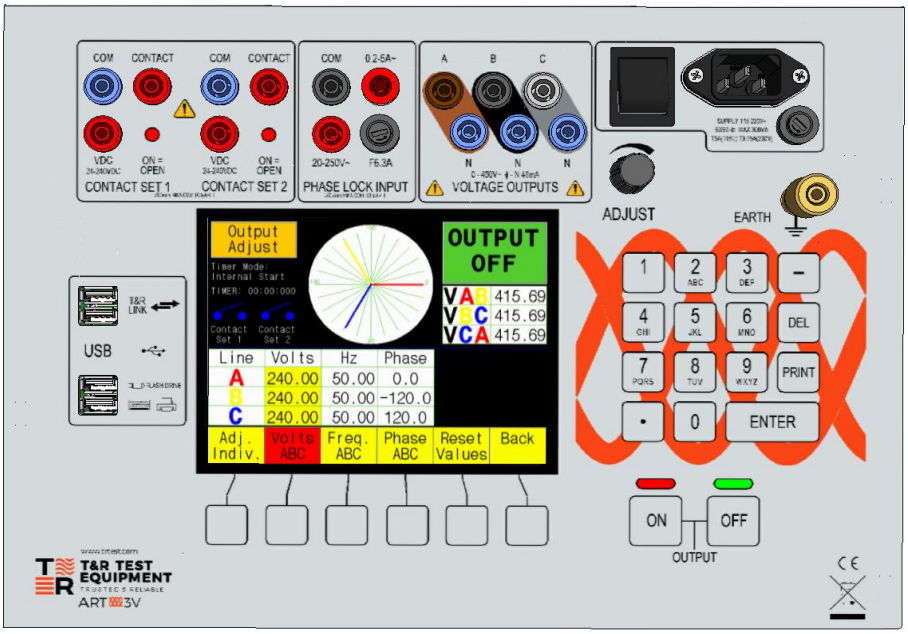
T&R TEST EQUIPMENT

TRUSTED & RELIABLE

OPERATING AND MAINTENANCE MANUAL

Product: **Digital Voltage Source**

Type: **ART3v**



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GENERAL SAFETY STATEMENT


WARNING

The following safety precautions must 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 any system to be connected to the unit is not live.
- Do not connect and disconnect leads while the outputs are switched on. Breaking the output circuit with current flowing may cause 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 available that must 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. Refer to the product manual for ratings information before making any connections.
- 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. (Excludes removable lid)
- 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.

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 cause injury or death to the operator or other personnel if not carried out correctly using applicable safety procedures.

CONTENTS

1 DESCRIPTION OF EQUIPMENT

The ART3V is a relay test system designed for testing voltage and frequency protection relays. It generates a three phase voltage output from a single phase supply, and may be used in conjunction with a current source to test directional relay protection.

1.1 Front Panel Layout

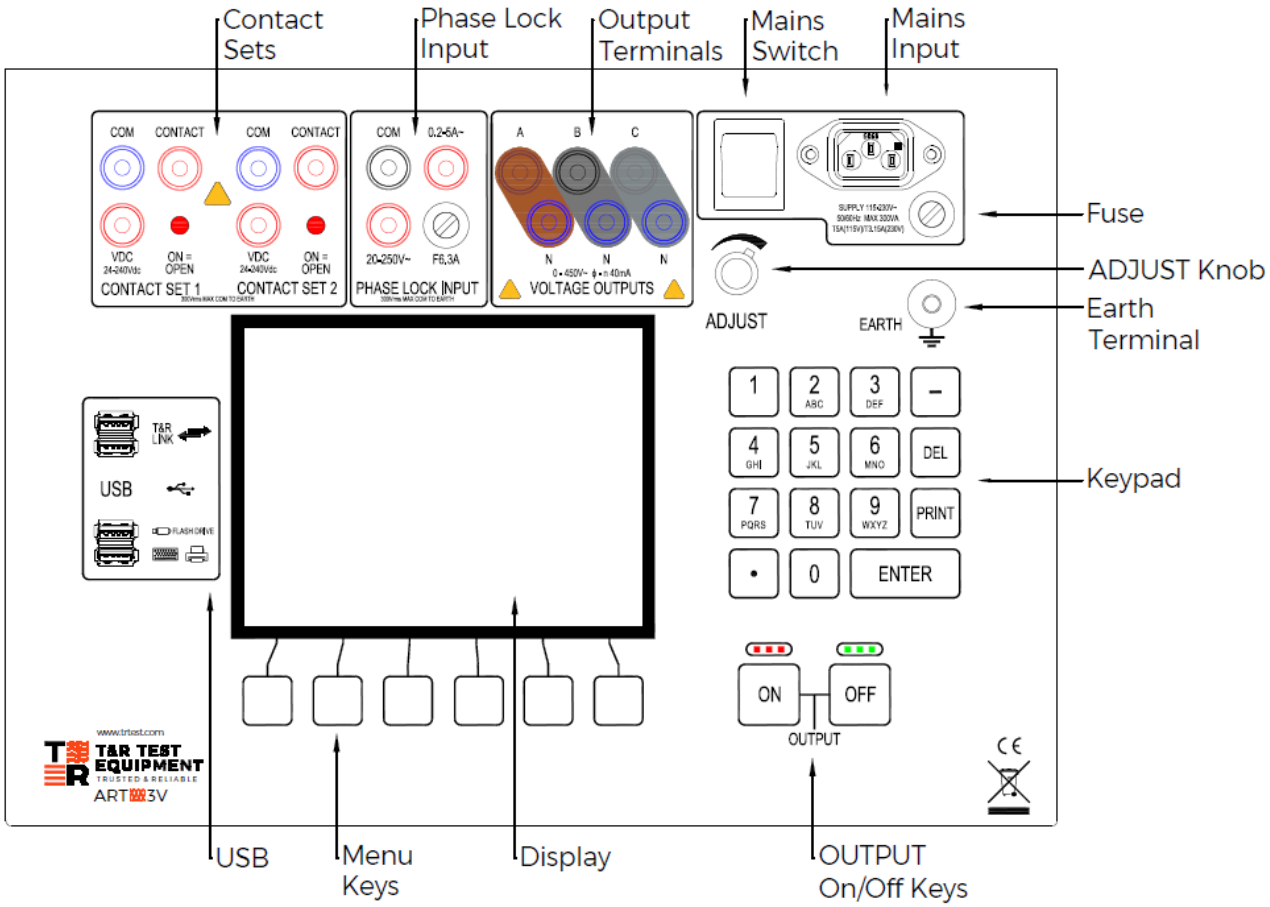

Figure 1.1 ART3V front panel layout

1.2 Electrical Specification

1.2.1 Supply Requirements

The ART3V requires a single phase 45 - 65Hz supply of 90 - 264V. The maximum power requirement of the unit is 300VA.

1.2.2 Outputs

The unit has three independent phase outputs, each phase has the following ratings*:

Voltage:	0-450Vac phase-neutral
Current (continuous):	40mA at 450Vac
Phase Lock:	45Hz to 65Hz
Variable Frequency:	30-999.99 Hz
Variable Phase angle:	±180.0º

*All output ratings are based on an ambient temperature of 25°C

1.2.3 Metering Resolution and Accuracy

Parameter	*Resolution*	*Accuracy*
Output voltage (phase-neutral)	0.01V	±0.1% of reading + 2 digits
Output voltage (phase-phase)		±0.3% of reading + 3 digits
Phase angle adjustment ±180°	0.1°	±0.3° phase-phase
		±3° reference to output
Frequency range 30.00 to 999.99Hz	0.01Hz	±0.05% of reading + 2 digits

1.2.4 Timing System Specification

The ART3V is fitted with an integrated timing system, linked to the main output and the two contact sets. Using **internal start** contactor mode, timing is automatically started when a new value is entered (when the output switched ON), and stopped on a change of state of either contact set 1 or 2. The maximum voltage appearing on the relay contact test sockets (COM – CONTACT) is 24VDC, and the maximum current flowing in the test circuit when the relay contacts are closed is 20mA DC. The contact test circuit is fully isolated.

The VDC contact inputs are sensitive to DC voltage in the range 24-240VDC. A change of voltage from 0 to 24-240VDC or vice-versa will trigger the timer circuit in the same way as a change of contact state on the contact input. These inputs may be used with 'wet' contacts with dc voltage present (+ to VDC, - to COM).

1.2.5 Phase Lock

The main output may be locked to the following inputs:

- Mains supply
- External reference input (V or I)

The unit will never automatically lock to an input signal. To lock the output, enter phase lock mode and select the required lock source. Unless there is an external reference input, the output can only be locked to mains. Once an external reference input is connected, only then can it be selected for phase locking.

For the polarity configuration for both inputs with respect to the main output, please see Section 2.3.6.

1.2.5.1 *External reference lock ratings*

Voltage range:	20-250Vac
Frequency range:	45 to 65Hz*
Maximum Burden:	0.25VA
Current range:	0.2-5Aac
Maximum Burden:	3VA

External Lock frequency range extends to 999.99Hz with linearly reduced phase accuracy

1.2.6 Temperature Range

The operating temperature range for the unit is -0°C to +45°C.
The storage temperature range for the unit is -20°C to +60°C.

1.2.7 Overload Protection

The mains input and phase lock current input are protected by the following fuses:

Mains supply	20mm T3.15A for 230V supply and 20mm T5A for 115V supply.
External current input	20mm F6.3A

1.2.7.1 *Overcurrent Trip*

The main voltage outputs are protected by an electronic over current trip which operates above 40mA. An overload on the output is indicated by the message shown in Figure 1.2. The unit will be temporarily disabled while the message is displayed.

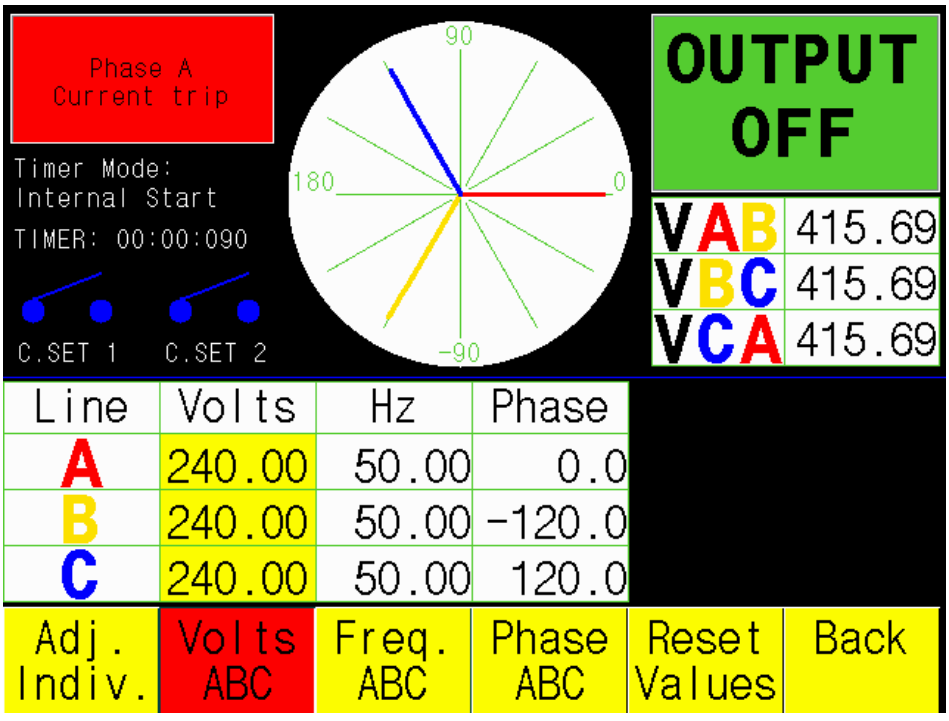

Figure 1.2 Overcurrent trip error message for Phase A

1.2.7.2 Over Temperature Trip

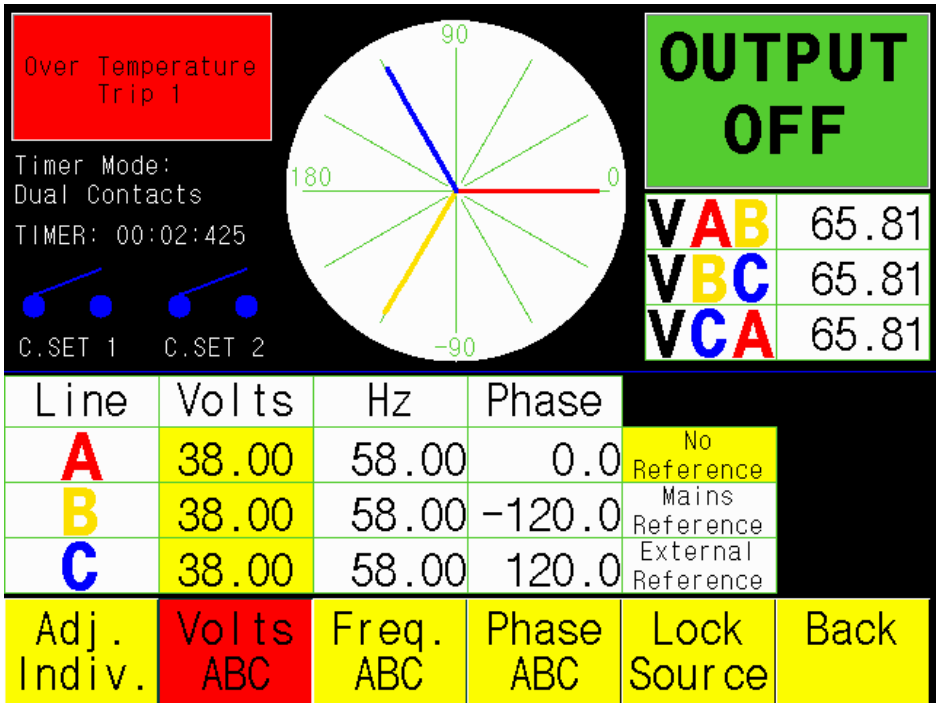

Figure 1.3 Over-temperature error message

The unit is fitted with three over temperature sensors which will de-energise the output if the main heatsink or internal temperature exceeds 70°C. In this situation the error message shown in Figure 1.3 is displayed. The unit must then be allowed to cool before the output may be switched back on.

