Transverter Interface for FT817 and Similar Low Power Transceivers

Andy Talbot G4JNT 2016-07-09

Overview

This module is a PIN diode switched bidirectional interface between a low power transceiver, and the low power input / output of a transverter. This can use either a single bidirectional mixer for Tx/Rx , or separate mixers. PTT control superimposed as a switched DC level on the transceiver antenna port is intercepted and used to produce $+V_{RX}$ and $+V_{TX}$ supplies. Links on the PCB select the polarity used for this switching signal.

Adjustable Tx drive level is provided via a PIN diode attenuator so a control voltage of 2 – 5V will vary the transmit attenuation over a 10dB range to cater for rigs with different output power, and / transverter varying drive level requirements. Maximum continuous power from the transceiver should not exceed 2 Watts for any extended period.

The module is designed primarily for operation at 144MHz, but operation at 432MHz is perfectly OK when coupling and decoupling components are chosen properly. Operation at 1296MHz may also be possible.

Operation

Figure 1 shows the circuit diagram in full. DC on the transceiver antenna port is routed to a switch consisting of a pair of P-Channel FETs providing +V supplies on Rx and Tx lines alternately. The '2955 FETs specified are rated at 2 Amps so the resulting switched supplies should be adequate for powering transverter Tx and Rx rails. The two supplies drive the PIN switching diodes in the module itself. LEDs indicate correct switching operation

The FT817 is run at its low power setting, delivering 0.5W (27dBm) of IF drive at 144 or 432MHz. Most mixers need a drive of no more than around 0 to 2dBm, and sometimes lower if good linearity is essential, so the attenuation needed on Tx has to be adjustable over the range 25 to 30dB. It also has to be able to dissipate the half watt generated by the transmitter. The two PIN diodes on the left hand side of the diagram are the primary RF switches. A voltage of around 8 to 12V is applied to one of the TXP or RXP lines for Tx or Rx operation respectively. Chokes to decouple the RF pass this voltage to one of two PINs in the Tx or Rx path. The common point of the two diodes is connected at RF to the transceiver input via a DC blocking capacitor. A resistor to ground here has the drive voltage (minus the diode drop) superimposed across it and defines the current that passes though the forward conducting diode. With the values given this is around 7mA and results in a diode resistance for the BAP64 devices used, of around 3 ohms. The unpowered line (RXP when in transmit) is maintained at zero volts with a pull-down resistor, and since the common of the diodes is at +V, means the one in the RF path not in use is reverse biassed to minimise junction capacitance and give the best possible isolation.

On transmit the RF passes first into a 6dB attenuator stage to dissipate most of the power. Several 0805 sized 0.1Watt rated resistors are used in a parallel-series combinations to give the required attenuator values and stay within their rating. A BAP70-03 attenuator diode follows, the 4k7 resistor feeding this allowing a control voltage of 1 to 5V to give a resistance variation of around 200Ω to 30Ω This results in additional attenuation that can be varied over approximately 5 to 16dB. Intermediate resistors either side of this were selected to give an acceptable match on the Tx input for all diode current settings, and supply the attenuation range needed. A final fixed attenuator of 10dB completes the chain to make up the total attenuation for the path. Another switching diode transfers the attenuated RF signal to the mixer port.

On receive, two PINs in series connect the antenna port to the Rx output. Loss through these two diodes is typically 1 to 1.5dB. In transmit they are biassed off, providing more than 40dB isolation. Note that in neither case is the second PIN diode, on the right hand side of the diagram, run with reverse bias. In practice there is sufficient isolation from the first one to make this unnecessary.

The output ports for Tx and Rx appear as separate terminals, but can be directly paralleled for single mixer operation.

Photo 1 shows the complete transverter interface module built on a 55 x 43mm PCB with a groundplane on the underside. The two PIN diode types used in this project are available from RS Components for a few pence each, (subject to buying a minimum quantity of 20).

PCB details including a mirrored artwork at 1:1 scale for home construction can be found at
www.g4jnt.com/DownLoad/144TVIF_TopCopper_Mirrored.pdf

Component layout can be seen in Figure 2.

Measured Results

A DG8SAQ network analyser was used to measure performance at 144 and 432MHz of a previous earlier version of this module published in RadCom December 2013, page 60. RF-wise it is the same as this module but without the DC switching circuitry and was built with lower value coupling and decoupling components, targeted more towards use with a 432MHz IF. The important parameters are the loss in the receive chain due to non-zero on-resistance of the switching diodes, the leakage of Tx power into the Rx path to the mixer that would interfere with the adjustable attenuation (Rx and Tx mixer ports were separated for the measurement), and the variable attenuation range.

