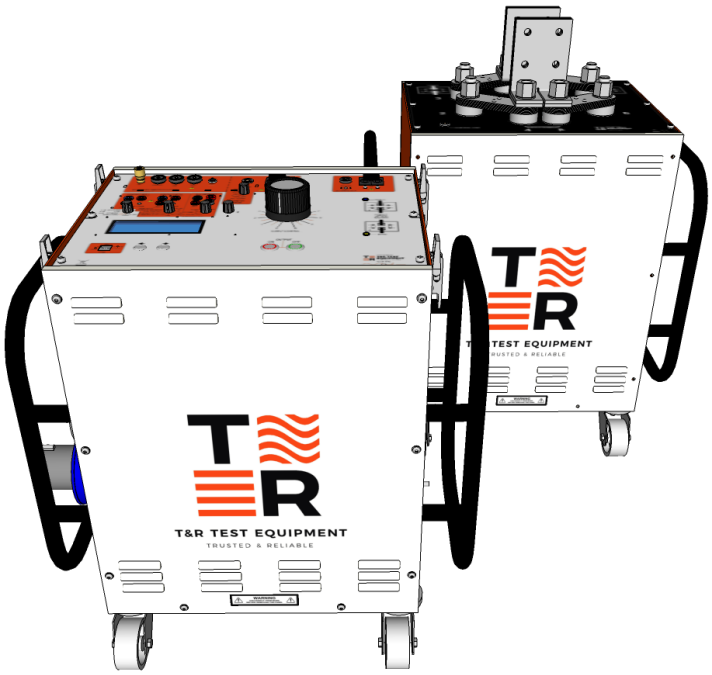
OPERATING AND MAINTENANCE MANUAL

Product: ***Primary Current Injection System***

Type: ***CU-Ps and PLU-5k or PLU-6k***



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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 isolated from the supply and earthed.
- 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 CU-Ps systems have a very high output current (up to 12kA), and therefore generate large magnetic fields around the output leads and loading transformer. 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 CU-Ps 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

HOT – 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.

HOT — Parts of the unit may become hot during use, particularly when operating at high currents.

CONTENTS

1 DESCRIPTION OF EQUIPMENT

The CU-Ps is a primary current injection system offering output currents up to 6000A. The system consists of a separate control unit containing all metering and control functions and a loading unit that provides the high current output. The CU-Ps is ideally suited to primary current injection, stability testing and circuit breaker testing. In addition, the CU-Ps also offers direct-reading CT ratio and polarity tests and a 100A secondary injection output.

Two loading units are available, delivering a maximum output current of 5000A or 6000A. Each loading unit can be configured for series or parallel output to allow for a wide range of load impedances. For example, the PLU-6k may be configured in series mode to give a maximum current of 6000A at 6.6V range or configured in parallel mode to give a maximum current of 12000A on the 3.3V.

The control units are rated at 12kVA for 1 second. All metering is digital. A memory facility is provided to hold the current reading when the output trips or is switched off. The current is thyristor controlled and is automatically switched off when the device under test trips.

The CU-Ps system has a high accuracy timing system, allowing timing tests to be carried out to a resolution of 1ms. Selection for normally open or normally closed contacts is automatic, and the status of the contacts is shown on the front panel.

Timing modes are available to test under and over current devices, re-closers, under and over voltage devices, current trips and circuit breakers. A full range of high current output leads are available to complement the system in a range of lengths.

WARNING

The CU-Ps and associated loading units are designed to be used on ‘dead’ systems (i.e. no externally supplied voltages are present on the test object). Under no circumstances connect a CU-Ps to a live system. Always check that the power to the device under test is off and the circuit is isolated and earthed before making any connections.

1.1 Control Unit Front Panel Layout and Functions

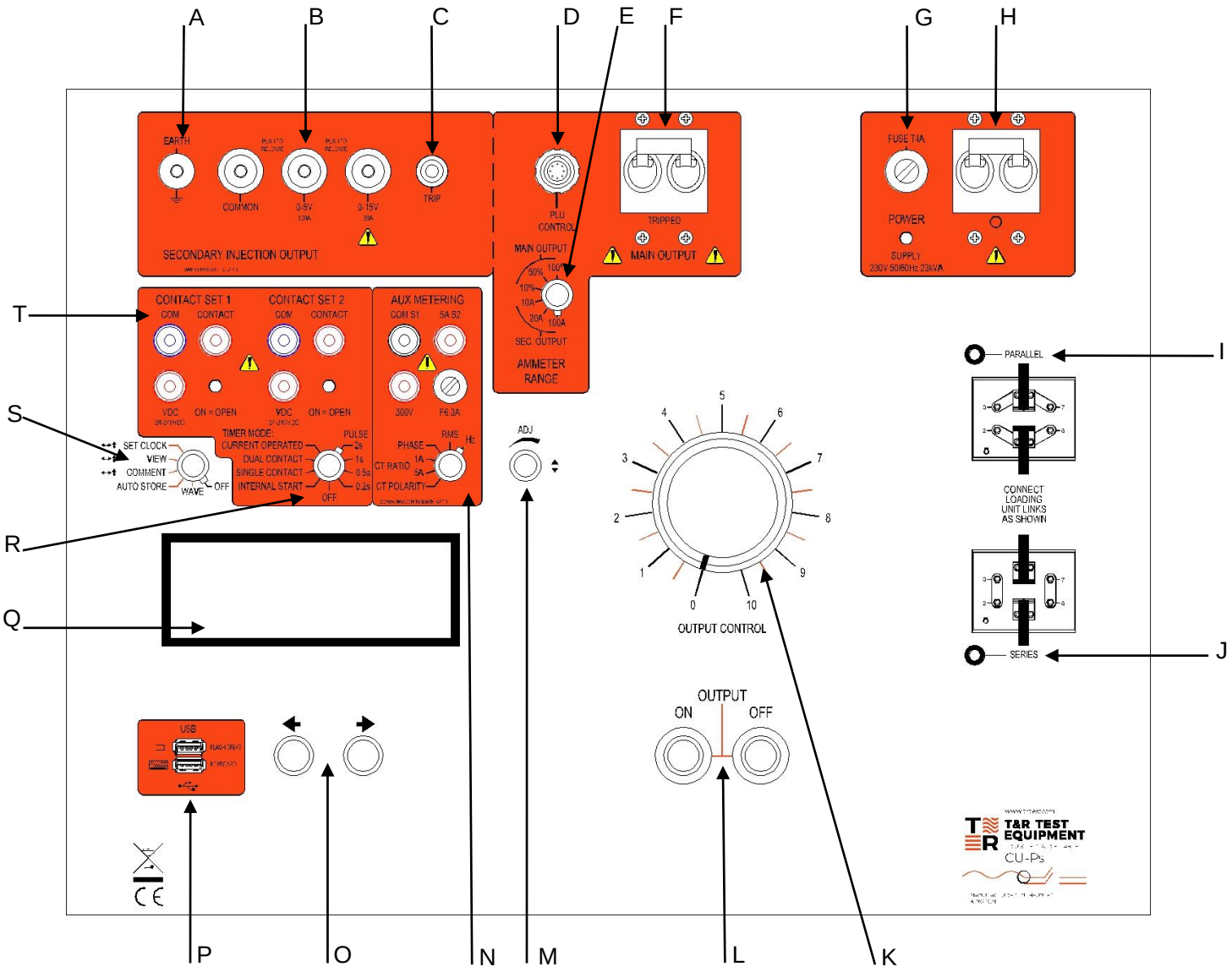


Figure 1.1 CU-Ps front panel layout

	ITEM	FUNCTION
A	Earth terminal	Connect to local earth
B	Secondary injection output	0-100A Secondary injection output
C	Secondary output circuit breaker	Protection for secondary current output
D	PLU metering connection	Metering/control connection to loading unit
E	Metering range/output selection switch	Selects between outputs on CU-Ps (primary/secondary injection) and metering range
F	Primary output circuit breaker	Protection for primary current output
G	Fuse	Fuse for metering and control circuits
H	Mains input switch/circuit breaker	Supply isolation switch and protection
I	Parallel indicator	Illuminated when PLU is connected in parallel mode
J	Series indicator	Illuminated when PLU is connected in series mode
K	Main output control	Sets output current
L	Output ON and OFF pushbuttons	Switch output on and off and indicate output state
M	Adj. digital pot	Used to adjust time and storage results
N	Auxiliary metering inputs and selector	Voltage and current input for auxiliary metering circuit
O	Select pushbuttons	Used to adjust time and storage results
P	USB sockets	USB sockets for keyboard and memory key
Q	Main display	Displays output current, auxiliary metering, timer and PLU mode.
R	Timer and pulse selector	Timer mode selection and pulse duration switch
S	Store result selector	Controls result storage functions
T	Timer inputs	Timer contact inputs

1.2 Loading Unit Front Panel Layout

The CU-Ps system is available with a range of optional loading units and output lead sets.

The loading unit is connected to the control unit using a metering cable and a power cable. The load is connected between the terminals 1&5 and 4&8.