The message will automatically clear when the unit has cooled to 55°C.

1.3 Construction

The ART3V relay test system is housed in a robust plastic case fitted with a carrying handle. The front panel of the unit is protected by a removable hinged lid.

WARNING

THE UNIT IS COOLED BY FANS WITH AIR INTAKE AND OUTLET MESHES ON THE FRONT PANEL SURROUND. THE UNIT MUST NOT BE OPERATED WITH THE AIR VENTS BLOCKED.

2 USING THE ART3V

2.1 Getting Started with the ART3V

Connect the ART3V to a suitable supply (See 1.2.1 Supply Requirements) using the mains cable supplied. When the set is switched on using the main switch, the ART3V runs an initialisation sequence, and then a welcome screen is displayed as shown in figure 2.1.

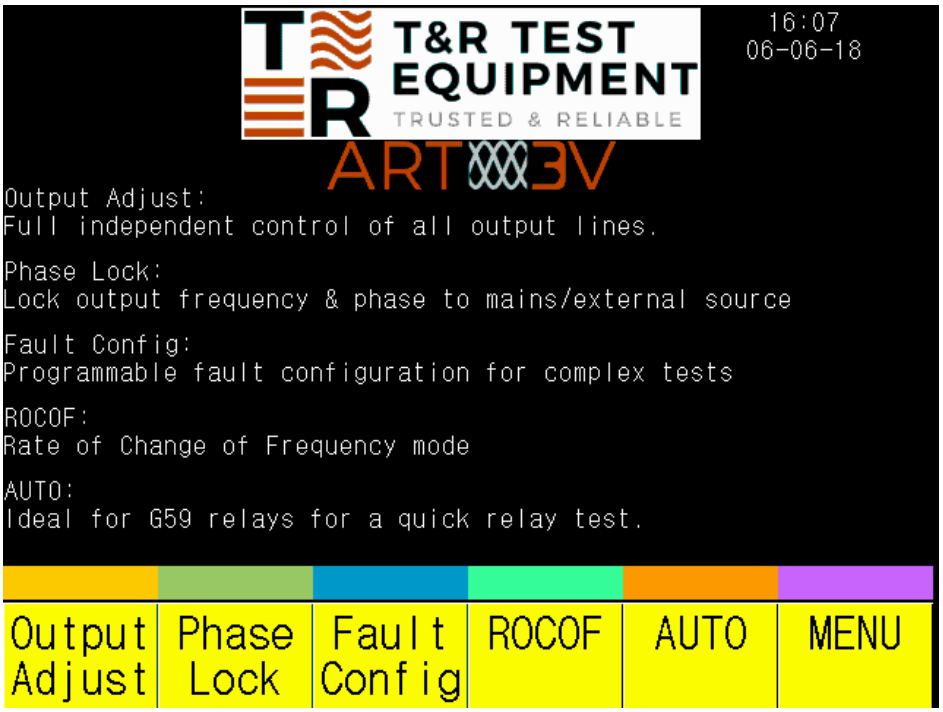

Figure 2.1 Welcome Screen

If the display is not easy to read, adjust the brightness in MENU > Settings > Brightness.

When the ART3V is powered up the output cannot be switched on until one of the operational modes is selected.

Note - The output must be switched OFF before returning to the menu from any mode.

2.1.1 Menu buttons

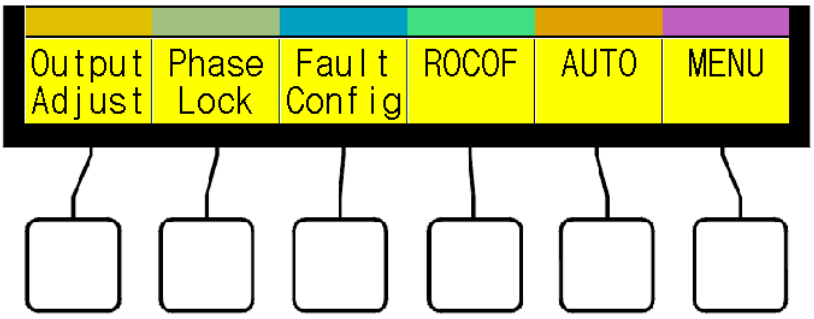

Figure 2.2 Menu buttons

The ART3V is controlled via a set of menus, selected by buttons situated below the bottom of the display. The function of the buttons changes depending on the mode of operation, as do the labels displayed.

2.1.2 Connections

WARNING

Before making any connections, ensure that the system to be tested is isolated from the supply and earthed. Measure the voltages on the connection points on the object under test to check that there is no voltage present before making any connections. Making connections to the unit with the output switched on may damage the unit.

2.1.2.1 Star loads

Star loads are connected to the output of the ART3V by connecting the three neutral terminals for a common neutral. This can be done using the *Neutral Link Accessory* as shown in Figure 2.3.
Note: A star load will not function correctly without all the neutrals connected.

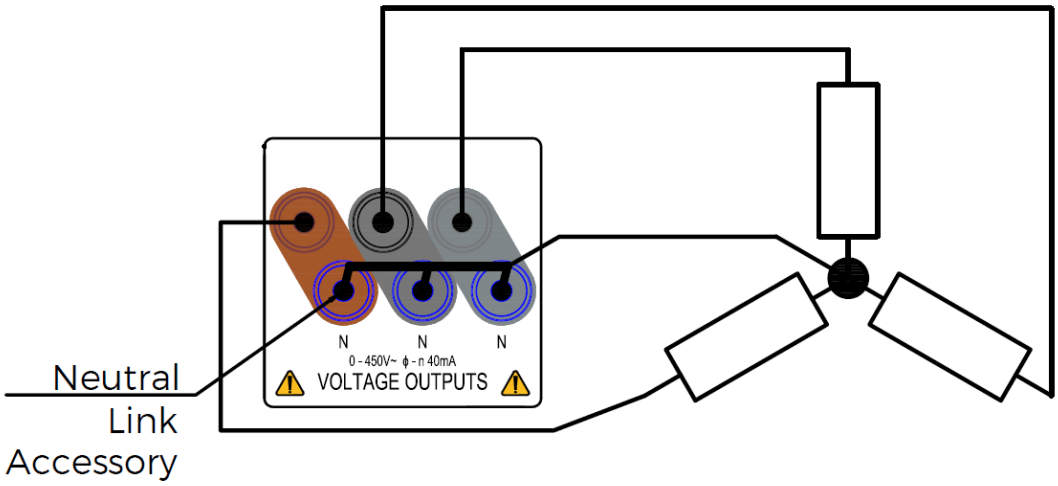

Figure 2.3 Connection of star load to ART3V

2.1.2.2 Single phase loads

Single phase loads may be supplied from the ART3V either between any phase and neutral or between two phases whose neutrals are connected. Connecting between two phases is only necessary when a higher output voltage is required.

The maximum voltage obtainable is 450V between phase and neutral, and 900V between two phases (if the phase angles of the two phases are set to 180° apart, and the neutrals are connected).

Phases can be connected in parallel for a higher current output. Before doing so the user must enter Menu > Settings > Output Config to select the desired output combination. This will lock the selected outputs to be in phase for parallel output operation.

Never connect 3 output phases together in series.

2.1.2.3 Delta loads

Delta loads may be connected directly to the output of the ART3V as shown in Figure 2.4. In this configuration, wire links must be connected between phases.

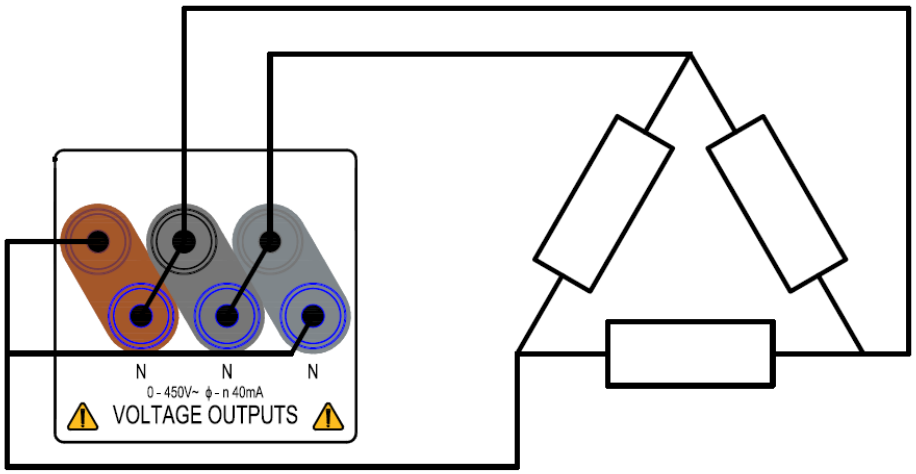

Figure 2.4 Connection of delta load to ART3V

2.2 Output Adjust Mode

Output Adjust mode allows control of the output voltage, phase angle and frequency of the three phases either simultaneously or individually (Figure 2.5). To return to the previous menu, press the BACK key.

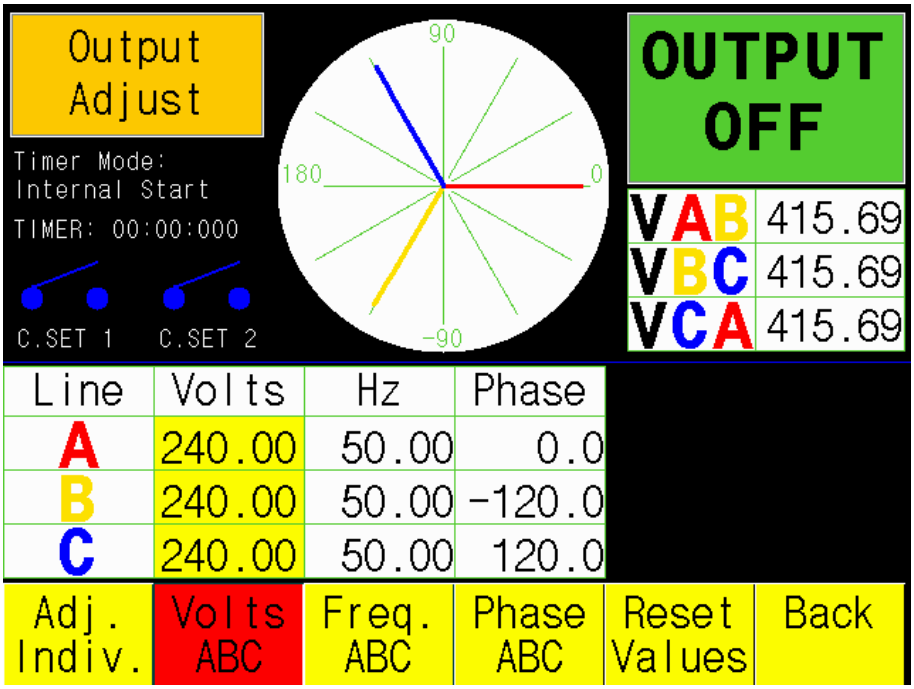

Figure 2.5 Output Adjust mode screen

2.2.1 Output Control

In all modes apart from 'Fault Config' the output is switched ON and OFF by the large ON and OFF keys. The output is OFF when the green OFF key is illuminated, and ON when the red ON key is illuminated. The voltages shown for V_A, V_B, and V_C appear at the output terminals when the output is switched ON.

2.2.2 Volts ABC

The voltage is changed using either the ADJUST knob or the keypad. To change the output voltages, first highlight voltage adjustment for phases A, B & C by pressing the VOLTS ABC menu key. The button text will then highlight in red and the values will be highlighted in yellow (Figure 2.6). When the Volts ABC option is selected, all three output voltages are adjusted together. The output voltage may be pre-set when the output is OFF, or changed whilst the output is ON.

Note. Only when table values are highlighted in yellow can they be adjusted with the keypad or the ADJUST control.

2.2.2.1 Adjusting Voltage Using the Adjust Knob

Continuous variation of the output can be achieved by rotating the ADJUST knob. Clockwise rotation increases the voltage and anti-clockwise rotation decreases the voltage. If the output is ON, the change in output voltage is seen at the output as the control is rotated.

2.2.2.2 *Setting Voltage Using the Keypad*

Voltages are set by typing a value on the keypad. Ensure Volts ABC is highlighted to start typing a value on the keypad. The display of Volts will change to show the value being typed, as shown in figure 2.6.

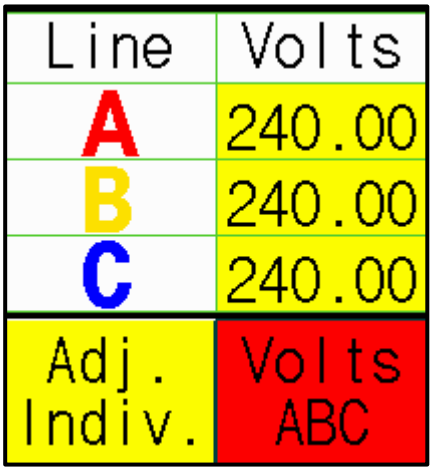

Figure 2.6 Voltage entry using keypad

The output voltage does not change until the ENTER key is pressed when using the keypad.

If an invalid value is entered, the entry will be cleared and the unit will revert to the previous entry.

If a wrong key is pressed, the DEL key can be used to delete it.

2.2.3 Frequency ABC

Output frequency control works the same as voltage & phase control. Frequency is changed using either the ADJUST knob or the keypad. To change the output frequencies, first highlight frequency for phases A, B & C by pressing the FREQ ABC menu key. When the Freq. ABC option is selected, all three output frequencies are adjusted together. For using the keypad and the ADJUST knob, see Section 2.2.2.1 - 2.2.2.2.