		144MHz	*432MHz*
Rx Path Loss		1.7dB	1.8dB
Rx path isolation on Tx		67dB	48dB
Tx Attenuation	IFWD = 100uA (~1.3V)	37.8dB	38.5dB
Tx Attenuation	IFWD = 350uA	29.8dB	30.1dB
Tx Attenuation	IFWD = 1mA (5V)	25.4dB	25.6dB

Figure 3 shows a plot of transmit attenuation versus control current and Figure 4 Shows a plot of the transmit path for 350µA diode current over the frequency range 0 to 500MHz. Performance drops off below 144MHz due to the value of coupling capacitors and bias inductors chosen. Operation at 50 or 28MHz would be possible while still using the same choice of PIN diode by increasing these to 10nF and 10uH respectively.

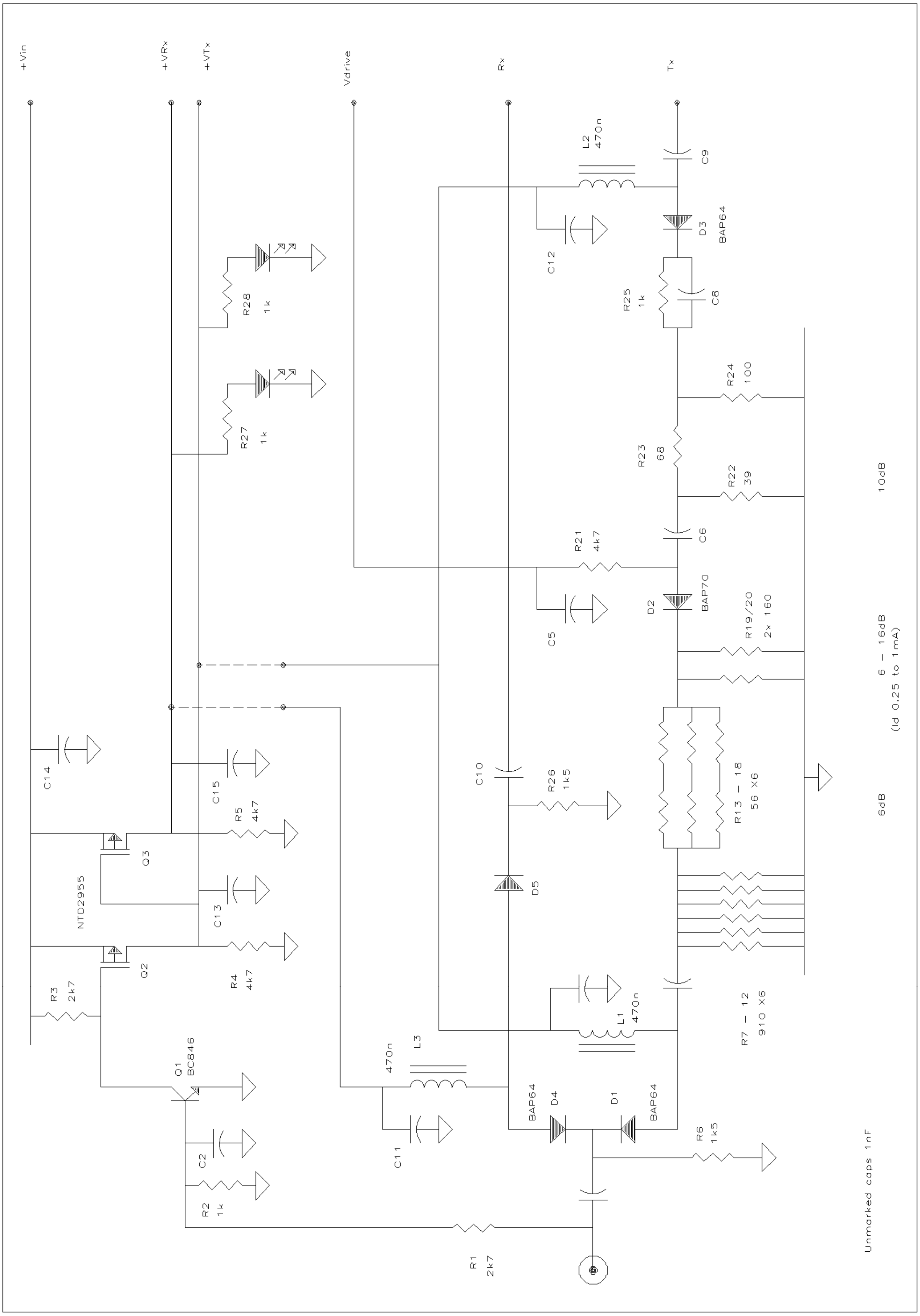

Figure 1 Circuit Diagram of the complete Transverter Interface

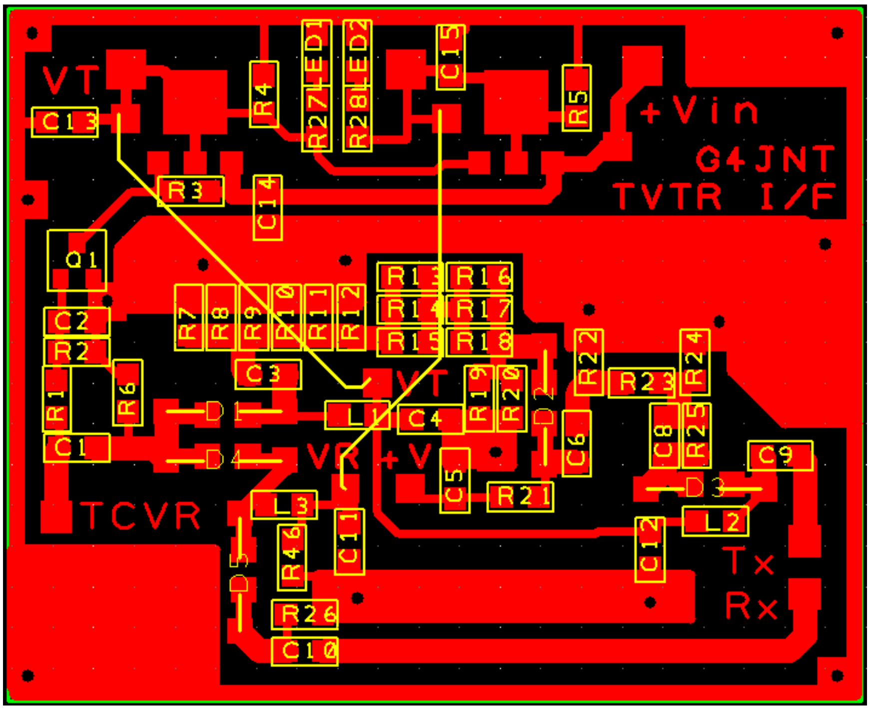

Figure 2 PCB Layout

Figure 3 Network analyser plot of the Transverter Interface path on transmit (the red S21 plot). Note the broad constant attenuation above 100MHz. This can be varied by adjusting the diode forward current. S11 shows the Return Loss at the transmitter input. A value here of 17dB corresponds to a VSWR of about 1.3

