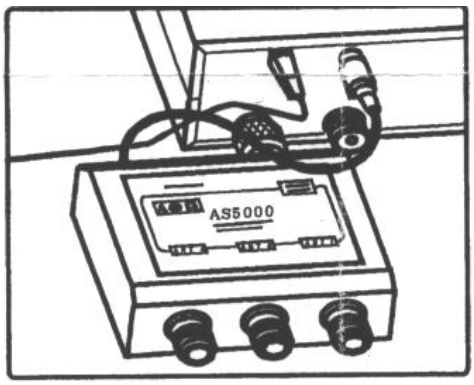
Langenbrettach, Jan. 5th 2012
Matthias Bopp

# Automatic Antenna Switch for the AOR AR5000

Rev. 1.0

Recently I was able to acquire second hand an AR5000 wideband receiver and wanted to extend the number of antenna ports from originally 2 to 4 ports.

This is exactly what the optional antenna switching unit supplied from AOR is providing. It is connected to ANT 1 and the control switching signal is taken from ACC 2. ANT 2 is left unaffected and available for connection to an aerial leaving the AS5000 to provide access to ANT 1, ANT 3 and ANT 4. A detailed description of the ACC2 port and its signals can be found in another document provided on my website.

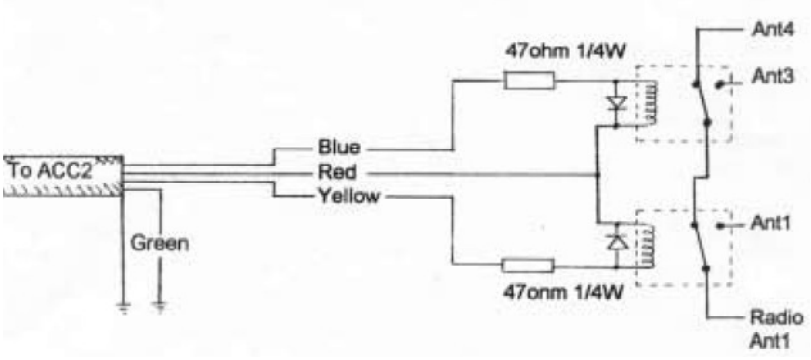




Switching can be accomplished automatically using a user defined form of band plan (frequency bands associated with each antenna port) or manually from the ANT select menu.

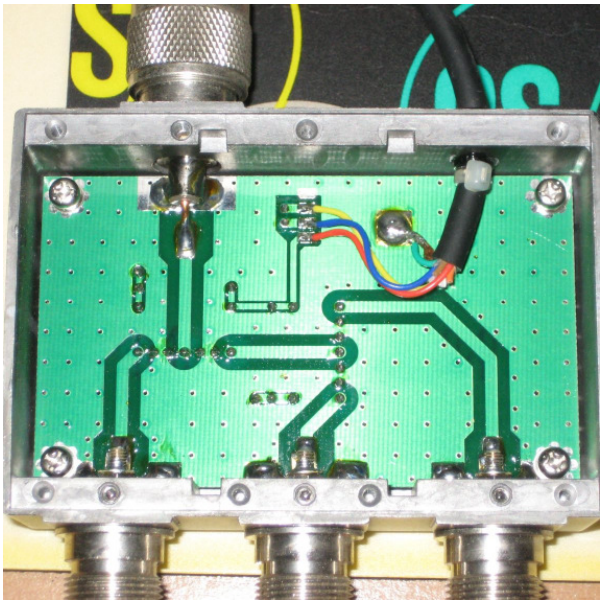
Here is the truth table for the antenna switching unit:

| Antenna port | ANT SW A | ANT SW B |
|---|---|---|
| ANT 1 | High | High |
| ANT 3 | Low | High |
| ANT 4 | Low | Low |

Below find the AS5000 circuit diagram. ANT SW A (PIN 5 of ACC2) is the yellow wire, ANT SW B (PIN 6 of ACC2) is the blue wire, the red wire is +12V DC (PIN 1 of ACC2). Ground (PIN 8 of ACC2) and shield are connected



Here are some more detailed pictures of the AS-5000 including a view inside:

In the AS-5000 device 2 antenna relays are cascaded and thus the specification in terms of insertion loss and isolation varies for the different ports:

Insertion loss:
ANT1 to COM 1 dB max.
ANT3 to COM 1.5 dB max.

