.

An auxiliary single-phase output is provided to supply power to a DVS3 mk2 voltage source. A separate transformer supplied from phase A powers this output.

5.1.1 Front Panel Layout

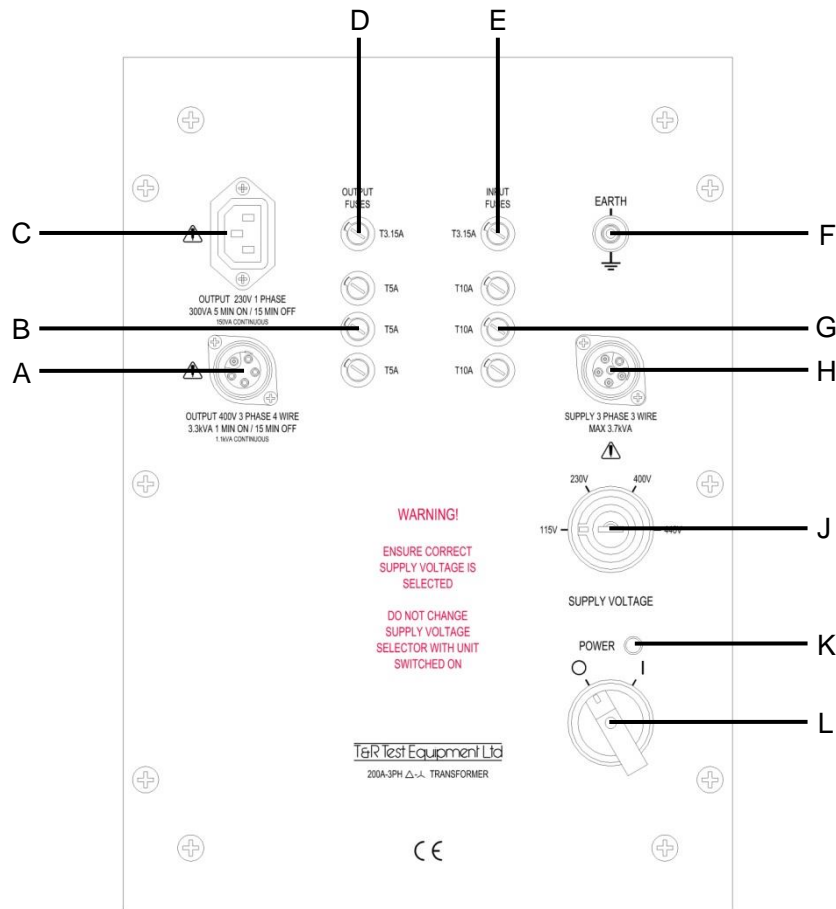


Figure 5.1 Delta-Star transformer front panel layout

Ref	Item	Function
A	Mains outlet - 4 wire	400V 4 wire output to 200A-3PH mk3
B	3 phase output fuses	Three phase output fuses
C	Single phase output	230V single phase output for DVS3
D	Single phase output fuse	Fuse for single phase output
E	Single phase input fuse	Fuse for single phase input
F	Earth terminal	Connection to local earth
G	Three phase input fuses	Three phase input fuses
H	Mains input – three wire	115V-440V three wire input
J	Input voltage selector key switch	Input voltage selector switch
K	Mains on/off indicator	Lit when power is on
L	Mains on/off switch	Isolate unit from mains

5.1.2 Electrical Specification

5.1.2.1 Supply Requirements

The input to the delta-star converter is a 3 wire three phase supply. The input may be switched to one of the following voltages:

- 115V±10% 3 phase 3 wire 1500VA max
- 230V±10% 3 phase 3 wire 1500VA max
- 400V±10% 3 phase 3 wire 1500VA max
- 440V±10% 3 phase 3 wire 1500VA max

5.1.2.2 Three Phase Output

A three-phase output is provided to supply the 200A-3PH mk3. Do not connect any other type of equipment to this output.

Voltage: 400V±10%

Type: 4 wire 3 phase isolated from mains

Rating: 200VA continuous/600VA 1 min on/15 min off

5.1.2.3 Single phase output

A single-phase output is provided to supply the DVS3 mk2. Do not connect any other type of equipment to this output.

