



INSTRUCTION MANUAL

RFL 9550 Line Trap



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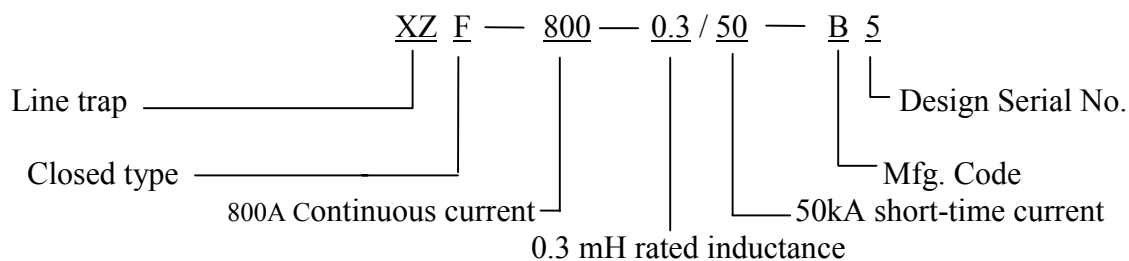
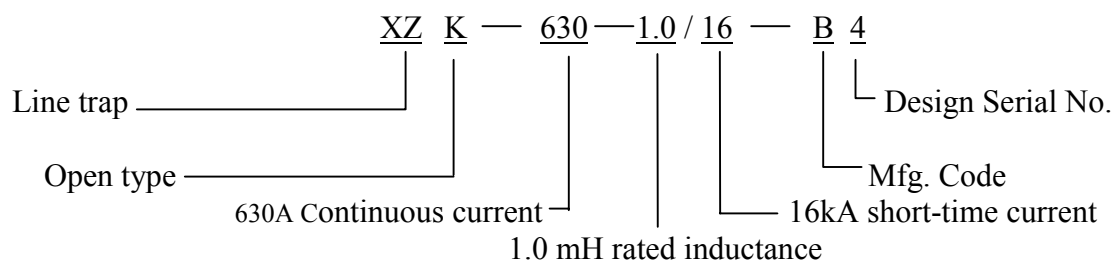
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RFL 9550 Line Trap

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1.0 BREAKDOWN OF MODEL 9550 TYPE DESIGNATION:



2.0 CHARACTERISTICS OF LINE TRAPS

2.1 The specification of the product can cover various grades of short circuit current. The RFL 9550 XZK line trap is suitable for short-circuit current of middle and low-grade, while the RFL XZF line trap is suitable for short-circuit current of high and very-high grade. The capability of the RFL 9550 XZF line trap to resist short circuit current is almost without limit.

2.2 Temperature Rise and Loss

The average temperature rise of the RFL 9550 XZK line trap is normally limited to 90°C, and 110°C for hot spots. The average temperature rise for the RFL 9550 XZF Class F line trap is limited to 115°C, and 135°C for hot spots, according to RFL's internal standard. Compared with the requirements of ANSI or IEC standards, RFL's standard meets the requirements for the tropical-zone and with the least power consumption.

2.3 Structural Characteristics

Line traps are normally composed of a main coil, tuning device, and protective device.

A. Main Coil

The main coil of the RFL 9550 XZK line trap is usually wound with rectangular bare aluminum conductor with its turns supported by fiberglass spacers, all of which is immersed in lacquer for good integration. The main coil of the RFL 9550 XZF line trap is solidified into a whole body by insulated rectangular single layer cable bound with multiple layers of epoxy resin fiberglass tape for excellent rigidity. As a consequence, the traps are capable of resisting ultraviolet rays and aging. The spiders on both ends of the coil are made of extruded and flat aluminum alloy solidified to a whole body by means of epoxy resin fiberglass tape bound horizontally, which makes them possess high mechanical strength, corrosive resistance and low loss, etc. Both ends of the coil are pressed or pulled tightly together by reinforced fiberglass rods with high mechanical and electrical strength. The total coil is designed to withstand power frequency current as well as the short circuit current of the power system.

B. Tuning Device

The tuning device is composed of a capacitor, inductor, and resistor, which forms a resonant circuit with the main coil to block the HF signals. The voltage drop across both ends of traps with small capacity is usually comparatively low, and mica capacitors or glass film capacitors are used. In the case of large or medium size traps which are used for HF teleprotection, HV polystyrene capacitors are employed.