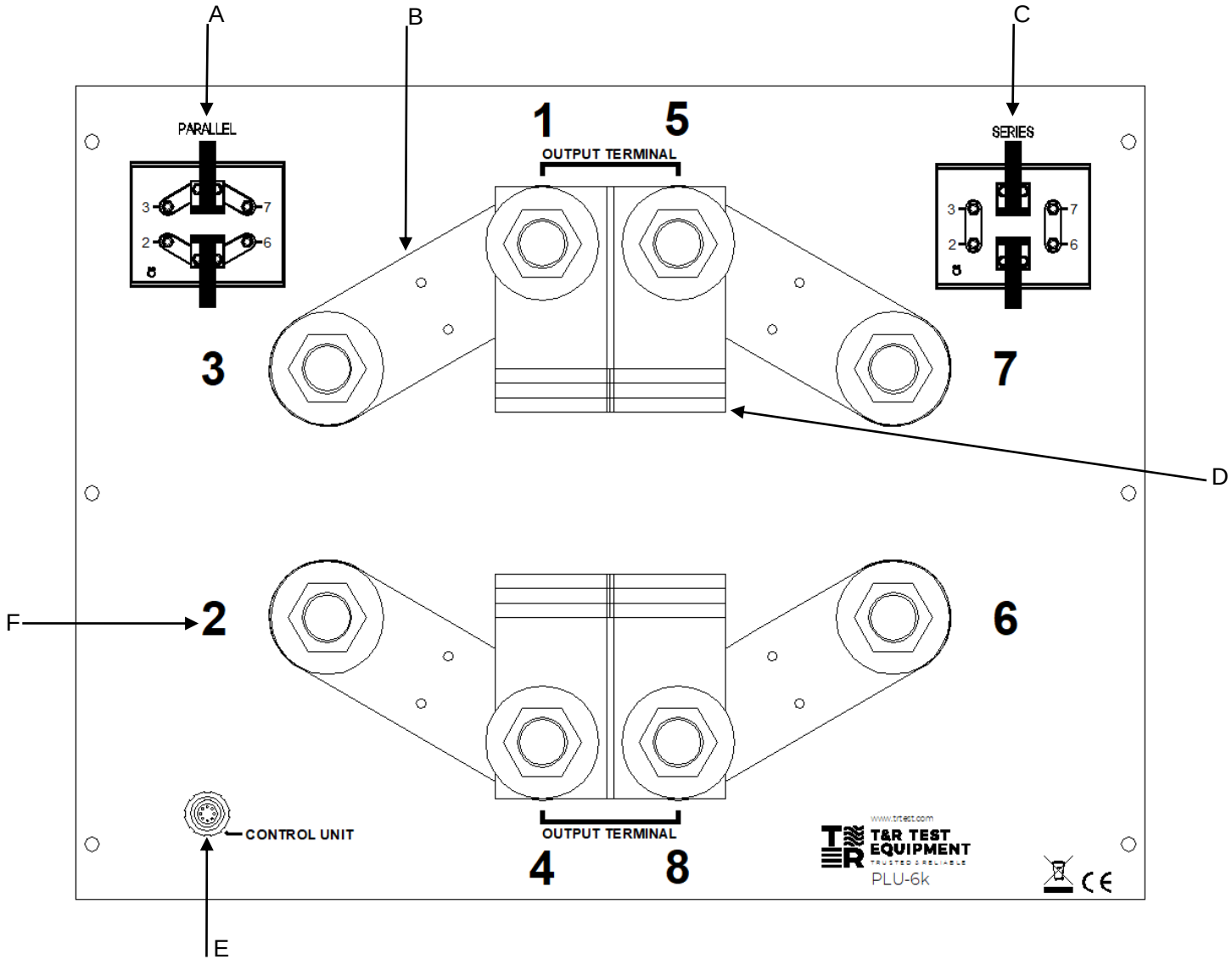


Figure 1.2 Loading unit front panel shown in Parallel Mode

	ITEM	FUNCTION
A	Parallel Mode Diagram	Diagram to show how to connect Links for Parallel Mode
B	Connecting Links	Used to connect terminals for Series and Parallel Modes
C	Series Mode Diagram	Diagram to show how to connect Links for Series Mode
D	Output Terminals	High current output to object under test
E	CU-Ps metering connection	Metering/control connection to control unit
F	Terminal Numbers	Numbers to identify terminals

1.3 Electrical Specification

1.3.1 Supply Requirements

The CU-Ps systems require a single phase 50/60Hz supply of 230V±10%. The maximum power requirement of the system depends on the level of current to be drawn from the control unit. For maximum output a 63A supply is required.

Maximum power requirement	23kVA 5 min on/15 min off 44kVA overload 1 second

Overload ratings are also available when operating in pulse mode. In this mode the output current (and therefore supply current) may be higher for a maximum of two seconds. In every case the maximum achievable output current is defined by the output cable and load impedance.

1.3.2 Loading Unit Outputs

The loading units have two output windings which may either be connected in parallel or series, allowing the output to be configured for a higher current with a lower voltage or a lower current with a higher voltage. The links on the control unit must be connected to select series or parallel operation:

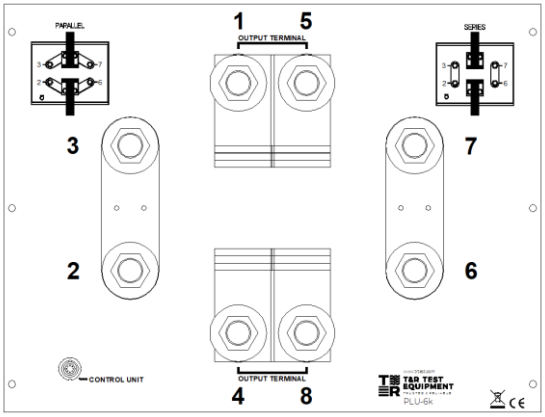
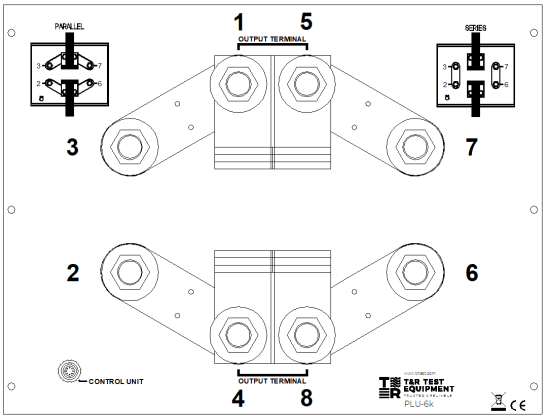
Configuration		Link terminals
Series		2-3 6-7
Parallel		1-3 2-4 5-7 6-8

Figure 1.3.1 Loading unit series/parallel links arrangement

To change the links, ensure the CU-Ps system is turned OFF from the main supply. Remove all eight retaining nuts, and then remove the output terminal plates. Re-configure the links as required, and then replace the output terminal plates and nuts. Ensure that all the nuts are tightened.

The user selects whether the PLU loading unit is in Parallel or Series mode on the CU-Ps control unit when:

- The CU-Ps is turned ON from the mains supply AND the ammeter select switch is in the main output range

  OR;

- The ammeter range select switch is moved from Secondary Injection to Main Output.

An LED will illuminate on the CU-Ps front panel next to the diagram of the selected mode.

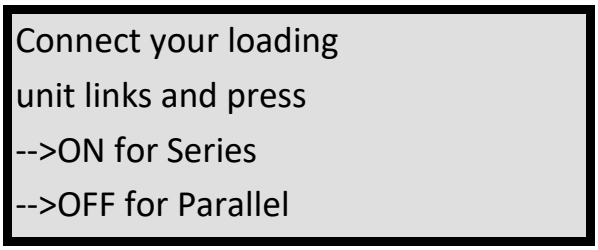


Figure 1.3.2 Loading unit series/parallel selection

Loading Unit		PLU-5k		PLU-6k	
Output Arrangement		**Parallel mode**	**Series mode**	**Parallel mode**	**Series mode**
Open Circuit V*		0-4V	0-8V	0-3.3V	0-6.6V
Continuous	**Current**	2500A	1250A	3000A	1500A
	Max kVA	10	10	10	10
5 min on/15 min off	**Current**	5000A	2500A	6000A	3000A
	Max kVA	10	10	10	10
2 sec on/1 min off	**Current**	8000A	4000A	9600A	4800A
	Max kVA	32	32	32	32
1 sec on/1 min off	**Current**	10000A	5000A	12000A	6000A
	Max kVA	40	40	40	40
0.5 sec on/0.5 min off	**Current**	10000A	5000A	12000A	6000A
	Max kVA	40	40	40	40
0.2 sec on/0.5 min off	**Current**	10000A	5000A	12000A	6000A
	Max kVA	40	40	40	40
*open circuit voltage at 230V mains					

The main output from the CU-Ps control unit is a 0-230V supply rated at 100A for 5 minutes on/15 minutes off. This output is NOT isolated from the mains and is not designed to be used without an isolating loading unit. The units are designed to drive the T&R PLU-5k and PLU-6k loading units, which provide an isolated low voltage high current output.

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:

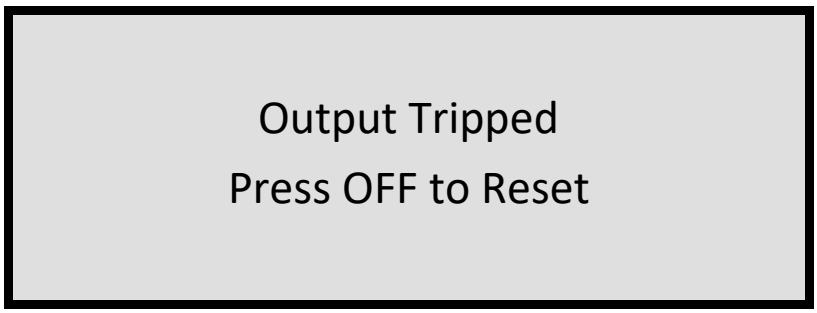


Figure 1.3.3 Output tripped message

NOTE: If the metering cable is not connected between the control unit and the external loading unit, the ammeter will not function, and the output will not switch on when the output ON push-button is pressed. The metering cable between the control and external loading unit acts as an interlock circuit.

The control unit automatically selects the correct metering ranges and protection for the loading unit connected.

1.3.3 Secondary Injection Output

The CU-Ps has two secondary injection outputs capable of injecting up to 100A without the use of a loading unit. The secondary injection output is selected using the metering range select switch.

Unit	Range	Voltage	Current		
			Continuous	5 min on/15 min off	1 min on/15 min off
CU-Ps	33A	15V	10A	20A	33A
	100A	5V	33A	67A	100A

The secondary injection output will only activate if the power and metering leads to the loading unit are disconnected.

WARNING

Ensure both the power and the metering leads are disconnected to the PLU-xk before using the secondary injection outputs.

