DIFFERENTIAL HYBRID CIRCUIT FOR CABINET MOUNTING

DESCRIPTION OF HPFA

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1 INTRODUCTION

1.1 GENERAL

The differential hybrid circuit for cabinet mounting type HPFA is mainly used to connect a Power Line Carrier (PLC) terminal to two or three phases of a power line in order to improve the reliability of transmission.

The HPFA can also be used in the parallel coupling of two PLC terminals which use adjacent frequency-bands, in order to avoid interferences between them due of the increased number of channels transmitted on the same physical medium.

1.2 CONSTITUTION

FIGURE 1 shows the electrical circuit of the HPFA unit.

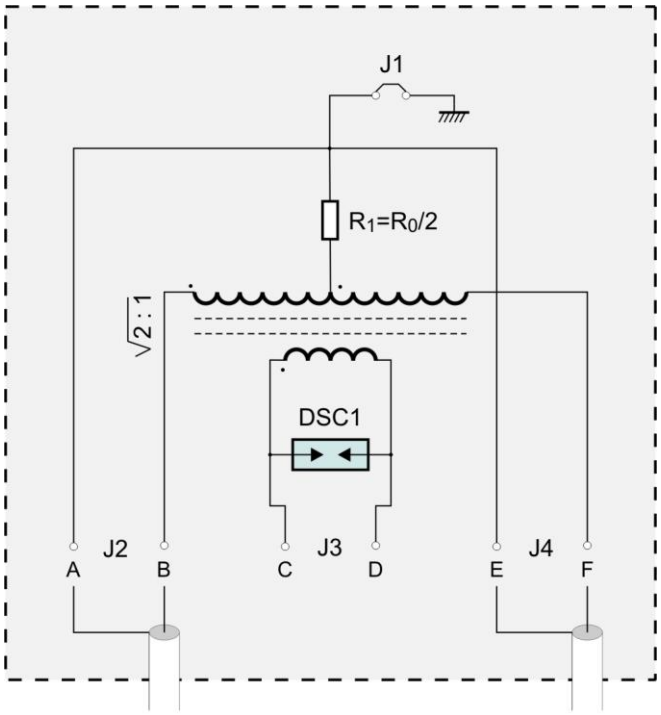

FIGURE 1 Electrical schema of the HPFA circuit

The HPFA circuit is made of one differential transformer, with a 1:$\sqrt{2}$ turn ratio between primary and secondary windings, and a resistor, the value of which is half that of the nominal impedance of the equipment, connected between the centre tap of the secondary-winding and the terminal for connecting the shield of the coaxial cables to earth. This resistor only dissipates power if one of the phases used fails.

Contains three connections, a central (C-D terminals of J3) which, in the case of phase-to-phase links, is connected to the PLC equipment, and two connections (A-B terminals of J2 and E-F of J4) which, in the case of phase-to-phase links, is connected to the coupling unit of each phase, see FIGURE 7. The location of these connections is shown in FIGURE 2.

For higher security when connecting two PLC equipment to the same line, includes a gas surge arrester (DSC1) connected between equipment-side terminals.

All the above elements are mounted on a metal plate of 3 s.u. in height, prepared for fixing to the rails located inside the back wall of a cabinet.

Two differential hybrid circuits type HPFA are needed for three-phase coupling, see FIGURE 8.