Voltage: 230V±10% single phase

Type: Single phase isolated from both the mains and three phase outputs

Rating: 150VA continuous/300VA 5 min on/15 min off

5.2 Operation

5.2.1 Supply Voltage Connections

The 200A-3PH mk3 delta-star transformer is supplied with a 4-core supply cable. The cores are marked to ensure correct phase rotation. The mains input lead is marked as follows:

L1	Brown
L2	Black
L3	Grey
Earth	Green and yellow

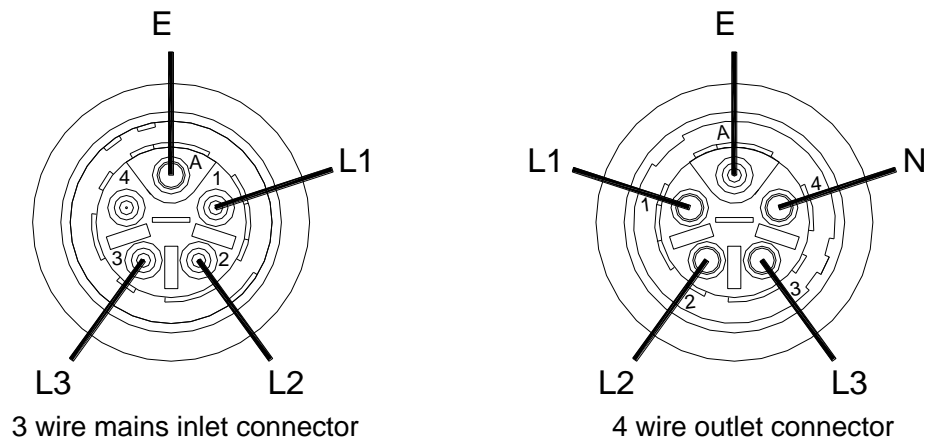


Figure 5.2 Mains inlet and three phase output connectors

5.2.2 Connections between units

Ensure that the supply is switched off.

Set the supply voltage selector key switch to match the supply voltage.



WARNING

SETTING THIS SWITCH TO THE WRONG VOLTAGE MAY DAMAGE THIS UNIT AND ANY EQUIPMENT CONNECTED TO IT.

DO NOT SWITCH THE SUPPLY VOLTAGE SELECTOR WITH POWER APPLIED.

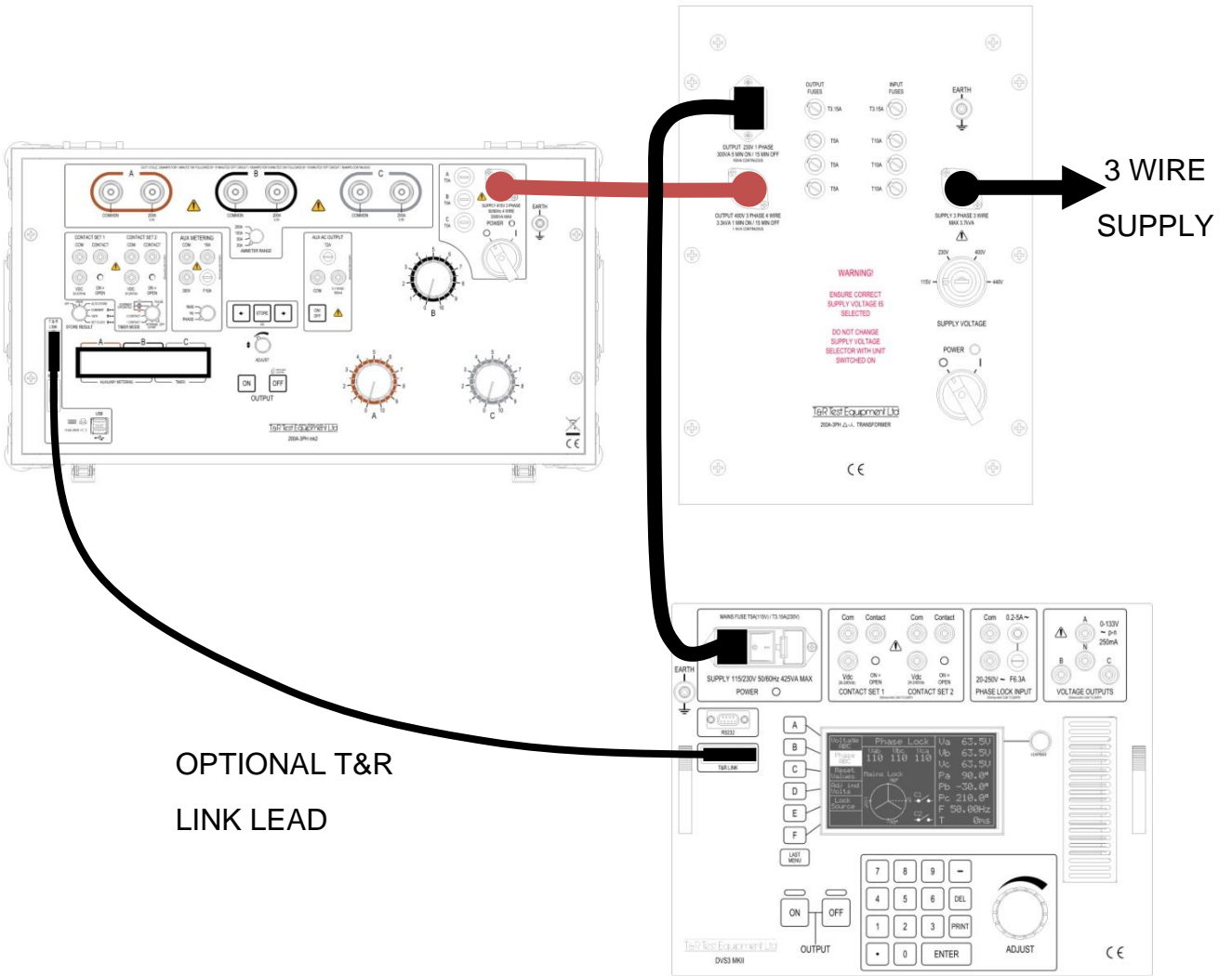
Connect the three-phase output from the delta-star transformer to the 200A-3PH mk3 using the interconnecting lead supplied.