1.3.4 Metering

The CU-Ps systems are fitted with a memory ammeter that holds the output current's reading at the precise moment that the output circuit is switched off. In timing modes where the contact inputs are used to signify the end of a test, the last valid current before the contacts changed state is held. This also holds true for the current operated timer mode. The ammeter will capture and calculate the rms of a single cycle of output current.

The output metering ranges for the loading unit depend on the loading unit connected. The metering ranges are identified as 10%, 50% and 100% on the control unit. These relate to the maximum current that is available from the loading unit (on a PLU-6k the metering ranges are 600A, 3000A and 6000A when connected in series mode). When using the 0.2s, 0.5s and 1s pulse modes the trip level is doubled e.g. the PLU-6k will trip at 12000A using all the pulse modes except the 2s range.

1.3.4.1 Loading Unit Ammeter Ranges when set for series connection

Loading unit	Metering range	Metering full scale	Accuracy	Trip current
PLU-5k	10%	500.0A	0.5%rdg+5d	525A
	50%	2500A	0.5%rdg+5d	2625A
	100%	5000A	0.5%rdg+5d	5250A
PLU-6k	10%	600.0A	0.5%rdg+5d	630A
	50%	3000A	0.5%rdg+5d	3130A
	100%	6000A	0.5%rdg+5d	6300A

1.3.4.2 Loading Unit Ammeter Ranges when set for parallel connection

Loading unit	Metering range	Metering full scale	Accuracy	Trip current
PLU-5k	10%	250.0A	0.5%rdg+5d	265A
	50%	1250A	0.5%rdg+5d	1275A
	100%	2500A	0.5%rdg+5d	2625A
PLU-6k	10%	300.0A	0.5%rdg+5d	315A
	50%	1500A	0.5%rdg+5d	1575A
	100%	3000A	0.5%rdg+5d	3150A

1.3.4.3 Secondary Injection Output Ammeter Ranges

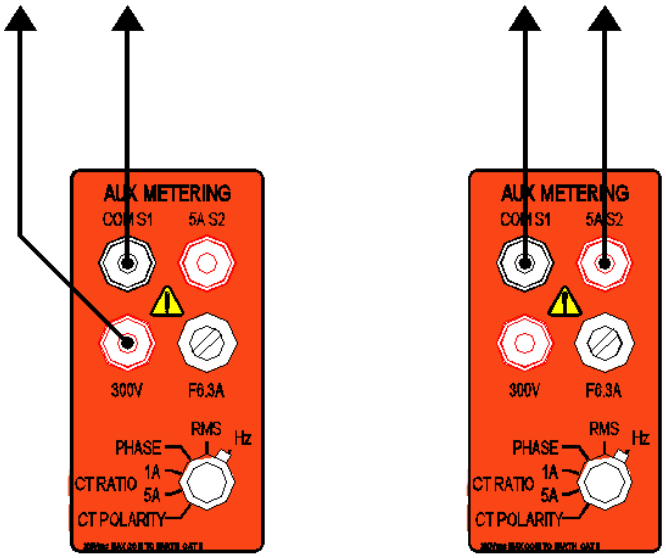
Unit	Ammeter range	Accuracy	Trip current
CU-Ps	10.00A	±0.5%rdg±5d	10.5A
	20.00A	±0.5%rdg±5d	21A
	100.0A	±0.5%rdg±5d	105A

1.3.4.4 Auxiliary Meter Ranges

The CU-Ps has an auxiliary metering input with 300V/5A inputs. This can additionally measure the phase angle between output current and auxiliary input or the ratio between output current and auxiliary current.

Two inputs are provided, one for voltages up to 300V and the other for currents up to 5A. The input in use is automatically selected by the unit. Do not connect to both inputs simultaneously.

Do not exceed the input ratings.



Voltage input *Current input*

Figure 1.3.4 Auxiliary inputs

Auxiliary metering range	Full scale	Function
RMS	300.0V/5.000A Accuracy ±0.7%rdg±5d	Displays the RMS voltage or current of the signal connected to the input
CT polarity	Fwd/Rev	Indicates the polarity of a CT connected between the current output (primary) and auxiliary current input (secondary)
CT ratio 5A	5000:5A	Displays the ratio of a 5A CT connected between the current output (primary) and auxiliary current input (secondary)
CT ratio 1A	5000:1A	Displays the ratio of a 1A CT connected between the current output (primary) and auxiliary current input (secondary)
Phase	-179.9° to +180.0°	Displays the phase angle between the output current and the voltage or current connected to the auxiliary input. Only active if the output current is <10% of the selected metering range and the auxiliary input is >0.5A or 20V.
Hz	45.00-99.99Hz	Displays the frequency of the voltage or current of the signal connected to the input. Only active if the auxiliary input is >0.5A or 20V.

1.3.5 Timing System

The CU-Ps systems are fitted with an integrated timing system linked to the output and the 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. The timer is auto-ranging.

Full details of operating the timer are given in section 2.

Timer mode	Range	Resolution	Accuracy
Pulse 2s	0-2.000s	1ms	±0.01% rdg ±2d
Pulse 1s	0-1.000s	1ms	±0.01% rdg ±2d
Pulse 0.5s	0-0.500s	1ms	±0.01% rdg ±2d
Pulse 0.2s	0-0.200s	1ms	±0.01% rdg ±2d
Off	-	-	-
Internal start	0-999.999s/ 0-9999.99s/ 0-99999.9s	1ms/ 10ms/ 100ms	±0.01% rdg ±2d
Single contact			±0.01% rdg ±2d
Dual contact			±0.01% rdg ±2d
Current operated			±0.01% rdg ±4d

In current operated mode timing results obtained with test currents below 20% of the selected ammeter range are of doubtful accuracy and should be ignored.

The CU-Ps systems have two contact inputs which are used to start and stop the timer depending on the mode selected. Each input has a connection for volt-free contacts and for triggering by a DC voltage. In each case, the input auto-selects for normally open or normally closed contacts. The contact state is shown by an LED (off when the contact is closed, on when the contact is open).

The maximum open circuit voltage across the contact input is 24V, and the short circuit current through the contacts is limited to 20mA.

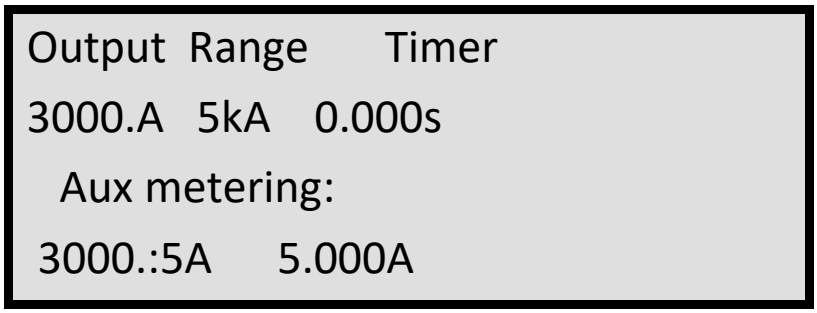
The contact inputs are fully isolated.

1.4 Displayed Values and Messages

1.4.1 Displayed Values

The CU-Ps display simultaneously shows the injected test current, the loading unit metering range full scale, the timer result, the selected auxiliary input value and quantity and the state of the output on a liquid crystal display. It also displays warning and error messages, detailed in the following section.

CU-Ps Output current Full Scale of loading unit range Timer



Auxiliary metering

Figure 1.4.1 Normal values displayed on screen

1.4.2 Warning Messages

In addition to the normal display screens, the CU-Ps systems 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 push-button 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.

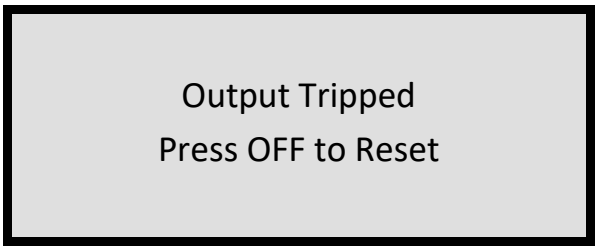


Figure 1.4.2 Over-current trip warning message

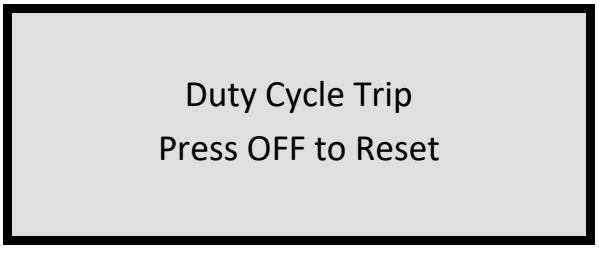


Figure 1.4.3 Duty cycle trip warning message

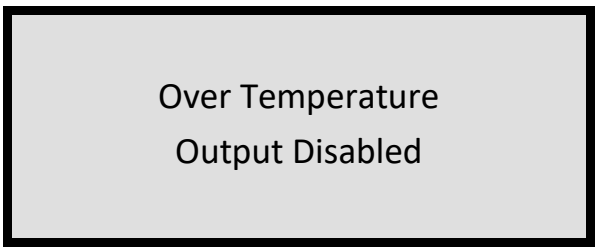


Figure 1.4.4 Unit over temperature warning message

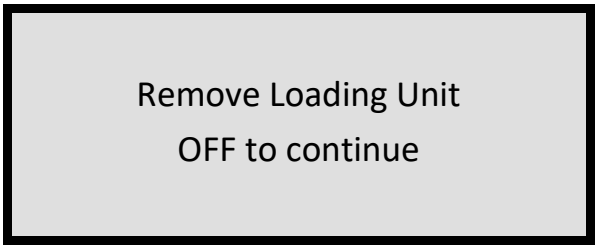


Figure 1.4.5 Secondary injection selected with loading unit power lead plugged in to CU-Ps

