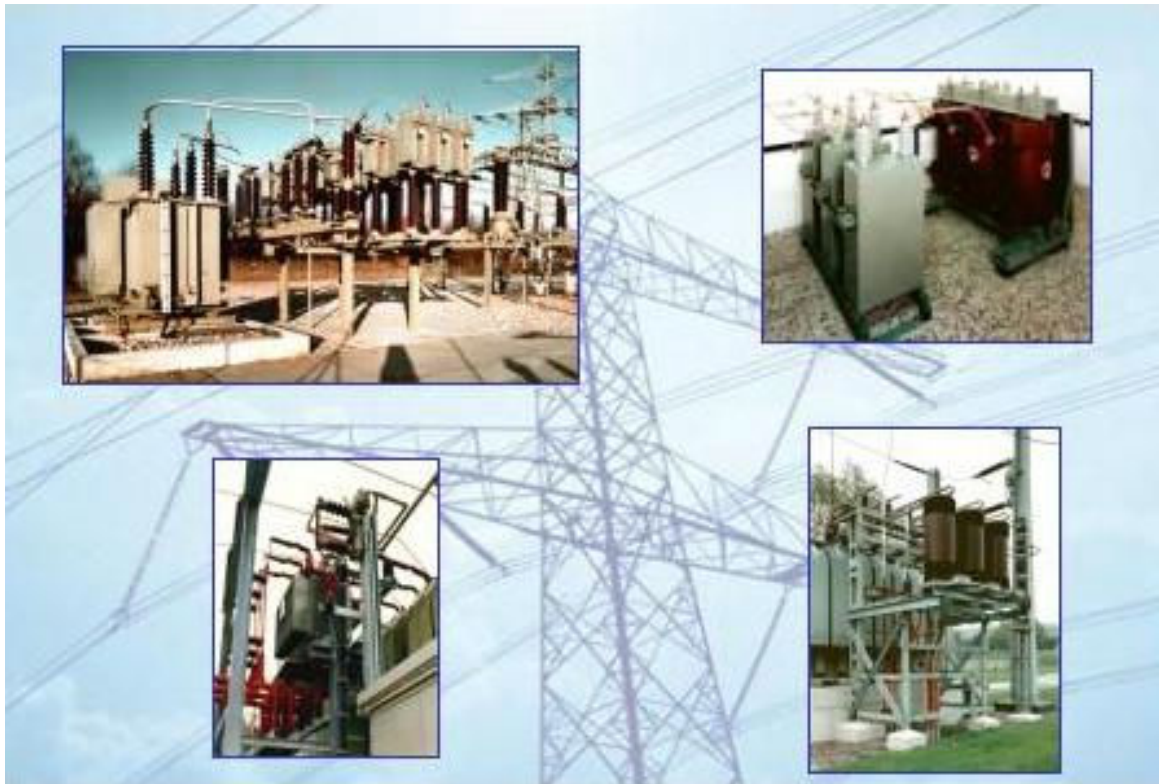


Ripple Control Couplings

RAP – RAT - RAW



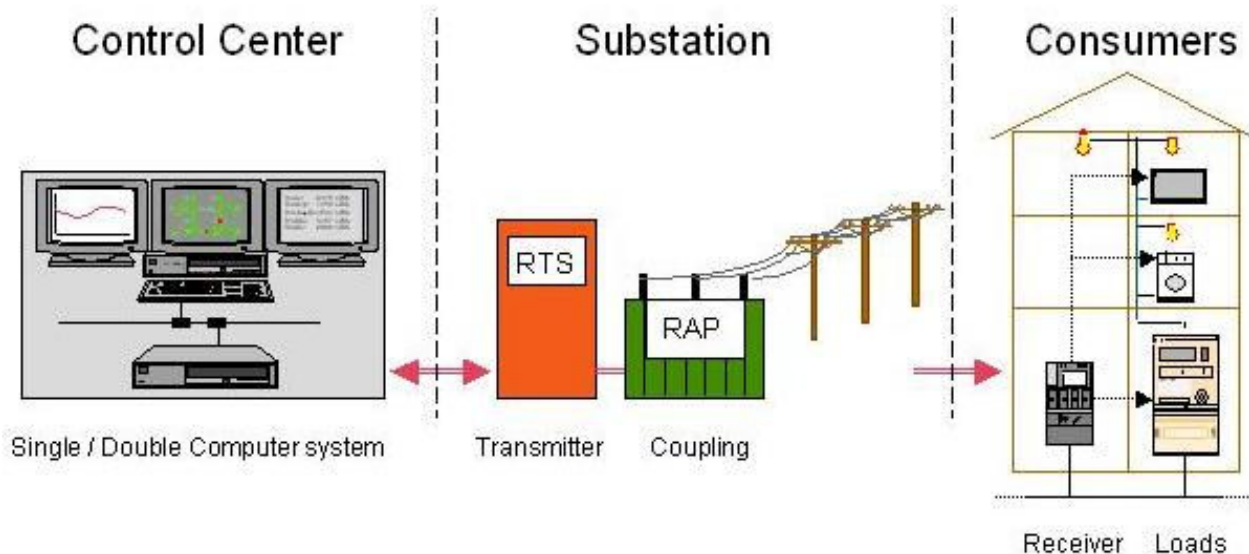
General

Ripple control is a perfect communication method for Load Management tasks. It is based on broadcast information where the power supply network is utilized as the transmission medium. The audio frequency (AF) is fed into the network via suitable coupling filters. This AF can be fed in series or parallel to the supply network at high, medium or low voltage level and is superimposed on the entire network.

The encoded commands are available at any point in the network and can be picked up by receivers, decoded and converted into switching commands. The choice of injection level (from 150 kV to 0,4 kV) is governed by economical and operational aspects. The design of the unique coupling is based on computer aided calculations of the 50/60 Hz network data for the selected audio frequency. This system is noteworthy for the reliability of communication that it requires no additional matching facilities (frequency traps) in the network.

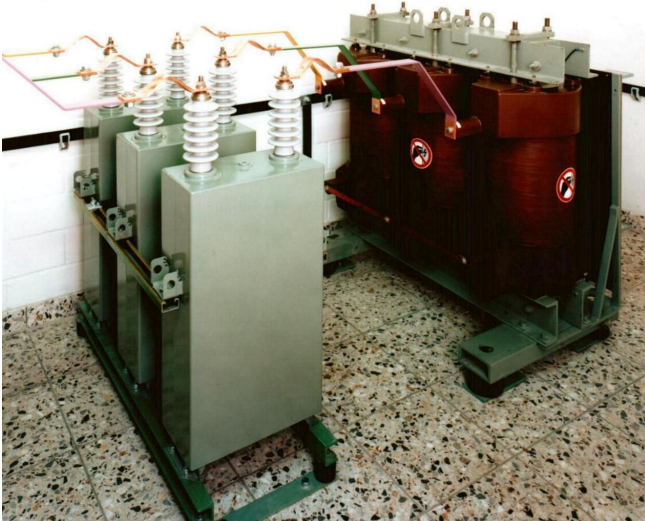
Operation of the power supply network is neither restricted nor affected by implementation of the Ripple Control System.

The AF coupling consists of filter circuits tuned to the frequency being used. Its task is to separate the power network galvanically from the AF transmitter and to damp repercussions from the network on the transmitter. The frequency generated by the AF transmitter must be transferred to the network with minimum losses and distortion. Modern Ripple Control Systems feature compact, space-saving design, low losses and complete freedom from maintenance.



Types of coupling equipment

Depending on the requirements the injection method may either be done by parallel coupling (which is today the most common) or by serial coupling. Both types of coupling are suitable for signal injection at medium or high voltage level. Usually parallel couplings are used for higher frequencies (> 200 Hz) and serial couplings are for lower frequencies < 250 Hz.



Parallel coupling RAP

The signal is injected in parallel to the network supply transformer. It consists of primary capacitors, coupling transformer, tuning and matching equipment on the LV side. The coupling transformer with iron core and air gap ensures excellent transmission characteristics and isolates the MV / HV network from the transmitter output circuit.

