

# High Impedance Protection Accessories

## Auxiliary Units – 7XG15 and 7PG1110-7AE10

### Description

#### 7XG15 High Impedance Component Box

High impedance protection operates on the differential current-balance principle. In each zone, the current transformers of the incoming and outgoing circuits are connected together and form a current balance group.

A relay is connected at a convenient point to form a spill circuit. An internal fault upsets the current balance and causes the relay to operate. The system employs one or more relay elements with sensitive current setting and low operating burden.

An external series resistor is used to give each relay element the voltage setting required to ensure stability under through fault conditions. This is the setting or stabilizing resistor.

The resistance of the setting resistor should be sufficient to ensure the effective setting voltage exceeds the voltage developed by a through fault with one CT fully saturated.

The current setting of the 7SR23 may be adjusted to achieve the desired primary operating current.

Non-linear resistors (e.g. Metrosils) are used to protect the relay components, the insulation of secondary wiring and current transformers, by suppressing high voltage peaks which may otherwise be developed by the current transformer secondary winding under internal fault conditions.

Resistors and non-linear resistors are fitted on a per phase basis.

The resistors and non-linear resistors may be fitted as discrete components; however the High Impedance Component Box 7XG15 contains these items within a 4U high, size E6 relay enclosure.

#### 7PG1110-7AE10 CT Shorting Relay

C.T. Supervision and Shorting: Unbalance in any current-balance group due to an open-circuited current transformer, the primary of which is carrying load current, produces a voltage across the relay circuit. This causes a spill current to flow and leads to instability of the protection. This condition is monitored using a sensitive element, either within the main protection relay or as a stand alone device.

CT supervision is especially recommended for protections applied to High Voltage switchgear and for schemes at all



[Sc\_7SR23\_Auxiliary, 1, ...]

Figure 6.1/1 7XG15 and 7PG1110-7AE10

voltages where current transformers are switched to accommodate different busbar arrangements.

When an unbalance is detected, the alarm element is used to operate a suitably rated CT shorting relay, which will prevent any protection maloperation. The relay is arranged to short circuit the CT secondary wiring, diverting current from the protection relay and preventing its operation.

The 7PG1110-7AE10 (AR901) CT shorting relay is such a device, its contacts are rated to carry in excess of 50 A for three seconds, which is suitable for the majority of installations.

This relay is supplied in a 4U, size E2 relay enclosure.

### Applications

Auxiliary units for High impedance Busbar and Auto transformer protection.

Used in conjunction with the 7SR23 High Impedance Protection Relay, the High Impedance Component Box 7XG15 and its associated CT Shorting Relay 7PG1110-7AE10 provides a complete, panel mounted solution for the provision of High Impedance Protection.

Features of the system include: CT supervision using elements within the 7SR23.