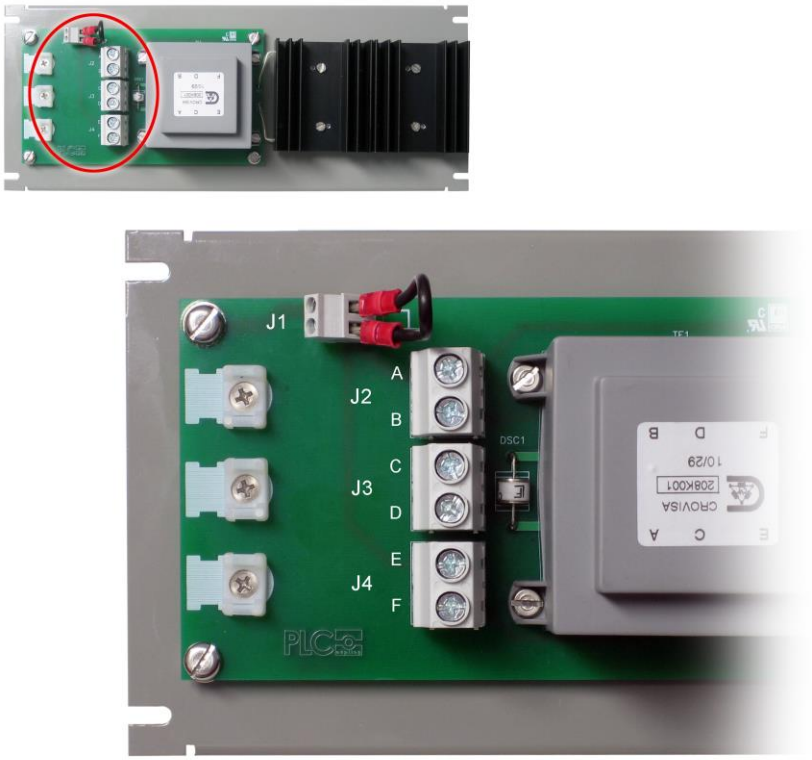

FIGURE 2 Location of the J2, J3 and J4 connections

1.3 TECHNICAL CHARACTERISTICS

1.3.1 Electrical characteristics

Application	Phase-to-phase coupling Two PLC terminals coupling Three-phase coupling
Nominal impedance (equipment side)	50 or 75 Ω. Others on request
Bandwidth	40 ÷ 500 kHz
Nominal peak-envelope power	400 W
Distortion and intermodulation	Better than 80 dB below the level corresponding to the nominal power
Insulation between primary and secondary windings	>2,5 kV_{rms} / 50 Hz
Insulation between the connection terminals and chassis	>1.5 kV_{rms} / 50 Hz
Composite loss	< 0.3 dB in the whole band
Return loss	> 25 dB in the whole band
Gas surge arrester (equipment side)	
Type	CG2-350L
Sparkover voltage	350 V_{rms}
Discharge current	20 kA_{rms} (8/20 μs)

1.3.2 Operating conditions

Temperature and humidity	From –25 °C to +55 °C and relative humidity not greater than 100%, in accordance with IEC 870-2-2 class C3 (climatogram 3K7)

1.3.3 Mechanical characteristics

Connection terminals	Screwed terminals. Suitable for flexible conductors of 0.5 to 10 mm^2 and rigid conductors of 0.5 to 16 mm^2
Dimensions	See FIGURE 3
Weight	1.9 kg

