Bistable Transfer Relay with External Control Unit

By Oliver Micic, DG7XO *(reprinted from CQ-DL, Sep 2015 with permission, copyright DARC)*

A transfer relay is a four-port switch used either to transfer two antennas between two transceivers (Transfer mode) or to route signals through or around an auxiliary piece of equipment such as a filter or preamp (In-Line/Bypass). **Figure 1** shows the three configurations.

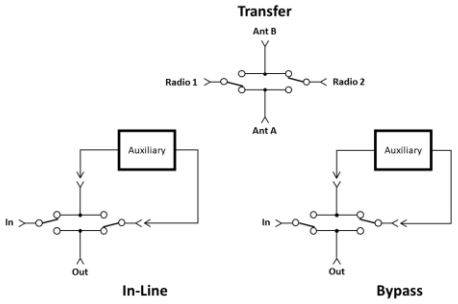


Figure 1 – Transfer relay modes

In Transfer mode each transceiver can only be connected to one antenna at a time by the relays. In In-line/Bypass mode signals are routed through the auxiliary equipment or it is bypassed. (Note that when bypassing the auxiliary equipment, the auxiliary ports are connected directly together.)

The transfer relay uses bistable or "latching" relays so the circuit remains in the selected configuration with power removed. A latching relay has two states and remains in one state (i.e. "latches") with power removed. The relay's state is changed by reversing voltage polarity across the relay coil. Once the state is changed, voltage can be removed.

The transfer relay for the HF bands consists of two units; the switching unit with two latching relays and a control unit. **Figure 2** shows the schematic. Using diode H-bridges to route voltage to the relay coils requires only a single supply voltage polarity. A PCB template is provided in the package of information with this article as a PDF file that can be used by a board fabrication service. Firmware for the processor is also provided. Programmed microprocessors may be available from DG7XO.

Switching Unit Design

The switching unit is constructed on a 42.2mm x 43.2mm PCB. A dual LED displays the relay state. The relays specified have contacts that are specified for 10 A @ 277 Vac or 2500 VA.

To use 24V relays, disconnect the 12 V trace from the H-bridge. There is a designated solder pad for an external supply connection.

To increase operating safety, the relay coils can be connected in series. In this way, if a coil opens there is no danger of the transceiver ports being connected directly together. Connecting the relay coils in series requires a supply of twice the relay coil voltage.