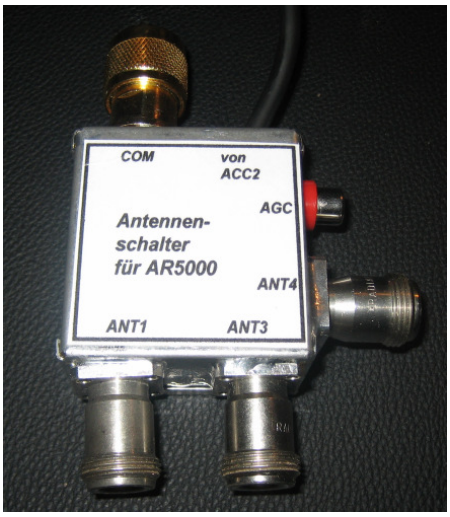
Isolation:
ANT1 to ANT3 40 dB min.
ANT1 to ANT4 50 dB min.

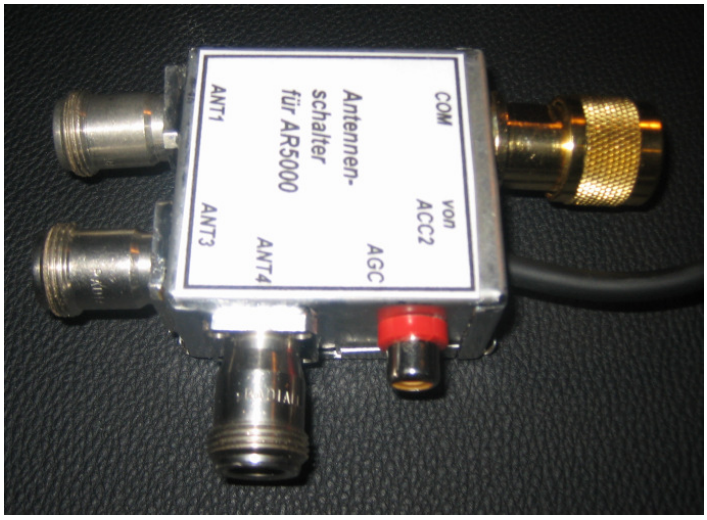
All data is specified at a test frequency of 1GHz.

A friend measured his AS-5000 and got the following results for ANT1 to COM, which are well within the given specifications:

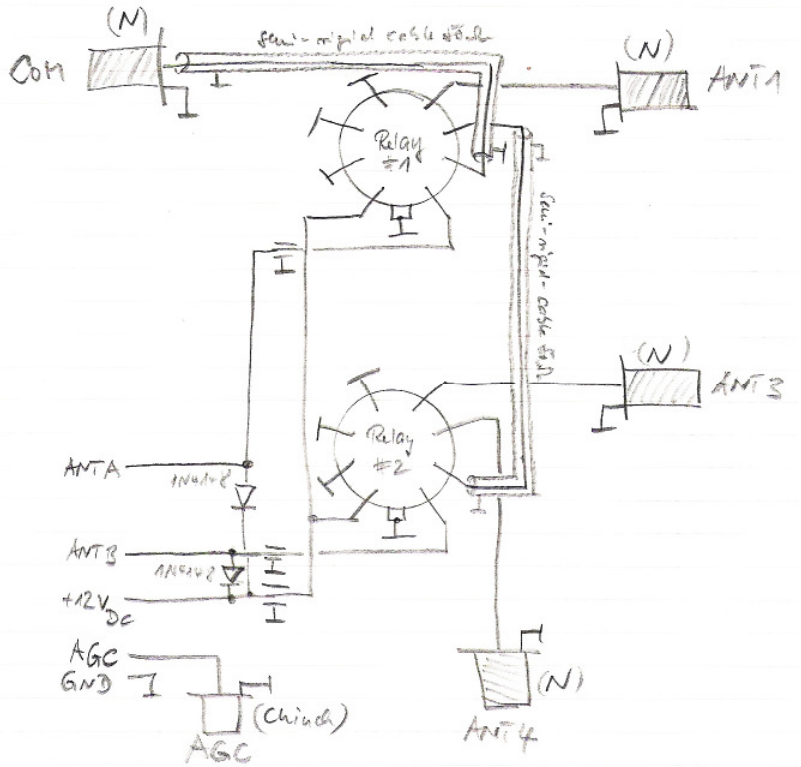
| Frequency / GHz | Insertion Loss /dB |
|---|---|
| 0.5 | 0.5 |
| 1.0 | 0.9 |
| 1.5 | 1.5 |
| 1.8 | 1.6 |
| 2.2 | 1.9 |
| 2.5 | 2.1 |