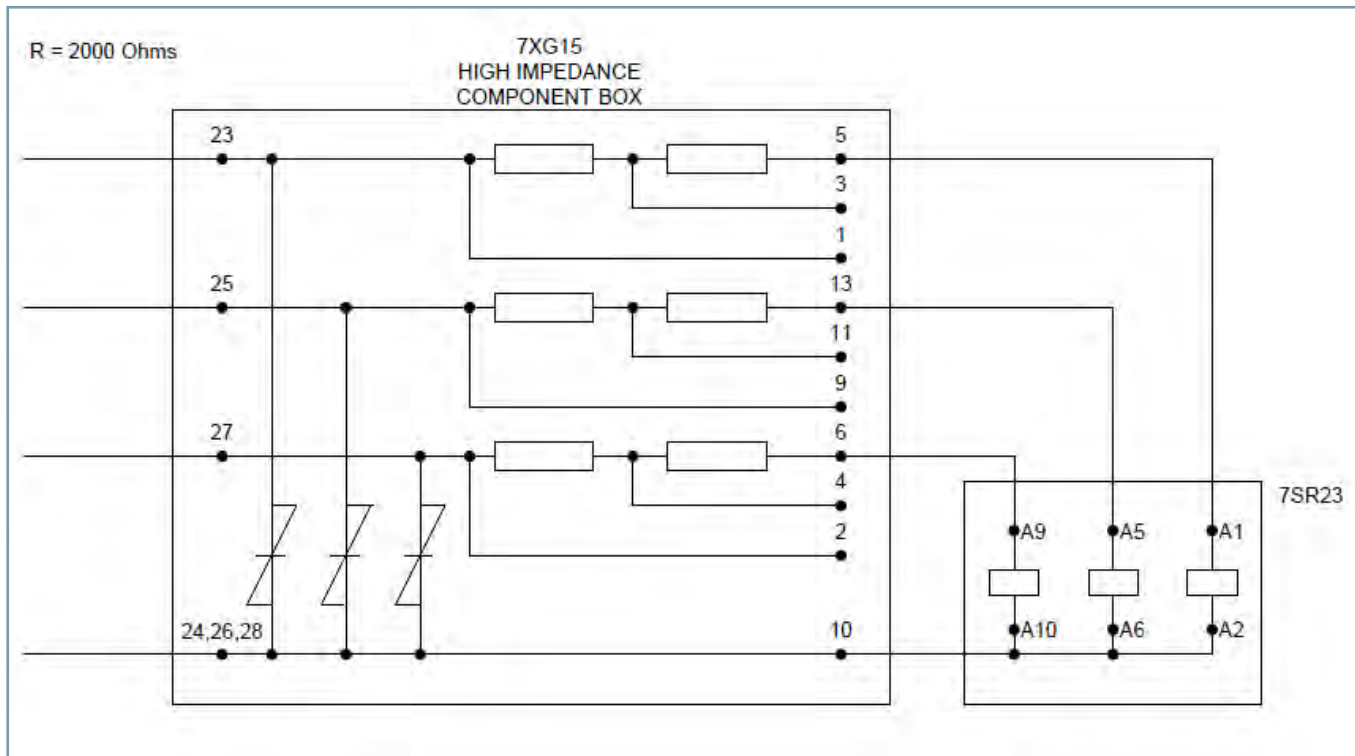
Provision of test points on the front panel of the Component Box.

CT shorting on the detection of a CT fault, and whenever a protection operation occurs. This limits the dissipation of the resistor and metrosil networks within the protection panel.

# High Impedance Protection Accessories

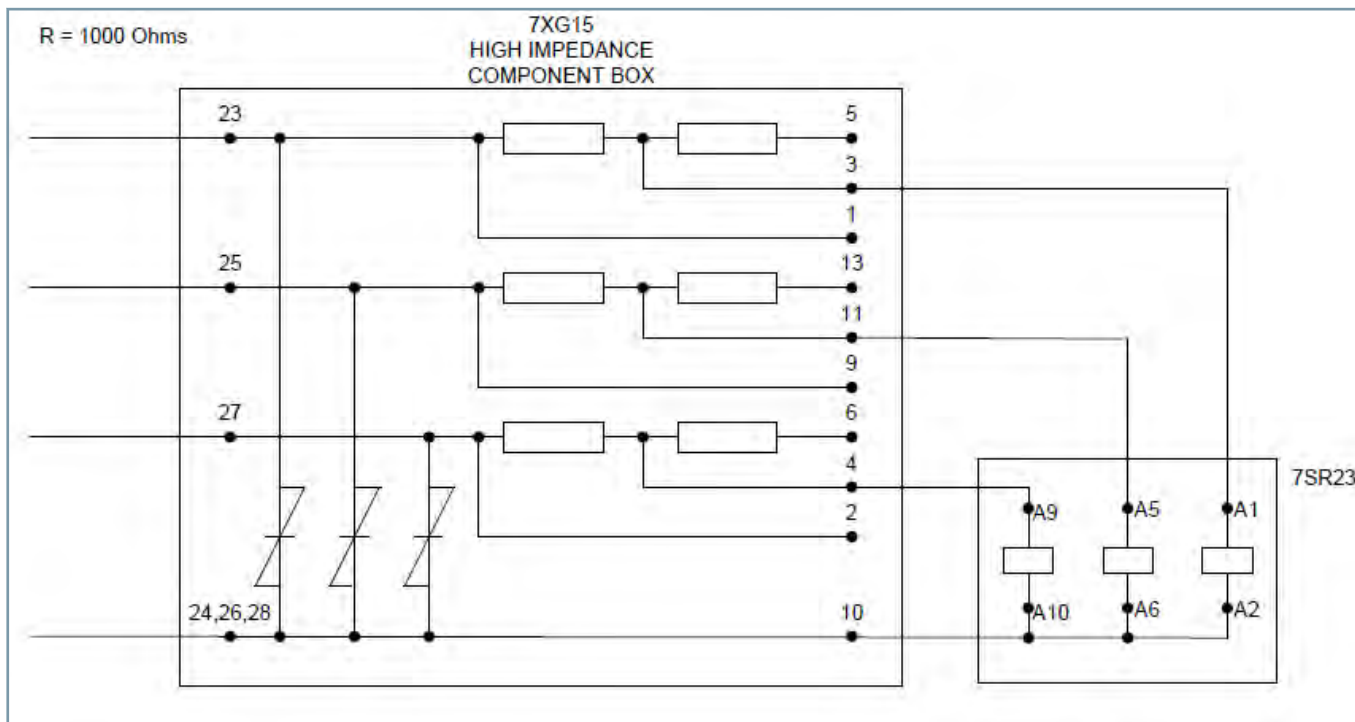
Auxiliary Units – 7XG15 and 7PG1110-7AE10