The output frequency does not change until the ENTER key is pressed when using the keypad.

If an invalid value is entered, the entry will be cleared and the unit will revert to the previous entry.

If a wrong key is pressed, the DEL key can be used to delete it.

2.2.4 Phase ABC

Output phase control works the same as voltage control. Phase is changed using either the ADJUST knob or the keypad. To change the output phases, first highlight phase for phases A, B & C by pressing the Phase ABC menu key. When the PHASE ABC option is selected, all three output phases are adjusted together. The value entered is assigned to phase A. Phase B & C are re-calculated according to their phase difference to A. Phase values can be entered in any format but will always be displayed on the screen between ±180.0º, unless phases are adjusted individually (see Section 2.2.6 Individual Adjustment). For using the keypad & ADJUST knob, see Section 2.2.2.1 - 2.2.2.2.

Note. Phase adjustment & display will be incorrect if all output frequencies are not equal.

The output phase does not change until the ENTER key is pressed when using the keypad.

If an invalid value is entered, the entry will be cleared and the unit will revert to the previous entry.

If a wrong key is pressed, the DEL key can be used to delete it.

2.2.5 Reset Values

If any values have been adjusted, the Reset Values option provides a convenient way of resetting all outputs to the user saved nominal values. The default is 240V, 50Hz but this can be changed in the Settings menu (See Section 2.6.1). When pressed the outputs will change to the default without the need to press the ENTER key.

Note. When pressed the outputs will change to the nominal values even if the output is switched ON.

2.2.6 *Individual Adjustment*

All output values can be adjusted individually using the ADJ. INDIV. option. First select Volts ABC, Freq. ABC or Phase ABC, then use the ADJ. INDIV. option to select the specific phase to adjust (Figure 2.7). The value is changed using either the ADJUST knob or the keypad. For using the keypad & ADJUST knob, see Section 2.2.2.1 - 2.2.2.2.

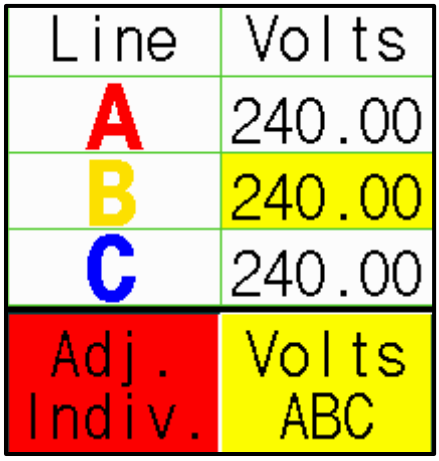

Figure 2.7 Individual adjustment of Phase B output voltage

The output phase does not change until the ENTER key is pressed when using the keypad.

If an invalid value is entered, the entry will be cleared and the unit will revert to the previous entry.

If a wrong key is pressed, the DEL key can be used to delete it.

2.3 Phase Lock Mode

Phase Lock mode allows the frequency and phase of the output to be locked to the mains or an external voltage or current. Frequency control is not possible in this mode. On entry to the mode, the output voltage is locked to 'No Reference' meaning it is not locked to any source. The output will default to the users nominal frequency.

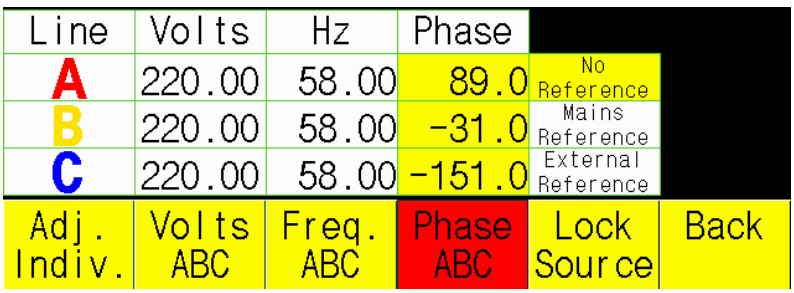

Figure 2.8 Phase lock mode screen

2.3.1 *Output Control*

In all modes apart from 'Fault Config' the output is switched ON and OFF by the large ON and OFF keys. The output is OFF when the green OFF key is illuminated, and ON when the red ON key is illuminated.

The voltages shown for V_A, V_B, and V_C appear at the output terminals when the output is switched on.

2.3.2 Volts ABC

The voltage is changed using either the ADJUST knob or the keypad. To change the output voltages, first highlight voltage adjustment for phases A, B & C by pressing the VOLTS ABC menu key. The button text will then highlight in red and the values will be highlighted in yellow (Figure 2.6). When the Volts ABC option is selected, all three output voltages are adjusted together. The output voltage may be pre-set when the output is off, or changed whilst the output is on. For using the keypad & ADJUST knob, see Section 2.2.2.1 - 2.2.2.2.

Note. Only when table values are highlighted in yellow can they be adjusted with the keypad or adjust control.

2.3.3 Phase ABC

Output phase control works the same as voltage control. Phase is changed using either the ADJUST knob or the keypad. To change the output phases, first highlight phase for phases A, B & C by pressing the Phase ABC menu key. When the PHASE ABC option is selected, all three output phases are adjusted together. The value entered is assigned to phase A. Phase B & C are re-calculated according to their phase difference to A. Phase values can be entered in any format but will always be displayed on the screen between ±180.0º, unless phases are adjusted individually (see Section 2.2.6 Individual Adjustment). For using the keypad & ADJUST knob, see Section 2.2.2.1 - 2.2.2.2.

The output phase does not change until the ENTER key is pressed when using the keypad.

If an invalid value is entered, the entry will be cleared and the unit will revert to the previous entry.

If a wrong key is pressed, the DEL key can be used to delete it.

2.3.4 Individual Adjustment

The output values can be adjusted individually using the ADJ. INDIV. option. First select Volts ABC or Phase ABC, then use the ADJ. INDIV. option to select the specific phase to adjust. The value can then be changed using either the ADJUST knob or the keypad. For using the keypad & ADJUST knob, see Section 2.2.2.1 - 2.2.2.2.

2.3.5 Lock Source Selection

The ART3V is able to phase lock to the following inputs:

- The unit mains supply (Mains Reference)
- External voltage input 20-250V (External Reference)
- External current input 0.2-5A (External Reference)

'No Reference' is automatically selected when the unit enters phase lock mode.

Selecting the Lock Source option will toggle between mains reference and no reference. If there is an external voltage or current reference signal connected, this will allow toggling between all three. If the external voltage or current reference signal is too small (<0.2A or 20V) the unit will not allow External

Reference to be selected until the signal exceeds the lower input limits. The lock source cannot be changed when the output is ON.

2.3.6 Phase Relationship Between Phase Lock Inputs and Output

2.3.6.1 External Lock Voltage Input

The voltage at the phase A output is in phase with the external lock voltage input when the displayed phase angle for the phase A output is 0°.

2.3.6.2 External Lock Current Input

When using the external lock current input, the current flowing from the phase A voltage output is in phase with the current flowing into the external reference common terminal when the displayed phase angle for the phase A output is 0°. (Figure 2.10)

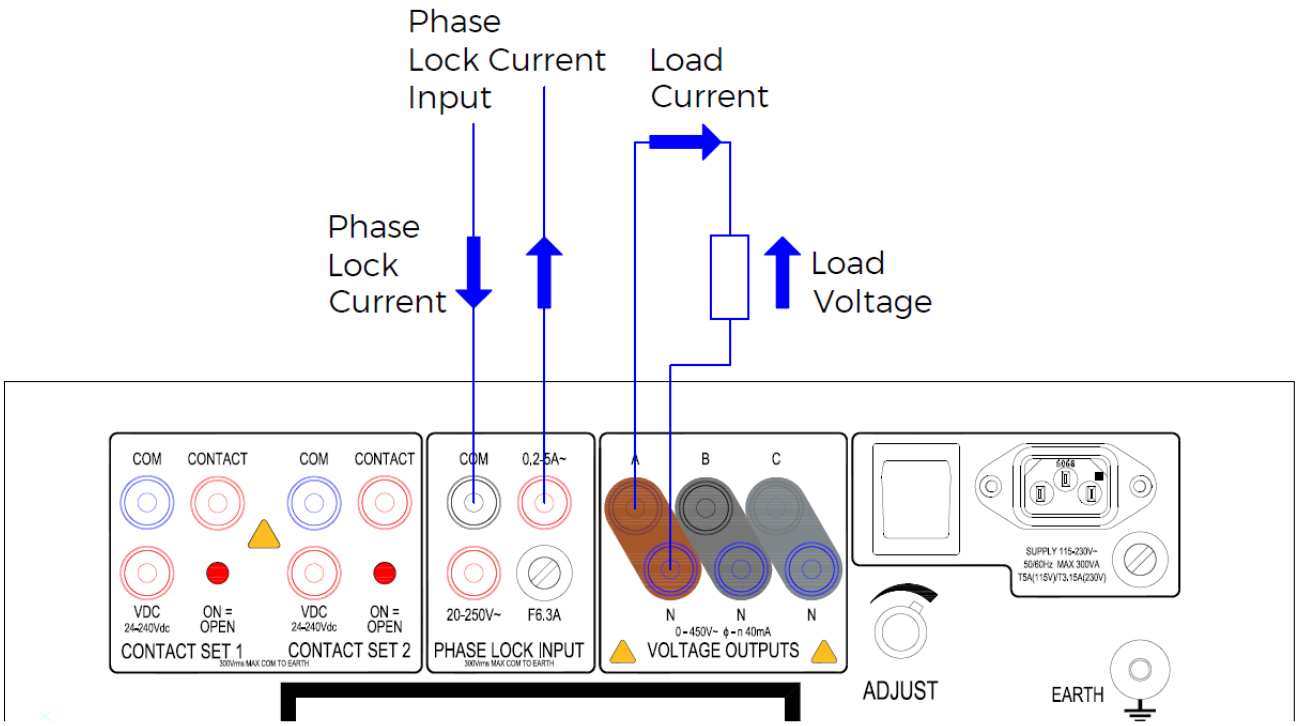

Figure 2.10 Phase lock current input

2.4 Fault Config Mode

Fault Config mode allows a complex three stage sequence of events to be programmed. The unit will step between three sets of output conditions when pre-set conditions are met. This mode is used when any number of parameters need to be changed simultaneously, and the timer also needs to be triggered.

All output parameters may be pre-programmed for this mode:

- Voltage
- Frequency
- Phase angle

Voltages, frequencies and phase angles can be set for all three phases or for each phase individually.

Note. If frequency values are changed individually at any stage, the phase values will be incorrect. It is not recommended to change individual frequencies for this test.

The unit will step between condition stages when one of the following selectable events occurs:

- Contact change on Contact set 1
- Contact change on Contact set 2
- Pre-set time elapsed

In addition, the timer may be programmed to start or stop on any of the following events during the test:

Screen Selection	Timer Function	Description
Stage 1	Timer Starts on	Start of Pre-Fault condition
Stage 2	Timer Starts on / Timer Stops on	Pre-Fault to Fault Condition
Stage 3	Timer Starts on / Timer Stops on	Fault to Post-Fault Condition
Output OFF	Timer Stops on	End of test
Contact Set 1	Timer Starts on / Timer Stops on	Contact Set 1 change event
Contact Set 2	Timer Starts on / Timer Stops on	Contact Set 2 change event

2.4.1 Main Menu

Fault Config mode is controlled via a page-wide menu. In this menu, timer start, timer stop and stage change conditions can be easily set up.

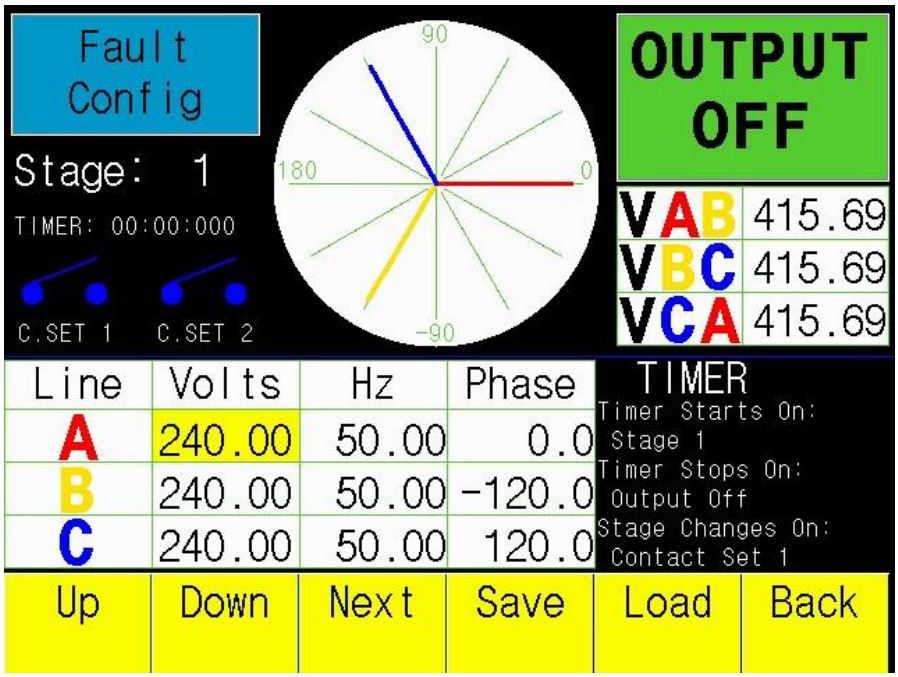

Figure 2.11 Fault Config main screen

2.4.2 Setup Options

The Fault Config screen can be navigated by pressing the UP & DOWN keys. This will move the selection through all individual parameters for each phase and the three adjustable parameters (voltage, frequency and phase angle) for the selected stage number. When highlighted, a value can be changed with the keypad or the adjust control.