C. Protective Device

This device is used to limit the lightning and switching over-voltages applied to the line trap, and to a certain extent protect the tuning device and main coil. According to the voltage drop across the trap, one or two series Fs – 0.5 model valve-type arresters are used for small sized line traps and YG₂ or YG₁ special gapped Zinc-oxide arresters for medium and large size traps.

3.0 SERVICE CONDITIONS

3.1 Service location: Outdoors.

3.2 Ambient temperature range: -40°C to + 45°C (in accordance with ANSI and IEC).

3.3 Maximum altitude: Not higher than 1000 meters (3280 feet) above sea level.

3.4 Atmospheric: Free from damaging fumes or excessive dust.

3.5 Unusual service conditions: When a line trap is applied in abnormal conditions that exceed the conditions defined above, such as salt-fog, industrial dirt, vapor, and other severe atmospheric conditions, customers are welcome to discuss these special requirements with RFL.

4.0 MAIN PROPERTIES OF LINE TRAPS

- 4.1 The schematic of wide-band tuned line traps is shown in Fig. 1a and 1b. Though in practice, there are many kinds of tuning circuits, for example, narrow-band (single frequency) tuning double frequency tuning, etc. The wide-band type of tuning is the most practical because of its flexibility.
- 4.2 Characteristic curves of the wide-band tuned line traps (see Fig. 2a and 2b).

The symbols in the drawings are defined as follows:

- f: Carrier frequency
- f_1 : Lower limit of blocking band
- f_2 : Upper limit of blocking band
- f_c : Center frequency
- f_1' : Lower limit of blocking band based on impedance
- f_2' : Upper limit of blocking band based on impedance
- Z_b : Blocking impedance
- R_b : Blocking resistance

4.3 Emergency Overload Rating

The emergency overload tolerance of the line trap's main coil at various ambient temperatures is shown in Fig. 3, in which I represent actual current, I_N = rated current.

5.0 TESTING

5.1 Measurement of Blocking Impedance and Blocking Resistance

The bridge method is applied as shown in Fig. 4 to measure blocking resistance and blocking impedance. Values should be within the defined operating frequency band. Care should be taken in measurement as follows:

- a. The lead wire should be kept as short as possible and the number of connectors kept to a minimum.
- b. Before measurement, calibrate the instruments (including the lead wire) to zero.
- c. The main coil should be away from surrounding objects located above and below at a distance of about one diameter of the coil.
- d. The main coil should be prevented from increase or decrease of half turn caused by the lead wire.

5.2 Measurement of Tapping Loss

The tapping loss (Unit dB) is measured by means of the method shown in Fig. 5. Based on the blocking impedance, the tapping loss is determined by the following formula:

$$A_t = 20 \log \left| \frac{U_1}{U_2} \right| = 20 \log \left| 1 + \frac{Z_1}{2Z_b} \right|$$

Based on the blocking resistance, the tapping loss is determined as follows:

$$A_{tR} = 20 \log \left| \frac{U_1}{U_2} \right| = 20 \log \left| 1 + \frac{Z_1}{2Z_b} \right|$$

Where: Z_1 – resistance equivalent to the impedance of line characteristic

U_1 – voltage between terminals 1 and 2 when switch S_1 is open

U_2 – voltage at terminals 1 and 2 when switch S_1 is closed and switch S_2 is in position 4 for measurement of A_t ; or voltage at terminals 1 and 2 when switch S_2 is in position 5 or 6 for measurement of A_{tR} .

Note: When measuring the tapping loss based on the blocking resistance, the reactance component of the trap is compensated for by adjusting the capacitor “C” or inductor “L” and hence the choice of positions for switch S_2 .

5.3 Power Frequency Spark-over Voltage Test of Lightning Arrester

There must be a protective resistance for limiting current during measurement and the resistance values are shown in Table 1. The test procedure is as follows:

The power frequency voltage, connected to the arrester being tested, is gradually increased with an analog alternating current meter (μA / mA scale) or a universal meter with equivalent AC scale connected in series to monitor the current.

- a. Start spark-over voltage: The pointer of the current meter is going up normally and suddenly increases to a value and swings, but the voltage can still step up continuously.
- b. Maximum discharge voltage: (Because it is harsher for the test equipment and products, this kind of test is carried out as infrequently as possible or even without it on site). At this moment, the pointer of the voltage meter is not going up but swinging and dropping. The discharge current of the arrester will be limited to below 100 mA and simultaneously the power supply must be cut off since the voltage is down to zero.

- c. The spark-over measurement for each arrester should be made at least 5 times, at an interval of no less than 30 seconds per measurement. Every cycle from voltage rise to drop to zero should be no longer than 4 seconds. The arithmetic average value is taken as a result. If the first measurement is greatly different from the other 4 measurements, it can be discarded and one more measurement should be performed. Start spark-over voltage should be in accordance with values listed in Table 1.