## Connection Diagrams



[6C\_7XG15\_2000\_1\_...]

Figure 6.1/2 7XG15 High Impedance Component Box - 2000 Ohms



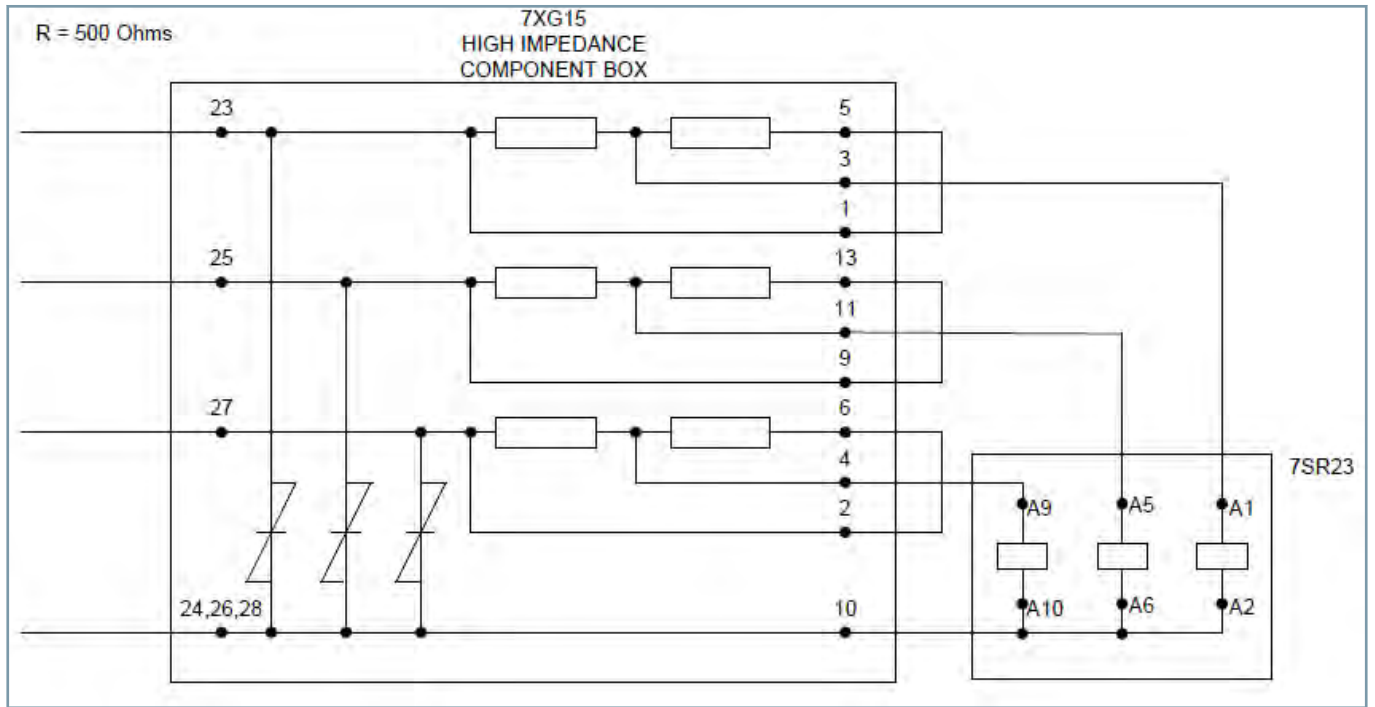
[6C\_7XG15\_1000\_1\_...]