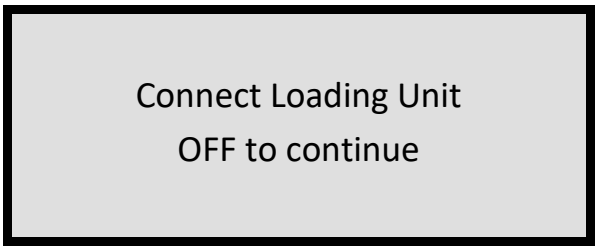


Figure 1.4.6 Primary injection selected with loading unit not connected

Figure 1.4.7 Loading unit fault cleared, waiting for user

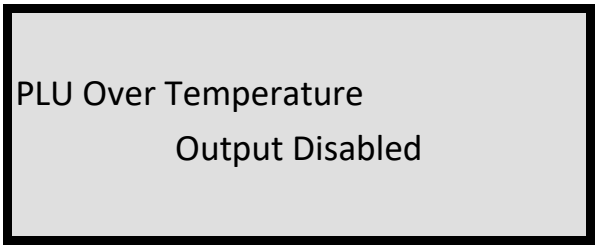


Figure 1.4.8 Loading unit over temperature

1.5 Primary Current Injection Lead Sets

1.5.1 Description

The optional 3000AL, 4000AL, 5000AL, 6000AL lead sets supplied for use with the CU-Ps are made up from several 70mm^2 cores and have different continuous and intermittent ratings. The rating is also affected by the arrangement of the individual 70mm^2 cables making up the high current cable. The leads are supplied with the cables strapped together, but to achieve their maximum rating the straps must be cut, and the cores laid out side by side whilst testing.

Lead set type	Continuous rating		5 minutes on/15 minutes off rating	1 sec on/1 minute off rating
	Cores strapped together	Cores laid out flat	Cores strapped together	Cores strapped together
3000AL	1200A	3000A	1500A	6000A
4000AL	1400A	4000A	2000A	8000A
5000AL	1600A	5000A	2500A	10000A
6000AL	1800A	6000A	3000A	12000A
8000AL	1800A	6000A	3000A	12000A


CAUTION

The cables and terminals will become hot in use. Ensure adequate cooling time is allowed before touching cables or connectors after tests.

Note: The output leads should not be rested against any sharp edges whilst testing. The insulation on the cables softens as it heats up, and it is possible for sharp edges to damage the insulation on the cable under these circumstances. Eddy current heating may occur in ferrous metals that the pair of cable rests against, and this could heat the cable insulation further.

1.5.2 Factors Affecting Maximum Output Current

The maximum output current obtainable from each tap of the loading unit output depends on the following factors:

- Lead impedance
- Lead length
- Load impedance

The lead impedance is often dominant in defining the maximum current that may be injected into the load. The cross-sectional area of the leads and the lead layout have a large effect on impedance.

Figure 1.5 shows the ideal lead layout for the maximum current obtainable from a CU-Ps and PLU-6k with a 3m 5000AL output lead set.

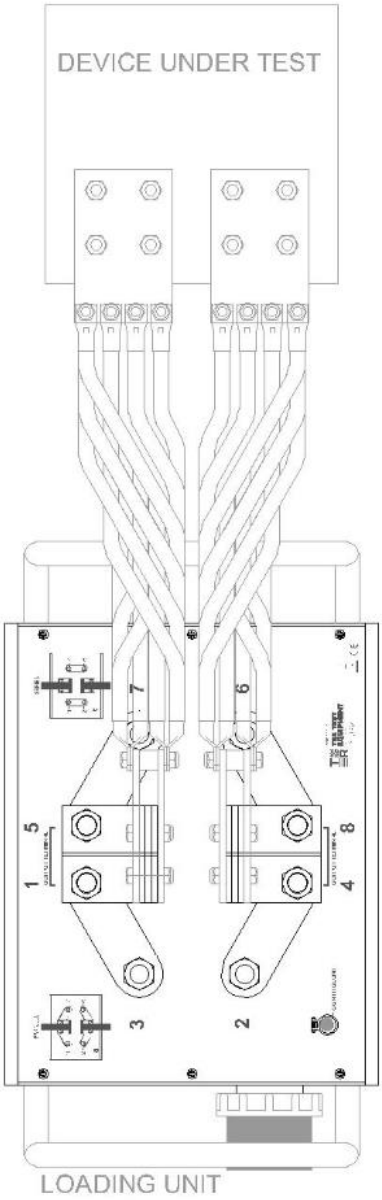


Figure 1.5 Ideal lead routing for maximum output current

1.6 Overload Protection

The CU-Ps is fitted with a range of overload protection devices:

Location	**Protection**
Mains supply	Circuit breaker 100A fuse
Main output	Circuit breaker Electronic over-current trip Electronic duty cycle trip Thermal protection
Contact circuits	Auto-resetting semiconductor fuses
Auxiliary metering current input	F6.3A fuse

1.7 Construction

The CU-Ps control unit is housed in a robust steel case with castors for mobility. The front panel is protected by a steel cover which is fixed to the main case with catches. The unit is also fitted with steel handles at each end of the main chassis.

The external loading units, both the PLU-5k and PLU6-k, are housed in a steel case which is similar in construction to the CU-Ps control unit. The loading unit is not fitted with a protective cover.

1.8 Installation

The CU-Ps and associated loading units are designed for use in an indoor environment.

Before installation, a suitable mains connector must be connected to the 3-core mains input cable provided. The connector and supply must be rated for 100A. It is also important to ensure that the unit is adequately earthed. It is suggested that the earth stud on the side of the unit is connected to a low impedance local earth. This is essential if the unit is used in a sub-station environment.

WARNING Ensure that the unit is adequately earthed. If necessary, an extra earth connection may be made between the earth terminal on the front panel of the control unit, or the earth stud on the case, and a suitable low impedance local earth.

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

WARNING The CU-Ps series control units and PLU series loading units are heavy. Avoid lifting.

2 OPERATION

This chapter describes how to use the CU-Ps systems in a variety of applications. Specific examples are given in the applications section.

2.1 Primary Current Injection with Loading Unit

The connections between the CU-Ps and loading unit are shown in figure 2.1.

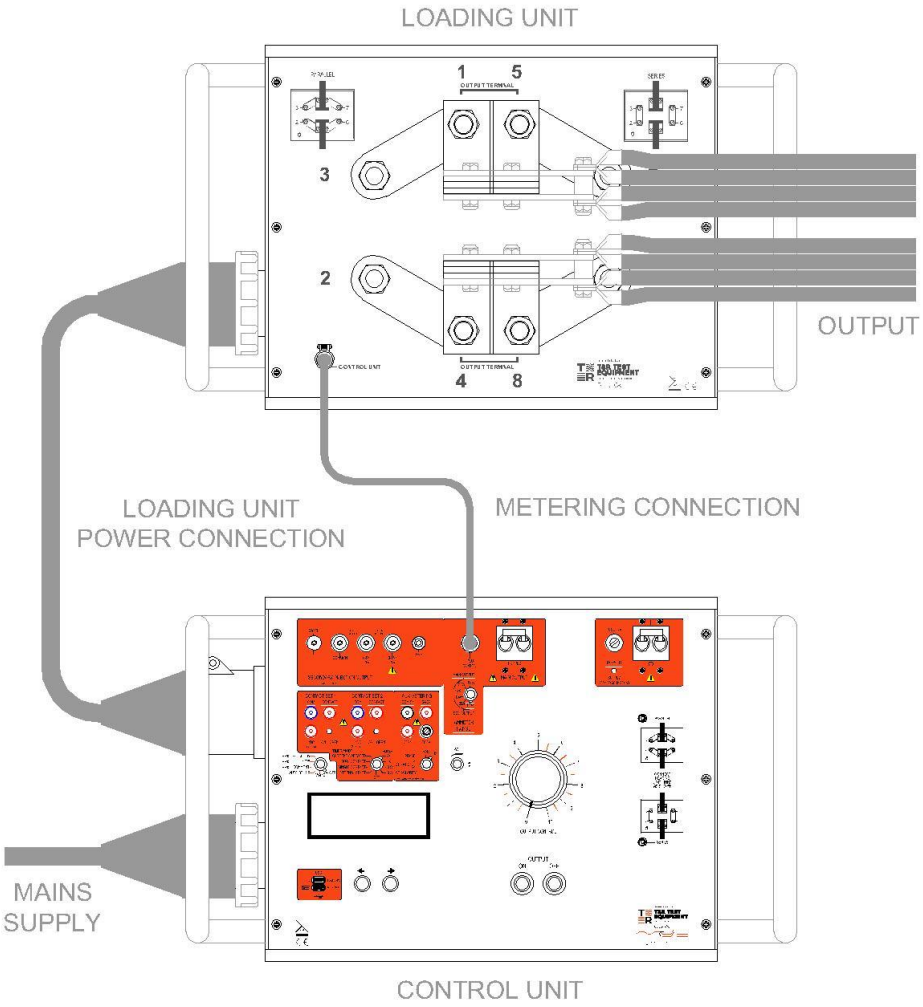


Figure 2.1 CU-Ps and loading unit connections

WARNING

It is vital to ensure that secure, low impedance connections are made between the output of the loading unit and the object under test. Ensure that the output cables are suitably rated for the test current to avoid danger of fire. If the connection to the load is broken whilst current is flowing, arcing may occur.

CAUTION

The output terminals and test leads may become hot during use. Allow adequate time to cool after the test before touching.

If the supply earth to the CU-Ps is of doubtful integrity, the earth terminal on the CU-Ps should be connected to a solid local earth.

The loading unit output from the CU-Ps control unit is ONLY for connection to a T&R Test Equipment PLU series loading unit. The loading unit provides isolation from the mains.

The main output is switched on and off using the ON and OFF pushbuttons. The current level is controlled by the main output control and protected by the output circuit breaker.

WARNING

Never break the high current output circuit when the output is switched on – this may cause arcing.

2.1.1 Connections

Ensure that the unit is switched off and the test object is isolated and grounded before making any connections.