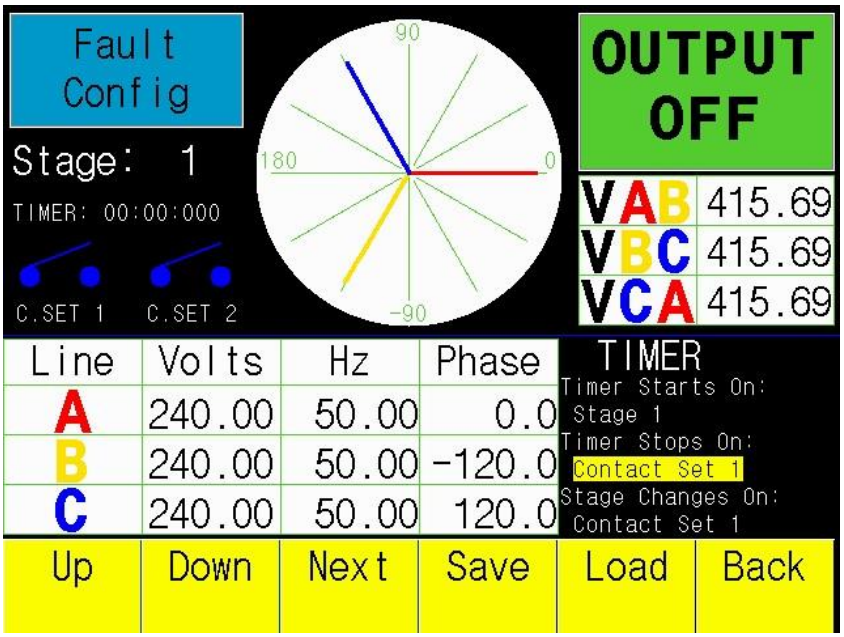

Figure 2.12 Fault Config Timer setup

When selected, the Timer Starts On condition can be changed between the following events using the adjust control:

- Stage 1
- Stage 2
- Contact set 1 change
- Contact set 2 change

Press the ENTER key to save the condition if it is a Stage number.

When selected, the Timer Stops On condition can be changed between the following events using the adjust control:

- Stage 2
- Stage 3
- Output Off
- Contact set 1 change
- Contact set 2 change

Press the ENTER key to save the condition if it is a Stage number.

Stage Changes On is used to set the condition to change to the next Stage. This will be different for each Stage. To navigate between the stages use the NEXT key. When selected, the Stage Changes On condition can be changed between the following events using the ADJUST control:

- Timer 0:000
- Contact set 1 change
- Contact set 2 change

The Timer value is set by typing in the time required while Timer 0:000 is highlighted. This is entered on the keypad followed by the ENTER key. The Timer value has a limit of 0:010s to 1:39:999s.

Values entered into this mode can be saved to the unit by the SAVE key for repeat tests. These will appear when you turn the unit on and enter the Fault Config screen. These can also be loaded in case of a change by the LOAD key.

2.4.3 Running the Test

In this mode the output is not switched on with the ON key. This will automatically turn the output ON and run through the test sequence. At the end of the test, the output will switch OFF. At any time during the test, the OFF key can be pressed to turn the output OFF and reset the Fault Config test.

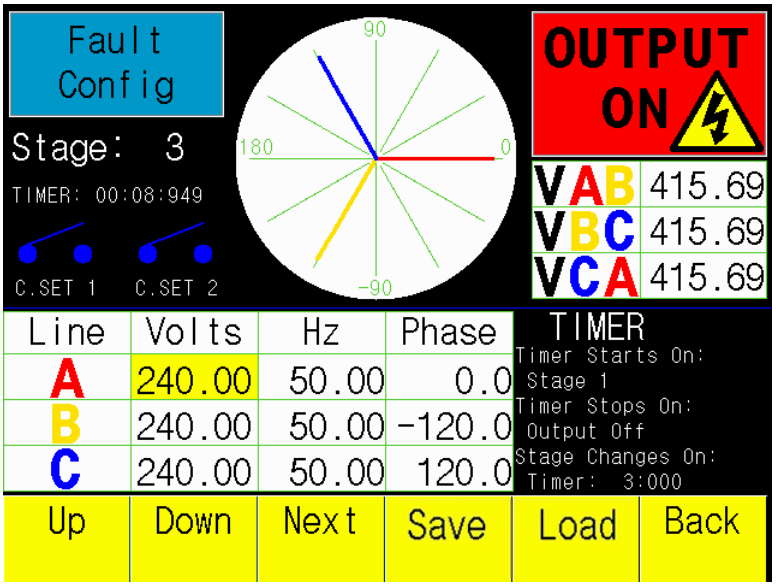

Figure 2.13 Example PF-F-PF test sequence

2.5 ROCOF Mode (Rate Of Change Of Frequency or df/dt)

2.5.1 Introduction

Testing df/dt protection with the ART3V is made easy by use of the ROCOF mode. Two basic modes of operation are supported: continuous sweep and single sweep. Continuous sweep mode continuously varies the frequency between pre-set lower and upper frequencies at the desired rate of change.

Single sweep mode sweeps the frequency from either the minimum to maximum frequency or the maximum to minimum frequency. In this mode the timer is reset and started when the frequency sweep is started. The timer will stop on a change of state of either contact set. In switching between sweep up and sweep down the Fstart and Fstop values are changed to suit.

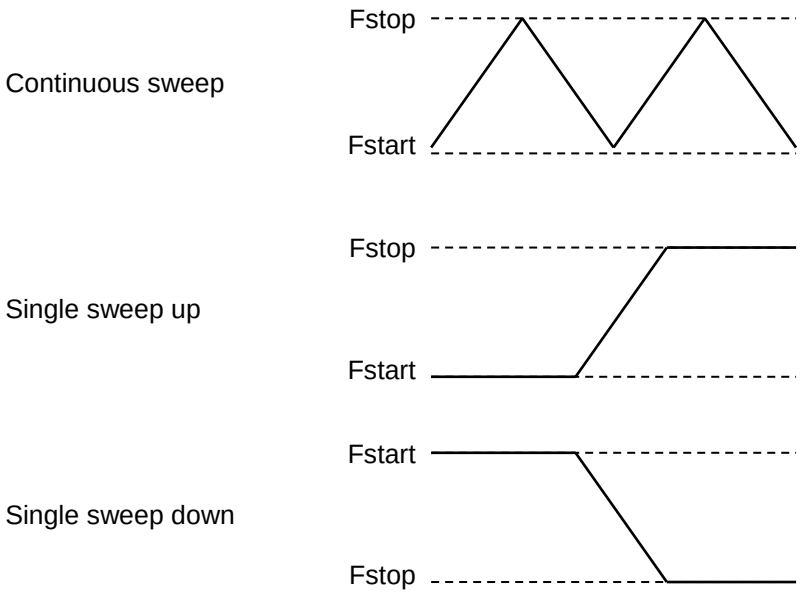

Figure 2.14 ROCOF frequency sweep types

In each of the above cases the rate of change of the frequency is set by the user, and the time taken to complete the sweep is calculated by the ART3V. The Sweep Type cannot be changed whilst a test is running.

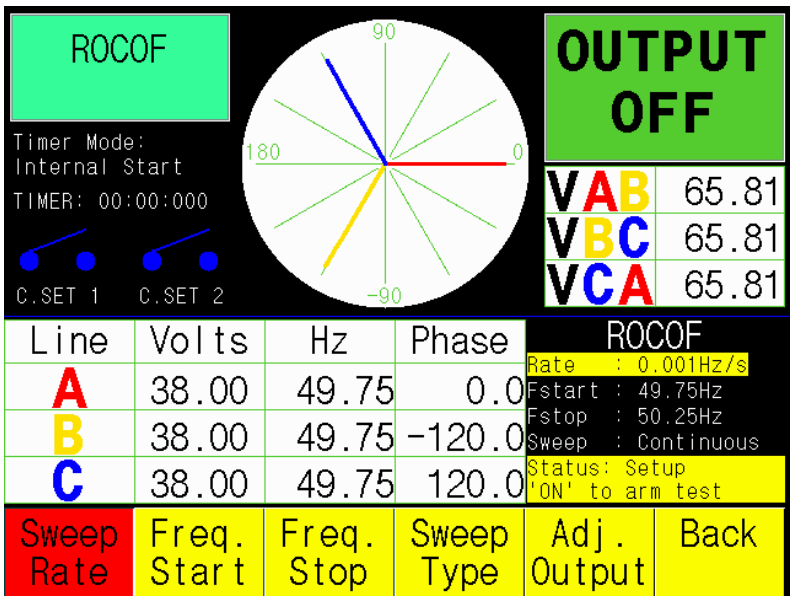

Figure 2.15 ROCOF screen

2.5.2 Continuous Sweep Operation

All parameters in ROCOF mode are controlled via the two main menus:

- To set the output parameters, the ADJ. OUTPUT key can be used to access the menu.
- To set ROCOF parameters, the ADJ. ROCOF key can be used to access the menu.

2.5.2.1 Setting Minimum Frequency, Maximum Frequency and Sweep Rate

The rate of change of the output frequency is controlled via the SWEEP RATE menu option in the ADJ. ROCOF menu. This can be adjusted using the ADJUST control or entered via the keypad.

The minimum and maximum frequency (Fstart & Fstop) are set with the FREQ. START and the FREQ. STOP menu options respectively. The values can be adjusted using the ADJUST control or entered via the keypad. The minimum frequency is 40Hz, and the maximum 70Hz.

Tests can start at the lowest or highest frequency, by setting Fstart and Fstop appropriately, enabling an initial upward or downward sweep. After a Continuous sweep has been stopped by a change of either contact set, the output is maintained at the final frequency until switched OFF.

2.5.2.2 Testing Relay Pick-up with Continuous Sweep

To start a continuous sweep test, press ON to first 'Arm' the output, this will switch the outputs ON at the selected values. Arming the output allows the device under test to be reset in to a nominal state before starting the frequency sweep. When the ENTER key is pressed the output will continuously sweep between the pre-set minimum and maximum values. The sweep rate may be adjusted while the output is ON and the test is PAUSED to find the relay pick-up value. A test is PAUSED by pressing the ENTER key during the test. Pausing a test will hold the frequency at the point the ENTER key was pressed whilst maintaining the output voltage and phase relationships. While the test is PAUSED the user can adjust the Sweep Rate using the ADJUST control. A test will resume when the ON key is pressed. When a test is resumed, it will start again with the updated Sweep Rate (Hz/s) and the timer will be reset to 00:00:000. This process should be repeated until the relay trips, then the Relay pick-up value (Hz/s) is known.

2.5.2.3 Timing Relay Operation with Continuous Sweep

Timing of df/dt relays can be carried out in continuous mode by entering a desired Sweep Rate (Hz/s) value to test. Press ON to first 'Arm' the output, once the relay has reset and ready for testing, press the ENTER key. The timer will start and the rate of change will be applied to the output. The timer will stop on a change of state of either contact set.

2.5.3 Single Sweep Operation

2.5.3.1 Pressing the SWEEP TYPE menu option cycles through the sweep types Single Up, Single Down and Continuous. Single Up and Single Down options allow single sweeps of frequency to be carried out from Fstart to Fstop at the desired rate. The values of Fstart and Fstop are exchanged when switching between Up and Down sweeps.

Single sweeps are started by selecting the Single Up and Single Down menu options. In each case, the timer is reset and started when the sweep begins. The timer is then stopped by a change of state of either contact set. After a single sweep has been stopped by a change of either contact set, or Fstop is reached, the output is maintained at the final frequency until switched OFF.

After a Single Up or Single Down type test has been completed, the Sweep Type can be inverted by pressing the SWEEP TYPE key, followed by the ENTER key, while the outputs are still ON. This allows the user to perform a semi-automated, continuous type sweep with pauses at the maximum and minimum frequencies selected.

Single sweep tests can also be paused like continuous sweep tests and have their sweep rate adjusted. A test is PAUSED by pressing the ENTER key during the test. Pausing a test will hold the frequency at the point the ENTER key was pressed whilst maintaining the output voltage and phase relationships. While the test is PAUSED the user can adjust the Sweep Rate using the ADJUST control. A test will resume when the ON key is pressed. When a test is resumed, it will start again with the updated Sweep Rate (Hz/s) and the timer will be reset to 00:00:000.

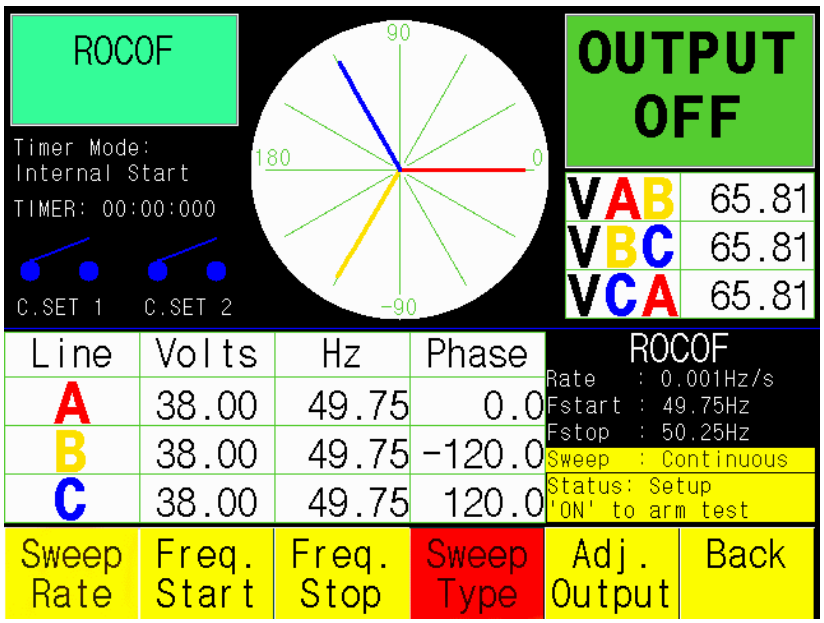

Figure 2.16 Sweep Type selection

2.6 Unit Settings

The unit settings section allows the default output settings of the unit to be defined. It is accessed by pressing the MENU key on the welcome screen and then pressing the SETTINGS key. Any new value entered on this page will only be stored indefinitely when the SAVE key is pressed. Return to the previous screen by pressing the BACK key.