Connect the single-phase output from the unit to the DVS3 mk2, if required.

Switch on the supply.

Switch on the delta-star transformer.

Switch on the 200A-3PH mk3 and DVS3 mk2



6. PERFORMANCE SPECIFICATION

6.1. Insulation Resistance at 1000V DC

The insulation resistance will not be less than 10 megohms between mains input to frame and all isolated outputs, and all combinations of isolated output to isolated output.

6.2. Applied Voltage Test

Mains input to frame: 2.0kV RMS for 1 minute.

All combinations of isolated output to isolated output and isolated output to frame: 1.0kV for 1 minute

6.3. Accuracy of Instrumentation and associated circuit components

6.3.1 Main Output Ammeter

Range	Resolution	Accuracy	Trip current
20.00A	0.01A	±0.6% rdg ±5d	21.0A
50.00A	0.01A	±0.6% rdg ±5d	52.5A
100.0A	0.1A	±0.6% rdg ±5d	105A
200.0A	0.1A	±0.6% rdg ±5d	210.0A

6.3.2 Auxiliary Metering

	Range	Resolution	Accuracy
Frequency (V)	40.00-99.99Hz	0.01Hz	±0.2% rdg ±2d
Frequency (I)	40.00-99.99Hz	0.01Hz	±0.2% rdg ±2d
Phase (V)	±180.0°	0.1°	±3 degrees
Phase (I)	±180.0°	0.1°	±3 degrees
AC Voltage	0-300.0Vac rms	0.1V	±0.7% rdg ±5d
AC Current	0-5.000Aac rms	0.001A	±0.7% rdg ±5d

6.3.3. Timing System

Timer mode	Range	Resolution	Accuracy
Internal start	0-999.999s/ 0-9999.99s/ 0-99999.9s	1ms/10ms/100s	±0.01% rdg ±2d
Single contact			±0.01% rdg ±2d
Dual contact			±0.01% rdg ±2d
Current operated			±0.01% rdg ±4d
Pulse mode	500ms	1ms	±2ms

7. REVISION

Product / Type: Secondary Current Injection Test Set / 200A-3PH mk3

File: OM0034.docx

Author: JTW

Issue / Date: 1 / 08/12/20

Modified By: M. Clancy

Checked By: K. Smith	Date: 08/12/20
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8. DRAWINGS REQUIRED

A2/002180 latest issue (200A-3PH mk3)