Serial coupling RAT

The ripple control signals are fed serial into the power supply of the medium voltage network via the RAT coupling. The inductivities of the RAT injection transformer and of the superimposed network are in series with the prevailing network load.

Two types of injection transformers are available: The RAT FGS transformer is casting raisin insulated, the RAT MRKE is oil insulated. Both are suitable for indoor as well as outdoor placement.

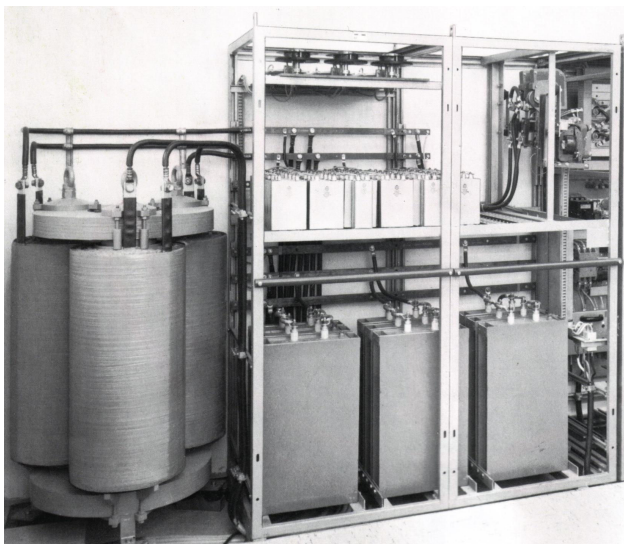


Serial coupling RAW

The signal is injected in series to the supply transformer. It consists of injection transformers, resonant circuit and short circuit devices. For the mains frequency the injection transformer serves as a current transformer and for the audio frequency as a power transformer.

Resonant circuits and injection transformers of the type RAW

In the majority of cases, at low frequencies, use is made of series coupling. ELSTER employs a combination of injection transformers and resonant circuits for this purpose.

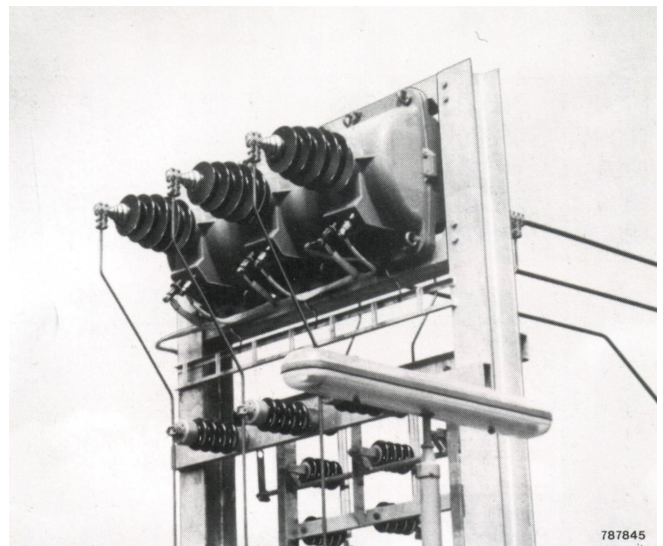


Functional Description

The injection transformers are connected in the power circuit and are, thus, in series with the 50/60 Hz power transformer. At the 50/60 Hz they act as a conventional current transformer, while at the audio frequency of injection, they become more transformers

The 50/60 Hz burden is made up of a series resonant circuit, which is tuned, to become a parallel resonant circuit at audio frequency, by means of an additional capacitor, in parallel, across same. The RAW is designed and constructed in accordance with the VDE specifications, as regards short-circuit power and interference / surge voltage ratings.

The injection transformers can either be mounted in outdoor switchyards or indoors, if required. The resonant circuit is installed, together with the ripple control transmitter, in an electrical switchgear room where less than 1000 V is permissible.