2.6.1 Settings

The individual settings available are selected by cycling up and down the list with the NEXT. and PREV. keys, or by rotating the ADJUST Control. When all the settings are as required press the SAVE key before exiting the screen with the BACK key.

2.6.1.1 Contactor Mode

Repeated pressing of the ADJUST key cycles through the available Contactor Modes:

- Internal Start: In this mode, the timer will begin when the ENTER key is pressed and the OUTPUT is ON. The timer will stop on any contact set change, when the ENTER key is pressed or when the OUTPUT is turned OFF .

- Single Contact: In this mode, the timer will begin on the change of a contact set. The timer will stop on another change of the same contact set. For example, the timer begins when CONACT SET 1 opens and the timer stops when CONTACT SET 1 closes.
- Dual Contacts: In this mode, the timer will begin on the change of a contact set and will stop on the change of different contact set. For example, the timer will begin on a change in CONTACT SET 1 and will stop on a change in CONTACT SET 2.
- OFF: In this mode, the timer is disabled.

2.6.1.2 Phase Colours

Repeated pressing of the ADJUST key changes the selected Phase Colours sets:

- Red, Yellow, Blue.
- Brown, Black, Grey.

2.6.1.3 Time

Pressing of the ADJUST key highlights hours; the NEXT. key will then move the highlight to minutes. Whilst highlighted the numbers can be set to 00-23:00-59 with the ADJUST Control knob.

2.6.1.4 Date

The format for the date is dd/mm/yy. Pressing of the ADJUST key highlights day; the NEXT. key will then move the highlight to month and year. Whilst highlighted, the numbers can be set using the ADJUST control knob.

2.6.1.5 USB Auto-Save

Repeated pressing of the ADJUST key toggles between ON and OFF. If USB Auto-Save is selected as ON, test results will be automatically saved to a USB if it is present in the USB FLASH DRIVE socket.

2.6.1.6 Output Config

Repeated pressing of the ADJUST key cycles through the available Output Configs:

- Individual Outputs.
- Parallel A, B.
- Parallel A, C.
- Parallel B, C.
- Parallel A, B, C.

Paralleled phases cannot have their individual voltage, frequency or phase angle changed.

2.6.1.7 Nominal Voltage

After pressing the ADJUST key a new default voltage can be typed in. The default voltage can be set between 0.01V and 450V.

2.6.1.8 Nominal Frequency

After pressing the ADJUST key a new default frequency can be typed in. The default frequency can be set between 30Hz and 999.99Hz. If the default frequency is set between 30Hz and 40Hz, the maximum voltage will be limited to 300V. This is to prevent oversaturation of the transformers.

2.6.1.9 Brightness

After pressing the ADJUST key the Brightness line is highlighted. The display brightness level can be changed with the ADJUST knob. The brightness level can be adjusted from 1 to 10.

2.6.2 Calibration

This menu is password protected and is for use by the manufacturer and authorised service representatives.

2.6.3 Prog. Update

This menu is password protected and is to be used when new software is released by the manufacturer. Additional instructions will be provided with software updates.

2.7 AUTO

The AUTO function is reserved for future development and is for use with T&R Test Equipment's current source, the ART3C.

2.8 Using the USB

WARNING: The USB sockets are NOT to be used as a power source.

2.8.1 Setting Up the USB

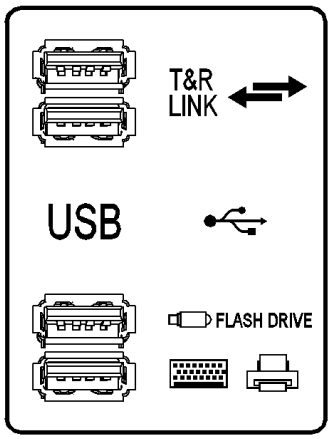

Figure 2.17 USB Socket layout

The ART3V is equipped with four USB Sockets. The USB sockets labelled as "T&R LINK" are reserved for future development of the T&R Test Equipment's T&R Link; a link allowing two designated T&R Test Equipment products to communicate with each other.
The USB socket labelled "FLASH DRIVE" is for a standard USB flash memory device.
The bottom USB socket is for a USB keyboard. The keyboard must be plugged in before the unit is switched ON.

2.8.2 Saving Data and Comments

To enable comments and data to be saved to the USB, "USB Auto-Save" must be set to "ON". This setting can be found in MENU and then SETTINGS. The results for tests will be stored on the USB flash drive as a CSV (Comma Separated Value) File that can be opened by any spreadsheet program. Comments can be entered using a USB keyboard, or via the ART3V keypad.

To save data to a USB flash memory stick, insert the USB key into the corresponding 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.

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

The following data is stored to the file for each reading:

- Unit Mode: Output Adjust, Phase Lock, Fault Config. or ROCOF
- Date
- Time
- Output Voltage for Phases A,B and C
- Output Frequency for Phases A,B and C
- Output Phase Angle for Phases A,B and C
- Timer Value
- Event: The Event could be the output being turned ON or OFF, a change of state of a contact set or the outputs being turned off because of an internal trip.

Event	Description
STEP	ENTER has been pressed
C-SET(1/2)-(O/C)	Contact set 1 or 2 has been Open or Closed
TURN-ON	Output has been turned on
TURN-OFF	Output has been turned off
TRIP_OVERCURRENT_(A/B/C)	Over current trip on phase A/B/C
TRIP_OVERTEMP(A/B/C)	Over temperature trip
TRIP_EXT_VOLTAGE_(A/B/C)	External voltage across terminals
TRIP_OPEN_CIRCUIT	Temperature sensors are not connected
ROCOF_PAUSE	ROCOF has entered paused mode
ROCOF_PLAY	ROCOF has resumed

- For ROCOF mode the Sweep Rate and Type is also stored for each event.

	A	B	C	D	E	F	G	H	I	J	K	L	M
1	MODE :	Out. Adj.											
2	Time	VA	VB	VC	FA	FB	FC	PA	PB	PC	Timer	Event	Comment
3	10:35:56	0. 0	0. 0	0. 0	50. 0	50. 0	50. 0	0	240	120	0	TURN-ON	...
4	10:36:04	240. 0	240. 0	240. 0	50. 0	50. 0	50. 0	0	240	120	4.625	STEP	...
5	10:36:15	240. 0	240. 0	240. 0	50. 0	50. 0	50. 0	0	240	120	10.885	CSET1-O	...
6	10:36:27	240. 0	240. 0	240. 0	50. 0	50. 0	50. 0	0	240	120	10.885	TURN-OFF	TEST 1

Figure 2.18 Results file opened in spreadsheet for Output Adjust mode.

For Fault Config mode a table is saved to show the above information for each stage as well as the stage timer information. Another table is written for each event that happens during the test, where it writes whether a contact set has changed, the Fault Config stage timer and the Contact Set timer values.

	A	B	C	D	E	F	G	H	I	J	K	L
1	MODE :	Fault Con	TIME :	10:37:24								
2	START :	On stage:	1									
3	STOP :	Output Off										
4	Stage	VA	VB	VC	FA	FB	FC	PA	PB	PC	Change O	Timer
5	1	240. 0	240. 0	240. 0	50. 0	50. 0	50. 0	0	240	120	Timer	3:000
6	2	280. 0	280. 0	280. 0	50. 0	50. 0	50. 0	0	240	120	C.Set 1	N/A
7	3	240. 0	240. 0	240. 0	50. 0	50. 0	50. 0	0	240	120	Timer	3:000
8												
9	Stage #:	1	C.Set #:	1	FC TIMER:	0	C.SET TIMI	0				
10	Stage #:	2	C.Set #:	1	FC TIMER:	4.944	C.SET TIMI	7.944				
11	Stage #:	3	C.Set #:	0	FC TIMER:	4.944	C.SET TIMI	11.055				
12	Comment	TEST 2										

Figure 2.19 Results file opened in spreadsheet for Fault Config mode.

The data will begin writing to the USB flash drive once the output is turned ON. Any change to the outputs will also be written to the USB. An option to write a comment will only be available once the output is turned OFF.

NOTE: No comments can be entered if the outputs are turned OFF due to an internal Overcurrent or Over Temperature Trip. The data from the test will still be saved to the USB memory stick.

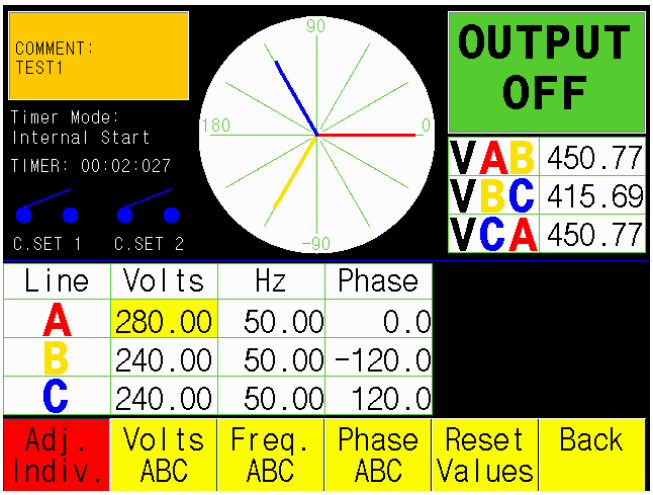

Figure 2.20 Comment Box

Comments are limited to 8 characters long. The COMMENT box appears in the top left corner of the screen. To enter a comment, use the keypad or a USB keyboard. Press ENTER to save the comment.

2.8.3 Viewing Saved Data and Comments

All files from the ART3V are stored on the memory key in the folder TRTEST, in a subfolder named by date (e.g. 23-02-18). The data file is created with a name composed of the sequence of the tests (e.g. 00.csv, 01.csv, 02.csv etc.). A new file is created when the first result is written to the memory key after the unit is switched on (switching the unit off and on or removing and re-inserting the memory key will force the unit to create a new results file). Data and comments cannot be viewed on the ART3V.

	A	B	C	D	E	F	G	H	I	J	K	L	M
1	MODE :	Phase Lock	Mains Lock										
2	Time	VA	VB	VC	FA	FB	FC	PA	PB	PC	Timer	Event	Comment
3	10:38:19	240. 0	240. 0	240. 0	49.96	49.96	49.96	0	240	120	0	TURN-ON	...
4	10:38:34	240. 0	240. 0	240. 0	49.94	49.94	49.94	0	240	120	9.434	CSET1-C	...
5	10:39:00	240. 0	240. 0	240. 0	49.93	49.93	49.93	0	240	120	9.434	TURN-OFF	TEST 3

Figure 2.21 Results file opened in spreadsheet for Phase Lock mode.

3 TESTING RELAYS WITH THE ART3V

All of the following examples are guides on how to test different relay types with the ART3V. It is essential to check the procedures against those recommended by the relay manufacturer in the relay commissioning/service manual.

The following abbreviations are used is this section to refer to test voltages, currents and frequencies:

V_N Nominal voltage (the rated voltage at the relay coil when the system is operating under normal conditions).

V> Voltage relay over-voltage trip level

V< Voltage relay under-voltage trip level

V_H AVR relay tap change up voltage

V_L AVR relay tap change down voltage

F_N Nominal frequency (the rated voltage at the relay coil when the system is operating under normal conditions).

F> Frequency relay over-frequency trip level

F< Voltage relay under-frequency trip level

f_{min} df/dt minimum frequency

f_{max} df/dt maximum frequency

I_N Current coil rated current (the current at a relay CT input when the system is operating at rated current).

3.1 Automatic Voltage Regulating Relays

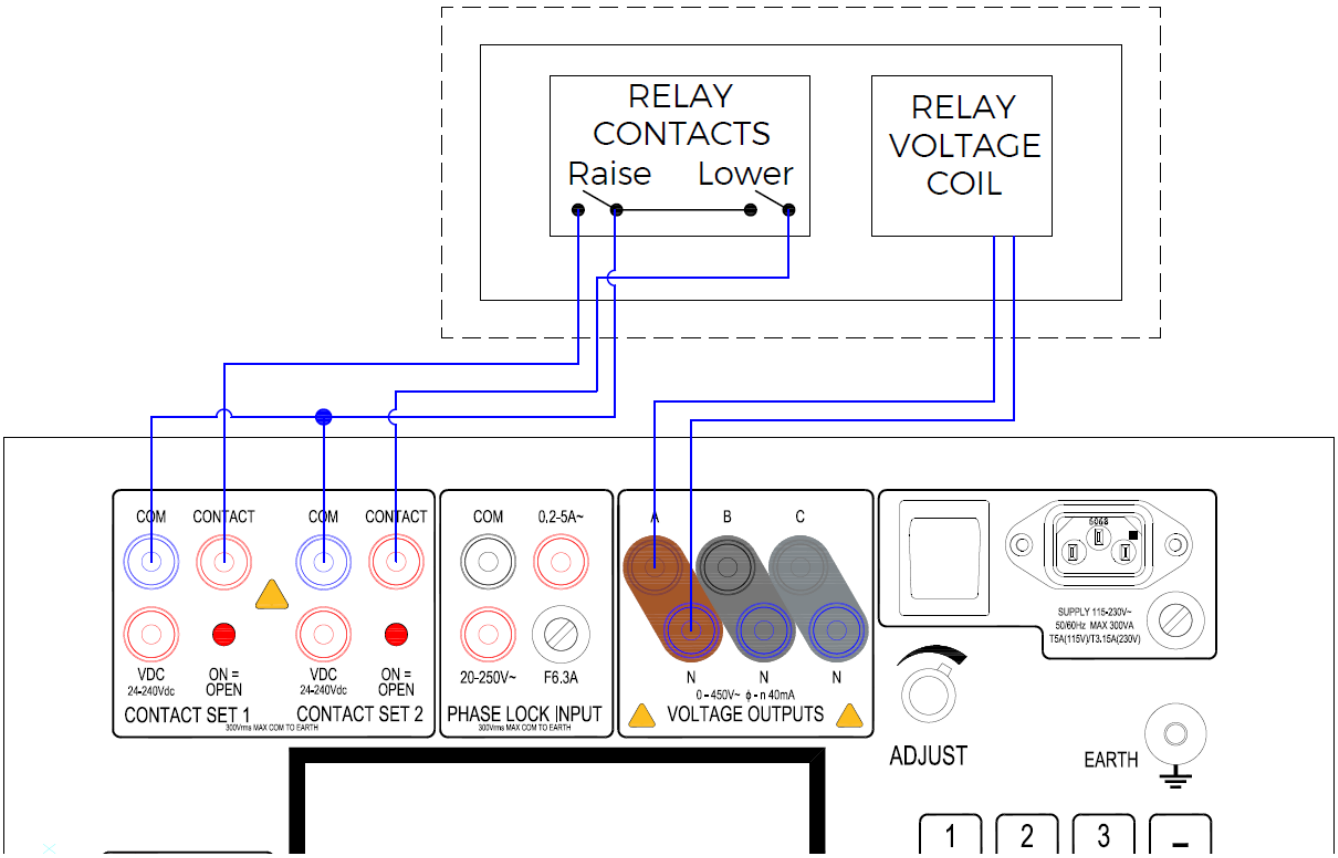

Figure 3.1 Connections for AVR relay

3.1.1 Connections

Ensure that the relay under test is isolated from the supply at all points (including contacts) and power to the ART3V is switched off before making any connections.