Control Unit Design

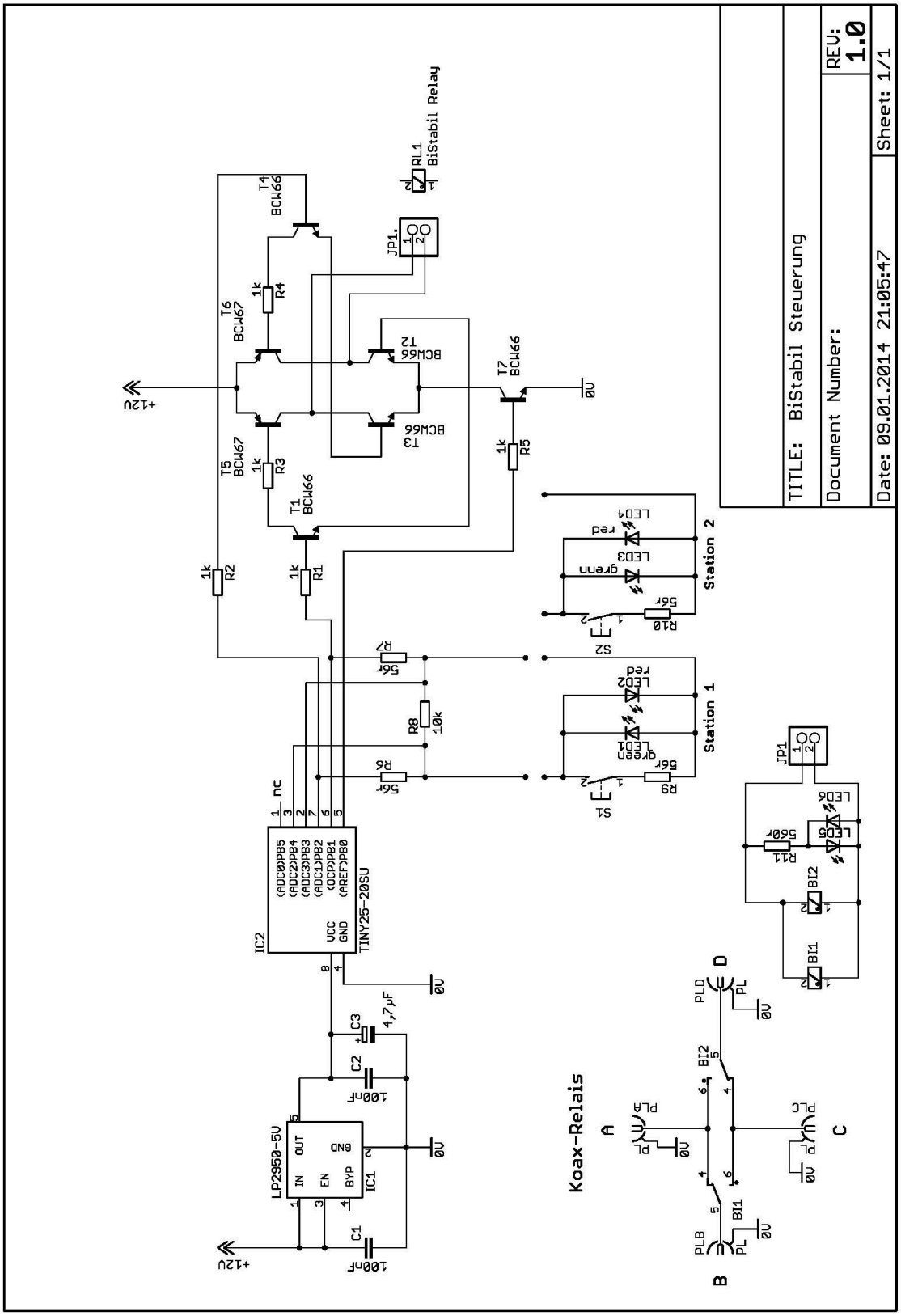
The control unit reverses the polarity of the relay coil voltage and memorizes the current switching state. Transistor H-bridges (T2, 3, 5, 6) route current through the relay coils. T1 and T4 switch the H-bridge between states. A dual bi-color LED shows relay state.

An Atmel ATTINY25-20SU microprocessor senses a momentary pushbutton switch closure (S1 or S2), changing the H-bridge driver stat while, monitoring the relays and LEDs through a built-in A/D converter. Up to two pushbutton switch modules as shown in the schematic can be wired in parallel.

The advantage of the pushbutton circuit is that there is no need for a direct connection to 12 V power on the control cable. Only a current-limited control voltage is needed and is short-circuit-proof. Only a single, two-conductor control cable is required. The cable to the two pushbutton units can be hard-wired or connectors can be used.

So that both relays are not energized continuously, coil voltage is only applied for 1 second by connecting and disconnecting the relay dc return path through T7. R8 serves as cable break protection. If current through the switch/LED module is interrupted, the relays will remain in that state.

Figure 2 – Transfer relay schematic. The control unit consists of the voltage regulator, microprocessor, and H-bridge. Koax-Relais is the switching unit along with the associated coil and status LEDs. Station 1 and Station 2 are the pushbutton and status display units and are connected in parallel. Station 1 and Station 2 can be installed in a common enclosure with the switching and control unit.



Construction

Switching Unit

The LEDs and current-limiting resistor R11 are soldered on the switching unit PCB's component side shown in **Figure 3**. (A single dual-LED is shown in the figure.) They are separated from the RF conducting path to minimize RF pickup. The circuit board is then placed upside down in the enclosure and soldered directly to the coaxial connectors.

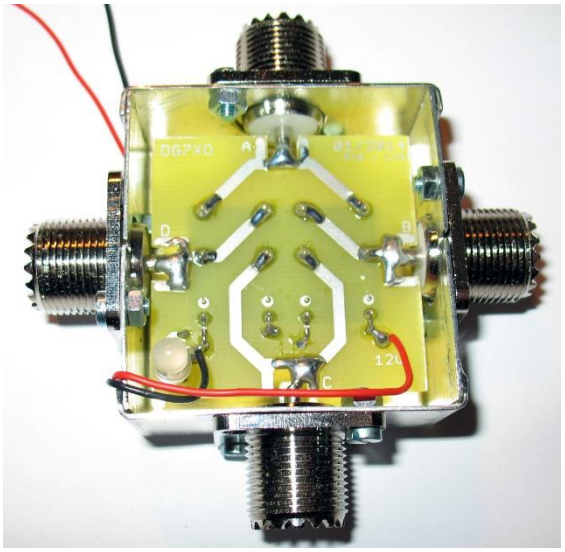


Figure 3 – The switching unit

A metal enclosure is required for shielding, to complete the common side of the RF circuit, and avoid introducing inductance into the signal path. The enclosure should be connected to the station's RF reference plane or bus and to the ac safety ground.