Configure the loading unit for either parallel or series output depending on the voltage and test current required. Ensure that all the nuts are fully tightened. See figure 1.3.1 for connection details.

Connect the loading unit to the control unit as shown in figure 2.1. When switched on the control unit will automatically detect the loading unit type.

Select the desired output on the loading unit; the unit will ask if the unit is connected in parallel or series configuration. Press the ON button for Series or the OFF button for Parallel mode.

Set the metering range switch to 10%, 50% or 100%. These ranges refer to % of maximum rated current of the connected loading unit, so for an PLU-5k 100% is 5000A and for an PLU-6k 100% is 6000A.

As shown in Fig 2.1, one output lead always connects to the link between terminal 1 dand 5, and the other connects to the link between terminal 4 and 8. Connect the output cables to the test object.

HOT

After testing, the output terminals and leads may be hot. Allow to cool before touching connections.

2.1.2 Testing

Always start the first test with the output control knob at zero to ensure that the test object is not subjected to an unintentional over-current.

Switch the output on using the ON pushbutton and then increase the output current to the desired test current. If you cannot achieve the desired test current, one of the following will be limiting the current:

- Output leads too long. Use shorter output leads.
- Output leads in a large loop – minimising the area in the loop of the output leads will maximise the current available.
- Output leads of insufficient cross-sectional area. Either use thicker output leads or use two output leads per connection.

2.1.3 After Testing

On completion of the test, switch off the output using the OFF push-button. Return the output control to zero and switch off the supply. Before disconnecting the test-object, ensure the mains supply switch is in the OFF position.

2.2 Secondary Current Injection

The secondary current injection output of the CU-Ps allows currents of up to 100A to injected for testing relays and trips.

To use the secondary injection output the loading unit power and metering leads must be disconnected and one of the secondary injection metering ranges selected.

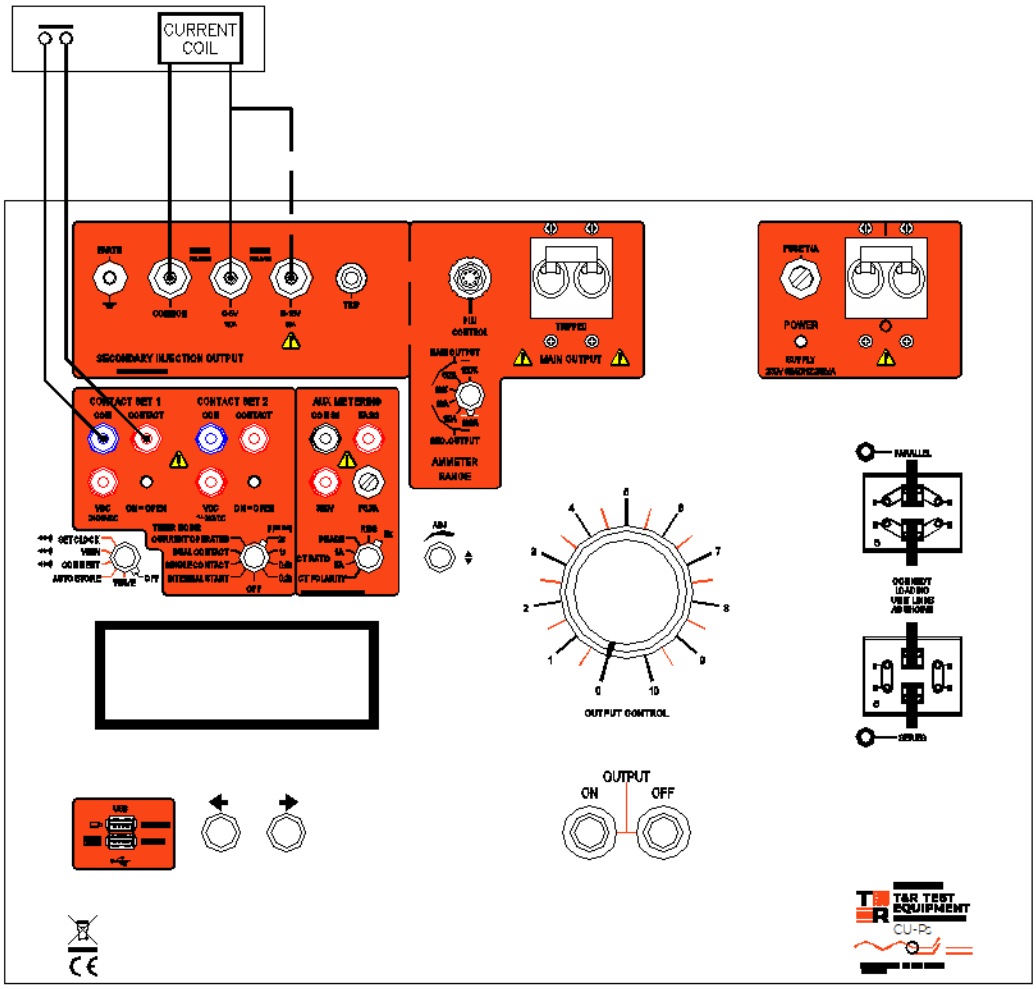


Figure 2.2 Secondary Injection Connections

2.2.1 Connections

Ensure that the unit is switched off and the test object is isolated and grounded before making any connections.

Connect the test object as shown in figure 2.2. The contact/timer connections will vary depending on the device type.

Set the ammeter range switch to SEC. OUTPUT 10A, 20A or 100A.

Connect the supply lead to the mains and switch the supply circuit breaker on.

2.2.2 Testing

Always start the first test with the output control knob at zero to ensure that the test object is not subjected to an unintentional over-current.

Switch the output on using the ON push-button and then increase the output current to the desired test current.

2.2.3 After Testing

On completion of the test, switch off the output using the OFF push-button. Return the output control to zero and switch off the supply. Before disconnecting the test-object, ensure the mains supply switch is in the OFF position.

2.3 Timing System

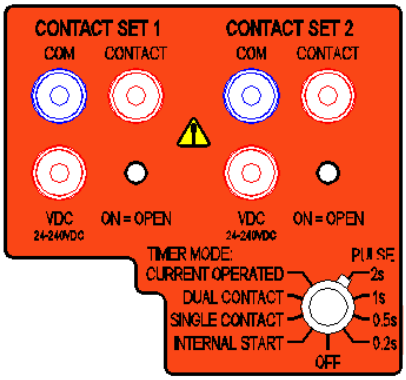


Figure 2.3 Timing Sockets and Timing Mode Selector

The CU-Ps timing system is closely integrated with the main output and is very flexible. A summary of the start and stop events for the timer is shown in the following table:

Timer Mode	Timer Start Condition	Timer Stop Condition	Automatic output off	Example application
Off	-	-	-	Set current
Internal Start	Main output on	Contact set 1 change	When timer stops	IDMT relay
Single Contact using Contact 1	C1 1st change	C1 2nd change	C1 1st change (timer start)	Auto-recloser
Single Contact using Contact 2	C2 1st change	C2 2nd change	C2 2nd change (timer stop)	Drop-off timing
Dual Contact 1st change C1	C1 change	C2 change	C2 change (timer stop)	
Dual Contact 1st change C2	C2 change	C1 change	C2 change (timer start)	Auto-reclose relay
Current Operated	Current >20% of selected metering range	Current < 20% of selected metering range	Current <20% Timer stop	Miniature circuit breakers
Pulse 0.2s	Main output on	Time = 0.2s	200ms	Set current for thermal devices
Pulse 0.5s	Main output on	Time = 0.5s	500ms	
Pulse 1s	Main output on	Time = 1s	1s	
Pulse 2s	Main output on	Time = 2s	2s	

The timer resets automatically when the output ON push-button is pressed. 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. This will trigger from either the voltage switching from zero (0VDC) 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.

2.3.1 Timer Modes

2.3.1.1 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.

2.3.1.2 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.

2.3.1.3 Timer Mode: Single 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. The output is automatically switched off when the timer is started. The timer is reset when the output is switched on. This timer mode is ideally suited to timing auto-reclose relays.

If a single contact mode is required where the output remains on until the second change of contact, this may be achieved by using single contact mode with contact set 2.

2.3.1.4 Timer Mode: Dual Contact

'Dual Contact' mode uses both contact set 1 and contact set 2. The time between C1 and C2 changing is always measured whether C1 or C2 changes first. If C1 changes first, the output switches off when the timer stops. If C2 changes first, the output switches off when the timer starts. In dual contact mode the timer will initially start when the output is switched on but will restart on the first contact change.

2.3.1.5 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 MCBs.

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.

Loading unit	Metering range	Range full scale	Approximate timer start/stop current
Secondary Injection from CU-Ps	10A	10A	2A
	20A	20A	4A
	100A	100A	20A
PLU-5k Parallel Mode	10%	500A	100A
	50%	2500A	500A
	100%	5000A	1000A
PLU-5k Series Mode	10%	250A	50A
	50%	1250A	250A
	100%	2500A	500A
PLU-6k Parallel Mode	10%	600A	120A
	50%	3000A	600A
	100%	6000A	1200A
PLU-6k Series Mode	10%	300A	60A
	50%	1500A	300A
	100%	3000A	600A

2.3.1.6 Pulse Mode

'Pulse' mode may be used to generate high current pulses into the test object. The electronic trips are set to double the normal trip current in the 0.2s, 0.5s and 1s pulse modes. In the 2s pulse mode, the trips function as normal. This is useful for setting the current when testing thermal devices and testing instantaneous trips.

2.3.2 General Procedure for Timing Tests

The procedure for timing is the same whether an external loading unit is connected or the secondary current injection output from the CU-Ps is used.

2.3.2.1 Connections

Ensure that the unit is switched off and the test object is isolated and grounded before making any connections.

Connect the loading unit to the control unit as shown in figure 2.1. In the case of the secondary injection output, make the connections shown in figure 2.2.

Set the ammeter range switch to one of the main output ranges (10%, 50% or 100%). Connect the output cables to the desired output on the loading unit and to the test object.