- Connect the output of the ART3V to the relay coil. Any phase output may be used, or higher voltage relays may be connected between two output phases.
- Connect the two output contacts from the relay to the contact inputs of the ART3V. Contact set 1 will then change state when a 'raise' command is issued form the relay and contact set 2 will change state when a 'lower' command is issued. Contacts with a DC voltage present may be connected between COM and VDC.
- Connect an auxiliary supply to the relay if required (not shown in figure 3.1)

3.1.2 Determining Operating Points

- Switch on the power to the ART3V and the relay auxiliary supply (if used).
- Set the ART3V to variable frequency or phase lock mode.
- Set the output of the ART3V to V_N (this should be the centre of the relay deadband voltage), and switch on the output.
- Increase the ART3V output voltage until the 'lower' contact changes state. This is V_L, the voltage at which the relay would request a lower tap voltage.

- Decrease the ART3V output voltage until the 'higher' contact changes state. This is V_H, the voltage at which the relay would request a higher tap voltage.

3.1.3 Timing Tests

If it is necessary to measure the relay time delay, this may be easily achieved.

- Set the output voltage to centre of the dead band (V_N)
- Type in a voltage above V_H using the keypad. When the ENTER key is pressed, the voltage is stepped to the new value and the timer is reset and started. When the contacts change state to request a higher tap, the timer stops.
- The tap change down output is tested in the same way, but with a voltage below V_L entered via the keypad.

3.2 AVR Relays with Line Drop Compensation

To test an AVR with line drop compensation it is necessary to add a current source to the test circuit to provide a current reference for the relay. A suitable current source for this purpose is the T&R Test Equipment 100ADM Mk4, or 200ADM-P.

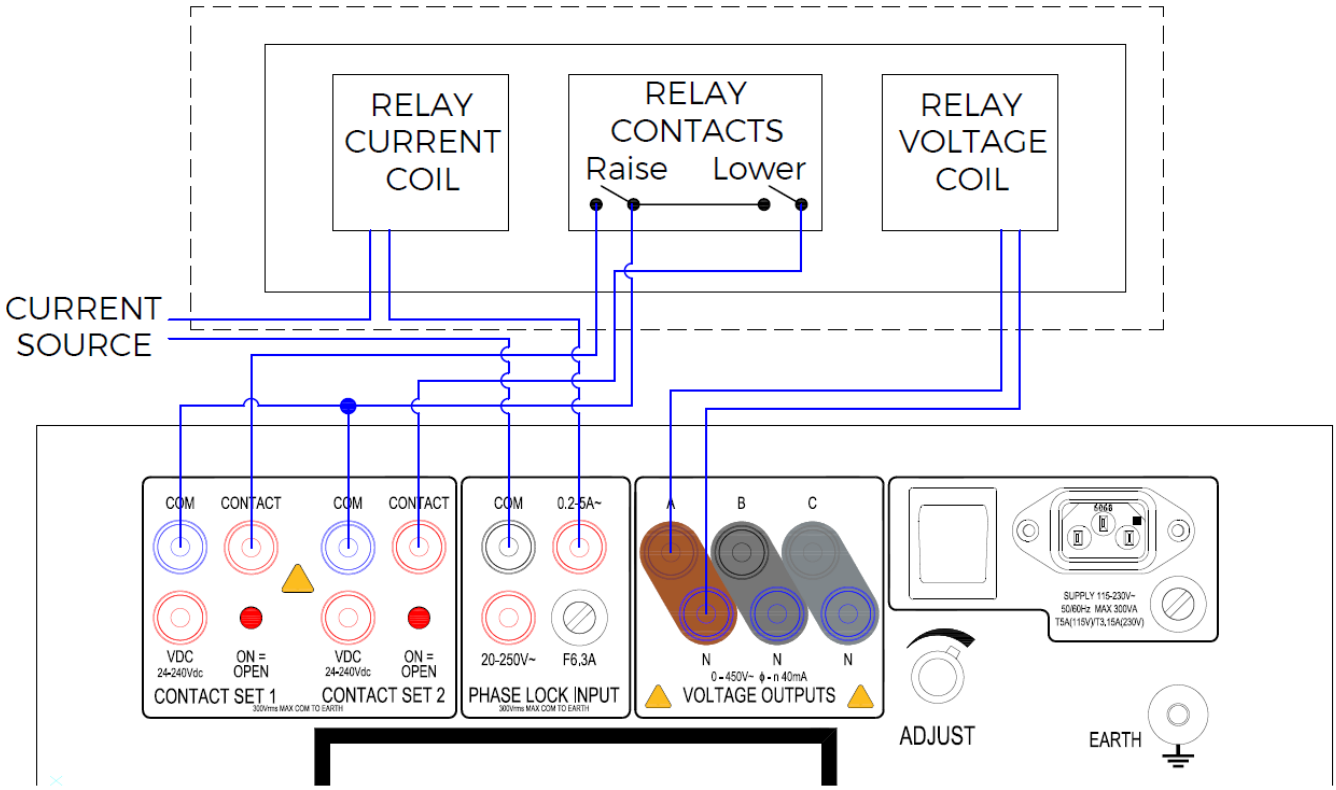

Figure 3.2 Connections for AVR relay with LDC

3.2.1 Connections

Ensure that the relay under test is isolated from the supply at all points and power to the ART3V and the current source is switched off before making any connections.

- Connect the output of the ART3V to the relay coil. Any phase output may be used, or higher voltage relays may be connected between two output phases.
- Connect the two output contacts from the relay to the contact inputs of the ART3V. Contact set 1 will then change state when a 'raise' command is issued form the relay and contact set 2 will change state when a 'lower' command is issued.
- Connect the output of the current source to the current coil of the relay via the phase lock current input of the ART3V, observing polarity.
- Connect an auxiliary supply to the relay if required (not shown in figure 3.2). The auxiliary dc supply output from the 200ADM-P may be used for this purpose.

3.2.2 Determining Operating Points

- Switch on the power to the ART3V, current source and the relay auxiliary supply.
- Set the ART3V to phase lock mode, and select 'external lock' using the Lock Source menu option.
- Set the output of the ART3V to V_N (this should be the centre of the relay deadband voltage), and switch on the output.
- Set the current source output control to zero, and switch on the current source output. Increase the current to the desired level for the test (usually I_N), and check that the ART3V has locked on to the current (the display will change from 'mains lock' to 'external lock'.
- Set the phase angle between the current and the voltage to the desired value (this is usually 90° to check resistive compensation and 180° to check reactive compensation). Refer to the relay service manual for more information.
- Increase the ART3V output voltage until the 'lower' contact changes state. This is the voltage at which the relay would request a lower tap voltage (V_L). This voltage will change with changes in phase angle.
- Decrease the ART3V output voltage until the 'higher' contact changes state. This is the voltage at which the relay would request a higher tap voltage (V_H). This voltage will change with changes in phase angle.

3.2.3 Timing Tests

For details of timing tests, please refer to section 3.1.3

3.3 Under and Over Voltage Relays

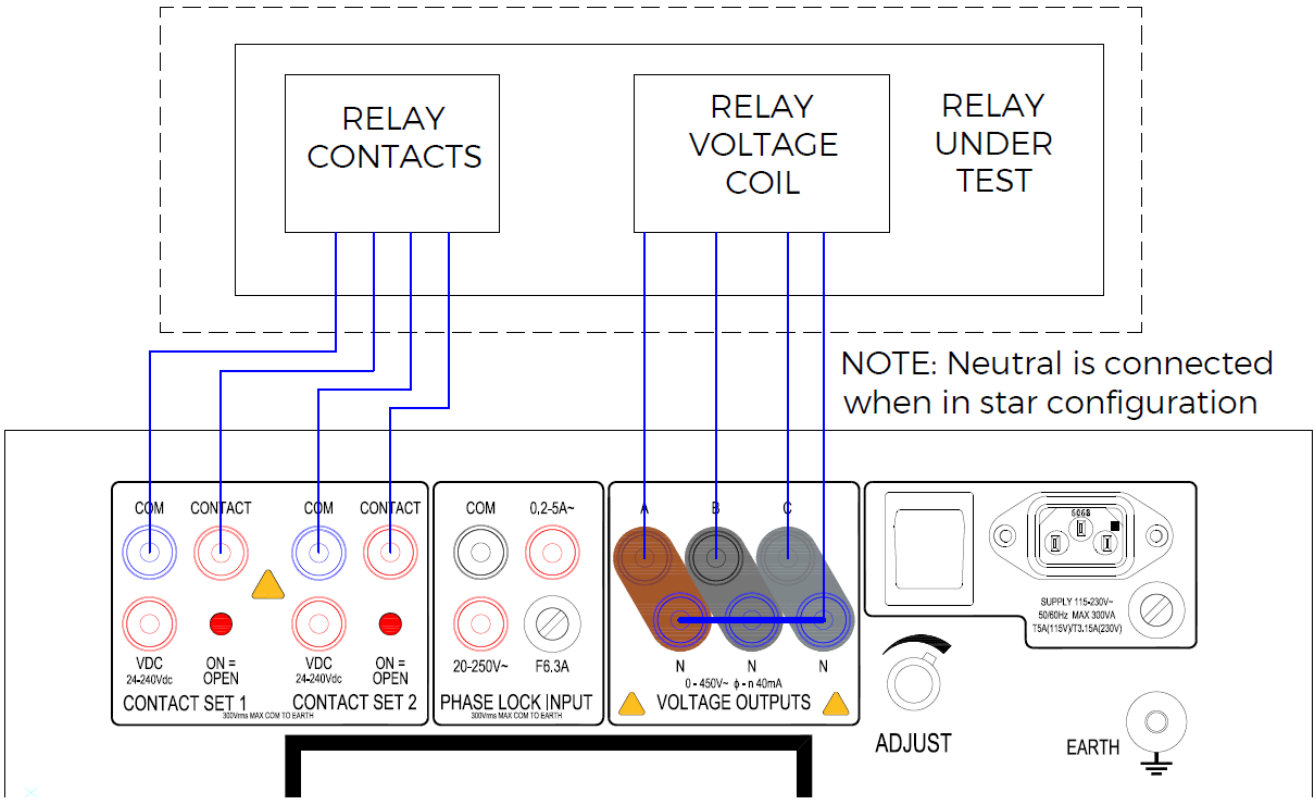

Figure 3.3 Connections for under and over voltage relays

3.3.1 Connections

Ensure that the relay under test is isolated from the supply at all points and power to the ART3V is switched off before making any connections.

- Connect the output of the ART3V to the relay coil.
- Connect the output contacts from the relay to the contact input 1 of the ART3V.
- Connect an auxiliary supply to the relay if required (not shown in figure 3.3).

3.3.2 Determining Operating Points

- Switch on the power to the ART3V and the relay auxiliary supply.
- Set the ART3V to variable frequency or phase lock mode.
- Set the output of the ART3V to the relay nominal voltage.
- Switch on the ART3V output, and increase the output voltage using the adjust control until the relay trips (shown by a change on contact set 1). This is the over-voltage trip level, V>.
- Return the ART3V output to the nominal voltage, and the decrease the output using the adjust control until the relay trips - this is the under-voltage trip level, V<.

3.3.3 Timing Tests

3.3.3.1 Over-voltage operating delay

- Set the output voltage to the V_N.
- Type in a voltage above V> using the keypad. When the ENTER key is pressed, the voltage is stepped to the new value and the timer is reset and started. When the contacts change state, the timer stops.

3.3.3.2 Over-voltage reset time

- Ensure that the voltage is above V>, and the relay is tripped.
- Enter the relay nominal voltage using the keypad. When the ENTER key is pressed, the timer is reset and started, and the voltage steps back to the nominal voltage. When the contacts change state, the timer is stopped, showing the reset time.

3.3.3.3 Under-voltage operating delay

- Set the output voltage to V_N.
- Type in a voltage below V< using the keypad. When the ENTER key is pressed, the voltage is stepped to the new value and the timer is reset and started. When the contacts change state, the timer stops, showing the under-voltage trip delay.

3.3.3.4 Under-voltage reset time

- Ensure that the voltage is below the under-voltage trip level, V<, and relay is tripped.
- Enter V_N using the keypad. When the ENTER key is pressed, the timer is reset and started, and the voltage steps back to the V_N. When the contacts change state, the timer is stopped, showing the reset time.