As decided to build a similar device like AS-5000 myself and add the capability, to supply the AGC voltage (available at ACC2) to a special connector. I also wanted to improve the insertion loss especially up to 1.3 GHz and as I had some small RF capable relays I wanted to give them a try. They are Series 712 TO-5 DPDT-relays from Teledyne and I found them in a surplus test equipment. I will attach a copy of its specification to the end of this document. They seemed to fit perfectly as they operate with +12V DC and 25mA and the ACC2 port supplies +12V DC with 50 mA max.

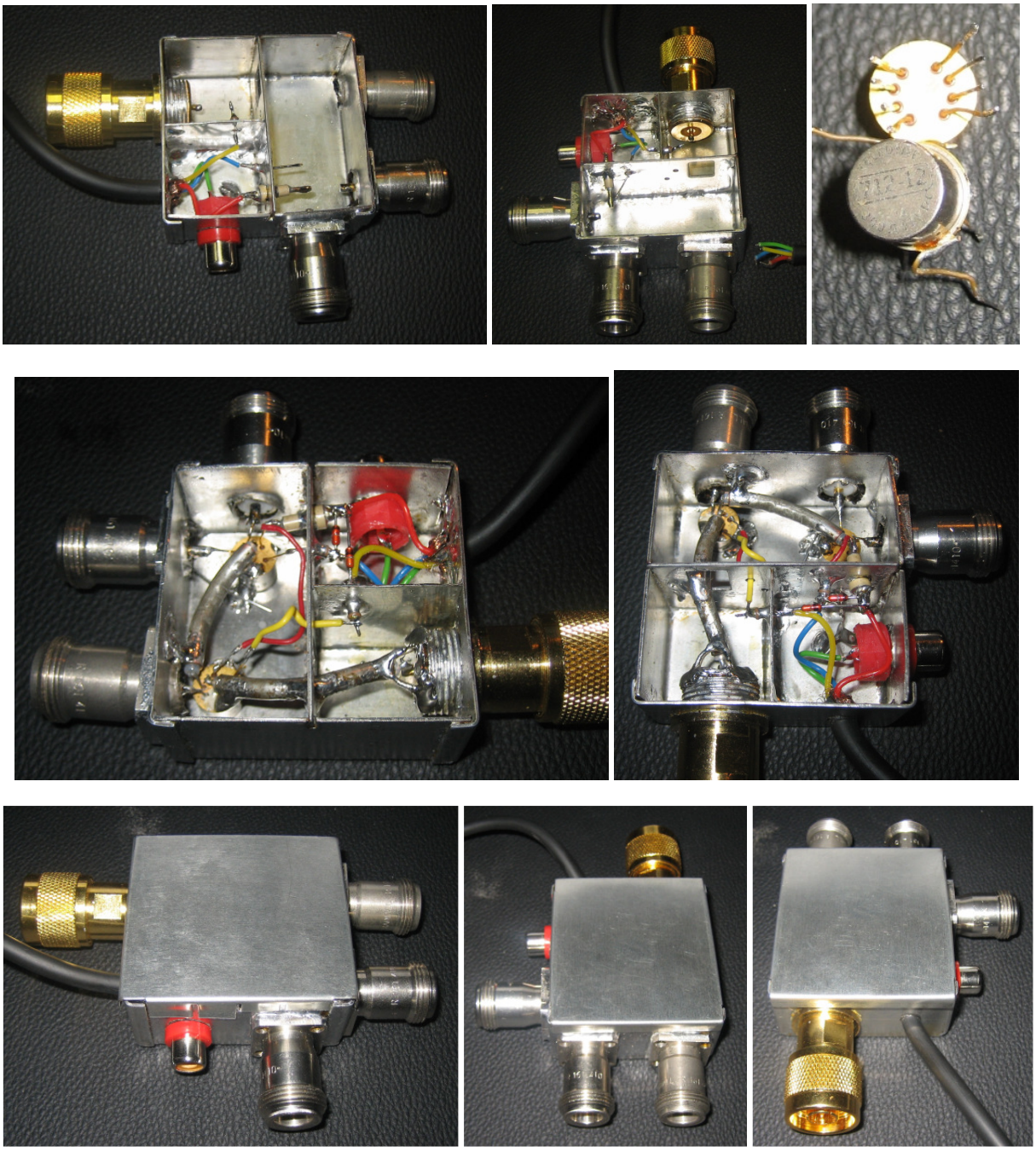



This is a draft schematic showing my setup. Please note that it is not to scale. The RF connections which are not using semi-rigid coaxial cables have to be kept very short.