Figure 6.1/3 7XG15 High Impedance Component Box - 1000 Ohms

6.1

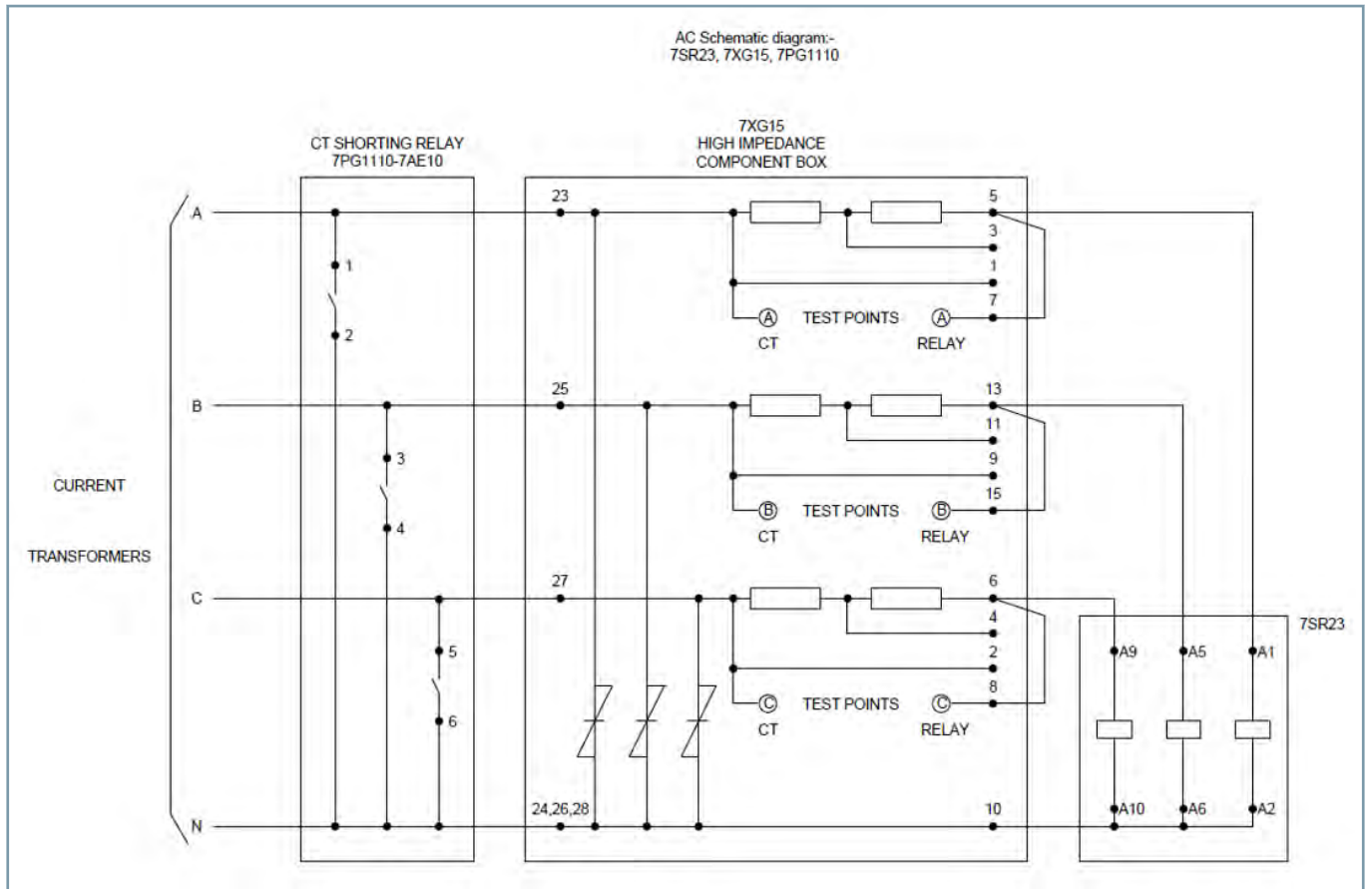
# High Impedance Protection Accessories

Auxiliary Units – 7XG15 and 7PG1110-7AE10



ISC\_7XG15\_500\_1\_1\_1

Figure 6.1/4 7XG15 High Impedance Component Box - 500 Ohms



ISC\_7XG15\_7PG1110\_AC\_1\_1\_1

Figure 6.1/5 7SR23, 7XG15, 7PG1110 AC Schematic Diagram

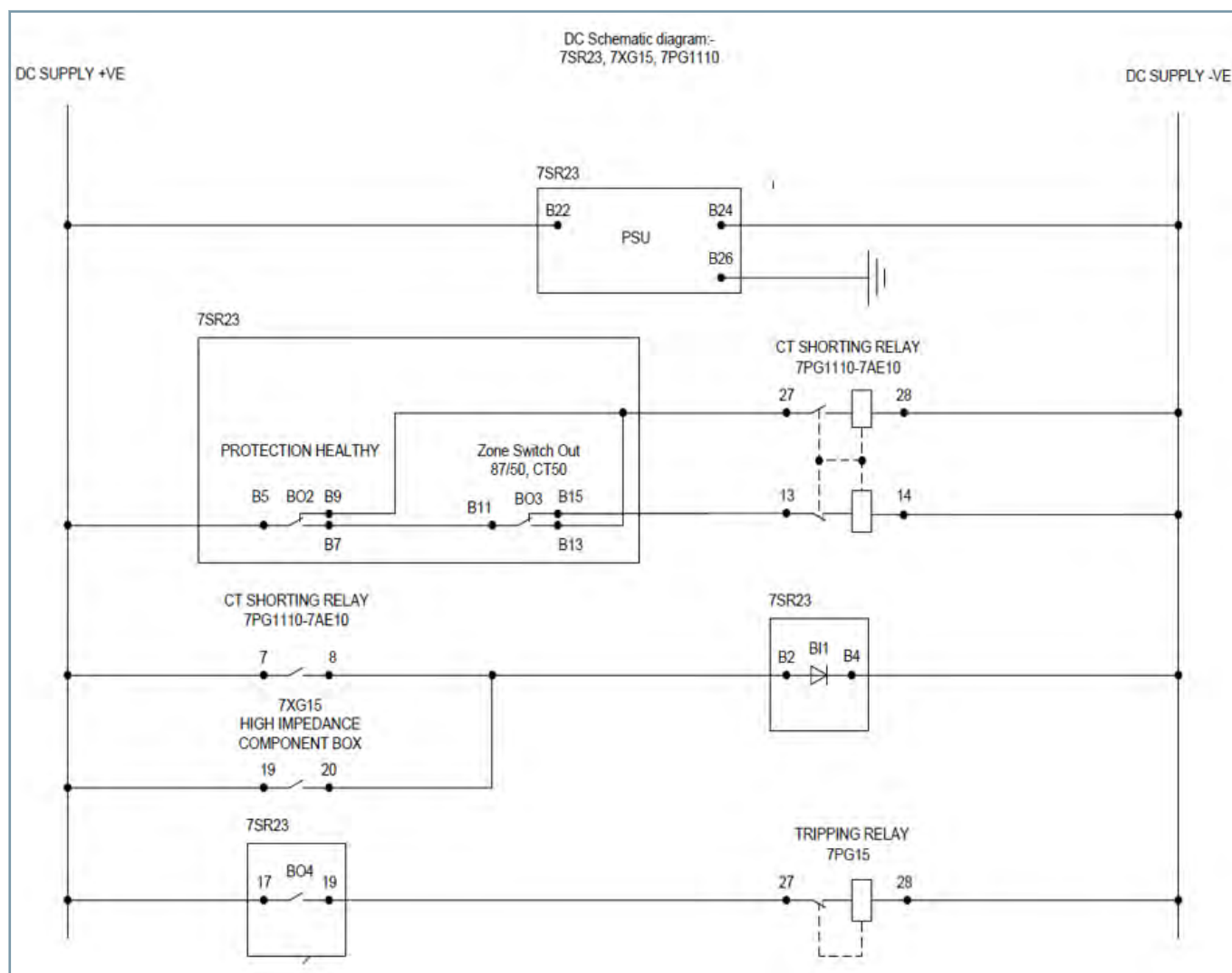


### NOTE

7SR23 DAD connections to the 7XG15 unit are correct for a setting resistance of 2000 Ohms. These connections must be varied on the 7XG15 unit where the alternative values of 1000 or 500 Ohms are required for a given application.

The CT Shorting Relay and the 7XG15 unit are both fitted with case shorting contacts. In the event that either device is withdrawn, the Current Transformers are automatically short circuited and indication is given by the 7SR23.