3.4 Under and Over Frequency Relays

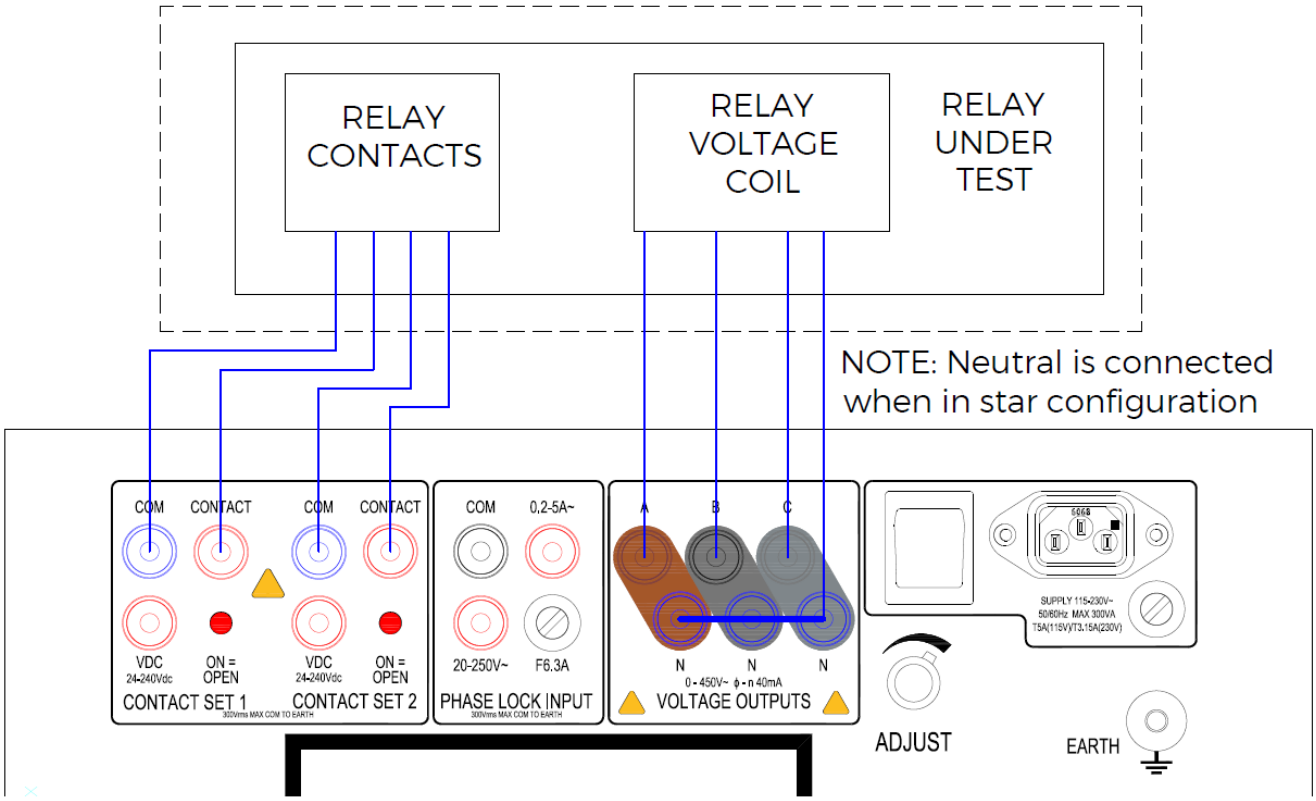

Figure 3.4 Connections for under and over frequency relays

3.4.1 Connections

Ensure that the relay under test is isolated from the supply at all points and power to the ART3V is switched off before making any connections.

- Connect the output of the ART3V to the relay coil.
- Connect the output contacts from the relay to the contact input 1 of the ART3V.
- Connect an auxiliary supply to the relay if required (not shown in figure 3.4).

3.4.2 Determining Operating Points

- Switch on the power to the ART3V and the relay auxiliary supply.
- Set the ART3V to variable frequency mode.
- Set the output voltage of the ART3V to V_N, and set the output frequency to the nominal system frequency, F_N.
- Switch on the ART3V output, and increase the output frequency using the adjust control until the relay trips (shown by a change on contact set 1). This is the over-frequency trip level, F>.
- Return the ART3V output to the nominal frequency, and the decrease the frequency using the adjust control until the relay trips - this is the under-frequency trip level, F<.

3.4.3 Timing Tests

3.4.3.1 Over-frequency operating delay

- Set the output voltage to V_N and the frequency to F_N.
- Type in a frequency above F> using the keypad. When the ENTER key is pressed, the frequency is stepped to the new value and the timer is reset and started. When the contacts change state, the timer stops, showing the over-frequency trip delay.

3.4.3.2 Over-frequency reset time

- Ensure that the frequency is above F>, and the relay is tripped.
- Enter F_N using the keypad. When the ENTER key is pressed, the timer is reset and started, and the frequency steps back to F_N. When the contacts change state, the timer is stopped, showing the reset time.

3.4.3.3 Under-frequency operating delay

- Set the output voltage to V_N and the frequency to F_N.
- Type in a frequency below F< using the keypad. When the ENTER key is pressed, the voltage is stepped to the new value and the timer is reset and started. When the contacts change state, the timer stops, showing the under-frequency trip delay.

3.4.3.4 Under-frequency reset time

- Ensure that the frequency is below the under-voltage trip level, and the relay is tripped.
- Enter F_N using the keypad. When the ENTER key is pressed, the timer is reset and started, and the frequency steps back to F_N. When the contacts change state, the timer is stopped, showing the reset time.

3.5 Directional Overcurrent Relays

To test a directional relay it is necessary to add a current source to the test circuit to provide a current reference for the relay. A suitable current source for this purpose is the T&R Test equipment 100ADM Mk4 or 200ADM-P.

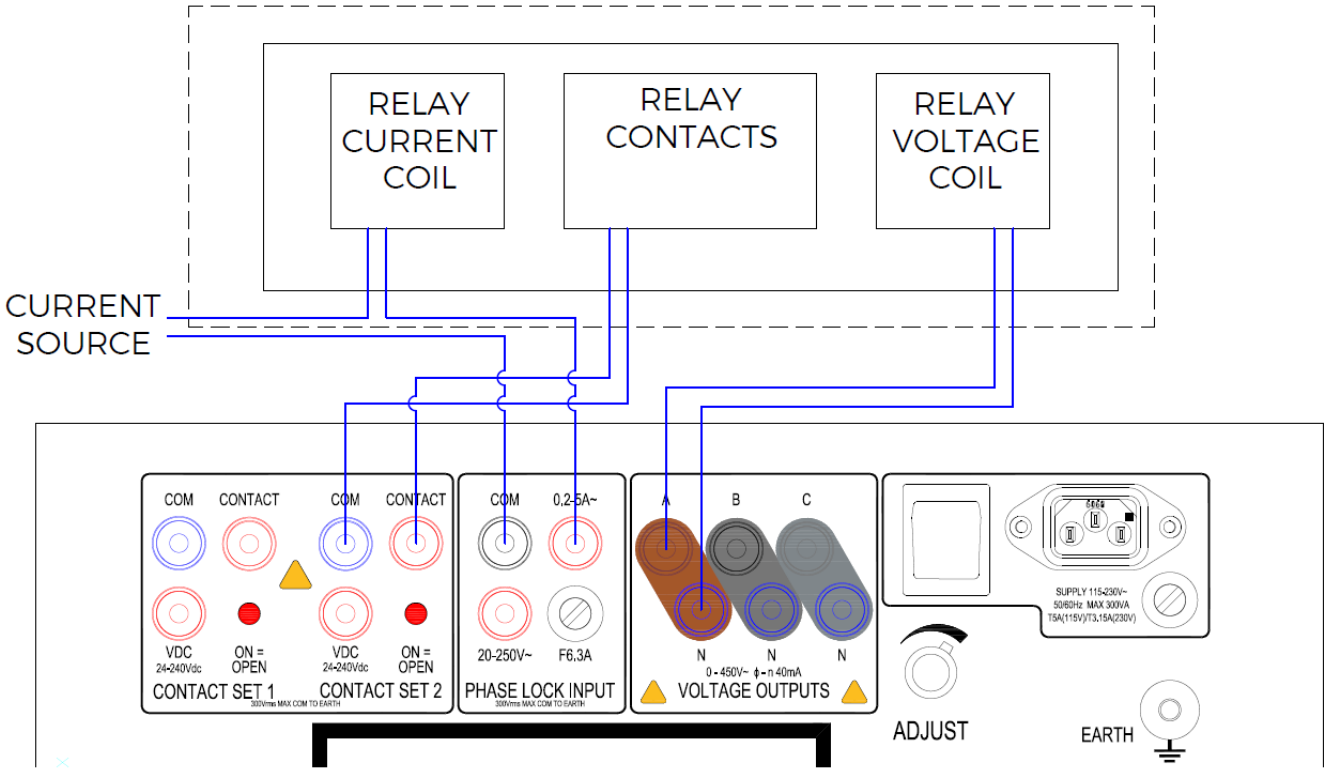

Figure 3.5 Connections for directional relays

3.5.1 Connections

Ensure that the relay under test is isolated from the supply at all points. Ensure that power to the ART3V and current source is switched off before making any connections.

- Connect the output of the ART3V to the relay voltage coil.
- Connect the output contact from the relay to contact set 1 of the ART3V.
- Connect the output of the current source to the current coil of the relay via the phase lock current input of the ART3V, observing polarity.
- Connect an auxiliary supply to the relay if required (not shown in figure 3.5). The auxiliary dc supply output from the 200ADM-P may be used for this purpose.

3.5.2 Determining Operating Points

- Switch on the power to the ART3V, current source and the relay auxiliary supply.
- Set the ART3V to phase lock mode, and select 'external lock' using the Lock Source menu option.
- Set the output of the ART3V to V_N.
- Set the current source output control to zero, and switch on the current source output. Increase the current to the desired level for the test (usually I_N), and check that the ART3V has locked on to the current (the display will change from 'mains lock' to 'external lock').

3.5.2.1 *Restraint angles*

- Set the phase angle between the current and the voltage to 0°, and check that the output contact is in the correct state.
- Rotate the voltage phase angle (select the Phase ABC menu option, and use the adjust control).
- The contact will change state as the relay enters and leaves restraint.

3.6 df/dt (ROCOF) relays

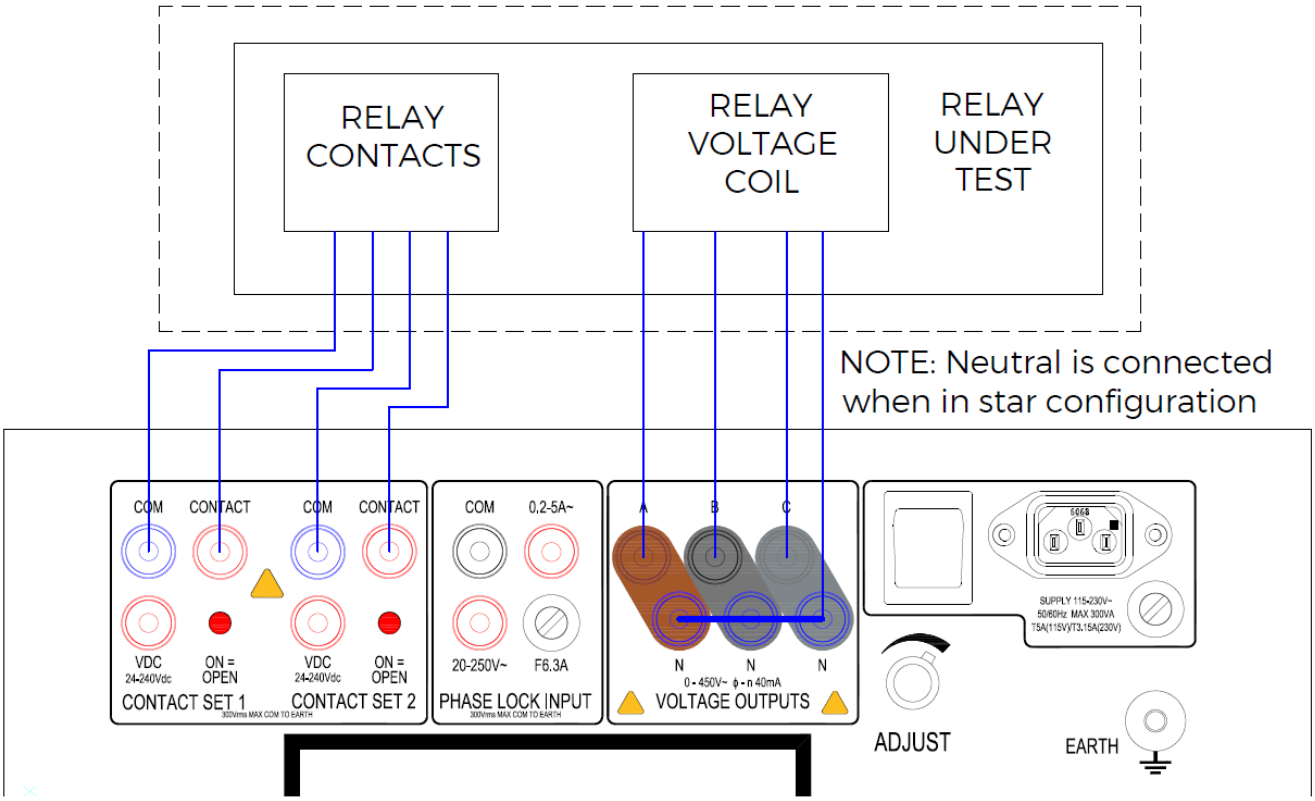

Figure 3.6 Connections for df/dt relays

3.6.1 Connections

Ensure that the relay under test is isolated from the supply at all points and power to the ART3V is switched off before making any connections.

- Connect the output of the ART3V to the relay coil.
- Connect the output contacts from the relay to the Contact input 1 of the ART3V.
- Connect an auxiliary supply to the relay if required (not shown in figure 3.6).