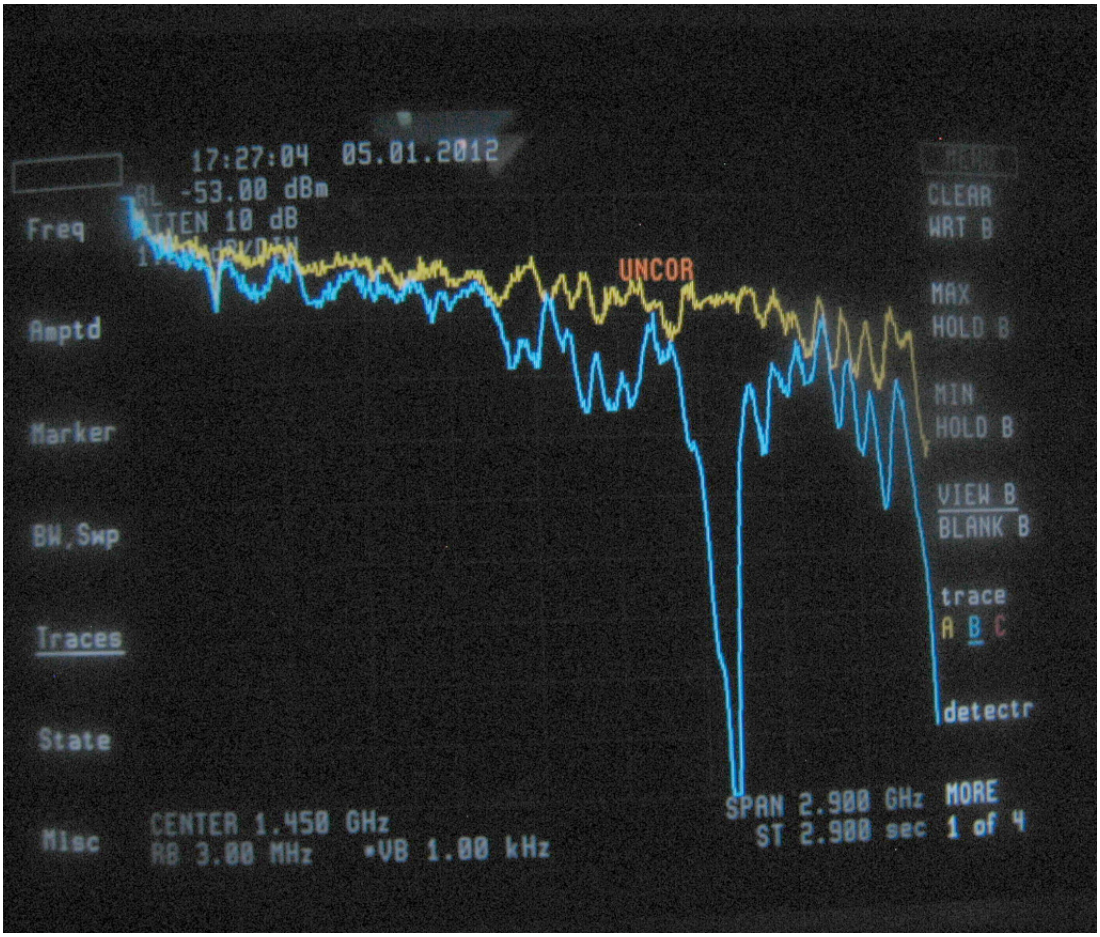


Here are some more pictures of my AS-5000 clone taken during its assembly and when finished:

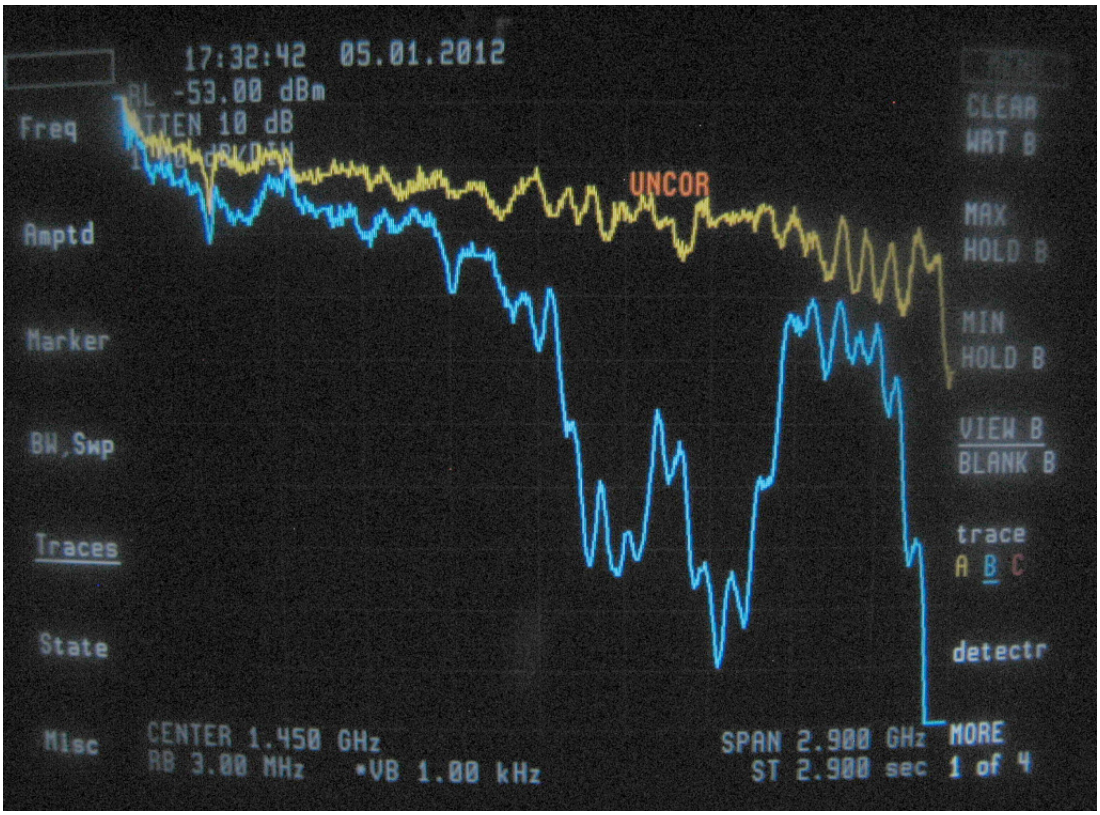


Well, now the question comes: how does the clone perform. I made some course measurements with a noise source and spectrum analyzer.

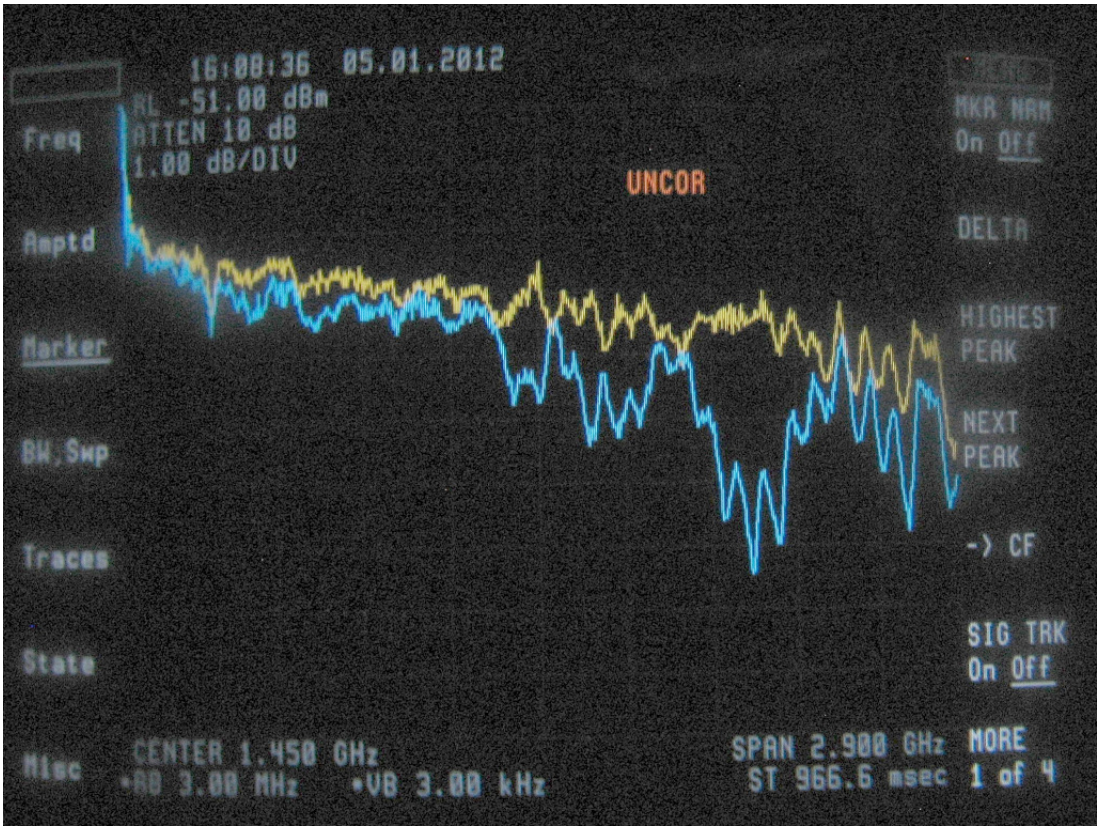
The three measurements show the insertion loss from COM to ANT1, COM to ANT3 and COM to ANT4. Horizontal scaling is 300 MHz per division (0 to 3 GHz total horizontal axis), vertical scaling is 1 dB per division (10 dB total vertical axis). The yellow curve is always the reference measurement without the antenna switcher inserted, the blue is the respective curve with the antenna switcher plugged in.