The 7XG15 unit is designed to be used in conjunction with the 7PG11 CT Shorting Relay. Do not use the 7XG15 unit without a CT shorting relay, or with alternative scheme connections.



BC\_7XG15\_7PG11\_DC\_1\_[-]

Figure 6.1/6 7SR23, 7XG15, 7PG1110 DC Schematic Diagram

# High Impedance Protection Accessories

## Auxiliary Units – 7XG15 and 7PG1110-7AE10



### NOTE

The rated DC voltage of the CT Shorting Relay and the 7SR23 DAD (Power Supply and Binary Inputs) must be compatible with the available auxiliary supply.

On the 7SR23, Binary Input 1 must be suitably mapped to provide a self –reset LED indication that the CT Shorting Relay is operated, and the protection is temporarily out of service (until the CT Shorting Relay Resets).

The CT Shorting Relay and the 7XG15 unit are both fitted with case shorting contacts. In the event that either device is withdrawn, the Current Transformers are automatically short circuited and indication is given by the 7SR23.

Binary Outputs on the 7SR23 are to be mapped as indicated. This is to allow automatic operation of the CT Shorting Relay as required by the scheme.

BO3 must be configured as hand reset. The protection is reset from the keypad on the 7SR23, this will also reset the CT shorting relay and indication.

CB Trip is to be via a latched Trip Relay.

This maximum voltage can be determined by means of a simple calculation which makes the following assumptions

- One current transformer is fully saturated making its excitation impedance negligible.
- The resistance of the secondary winding of the saturated CT together with the leads connecting it to the relay circuit terminals constitutes the only burden in parallel with the relay.
- The remaining current transformers maintain their ratio.

Thus the required relay operating voltage is given by:

$$V_S \geq I_F (R_{CT} + R_L) \cdot T$$

[To\_Function87GHApplication&SettingsFunction1, 1, en\_US]

Where:

$V_S$  = Relay circuit setting voltage

$R_L$  = The largest value of pilot loop resistance between the CT and the relay circuit terminals.

$R_{CT}$  = The secondary winding resistance of the CT.

$I_F$  = The CT secondary current corresponding to the maximum steady-state through-fault current of the protected equipment.

$T$  = Turns ratio of all current transformers (Primary turns / Secondary turns)

Method of establishing the value of relay setting resistors.

To give the required voltage setting the relay operating level is adjusted by means of an external series resistor as follows:

$$R_{STAB} = \frac{V_S}{I_S}$$

[To\_Function87GHApplication&SettingsFunction4, 1, en\_US]

Where:

$R_{STAB}$  = Resistance of the stabilising resistor

$V_S$  = Relay circuit setting voltage

$I_S$  = Relay setting current

### Fault Setting

The fault setting of a current –balance protection using a high impedance relay circuit can be calculated in the usual manner. It should, however, be noted that because the operating voltage of the relay circuit is relatively high, the excitation currents of the CTs in parallel with the relay may comprise a large portion of the fault setting.

Thus, if  $I_S$  = the relay setting current, and  $I_1, I_2, I_3$  etc are the excitation currents of the CTs at the setting voltage, and  $T$  is the CT turns ratio then Primary Operating Current =  $(I_S + I_1 + I_2 + I_3) \times T$

### Technical Data

7XG15	
Stabilising resistor values	2000, 1000, or 500 $\Omega$
Non-linear resistor	C = 1000, B = 0.22 to 0.25
Pressure tests	2 kV for 1 minute between phases, and all circuits to earth
Shock, bump, vibration, and seismic tests	IEC 60255-21-1,2,3
7PG1110-7AE10	
Make and carry for 3 s	50 A
Break	300 VA within the limits of 250 V and 5 A

### Cases

Modular Cases	
7PG1110-7AE10 relay	E2
7XG15 high impedance component box	E6

### Determination of Stability

The stability of a current balance scheme using a high impedance relay circuit depends upon the relay voltage setting being greater than the maximum voltage which can appear across the relay under a given through fault condition.