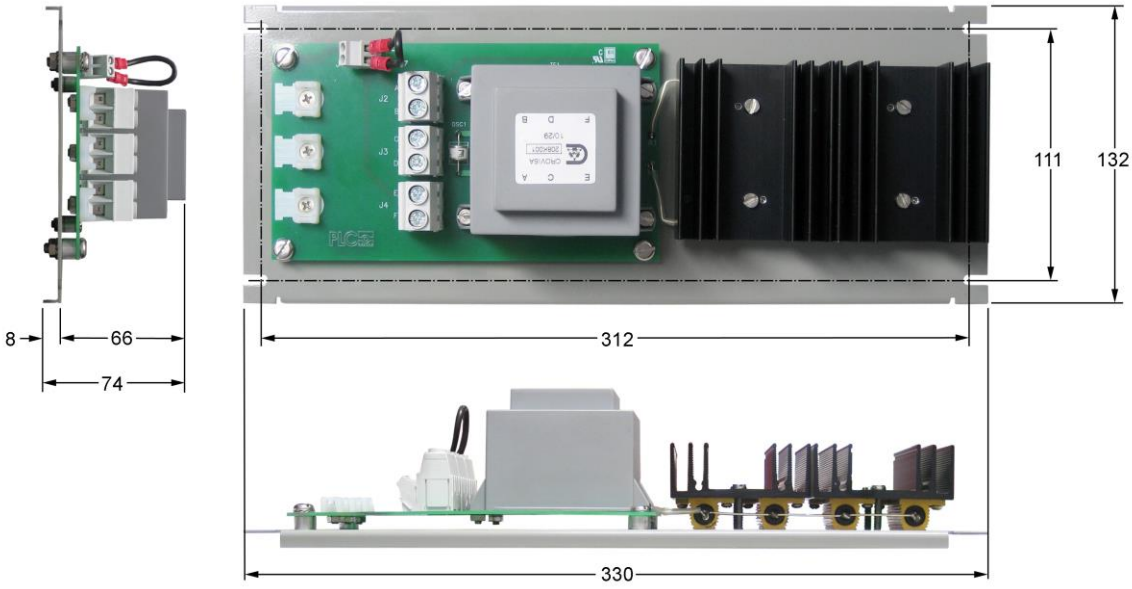

FIGURE 3 General dimensions in mm of the HPFA circuit

2 LINE COUPLING

The main functions done by the hybrid circuit are the 4-wire/2-wire conversion and the electric insulation between the inputs of the secondary winding. The following sections explain the use of these properties in the two kind of applications in which the HPFA circuit is used.

2.1 PHASE-TO-PHASE OR THREE-PHASE COUPLINGS

The phase-to-phase or three-phase coupling modes distribute the power among the coupled phases, as can be seen in FIGURE 4 and FIGURE 5.

The differential transformer, besides effecting this distribution, insulates the phases at the carrier frequency. For this reason, a fault in one of the phases used causes only a reduction in the received power, regardless of whether the fault is a short-circuit to ground or an open-circuit. Additional attenuation under fault is about 6 dB for phase-to-phase coupling, while for three-phase coupling may be from 2.5 dB if a single outer-phase fails to 12 dB if a centre-phase and one outer-phase fail simultaneously.

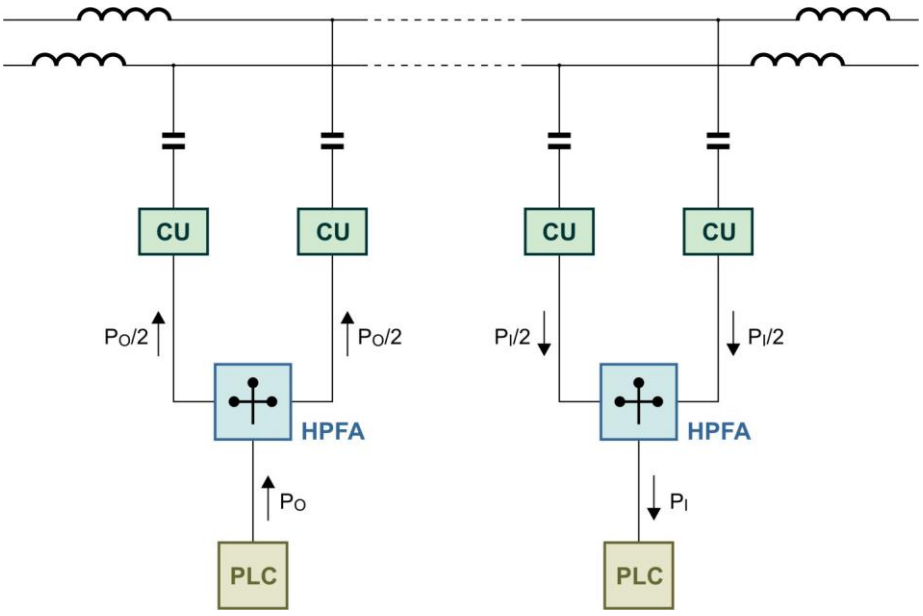

FIGURE 4 Power distribution in a PLC link with phase-to-phase coupling

As can be seen in FIGURE 5, for three-phase coupling two HFPA circuits are required.