General Description of Parallel Coupling RAP

The parallel coupling RAP is designed to meet the following requirements:

- Low-loss transmission of the audio frequency signals
- Low losses during transmission pauses due to high Q-factor of coupling transformer
- Protection of transmitter against influences of the 50/60 Hz power distribution network
- Isolation of the low-voltage coupling section from the network to be controlled
- Tuning of the coupling on the LV side by use of tuning capacitors in parallel to the LV winding of the coupling transformer
- Basic tuning in the factory affords short commissioning time

The coupling consists of:

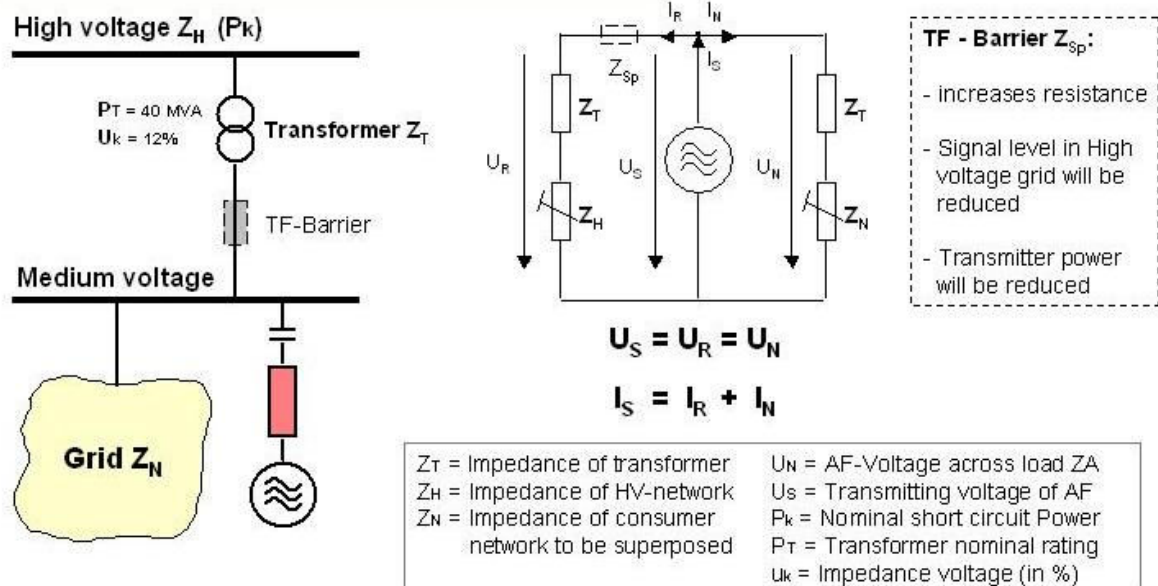
- The high-voltage capacitor C2 on the network side on which nearly the full 50/60 Hz voltage drops. The rating depends on network impedance, voltage and audio frequency.
- The capacitor C1 on the low-voltage side for nearly compensation of the audio frequency voltage drops occurring on the inductance of filter choke and LV winding on this side.

- The coupling transformer, which, together with C2 and C1, forms the primary and secondary resonant circuit. The coupling transformer also serves to insulate the HV network from the transmitter on the low-voltage side. By use of the HV winding of the transformer as part of the insulating transformer and as part of the HV series resonant circuit material can be saved.
- Protection and monitoring equipment.