3.6.2 Determining Operating Points

3.6.2.1 *Continuous Sweep Method*

This method of finding the operating point of the relay can be prone to error because of tripping delays and differences in sensitivity to rising and falling frequencies in some relays.

- Switch on the power to the ART3V and the relay auxiliary supply.
- Set the ART3V to ROCOF mode.
- Set the output voltage of the ART3V to V_N, and set the minimum and maximum output frequency to the desired test values (often $F_N \pm 0.25$Hz).
- Set the rate of change to a value that will not trip the relay.
- Switch on the ART3V output, and gradually increase the rate of change using the adjust control until the relay trips (shown by a change on Contact set 1). This is done by pausing the test with the ENTER key and then adjusting the Sweep Rate with the ADJUST knob.

3.6.2.2 Single Sweep Method

This method is slower, but accurate, and allows the difference in operating point for rising and falling frequency to be ascertained.

- Switch on the power to the ART3V and the relay auxiliary supply.
- Set the ART3V to ROCOF mode.
- Set the output voltage of the ART3V to V_N, and set the minimum and maximum output frequency to the desired test values (often $F_N \pm 0.25$Hz).
- Select the SWEEP TYPE menu option.
- Set the rate of change to a value that will not trip the relay.
- Select the Single Up sweep type option and wait for the frequency reach the maximum value. Press the Single Down sweep type option and wait for the frequency to reach the minimum.
- If the relay has not tripped, increase the rate of change, and repeat the process until the relay does trip.

3.6.3 Timing Tests

3.6.3.1 df/dt Delay using single sweep

This is the most accurate way of timing the df/dt delay.

- Select the SWEEP TYPE menu option.
- Set the rate of change to a value that will trip the relay, and press the Single Up sweep type option with the output switched off to set the output frequency to the minimum frequency.
- Switch on the output of the ART3V.
- Press the Single Up sweep type option sweep button. The sweep will start, and the timer will reset and start. When the relay trips the timer is stopped.

The same process may be used with a falling frequency sweep.

3.6.3.2 df/dt Delay Using Continuous Sweep

- Select the Continuous sweet type option.
- Set the rate of change to a value that will not trip the relay.
- Switch ON the output of the ART3V.

- Enter a rate of change that will trip the relay. When the ENTER key is pressed, the new rate of change will be applied to the relay and the timer will be started. The timer will stop when the relay trips.

3.7 Vector Surge (Step change of phase) relays

The ART3V can be used to test a vector surge relay by applying a series of increasing phase steps to the relay. The unit can also be used to time the response of the relay to a tripping condition.

A phase step is generated from the ART3V by shifting the phase by a set amount using the keypad whilst in variable frequency mode. It is important to understand that phase angles are entered and shown on the ART3V relative to a notional 0° phase reference. Therefore if the display is showing 5° for phase A, and a new phase of 7° is entered, a phase step of 2° is generated. The easiest way to carry out the tests is to enter a value for a phase shift, and set the phase back to zero before the next shift.

For example, start off with the ART3V in Output Adjust or Phase Lock mode, and select the PHASE ABC menu option. The display will currently be showing a phase of 0° for phase A. Type in 6 and press ENTER, and the ART3V will generate a 6° phase step. Typing in 0 and pressing ENTER will set the phase shift back to 0°, generating a -6° phase step in doing so.

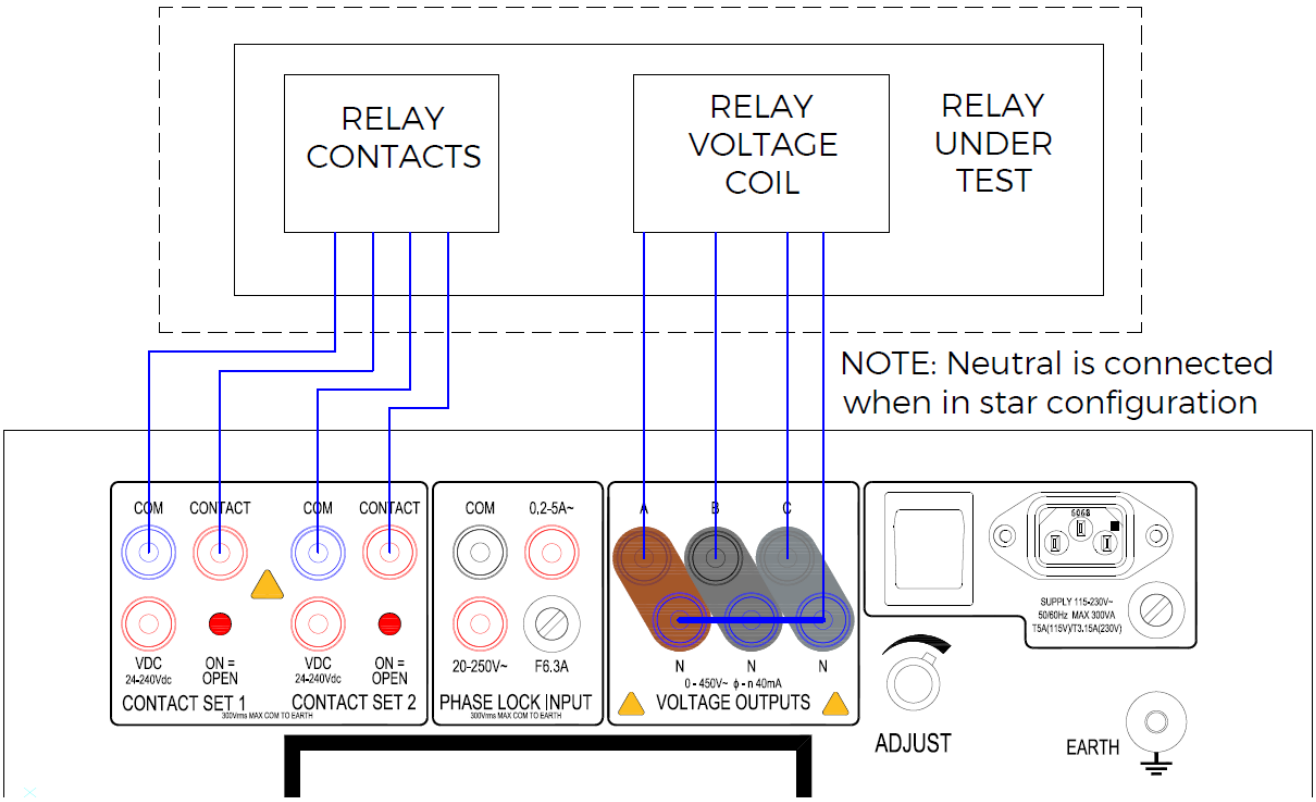

Figure 3.7 Connections for vector surge relays

3.7.1 Connections

Ensure that the relay under test is isolated from the supply at all points and power to the ART3V is switched off before making any connections.

- Connect the output of the ART3V to the relay coil.
- Connect the output contacts from the relay to the Contact input 1 of the ART3V.
- Connect an auxiliary supply to the relay if required (not shown in figure 3.7).

3.7.2 Determining the Operating Point

- Switch on the power to the ART3V and the relay auxiliary supply.
- Set the ART3V to variable frequency mode.
- Set the output of the ART3V to V_N.
- Switch on the output of the ART3V, and select the PHASE ABC menu option.
- Enter a phase step that should not trip the relay, for example 5°. Check to see if the relay has tripped, and then set the phase angle back to zero. If the relay has tripped, reset the relay and try again with a smaller phase step. If the relay has not tripped, apply gradually increasing steps to the relay until it does trip.

3.7.3 Timing Tests

- When the operating point of the relay has been ascertained using the procedure above, the relay response can then be timed.
- Start with the phase angle set to zero. Type in a new phase value which is at least 2° greater than the trip value measured above. The timer will start when the phase step is applied to the relay, and will stop when Contact Set 1 on the ART3V changes state.

3.8 Check Synchronising Relay

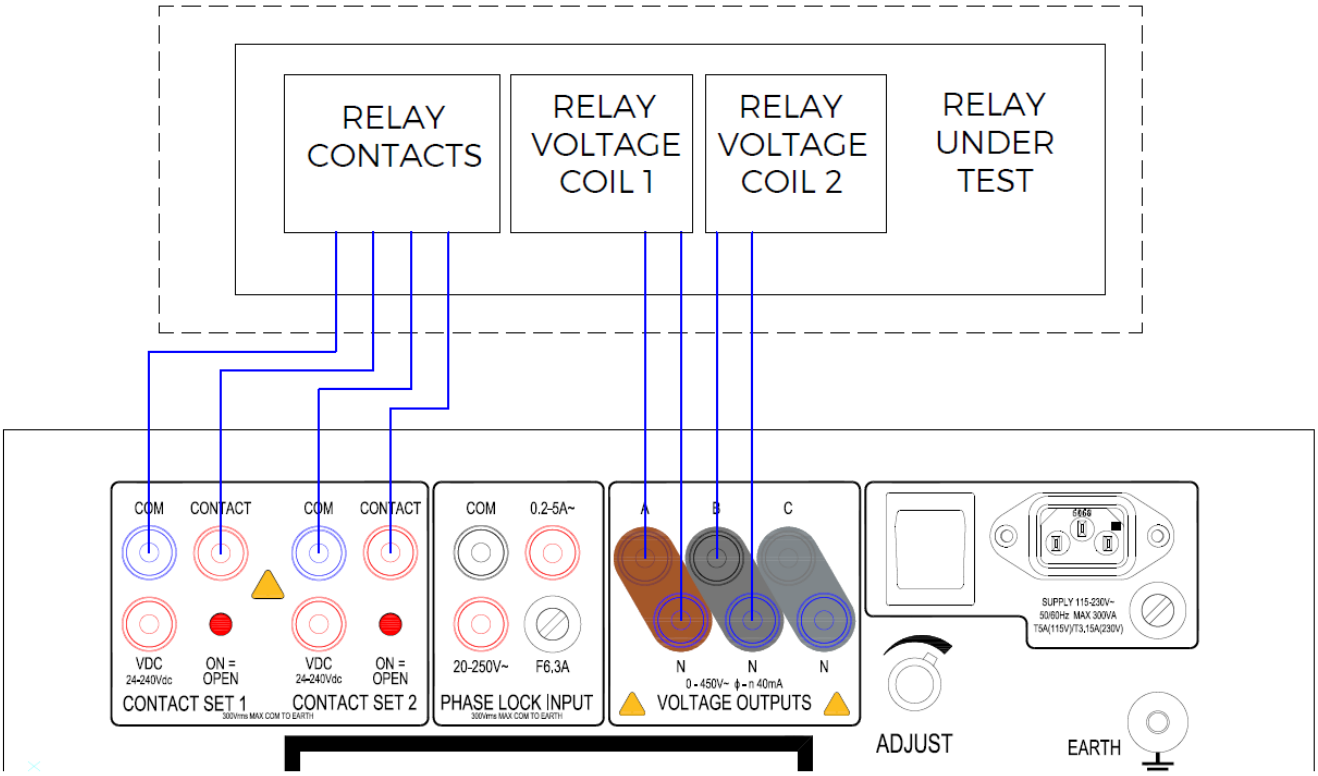

Figure 3.8 Connections for checking synchronising relays

3.8.1 Connections

Ensure that the relay under test is isolated from the supply at all points and power to the ART3V is switched off before making any connections.

- Connect the output of the ART3V to the relay coils.
- Connect the output contacts from the relay to the contact input 1 of the ART3V.
- Connect an auxiliary supply to the relay if required (not shown in figure 3.8).

3.8.2 Determining Operating Points

- Switch on the power to the ART3V and the relay auxiliary supply.
- Set the ART3V to variable frequency mode.
- Set the output voltage of the ART3V to V_N, and set the output frequency to the nominal system frequency, F_N.
- Select the ADJ. INDIV. key option, and use the ADJ. INDIV. key to set phase B to 0°. Phase A and phase B should now be in phase.
- Switch on the ART3V output. The relay contacts should close.
- The relay operating phase angle may now be found by altering the phase angle of phase B until the relay trips.

3.8.3 Timing Tests

- Set the output voltage to V_N, the frequency to F_N, and the phase angle of A & B to 0°.
- Enter a value of phase angle for phase B that will trip the relay using the keypad. When the ENTER key is pressed, the phase angle is stepped to the new value and the timer is reset and started. When the contacts change state, the timer stops, showing the trip delay.

4 MAINTENANCE

The ART3V requires no maintenance as the unit is completely solid state. It is suggested that the unit is returned to T&R Test Equipment Limited for calibration and safety checks as part of your scheduled calibration timetable. Do not allow liquids to enter the mesh air vents surrounding the front face of the unit.

5 STANDARD ACCESSORIES

5.1 Types of fuses supplied

a.	2 off	**T3.15A**	20mm
b.	2 off	**T5A**	20mm
c.	2 off	**F6.3A**	20mm

5.2 Standard Accessories Supplied with Unit

a. Accessory Bag.
b. Shoulder Strap.
c. Mains Lead.
d. 1 x 5m 4 core output lead terminated in 4mm plugs.
e. 1 x 5m 2 core timer lead terminated in 4mm plugs.
f. Neutral Link.
g. USB Flash Memory Key.
h. Spare Fuses.
i. Operating & Maintenance Manual.
j. Detachable Hinges.
k. 6 Croc Clips (4 Red, 2 Black).

6 OVERALL PERFORMANCE SPECIFICATION

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.

Applied Voltage Test

Mains input to frame and all isolated outputs 2kVDC for 1 minute.

All combinations of isolated output to isolated output 1kVDC for 1 minute.

Isolated output to frame 1kVDC for 1 minute.

Accuracy of Instruments: See **Section 1.2**.

7. REVISION

Product/Type: ART3V / Digital Voltage Source

File: ART3V manual v1.0

Author: NB

Issue/Date: v1.0 / 26.07.18

Modified By:

Checked By: NRE	Date: 31.07.18

For software versions 1.01

Drawings Required

A2/001990 latest issue