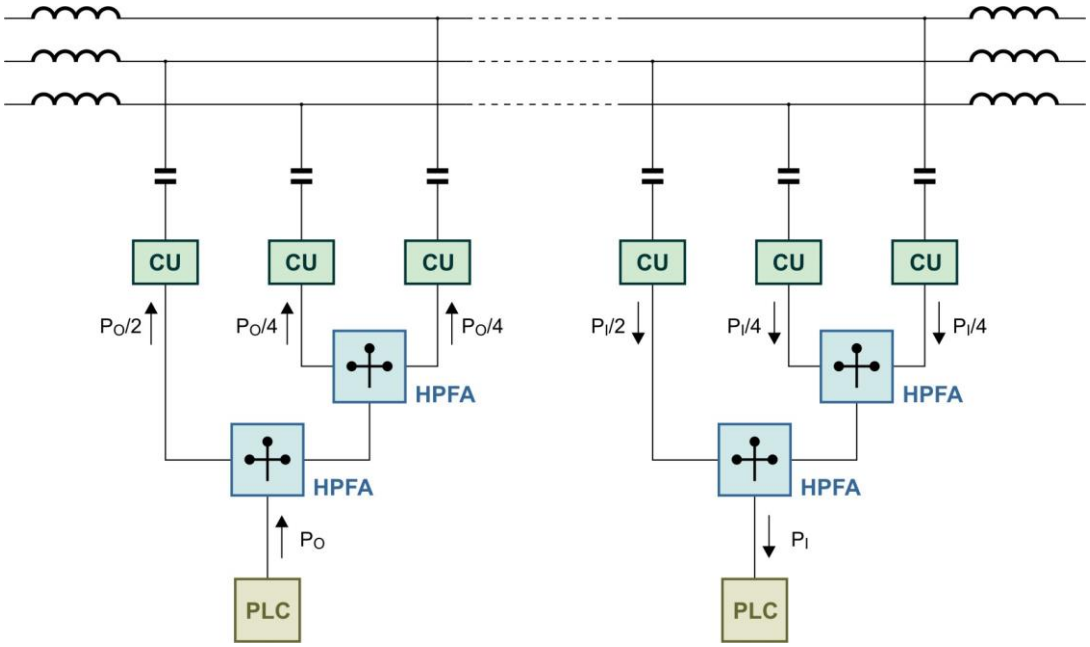

FIGURE 5 Power distribution in a PLC link with three-phase coupling

2.2 PARALLEL COUPLING OF TWO PLC TERMINALS

The HPFA circuit can be used for coupling two PLC-equipment to the same transmission medium without noticeable interaction between them. As can be seen in FIGURE 6, HPFA units act as hybrid circuits, and so introduce 3 dB transmission losses at each end of the link.

This kind of coupling is normally used for PLC terminals whose bands are contiguous or very close. If the occupied bands are sufficiently far apart, the output filters of the PLC terminals perform the separating function and so there is no need to use a HPFA circuit.