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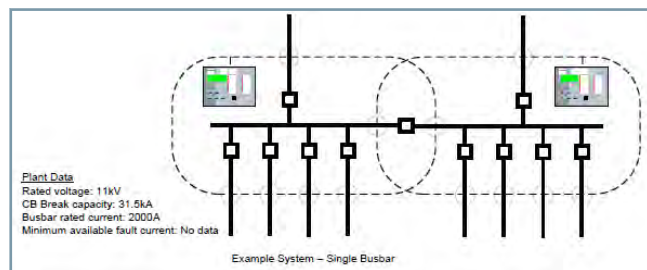
### Current Transformer Requirements

The basic requirements are:

- All CTs should have identical turns ratios.
- The knee point voltage of the current transformers should be at least twice the relay setting voltage. The knee point voltage is expressed as the voltage applied to the secondary circuit of a current transformer which when increased by 10 % causes the magnetising current to increase by 50 %.
- The current transformers should be of the low leakage reactance type to IEC 60044 class PX. Generally most modern current transformers are of this type and there should be no difficulty in meeting this requirement. Low leakage reactance current transformers have a jointless core with the secondary winding evenly distributed along the whole length of the magnetic circuit, and the primary conductor passes through the centre of the core.

See also the 7SR23 relay manual, applications section. (Chapter 7, Section 3)

### Example: 3-Pole Differential Busbar Protection



[sc\_Plant\_Data, 1, ...]

### Setting Requirements

Assigned through fault current (rated stability limit) = 31.5 kA (CB break capacity)

Required Fault Setting (Primary Operate Current)

- Approximately 50% of busbar rating, or
- 10 to 30 % of minimum fault current available, or
- As specified by the user

From the supplied plant data a primary operate current (POC) of 1000 A is chosen.

CT and Connection Details	
Turns ratio (T)	1/2000
Voltage knee point ( $V_K$ )	600 V
Magnetising current ( $I_{mag}$ ) @ $V_K$	100 mA
CT secondary resistance ( $R_{CT}$ )	10 $\Omega$
CT lead loop resistance ( $R_L$ )	0.15 $\Omega$ max

7SR23 Relay	
87/50-1 Element	Enabled
87/50-1 Current setting	0.365 A
87/50-1 Delay setting	0 s
CT50 Element	Enabled
CT50 Setting	0.02 A
CT50 Delay	3 s

Auxiliary Component Box	
$R_{STAB}$	500 $\Omega$
Metrosil	75 mm, c = 1000

Control Scheme Settings for 7SR23	
Protection healthy	BO2
87/50-1 Operated	BO3
CT50 Operated	BO3
Zone switch out	BO3
BI 1 Operated	L8
Self reset LED	L8 (L8 to be marked as "CT Shorting Relay Operated")
BO3 Minimum operate time	5 s

# High Impedance Protection Accessories

Auxiliary Units – 7XG15 and 7PG1110-7AE10

## Ordering Information - 7PG111 Auxiliary Relay (AR901)

Product Description	Order No.																	
	1	2	3	4	5	6	7	-	8	9	10	11	12	-	13	14	15	16
Auxiliary relay (AR901)	7	P	G	1	1	1	0	-	7	A	E	1	0	-	0	A	□	0
DC voltage operated relay																		
<u>Number of Elements</u>																		
Single element						1												
<u>Type of Flag</u>																		
No flag							0											
<u>Contact Operation</u>																		
CT shorting contacts									7									
<u>Contact Arrangement – NO</u>																		
0 NO										A								
<u>Contact Arrangement NC</u>																		
4 NC											E							
<u>Number of Contacts</u>																		
Four												1						
<u>Contact Type</u>																		
NO (Standard) / NC (Standard)													0					
<u>Time Delay</u>																		
No additional time delay															0			
<u>Housing Size</u>																		
Case size E2 (4U high)																A		
<u>Voltage Rating</u>																		
DC 30 V																	C	
DC 50 V																		D
DC 125 V																		F
DC 240 V																		H
<u>Back EMF Suppression Diode</u>																		
Not fitted																		0

6.1

# High Impedance Protection Accessories

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## Ordering Information - 7XG15 High Impedance Component Box

Product Description	Order No.																	
	1	2	3	4	5	6	7	-	8	9	10	11	12	-	13	14	15	16
Component Box	7	X	G	1	5	2	0	-	3	A	A	0	0	-	0	D	A	0
Setting resistor and metrosil unit for 7SR23																		
<b>High Impedance Protection.</b>																		
<u>Disc size, number of phases</u>																		
Three inch, single phase						2												
<u>B value</u>																		
0.22 to 0.25							0											
<u>C value</u>																		
1000									3									
<u>Resistors</u>																		
2000/1000/500 Ohm										A								
Case size E6 (4U high)																D		