6.0 INSPECTION & INSTALLATION

- 6.1 Upon arrival, the line traps should be carefully inspected for any damage or defects due to transportation. If any damage is found, a damage claim should be filed with the transportation company, and a copy of the damage claim sent to RFL.
- 6.2 After opening the packing box, check the products and documents in accordance with the packing list.
- 6.3 Check whether there is any damage to the products, short-circuit of coil turns, loss of parts, incorrect lead-wire, loose pulling rod, etc.
- 6.4 For large and medium-size line traps, the tuning and protective devices are usually fastened with fixation plate or rope which must be disassembled before test or operation.
- 6.5 For the traps equipped with bird barriers, based on the situation, some barriers are directly assembled during manufacturing and some are disassembled for transportation. The latter condition requires customer assembly before putting into service.
- 6.6 Disassemble the lightning arrester, measure its insulating resistance and check whether the arrester shows signs of leakage. Next check the spark-over voltage at power frequency per the method is described in paragraph 5.3.
- 6.7 After the arrester is re-assembled, measure the trap's blocking properties (measure per the bridge method as described in paragraph 5.1, or measure per the tapping loss method as described in paragraph 5.2).
- 6.8 There are suspended line traps with single hanging point or multiple hanging points. During erection, the lifting bolt must be tightened, making the trap in vertical state. In order to prevent phase-to-phase short circuit from swinging due to wind, the traps are equipped with bottom lifting bolts to tightly pull the lower part of the trap.
- 6.9 For mounting of the pedestal – type line traps, aluminum pedestal(s) is (are) assembled with the lower spider. Small size traps use a single pedestal, which can be mounted on top of a CC or CVT. The pedestal becomes an electrical as well as a mechanical connection to the CC or CVT. Check to make sure that the pedestal base is free of dirt or paint to ensure that a good electrical connection is achieved.

- 6.10 Large size traps employ multiple support pedestals, which can be mounted on support insulators. The mounting points must be leveled in order to prevent undue stress on the line trap or support insulators.
- 6.11 For lifting and handling, there is a lifting bolt and/or serial lifting holes in the upper portion of all RFL line traps. They are specifically designed for this purpose. Do not use other positions for lifting.
- 6.12 Before the trap is put into service, the pads (terminals) must be cleaned and coated with a conductive grease.

7.0 MAINTENANCE & REPAIR

- 7.1 The traps, especially the arresters, should be checked in accordance with the normal maintenance cycle of the substation. The ideal time to check these is in the Spring. The tests should be in accordance with paragraph 5.3. If any fault is discovered, replace the damaged part immediately to prevent any damage to the tuning device and main coil from voltage impulses. The replacement of the arrester should be in accordance with the original model and voltage as supplied by RFL.
- 7.2 When checking the line traps, attention should be paid to the insulating pull rod between the both ends of the trap to check whether there is any paint skin dropped off or burrs. If so, the defects should be ground up and then coated with insulating painting twice. At the same time, check whether there is any loose, cracks, rust, etc., for fastening bolts, pull rod nuts, joints, etc. Check to make sure that the vent is not blocked.
- 7.3 A medium repair every five years and an overhaul every ten years are required. Clean lead wire of the conductive parts, fastening parts, contacting surfaces and rusty parts once. Spray painting is needed for partial or the whole main coil. Carefully check whether there are any suspicious traces, or aging phenomena of the fastening pieces and insulating parts. Replace if required. The main parts can be ordered from RFL.
- 7.4 The outside surface of the main coil should be free of contamination from transformer oil, other oil, or dirt picked up during storage and transportation, to protect the painting skin from the influence of impurities, especially the conductor from corrosion.
- 7.5 The traps can be stored outdoors for a short time and they should be placed in a high, dry, ventilated place to keep the arrester and tuning device dry. If the traps are stored for a long time, they should be placed inside a room or shed, and not tightly covered with plastic cloth.

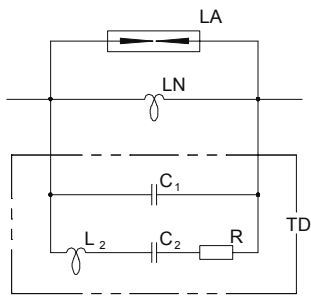


Figure 1a. Typical Circuit

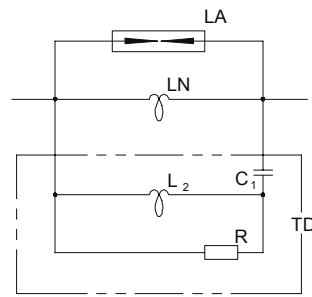


Figure 1b. Special Circuit.