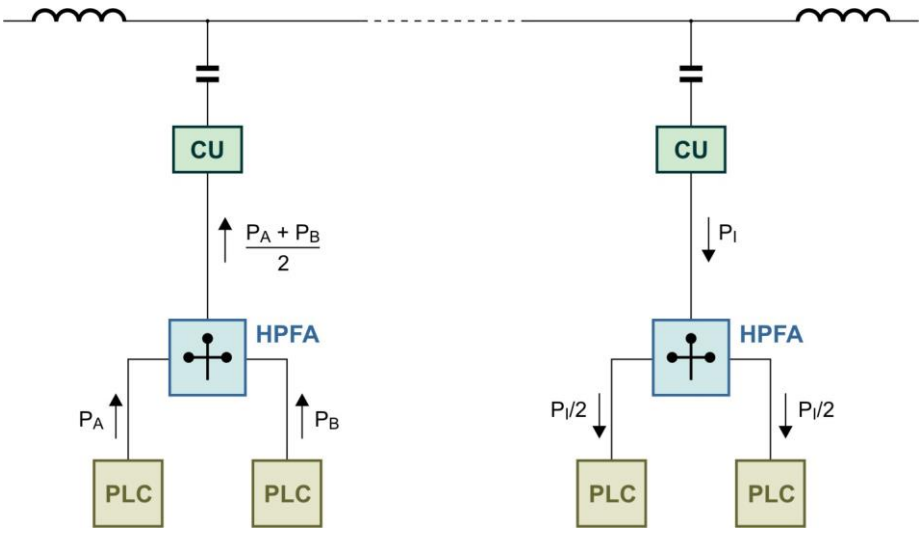

FIGURE 6 Transmitted and received power through hybrids when coupling two PLC terminals with adjacent frequency-bands

3 INSTALLATION

As can be seen in chapter 2, the HPFA circuit can be used for phase-to-phase coupling, for three-phase coupling and for the parallel coupling of two PLC terminals.

The following sections describe the connections to be carried out according to the type of coupling to the line.

3.1 PHASE-TO-PHASE COUPLING

The electrical schema for a phase-to-phase coupling is shown in FIGURE 7.

Strap J1 of HPFA allows to connect the shield of the coaxial cables connected to the coupling units to ground.