COM to ANT1



COM to ANT3



COM to ANT4

As can be seen the insertion loss up to 1 GHz is below 0.5 dB on all three ports respectively below 1 dB up to 1.3 GHz. The insertion loss between 1.5 GHz and 2.4 GHz is increasing strongly with some resonances. Between 2.4 and 2.5 GHz the switch has an insertion loss of maximum 1.5 dB on all three ports.

| Frequency / GHz | Insertion Loss /dB |
|---|---|
| 0.5 | <0.5 |
| 1.0 | <0.7 |
| 1.3 | <1.0 |
| 2.4 | <1.5 |

Conclusion: the AS5000 clone shows a quite flat frequency response with low in insertion loss up to 1.3 GHz. It shows thus a very nice performance in the ham radio bands HF, 2m, 70cm and 23cm. In addition it can also be used with good performance in the 13cm band. However above 1.5 GHZ it shows quite some resonances in its frequency response.

I always appreciate any feedback and suggestions for improvements. I am interested in any other hints with respect to the use or improvement of the AOR AR5000 wideband receiver. I am especially interested a copy of the service manual. Please send your feedback to Email address below. Many thanks in advance.

Best regards

Matthias DD1US

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Homepage: http://www.dd1us.de

TELEDYNE RELAYS

*A Unit of Teledyne Electronics and Communications*

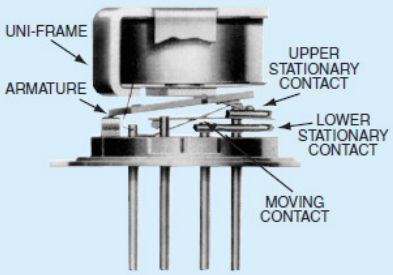
# COMMERCIAL TO-5 RELAYS

## DPDT

**SERIES 712**

| SERIES DESIGNATION | RELAY TYPE |
|---|---|
| 712 | DPDT basic relay |
| 712D | DPDT relay with internal diode for coil transient suppression |
| 712TN | DPDT relay with internal transistor driver and coil transient suppression diode |

### INTERNAL CONSTRUCTION




### DESCRIPTION

The TO-5 relay, originally conceived and developed by Teledyne, has become one of the industry standards for low-level switching from dry circuit to 1 ampere. Designed for high-density PC board mounting, the Series 712 relays are some of the most versatile ultraminiature relays available because of their small size and low coil power dissipation.

The following unique construction features and manufacturing techniques provide excellent resistance to environmental extremes and overall high reliability:

- All welded construction.
- Unique uni-frame design providing high magnetic efficiency and mechanical rigidity.
- High force/mass ratios for resistance to shock and vibration.
- Advanced cleaning techniques provide maximum assurance of internal cleanliness.
- Precious metal alloy contact material with gold plating assures excellent high current and dry circuit switching capabilities.