Connect the supply lead to the mains and switch the main supply switch on. The display will come on, showing the unit type and loading unit type whilst starting up.

2.3.2.2 Testing

It is advisable to make a preliminary test on the test object, starting at zero voltage, in order to test the load impedance, before performing the test with output control set at higher values. Therefore, ensure the output control knob is fully anti-clockwise before switching on.

Ensure the timer mode switch is in the off position and depress the ON push-button. Increase the current by rotating the output control knob in a clockwise direction until the desired current is indicated on the ammeter. Press the output OFF push-button.

Connect the test object contacts to the contact terminals on the test set, select the internal start timer mode. If the test object has no auxiliary contacts (e.g. thermal breakers), it will be necessary to use the current operated timer mode.

When the output ON push-button is pressed, the following will occur:

a. The timer will start and current will flow through the test object.

b. When the test object's contacts change state, the timer will stop, and the test current will be automatically switched off.

2.3.2.3 After Testing

On completion of the test, return the output control to zero and switch off the supply. Before disconnecting the test-object, ensure the mains supply switch is in the OFF position.

2.4 Storage of results

The CU-Ps 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
- Timer result
- Auxiliary current/voltage input value
- Auxiliary current/voltage input phase angle
- Auxiliary current/voltage input frequency
- Comment

2.4.1 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.

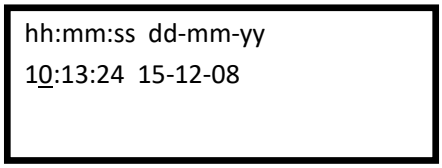
Insert the USB key into the upper USB socket on the unit before starting to test. Most USB memory devices have an LED that indicates when the device is accessed. This will flash when a result is written.

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

2.4.2 Setting the clock

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

- Set the STORE RESULT switch to SET CLOCK.



- Use the ← and → keys to select which digit to change.
- Use the 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.

2.4.3 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 or the comment is erased. The comment is erased when the unit is switched off.

Any English language USB keyboard can be used with the CU-Ps.

The comment can be typed on the USB keyboard using the letters a-z, numbers 0-9 and punctuation marks. A maximum of 59 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.

2.4.4 Auto-store

Set the STORE RESULTS switch to AUTO-STORE.

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

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 and are 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.

```
"CU-Ps   ","V0.12","C00","P1","A1"
"Time","Date","Main A","Timer","Aux A","Aux V","Phase","Freq Hz","Aux Range","Comment"
"11:18:40","28/10/19","2.38","7.961","0.000","0.0","0.0","0.00","6","CDG11 relay"
"11:18:49","28/10/19","3.73","5.252","0.000","0.0","0.0","0.00","6","CDG11 relay"
```

2.4.5 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 WAVEFORM.

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 OpenOffice Calc) can be used to show the waveform graphically.

2.4.6 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.

```
"CU-Ps   ","V0.12","C00","P1","A1"
"Time","Date","Main A","Timer","Aux A","Aux V","Phase","Freq Hz","Aux Range","Comment"
"11:18:40","28/10/19","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.

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=60µs). 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 60µs intervals for a total sampling time of 61.44ms.