Design and Operating Features

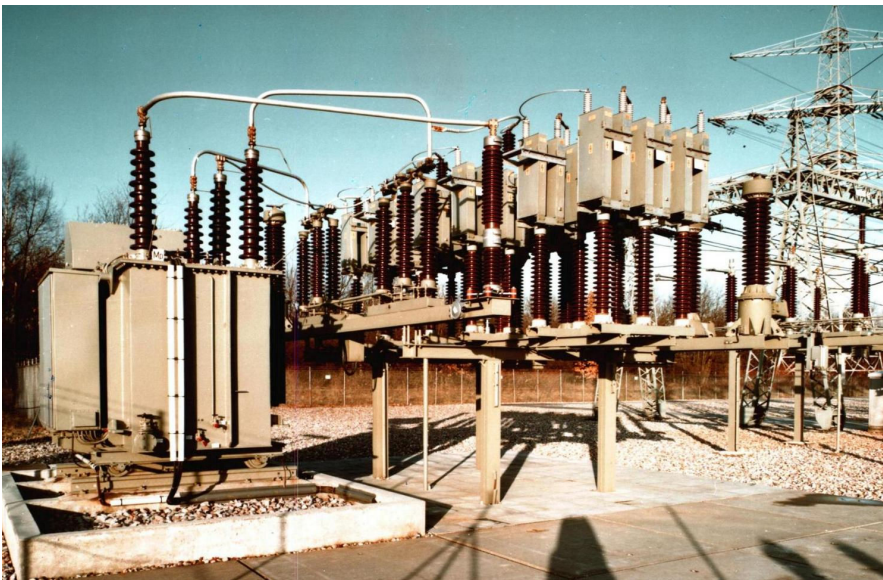
- The coupling transformer (reactance) with iron core and air gap ensures sufficient linearity of the magnetization characteristic for 50/60 Hz, control frequency and harmonic currents, so that good transmission properties are assured.
- The design of the coupling is such that installation in the immediate vicinity of iron parts and in areas of restricted space is possible.
- Due to the special design of the coupling, providing a low ohmic main reactance and high L2 / L1 ratio the 50/60 Hz system influences are reduced, so that no additional network frequency and harmonic wave traps are required to ensure perfect functioning of the transmitter. This is possible since the RAP coupling is having the advantages of loose and rigid coupling but is avoiding their disadvantages.

Principle of parallel injection

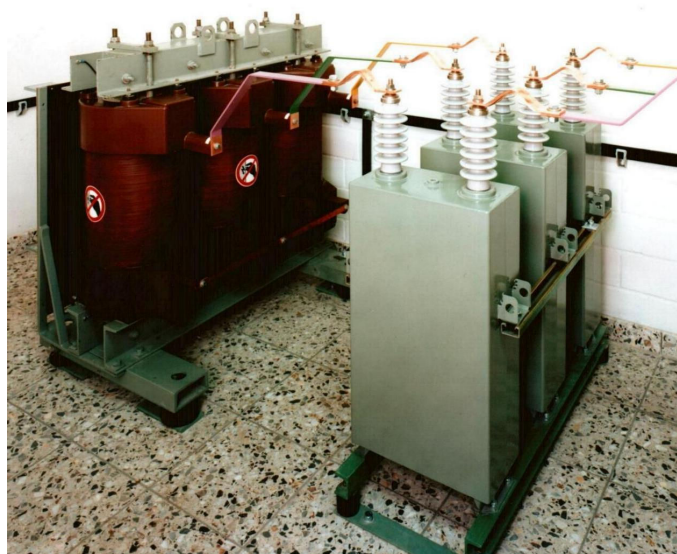


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110 kV Coupling RAP (HV)



20 kV Coupling RAP (MV)

Technical Data

Contractual features

Although ELSTER supplies a wide variety of coupling transformers e.g. single or three phase construction, dry or oil immersed types all of them varying in

measures according to injection power and isolation level, two typical applications shall be given for injection circuits at different voltage levels.

General	
System voltage	up to 150 kV
System frequency	50 or 60 Hz
Control signal	110 1350 Hz
Duty cycle: control signal	up to 15%, standard 4%
system voltage	100%
Coupling Transformer	
Nominal voltage class / BIL	according to VDE
Number of phases	1 or 3
Mounting	outdoor or indoor
Magnetic coupling factor	K = 0.9
Quality	Q = 2040
Construction / insulation	oil insulated
Cooling	air
Temperature rating	-40°C to +60°C (higher on demand)
Physical outlines	acc. to type
Coupling Capacitor (HV)	
Test voltage	according to VDE 0560
Mounting	outdoor or indoor
Operating temperature	-40°C to +60°C (higher on demand)
Operating stability	0.04% /°K over operating temperature range
Discharge mechanism	Internal resistors (option)
Protection	option

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