Modular Coupling Devices
MCD80
Power Line Carrier Communication

Principle of PLC Coupling

Phase-to-phase coupling is normally used due to the better performance, e.g. during line faults.
Modular Coupling Devices
MCD80

Elements of Coupling Devices

• Surge arrester for transients protection at the primary terminals of coupling device.
• Drain coil for draining of power frequency currents to earth.
• Earthing switch for direct and efficient earthing of primary terminals.
• Transformer for matching and galvanic isolation between primary and secondary terminals of coupling device.
• High-pass or band-pass filter elements for optimum matching.
• Coaxial cable to PLC equipment in cabinet.
Coupling Components

Principle of PLC Coupling

1. Surge arrester
2. Drain coil
3. Earthing switch
4. Transformer for impedance matching and galvanic isolation
5. High-pass or band-pass filter elements
6. Coaxial cable to PLC equipment - MCD80 coupling unit
Single Phase Coupling
Principle of PLC Coupling

Substation
- Line trap
- Coupling device MCD 80

HV-line
- Coupling capacitors
- A9BS or A9BP

Cabinet
- PLC equipment
  - Tx
  - Rx
Phase to Phase Coupling

- 2 single phase coupling devices
- Hybrid transformer for decoupling of signals and generation of push-pull signals
Modules of Coupling Equipment
Units and optional modules

- High-pass coupling filter A9BS
- High-pass coupling filter with hybrid transformer A9BT
- Band-pass coupling filter A9BP
- Band-pass coupling filter with hybrid transformer A9BR
- Attenuator A1AD
- Impedance transformer A1AE
- Separating filter A9CA
- Shunt tuning filter E9AA
High-Pass Coupling Device

A9BS

Special settings available for upper frequency of 1000 kHz
Tuning Characteristics

High-Pass Coupling Filter A9BS/A9BT

Composite loss $A_c$ and Return loss $A_r$

Coupling capacitance $C_k$ 4.7 nF  Nominal line impedance $Z_1$ 240 Ω
Lower cut-off frequency $f_1$ 80 kHz  Nominal return loss $A_r$ 12 dB
Upper cut-off frequency $f_2$ 500 kHz  Nominal composite loss $A_c$ 2 dB
High-Pass Coupling Filter

A9BS - Programmable

A9BT - Programmable, with 1 additional module
Band-Pass Coupling Device

The attainable frequency ranges can be calculated

\[
f_2 = \frac{f_1}{1 - 2.5 \times 10^{-7} \times \pi \times f_1 \times C_k \times Z_1 \over C_k + 1.0 \times 10^{-7}}
\]

- \( f_1 \) = lower frequency limit [Hz]
- \( f_2 \) = upper frequency limit [Hz]
- \( C_k \) = coupling capacitance [F]
- \( Z_1 \) = impedance of overhead line [Ω]
- \( Z_2 \) = equipment side impedance [Ω]
# Features of Coupling Equipment

<table>
<thead>
<tr>
<th>Feature</th>
<th>Benefit</th>
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<tbody>
<tr>
<td>Modularity</td>
<td>Compact unit with various modules to satisfy all coupling needs</td>
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<tr>
<td>Programmable</td>
<td>High-pass version permits field matching within a wide range of coupling capacitor values and different line impedances</td>
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<tr>
<td>High transmission power handling</td>
<td>Up to 1000 W PEP</td>
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<tr>
<td>Economical</td>
<td>Optimum utilization of coupling capacitance, versatile programming facilitates stocking of spares</td>
</tr>
<tr>
<td>Climate proof</td>
<td>Absolutely corrosion and weather proof owing to sealed polyglass housing</td>
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<tr>
<td>Maximum personnel protection</td>
<td>Insulated enclosure as well as design measures minimize electrical hazards</td>
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<tr>
<td>Standardized</td>
<td>Fulfill the standards according to: IEC 60481 (Coupling Devices for Power Line Carrier System) IEEE 643 (IEEE Guide for Power-Line Carrier Applications) ISO 9001 (Quality Management)</td>
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Carrier Combiner Unit A1AC

Phase to phase coupling with balanced hybrid in equipment room
PLC Link

PLC link performance data

At = Tapping loss of line trap
Ac = Composite loss of phase-phase coupling
Al = Composite loss of HV line
A = Overall attenuation of PLC link
PLC By-Pass Circuits

Straight through connection without local carrier equipment

\[ A_t = \text{Tapping loss of line trap} \]
\[ A_c = \text{Composite loss of phase-phase coupling} \]
\[ A = \text{Overall attenuation of by-passed signal} \]
\[ A = 4\ldots8 \text{ dB} \]
PLC By-Pass Circuits

By-pass circuit with local carrier in one direction using balanced hybrid A1AC

$A_t = \text{Tapping loss of line trap}$

$A_c = \text{Composite loss of phase-phase coupling}$

$A_h = \text{Composite loss of hybrid}$

$A = \text{Overall attenuation of by-passed signal}$

$A = 7...11 \text{ dB}$
PLC By-Pass Circuits

By-pass circuit with local carrier in one direction using separating filter A9CA

- $A_t = $ Tapping loss of line trap
- $A_c = $ Composite loss of phase-phase coupling
- $A_{sf} = $ Composite loss of separating filter
- $A = $ Overall attenuation of by-passed signal
- $A = 5...9$ dB

![Diagram of PLC By-Pass Circuits](image-url)
**PLC By-Pass Circuits**

By-pass circuit with local carrier in both directions using balanced hybrid A1AC

\[ A_t = \text{Tapping loss of line trap} \]
\[ A_c = \text{Composite loss of phase-phase coupling} \]
\[ A_h = \text{Composite loss of hybrid} \]
\[ A = \text{Overall attenuation of by-passed signal} \]
\[ A = 10\ldots14 \text{ dB} \]
PLC By-Pass Circuits

By-pass circuit with local carrier in both directions using separating filter A9CA

\[ A_t = \text{Tapping loss of line trap} \]
\[ A_c = \text{Composite loss of phase-phase coupling} \]
\[ A_h = \text{Composite loss of hybrid} \]
\[ A = \text{Overall attenuation of by-passed signal} \]
\[ A = 6\ldots10 \text{ dB} \]