```
"11:57:34","28/10/19","","","","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"
```

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

2.4.7 Viewing results

The VIEW RESULTS setting allows the results from the current day 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 ADJ and the file to view opened using ➔. The results in the file can then be stepped through using ADJ.

3 APPLICATION NOTES – TESTING SPECIFIC DEVICES

3.1 Secondary Injection of an Over-Current Relay

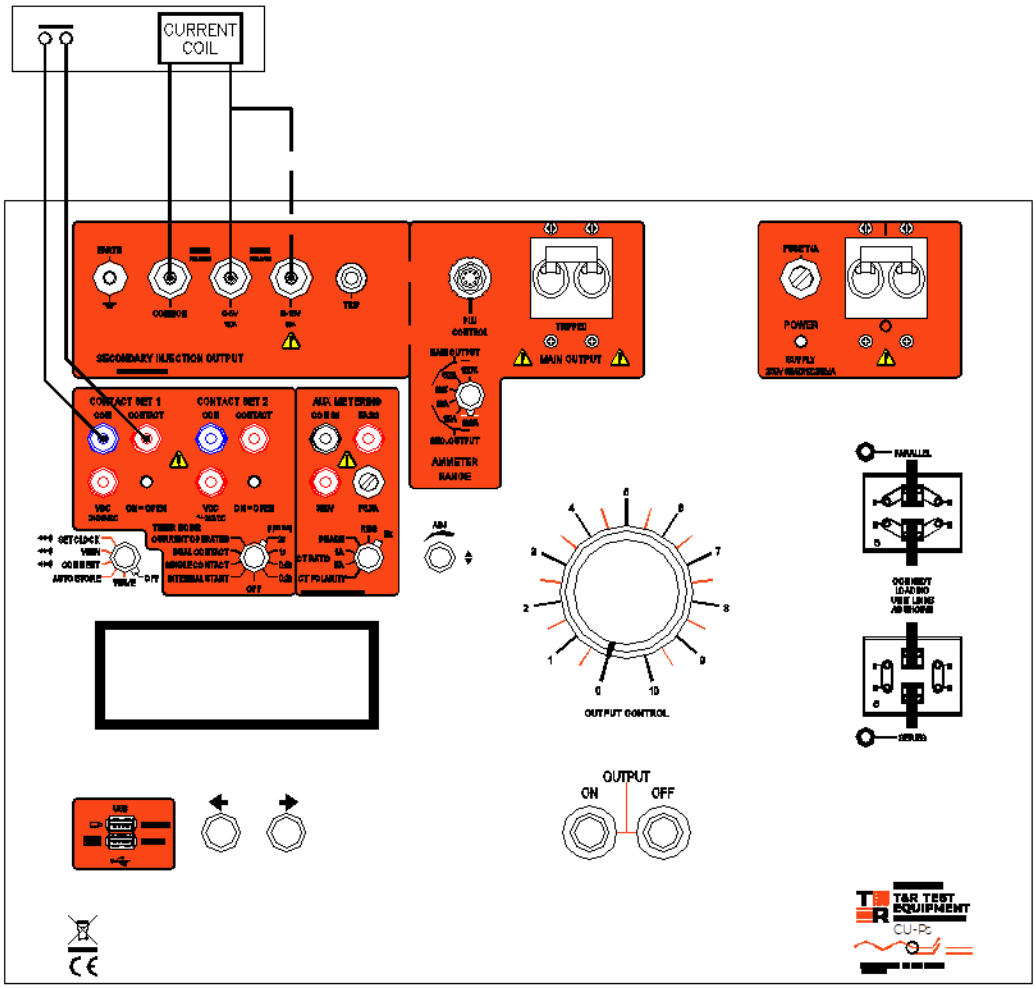


Figure 3.1 Secondary injection of over-current relay

3.1.1 Timer Mode

Internal start

3.1.2 Connections

Connect the relay current coil to the most appropriate output on the CU-Ps (5V 100A or 15V 33A).

Connect the trip contacts on relay under test to contact set 1 on the CU-Ps.

3.1.3 Test Procedure

Switch on the main supply switch.

Set the metering range switch to the most appropriate secondary injection range (10A, 20A or 100A). Set the timer mode switch to the off position.

Ensure that the output control is in the zero position.

Press the output ON push-button and increase the output current to the desired level.

Press output OFF push-button.

Select the internal start position on the timer mode switch.

Press the output ON push-button.

When the device under test trips the timer will stop, and the output will be switched off automatically.

3.2 Primary Injection of an Over-Current Relay

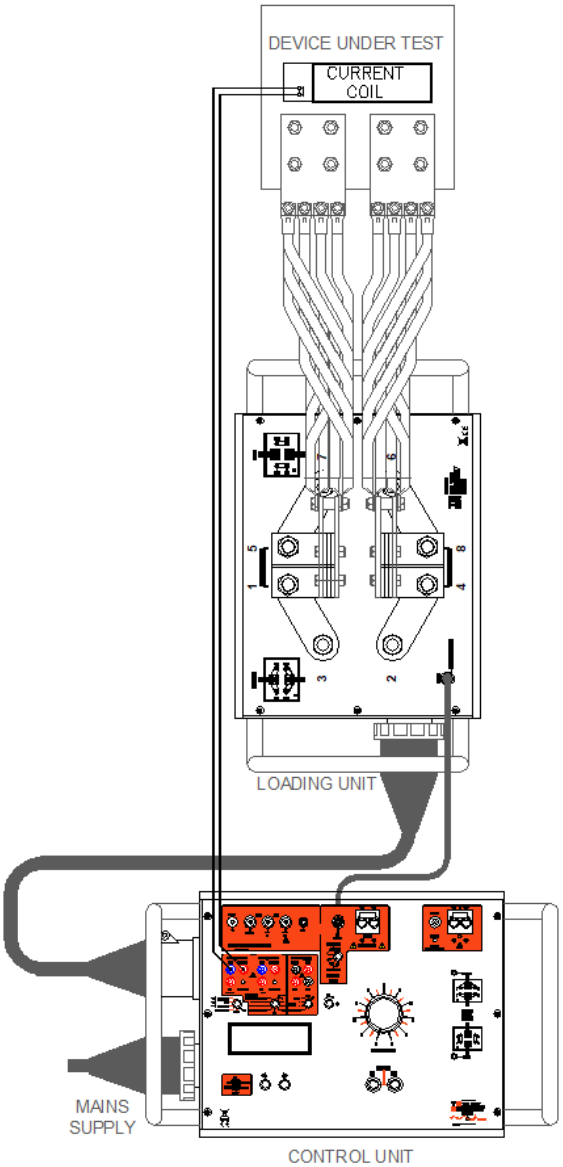


Figure 3.2 CU-Ps with over current device

3.2.1 Timer Mode

Internal start.

3.2.2 Connections

Connect current output from loading unit to desired input on device under test.

Connect trip contact on the relay under test to contact set 1 on the control unit.

3.2.3 Test Procedure

Switch on the main supply switch.

Set the ammeter range switch to a primary injection range (10%, 50% or 100%). Set the timer mode switch to the off position.

Ensure that the output control is in the zero position.

Check that connections are made as figure 3.2.

Press the output ON push-button and increase the current to the desired level.

Press the output OFF push-button.

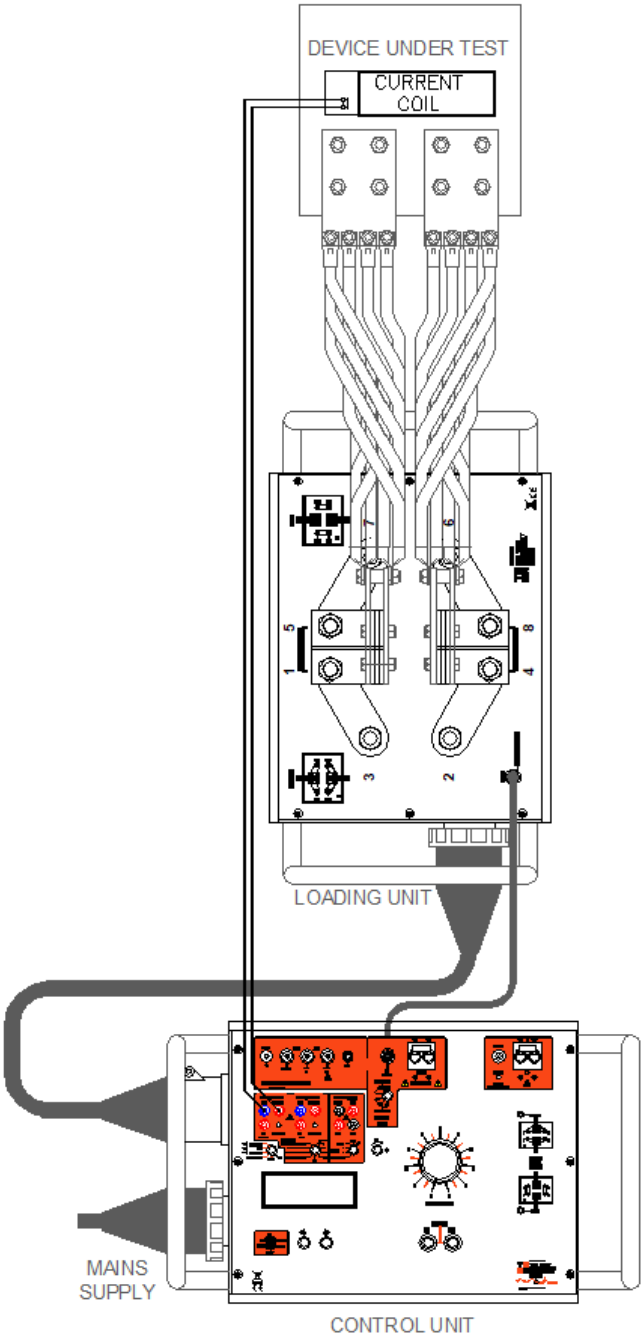
Select the internal start position on the timer mode switch.

Press the output ON push-button. When the device under test trips the timer will stop, and the output will be switched off automatically.

3.2.4 *Using Pulse Mode to Set the Current*

When setting the current into the load pulse mode may be used to avoid injecting current for long periods of time. Set the timer mode to pulse 0.2s and inject a series of pulses, adjusting the output current until the desired current is set. Set the timer mode to internal start and then press the ON push-button.

3.3 Timing of Auto-reset/Reclosing Devices



3.3.1 *Timer Mode*

Single contact.

3.3.2 *Connections*

Connect current output from loading unit to desired input on device under test.

Connect the trip contact on the relay under test to contact set 1 on the control unit.

3.3.3 *Test Procedure*

Switch on the main supply switch.

Set timer mode switch to the off position.

Ensure that the output control is in the zero position.

Check that connections are made as figure 3.3.

Press output ON push-button and increase the output current to the desired level.

Press output OFF push-button.

Select the single contact position on the timer mode switch.

Press the output ON push-button.

Figure 3.3 CU-Ps with auto-reclose device

When the device under test trips the timer will start, and the output will be switched off automatically.

When the device auto-resets the timer will stop.

3.4 Timing Devices with NO Auxiliary Contacts

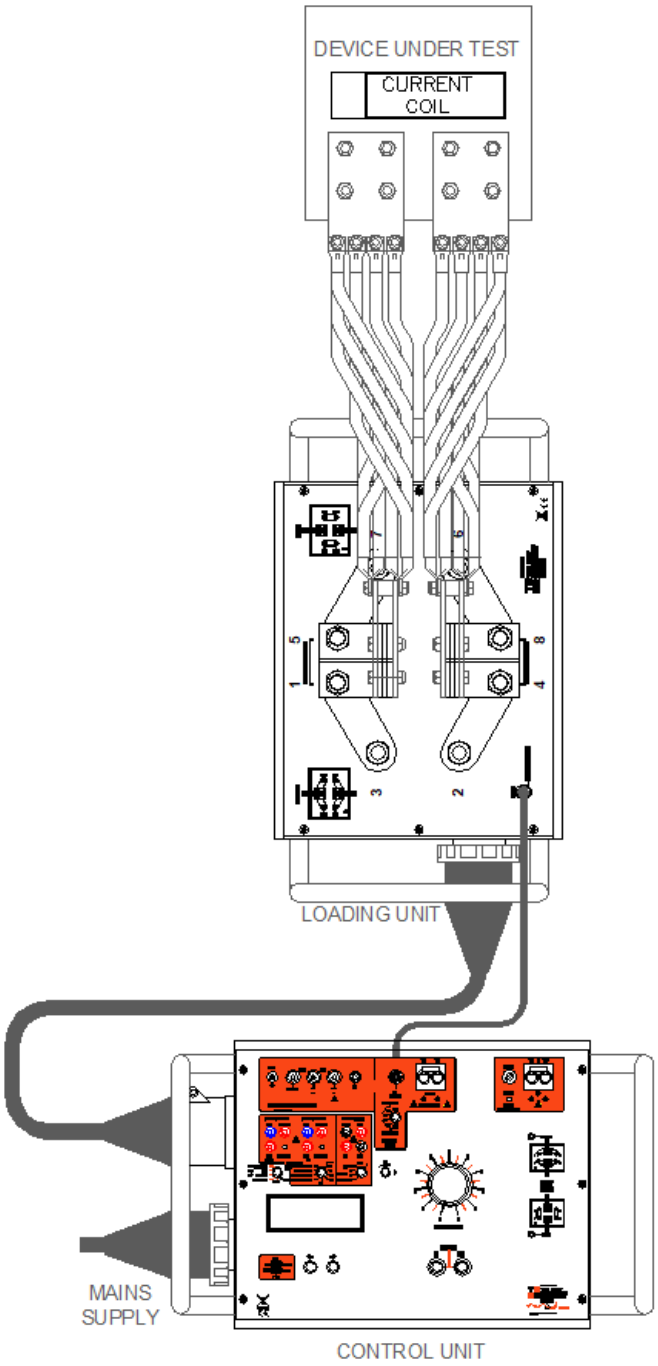


Figure 3.4 CU-Ps injecting into device with no auxiliary contacts

3.4.1 Timer Mode

Current Operated.

3.4.2 Connections

Connect current output from loading unit to desired input on device under test.

3.4.3 Test Procedure

Switch on the main supply switch.

Set timer mode switch to the off position.

Ensure that the output control is in the zero position.

Check that connections are made as figure 3.4.

Press output ON push-button and adjust output control until the desired output level is indicated.

Press output OFF push-button.

Select the current operated position on the timer mode switch.

Press the output ON push-button.

When the device under test trips the timer will stop, and the output will be switched off automatically.

3.5 Using the Control Unit as a Single Contact Timer

3.5.1 Timer Mode

Single contact.

3.5.2 Connections

Connect contact to be timed to contact set 1.

3.5.3 Test Procedure

Switch on the main supply switch.

Set timer mode switch to the single contact position.

Ensure that the output control is in the zero position.

Press output ON push-button. The timer system is now armed and will start when contact set 1 changes state (i.e. open to closed or vice-versa).

The timer will stop when the contacts return to their original state.

3.6 Using the Control Unit as a Dual Contact Timer

3.6.1 Timer Mode

Dual contact.

3.6.2 Connections

Connect contact to start timer to contact set 1.

Connect contact to stop timer to contact set 2.