LA: Protective Device
 L₂ : Tuning Inductor
 TD: Tuning Device

C₁, C₂: Tuning Capacitor
 LN : Main Coil
 R : Resistor

Figure 1. Wide-band Tuning Circuits.

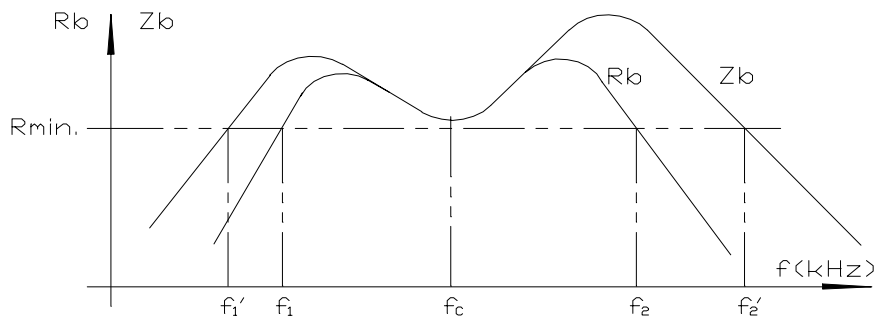


Figure 2a. Typical circuit.

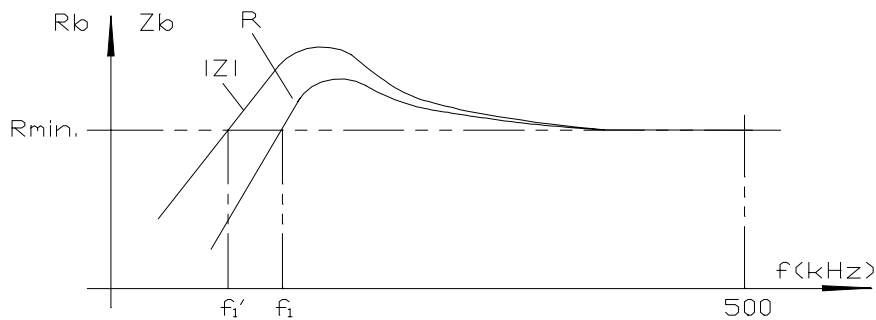


Figure 2b. Special circuit.

Figure 2. Characteristic of blocking resistance and impedance

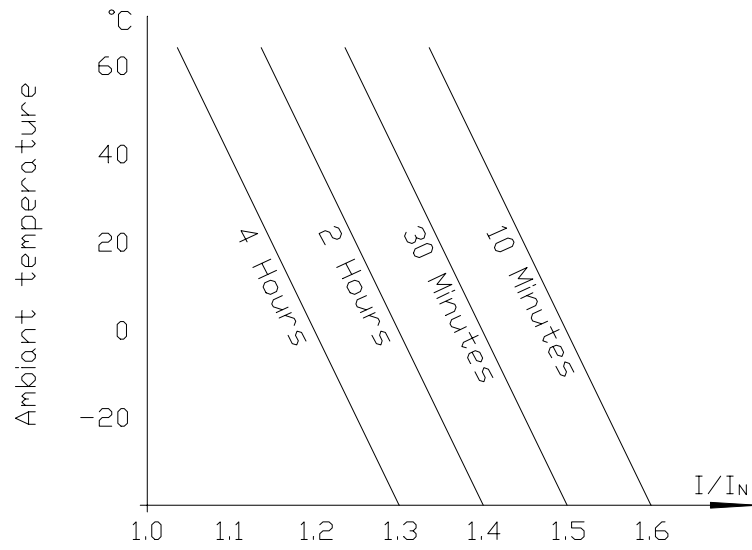


Figure 3.