The Series 712D relay has an internal discrete silicon diode for coil transient suppression. The hybrid Series 712TN relay has an internal silicon diode and transistor driver. The integrated packaging of the relay with its associated semiconductor devices greatly reduces PC board floor space requirements as well as component installation costs.

By virtue of its inherently low intercontact capacitance and contact circuit losses, the 712 has proven to be excellent ultraminiature RF switch for frequency ranges well into the UHF spectrum. A typical RF application for the TO-5 relay is in handheld radio transceivers, wherein the combined features of good RF performance, small size, low coil power dissipation and high reliability make it a preferred method of Transmit-Receive switching (see Figure 1).

| ENVIRONMENTAL AND PHYSICAL SPECIFICATIONS | | |
|---|---|---|
| **Temperature** (Ambient) | **Storage** | –65°C to +125°C |
| | **Operating** | –55°C to +85°C |
| **Vibration** (General Note 1) | | 10 g's to 500 Hz |
| **Shock** (General Note 1) | | 30 g's, 6 msec, half-sine |
| **Enclosure** | | Hermetically sealed |
| **Weight** | | 0.09 oz. (2.6g) max. |



SPECIFICATIONS ARE SUBJECT TO CHANGE WITHOUT NOTICE
www.teledynerelays.com



712/1203/Q1

## SERIES 712
## GENERAL ELECTRICAL SPECIFICATIONS (@25°C) (Notes 2 & 3)

| | | |
|---|---|---|
| **Contact Arrangement** | 2 Form C (DPDT) | |
| **Rated Duty** | Continuous | |
| **Contact Resistance** | 0.15 ohm max. before life; 0.25 ohm max. after life at 1A/28Vdc (measured 1/8" from header) | |
| **Contact Load Ratings (DC)** (See Fig. 2 for other DC resistive voltage/current ratings) | Resistive: 1 Amp/28Vdc<br>Inductive: 200 mA/28Vdc (320 mH)<br>Lamp: 100 mA/28Vdc<br>Low Level: 10 to 50 µA/10 to 50mV | |
| **Contact Load Ratings (AC)** | Resistive: 250 mA/115Vac, 60 and 400 Hz (Case not grounded)<br>100 mA/115Vac, 60 and 400 Hz (Case grounded) | |
| **Contact Life Ratings** | 10,000,000 cycles (typical) at low level<br>1,000,000 cycles (typical) at 0.5A/28Vdc resistive<br>100,000 cycles min. at all other loads specified above | |
| **Contact Overload Rating** | 2A/28Vdc Resistive (100 cycles min.) | |
| **Contact Carry Rating** | Contact factory | |
| **Coil Operating Power** | 450 milliwatts typical at nominal rated voltage | |
| **Operate Time** | 4.0 msec max. at nominal rated coil voltage | |
| **Release Time** | 712: 3.0 msec max. 712D, 712TN: 6.0 msec max. | |
| **Intercontact Capacitance** | 0.4 pf typical | |
| **Insulation Resistance** | 1,000 megohms min. between mutually isolated terminals | |
| **Dielectric Strength** | Atmospheric pressure: 350 Vrms/60Hz | |
| **Negative Coil Transient (Vdc)** | 712D, 712TN | 2.0 max |
| **Diode P.I.V. (Vdc)** | 712D, 712TN | 60 min. |
| **712TN Transistor Characteristics** | **Base Voltage to Turn Off (Vdc)** | 0.3 min |
| | **Emitter-base breakdown Voltage ($BV_{EBO}$) (Vdc)** | 6.0 min |
| | **Collector-base breakdown Voltage ($BV_{CBO}$) (@25°C & Ic = 100 µA) (Vdc)** | 60 min |

## DETAILED ELECTRICAL SPECIFICATIONS (@25°C) (Note 3)

| **BASE PART NUMBERS** (See Note 7 for full P/N example) | | **712-5 712D-5 712TN-5** | **712-6 712D-6 712TN-6** | **712-9 712D-9 712TN-9** | **712-12 712D-12 712TN-12** | **712-18 712D-18 712TN-18** | **712-26 712D-26 712TN-26** |
|---|---|---|---|---|---|---|---|
| **Coil Voltage (Vdc)** | Nom. | 5.0 | 6.0 | 9.0 | 12.0 | 18.0 | 26.5 |
| | Max. | 5.8 | 8.0 | 12.0 | 16.0 | 24.0 | 32.0 |
| **Coil Resistance (Ohms ±20% @25°C) (712TN: See Note 4)** | | 50 | 98 | 220 | 390 | 880 | 1560 |
| **Pick-up Voltage (Vdc, Max.) Pulse Operated** | | 3.6 | 4.2 | 6.5 | 8.4 | 13.0 | 17.0 |
| **Base Current to Turn On (mAdc, Min.) (See Note 5)** | | 3.00 | 2.04 | 1.36 | 1.03 | 0.68 | 0.50 |