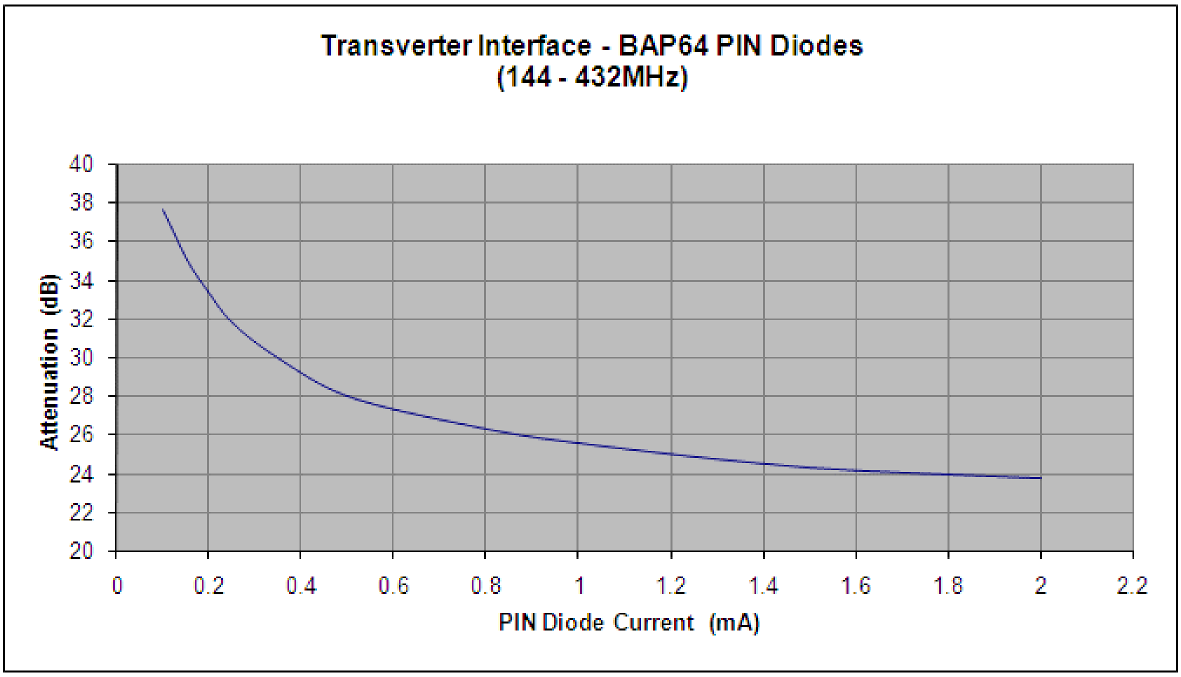

Figure 4 Transmit path level control

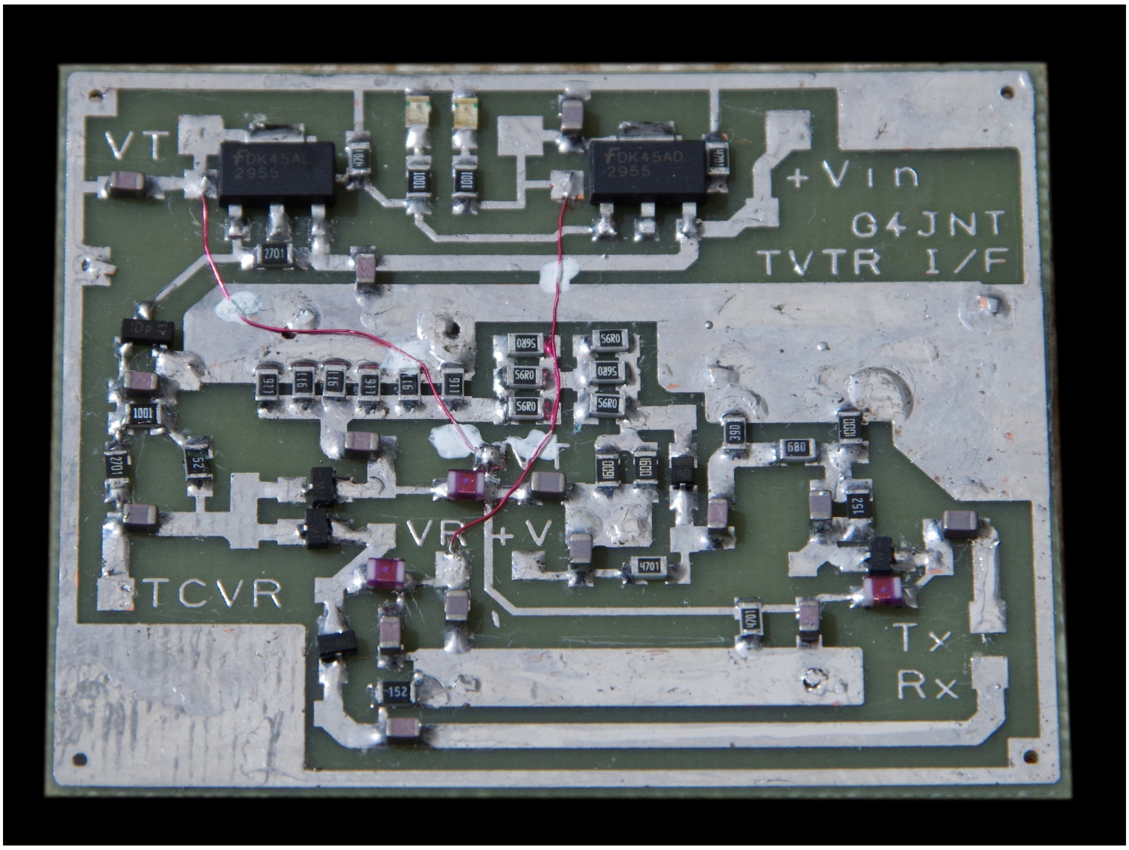

Photo 1 Complete Module