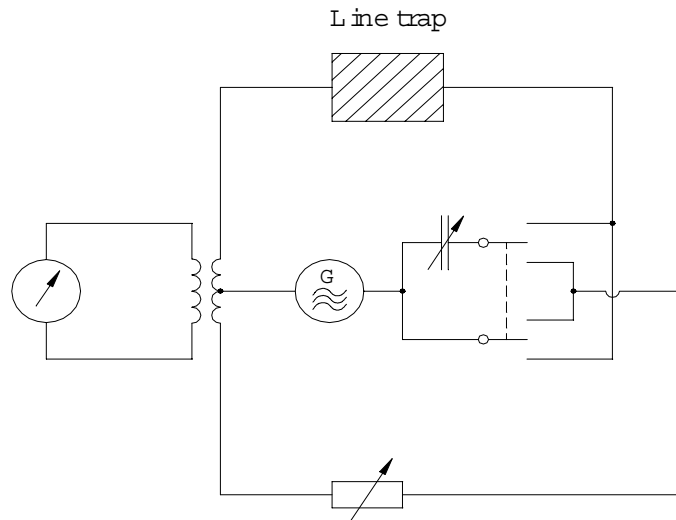
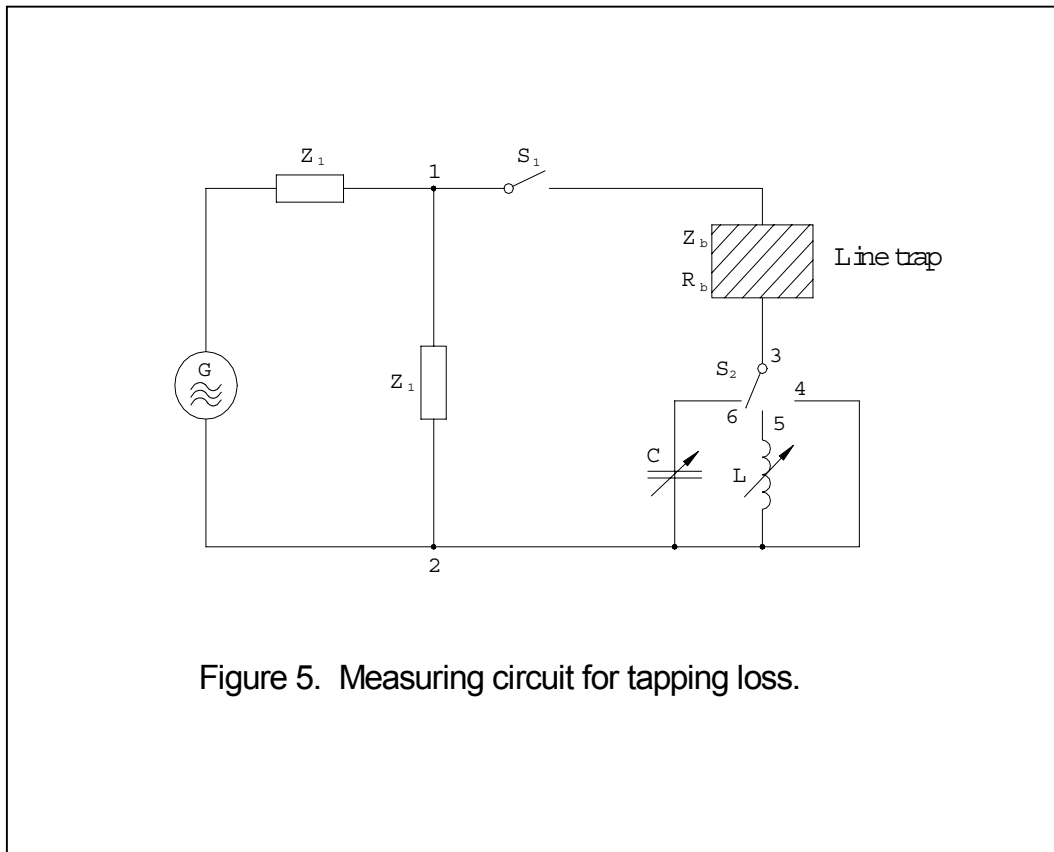


Figure 4. Measuring circuit for blocking characteristics.

Rated Voltage of Lightning Arrester (kV)	RMS Power Frequency Spark-Over Voltage Lower / Upper (kV)	Resistance for Limiting the Current in the Measuring Circuit (kΩ)
1.0	1.2 / 1.7	50
1.9	2.3 / 3.2	84
3.0	3.6 / 5.0	118
3.8	4.6 / 6.4	170
4.8	5.8 / 8.1	220
6.1	7.3 / 10.3	260
7.6	9.1 / 12.8	356
9.5	11.4 / 16.0	440
12	14.4 / 17.3	560
15	18.0 / 21.6	620
19	22.8 / 27.4	860
24	28.8 / 34.6	1200
38	45.6 / 54.7	1600

Table 1 Power frequency spark-over voltage for type YG-2 zinc-oxide lightning arresters





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