Control Unit

The control unit PCB (32.1mm x 34mm) including a pushbutton and LED can be placed in one enclosure as in **Figure 4**.

The control unit and switching unit can also be combined in a single enclosure. The boards are then connected together with small jumper wires. No special cable is required. The controller can also be replaced by a DPDT toggle switch and status LEDs.

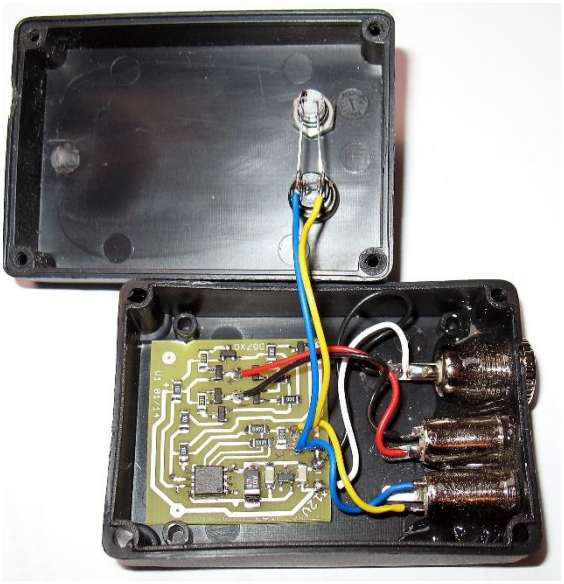


Figure 4 – The control unit with one pushbutton switch and status LED. Connnectors are provided for 12 Vdc and two external switch modules.

A second switch module with a pushbutton and LED can be installed in a second enclosure, if desired. (**Figure 5**)

Figure 5 – Control unit with a single external switch module.

PCB layout and parts placement diagrams are included in the package of information with this article.

Using the Transfer Relay

In the author's station two stations set up some distance apart. The control unit is used along with the switching unit at one station. A second switch module is used at the second station with a two-wire cable between the control unit and the external switch module.

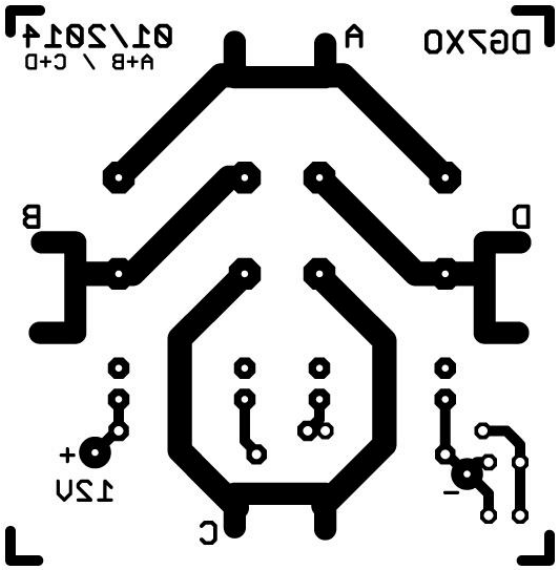
The complete transfer relay requires approximately 100 mA when the relay coils are activated to switch states. The H-bridge diodes in the control unit can provide up to 800mA. When the relay coils are not energized, the control unit uses approx. 25mA depending on LED current-limiting resistors R6 and R7.