## PERFORMANCE CURVES (Note 2)

TYPICAL RF PERFORMANCE

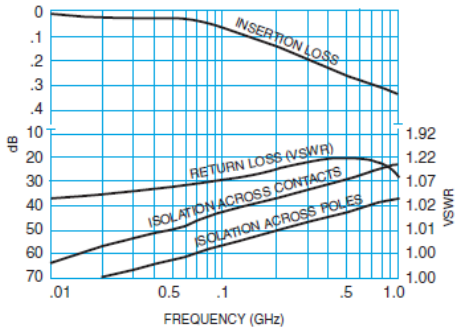



FIGURE 1

TYPICAL DC CONTACT RATING (RESISTIVE)

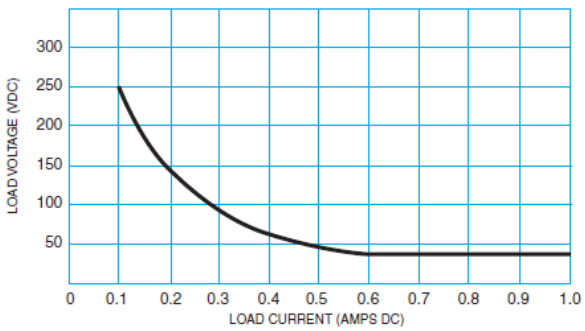
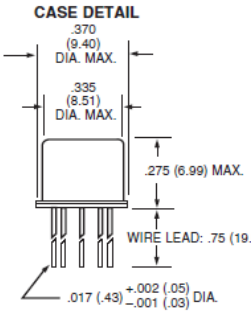



FIGURE 2

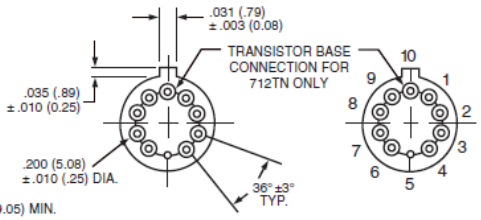
## SERIES 712

### OUTLINE DIMENSIONS

**CASE DETAIL**

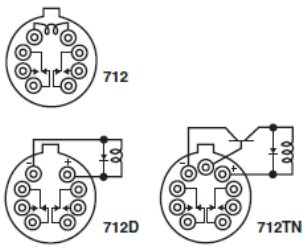



**TERMINAL LOCATIONS AND PIN NUMBERING (REF. ONLY)**
**(Viewed from Terminals)**




DIMENSIONS ARE SHOWN IN INCHES (MILLIMETERS)

### SCHEMATIC DIAGRAM



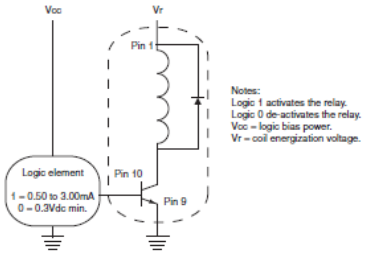

SCHEMATICS ARE VIEWED FROM TERMINALS

### GENERAL NOTES

1. Relay contacts will exhibit no chatter in excess of 10 µsec or transfer in excess of 1 µsec.
2. "Typical" characteristics are based on available data and are best estimates. No on-going verification tests are performed.
3. Unless otherwise specified, parameters are initial values.
4. For Reference Only. Coil resistance not directly measurable on 712TN relays.
5. Applicable to all coil voltages. See Base current to turn on.
6. Circuit is typical for all Series 712TN. Values shown are for 712TN-5 relay and apply for full temperature range.
7. The slash and characters appearing after the slash are not marked on the relay.
8. Unless otherwise specified, relays will be supplied with either gold-plated or solder-coated leads.
9.

### TYPICAL LOGIC INTERFACE

(See Note 5)




Teledyne Part Numbering System for Commercial Relays