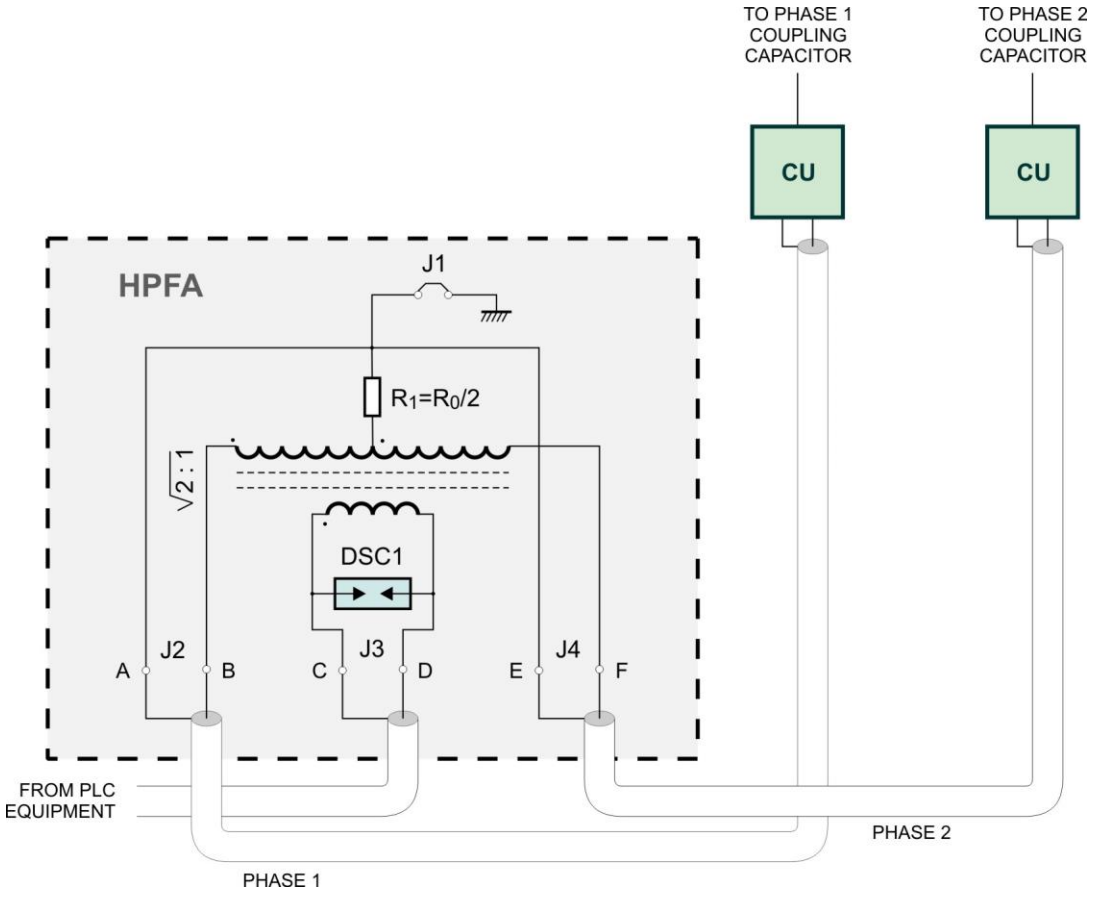

FIGURE 7 Connections for phase-to-phase coupling

3.2 THREE-PHASE COUPLING

Two HPFA circuits are required for three-phase coupling. FIGURE 8 shows the connections for a three-phase coupling.