3.6.3 Test Procedure

Switch on the main supply switch.

Set timer mode switch to the dual contact position.

Ensure that the output control is in the zero position.

Press output ON push-button. The timer runs and will restart when contact set 1 changes state (i.e. open to closed or vice-versa).

The timer will stop when contact set 2 changes state.

3.7 CT Polarity

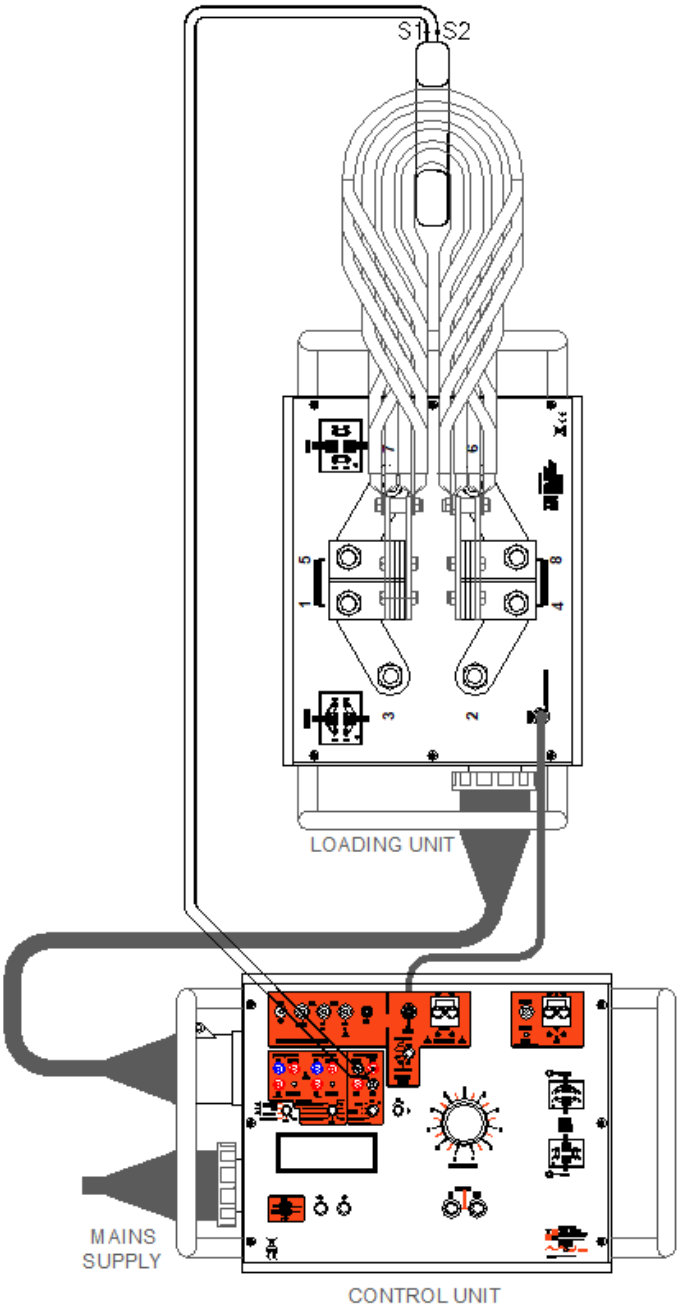


Figure 3.7 CU-Ps CT ratio/polarity

3.7.1 Modes & Settings

Timer mode: Off.

Auxiliary metering: CT polarity.

3.7.2 Connections

Connect current output from loading unit to busbar through CT primary (or loop lead through the CT). Ensure that CT P2 connects to COM terminal on loading unit.

Connect S1 & S2 on CT secondary to CU-Ps auxiliary metering input S1 & S2. Check that CT S1 connects to COM input.

3.7.3 Test Procedure

Switch on the main supply switch.

Set timer mode switch to the off position.

Ensure that the output control is in the zero position.

Check that connections are made as figure 3.7.

Choose a suitable test current. The test current must be greater than 10% of the metering range in use (e.g. 500A on 100% range with PLU-6k). The CT secondary current must not exceed 5A.

Press the output ON push-button and increase the output current to the desired test current. The display will show either “OK” for correct polarity or “REV” for reversed polarity.

Press output OFF push-button.

3.8 CT Ratio

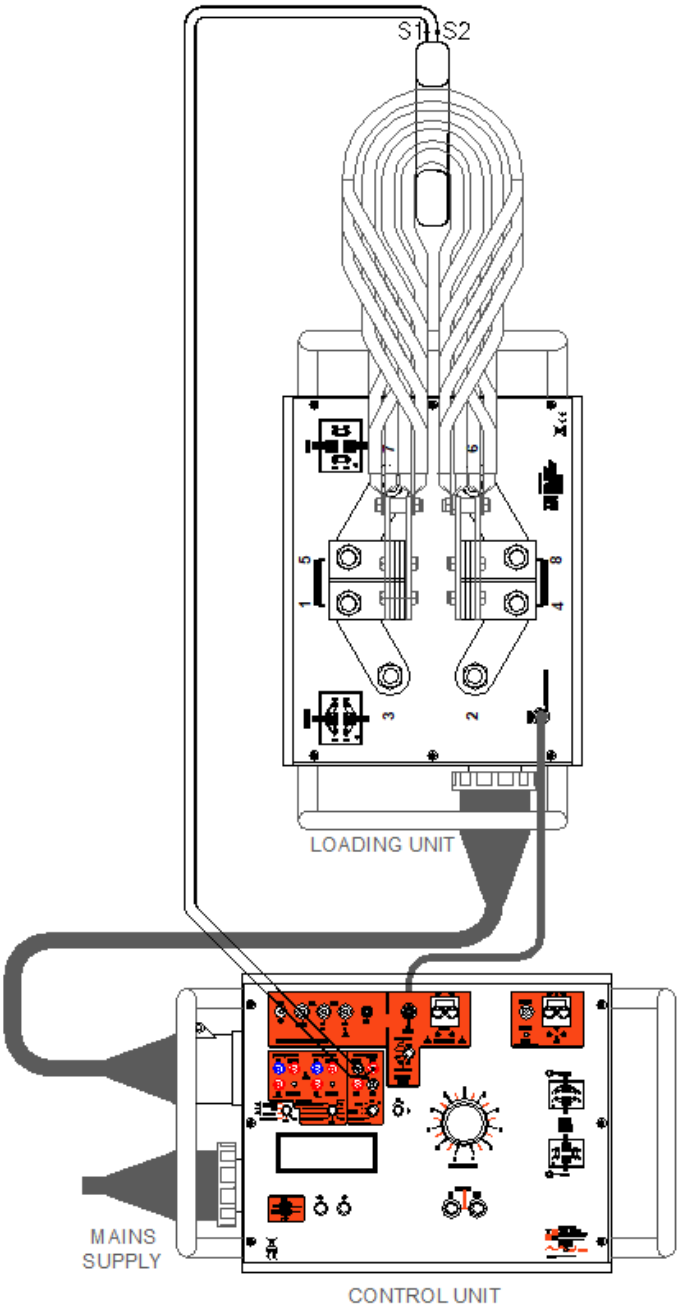


Figure 3.8 CU-Ps CT ratio/polarity

3.8.1 Modes & Settings

Timer mode: Off.

Auxiliary metering: CT ratio 1A or CT ratio 5A as appropriate to CT secondary.

3.8.2 Connections

Connect current output from loading unit to busbar through CT primary (or loop lead through the CT).

Connect S1 & S2 on CT secondary to CU-Ps auxiliary metering input S1 & S2.

3.8.3 Test Procedure

Switch on the main supply switch.

Set timer mode switch to the off position.

Ensure that the output control is in the zero position.

Check that connections are made as figure 3.8.

Press the output ON push-button and increase the output current to the rated CT primary current. Read off the CT ratio from the display.

Note: If the CT secondary is >5A a lower test current must be used such that no more than 5A flows into the metering input.

Press output OFF push-button.

4 MAINTENANCE

WARNING

The following actions should only be taken by suitably qualified and competent service personnel. 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.

4.1 Output Control Brushes

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

4.2 Removal of the CU-Ps from Case

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

a. Remove the 8 pozi pan head screws securing each of the side panels to the unit.

b. Remove side panels.

5 STANDARD ACCESSORIES

5.1 Spare Fuses Supplied

a. 1 off 20mm F6.3A

b. 1 off 32mm T4A

5.2 Standard Accessories Supplied

Description	Part Number
2 metre supply cable terminated at one end to suit the CU-Ps control unit mains input.	A018-0001
5 metre interconnecting lead terminated at both ends to supply power from the CU-Ps control unit to the PLU loading unit.	A240-0001
5 metre metering lead to connect the PLU loading unit to CU-Ps control unit	A204-0003
5 metre test lead set for timing tests between contacts and CU-Ps control unit.	S000-0534
5 metre 100A lead set for use with the secondary injection outputs on the CU-Ps control unit.	A199-0001
USB mini keyboard for writing comments.	A000-0002
USB key 2.0 8GB micro memory stick for storage of results.	A000-0003
User manual.	N/A

5.3 Optional Accessories Supplied

High Current Lead Sets for use with the PLU Loading Unit	
Description	**Part Number**
3000AL	A019-0001
4000AL	A020-0001
5000AL	A021-0001
6000AL	A022-0001

6 OVERALL 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 and all isolated outputs 2kV RMS for 1 minute.

All isolated inputs/outputs 1.5kV RMS for 1 minute.

6.3 Accuracy of Instruments

6.3.1 Loading Unit Current Output

Loading unit	Metering range	Metering full scale	Accuracy	Trip current
PLU-5k Parallel Mode	10%	500.0A	0.5%rdg+5d	525A
	50%	2500A	0.5%rdg+5d	2625A
	100%	5000A	0.5%rdg+5d	5250A
PLU-5k Series Mode	10%	250.0A	0.5%rdg+5d	260A
	50%	1250A	0.5%rdg+5d	1300A
	100%	2500A	0.5%rdg+5d	2600A
PLU-6k Parallel Mode	10%	600.0A	0.5%rdg+5d	630A
	50%	3000A	0.5%rdg+5d	3130A
	100%	6000A	0.5%rdg+5d	6300A
PLU-6k Series Mode	10%	300.0A	0.5%rdg+5d	315A
	50%	1500A	0.5%rdg+5d	1575A
	100%	3000A	0.5%rdg+5d	3150A

6.3.2 Secondary Injection Current Output

Unit	Ammeter range	Accuracy	Trip current
CU-Ps	10.00A	±0.5%rdg±5d	10.5A
	20.00A	±0.5%rdg±5d	21A
	100.0A	±0.5%rdg±5d	105A

6.3.3 Auxiliary Metering Input

Auxiliary metering range	Full scale	Accuracy
300.0V RMS	300.0V	±0.7%rdg±5d
5.000A RMS	5.000A	±0.7%rdg±5d

6.3.4 Timing System

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

7 REVISION

Product / Type:	Primary Current Injection – CU-Ps & PLU Loading Units
File:	OM0011.docx
Author:	G Bond
Date:	17.06.19
Issue / Date:	1 / 20.08.19
Modified By:	M Clancy

Checked By: N Eldridge	Date: 28.10.19

Drawings Required

A3/002121 latest issue (CU-Ps)

A3/002135 latest issue (PLU-5k)

A3/002127 latest issue (PLU-6k)