

Telephone Exchange Demonstrator

Introduction

The telephone exchange demonstrator is not an exact replica of a POTS (Plain Old Telephone Service) mechanical exchange but it works on the same principles. The demonstrator can handle up to 5 dial telephones and allows any phone to connect to any other phone. The line-finder step-relay connects to the calling line and the line-selector step-relay connects to the dialed line.

Lifting a handset closes the calling relay and advances the line-finder step relay until the off-hook line is detected. This opens the off-hook detect disconnect relay and locks out all of the other phone lines. Dialing a number causes the calling relay to advance the line-selector step relay to the destination phone line. After a short delay, the ring relay connects a 50v 20Hz AC signal (interrupted 2 sec ON, 2 sec OFF) to the outgoing line which rings the bell in the called phone. Lifting the handset on the called phone activates the called-line relay and disconnects the ring signal. With the calling relay and the called relay closed, both phones are connected via a coupling capacitor and the parties can speak and listen. Hanging up both phones opens both the calling and called relays and advances the line-selector step relay to its home position. The line-finder step relay stays where it is. A set of lights in the exchange shows the position of the step relays and thus the calling and called lines.

Relay Functions

KS1 = line-finder step relay
KS2 = line-selector step relay
K1 = off-hook detect disconnect relay
K2 = calling relay
K3 = calling line found relay
K4 = ring relay
K5 = called line relay
K6 = KS2 homing relay

Detailed Circuit Operation (see the schematic diagram)

In the quiescent state, K1 is open and all of the phone lines are connected to 50v through the K1-1NC thru K1-5NC contacts and the K2 coil. When a phone is lifted off-hook, K2 closes which closes and latches K1 (via K2-5NO and K1-7NO) and disconnects all of the phone lines (via K1-1NC thru K1-5NC). With K1 closed, K1-6NO and the auto-advance contacts of KS1 (KS1-1NO) pulse K2 which causes KS1 to advance (via K2-1NC, K1-10NO and K3-1NC) to the off-hook line, at which point K2 is held closed and KS1 stops advancing. After a few seconds, C5 charges through K2-7NO and K3 closes sending a dial tone to the calling phone via K3-4NO. Dialing a number causes K2 to pulse which advances KS2 (via K3-7NO, K2-2NC and K4-2NC) but does not open K3 due to the slow release resistor (R2) and capacitor (C5). K3-1NC inhibits the pulsing K2-1NC from advancing KS1. When the dialing pulses stop, there is a few second delay while C6 charges and K4 closes. This removes the dial tone via K4-3NC and disconnects K2-2NC from KS2 via K4-2NC. With KS2 off its home position and K4 closed, the RING-ENABLE signal is generated (via K4-1NO) which powers up the ring generator and injects a ring tone into the calling line via C3 and a ring signal into the called line via K5-1NC. When the called line goes off-hook, K5 closes and turns off RING-ENABLE via K5-3NC. The two phones are now connected by K5-1NO and C1 and biased at 50vdc by the coils of K2 and K5, allowing

a conversation to take place. When the called phone is hung up, K5 opens and momentarily injects the ring signal again. As soon as the caller hangs up, K2 opens and KS2 advances to its home position using K6-1NO and the auto-advance contacts of KS2 (KS-2NC via K4-7NO, K2-3NC and K5-2NC). The first closure of K6 unlatches K1 (via K6-2NC). When KS2 reaches position 25, power is removed from K6 which releases KS2 one last time, advancing the rotating contacts onto their home position.

In order to handle the situation where a caller hangs up before dialing a number, the last position of KS1 will pulse K6 (via the signal KS1-LP) which will unlatch K1 and stop KS1 from auto-advancing. In order to prevent KS2 from advancing in this situation, contacts K4-6NO are wired in series with contacts K6-1NO.

Since KS1 is left in the position of the last calling line, the next time the exchange is used, KS1 may need to find a line that is "behind" its starting position. In this case, K1 will be unlatched when KS1 reaches position 25 but the off-hook phone will close K2 again and the process will continue from the beginning as described above.

Brian Leckie
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