Author Biography

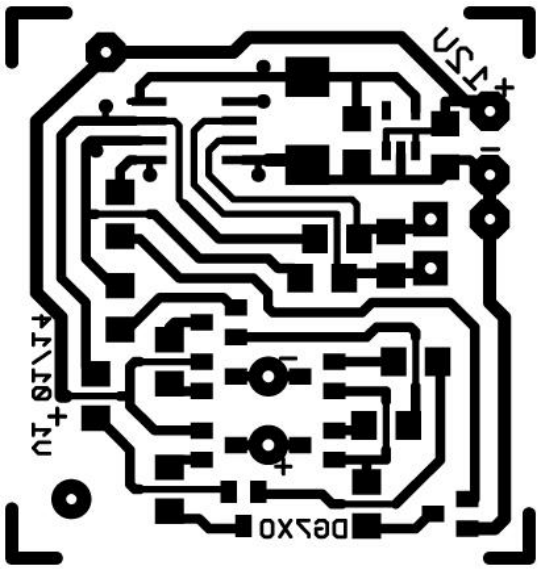
Liver Micic, DG7XO, born in 1976, licensed in 1995, is a member of DARC (E22) since 1994. After education as an energy electronics technician, he is currently working in high voltage network maintenance. His special interests include measurement engineering, microcontrollers, and home-building

Parts List

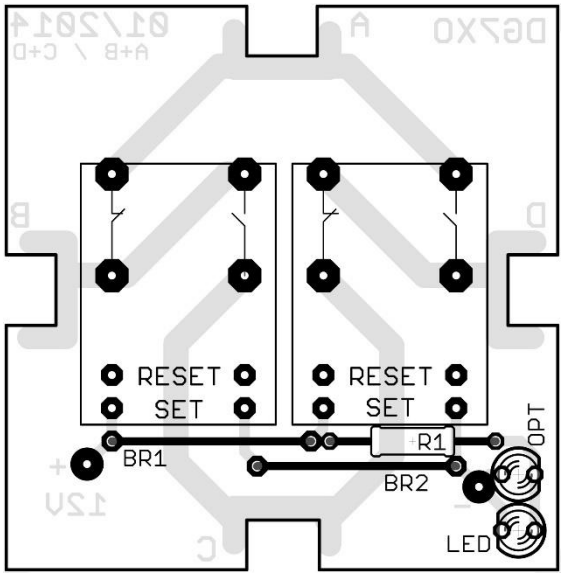
Part	Value	Package
R1	1k	1206
R2	1k	1206
R3	1k	1206
R4	1k	1206
R5	1k	1206
R6	56r	1206
R7	56r	1206
R8	10k	1206
R9	56r	1206
R10	56r	1206
R11	560r	Wire lead
C1	100nF	1206
C2	100nF	1206
C3	4,7µF/25V	Tantalum
T1	BCW66	SOT23
T2	BCW66	SOT23
T3	BCW66	SOT23
T4	BCW66	SOT23
T5	BCW67	SOT23
T6	BCW67	SOT23
T7	BCW66	SOT23
IC1	LP2980-5V	SOT25
IC2	Atmel ATTiny25-20	SO8
LED1/2	Dual-LED 3mm	3mm
LED3/4	Dual-LED 3mm	3mm
LED5/6	Dual-LED 5mm	5mm
S1, S2	Pushbutton, mom. SPST	Chassis mt
Bi1, Bi2	BiStabil Relais 1Off/1Schl. Hongfa HFE7-012-1HDST-L	12V
Enclosure	Koax-Relais	
Enclosure	Control Unit	
Gehäuse3	External Switch/Status 4x Coaxial Sockets	



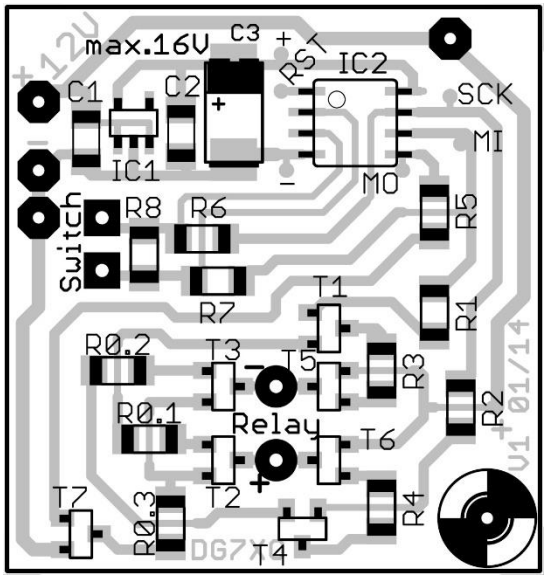
Switching unit PCB – circuit side



Control unit PCB – circuit side



Switching unit PCB – component side



Control unit PCB – component side

Assembled Control unit PCB