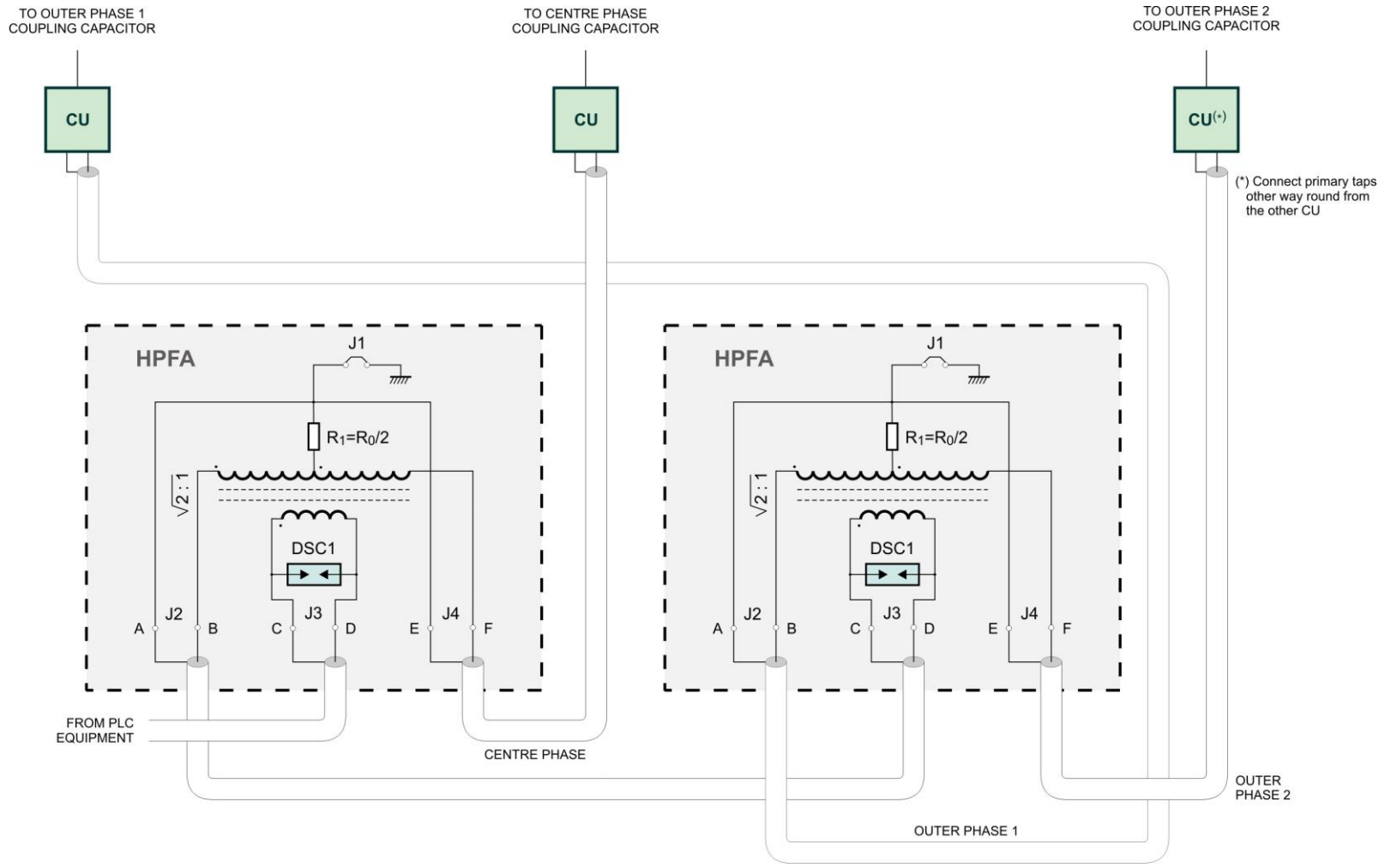

FIGURE 8 Connections for three-phase coupling

It must be noticed that in a three-phase coupling signals applied on external wires must have the same phase between them, and so must be in opposite phase in relation to the central conductor signal. Given that the hybrid of the second HPFA circuit inverts the signal at OUTER PHASE 2 branch, a second inversion of this signal must be carried out in the coupling unit to achieve a proper operation. Thus, the primary windings of the outer-phase matching transformers shall be connected in opposite way.

In the three-phase couplings, the shields of the coaxial cables which link the coupling units to the differential transformer may be connected to the ground terminal by setting the J1 strap.

3.3 PARALLEL COUPLING

The parallel coupling of two PLC-terminals can also be achieved with the HPFA circuit.

For this kind of coupling, the PLC terminals are connected to the secondary winding, and the coupling unit to the primary.

The wires that connect the equipment can be grounded through strap J1.

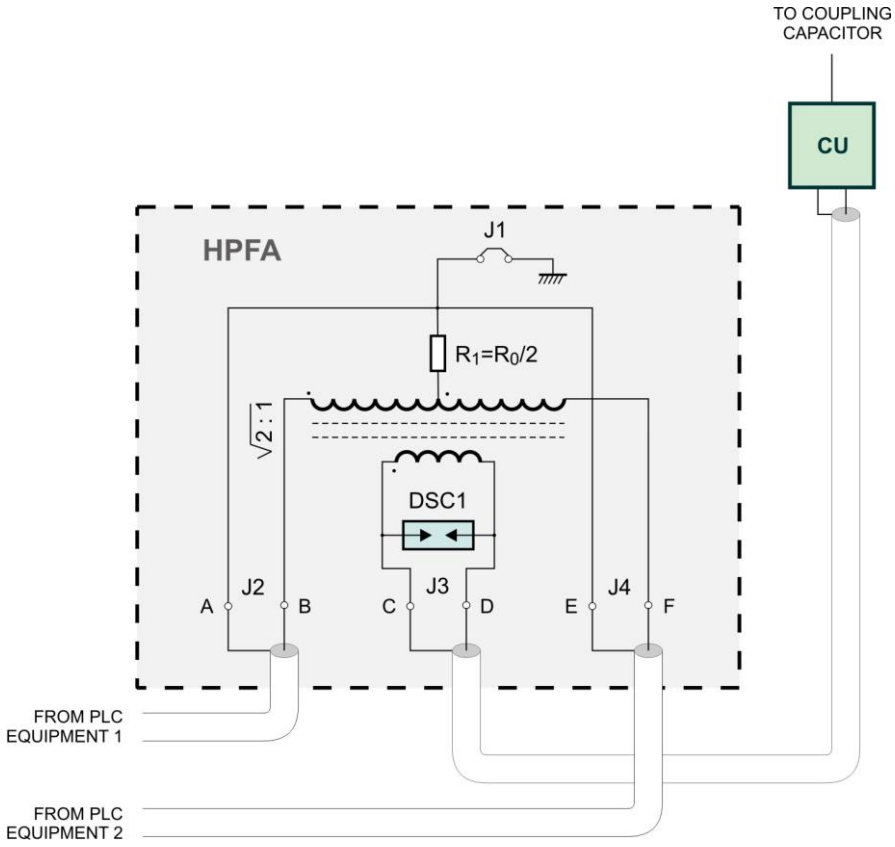

FIGURE 9 Connections for parallel coupling of two PLC-terminals