INSTRUCTION MANUAL

DIGIMIT 2002

MICROTELECOM S.R.L.

PAVIA DI UDINE – ITALY

PRELIMINARY

DIGIMIT 2002
DIGITAL HF SSB/CW TRANSMITTER

GENERAL DESCRIPTION

Digimit 2002 is a revolutionary transmitter for SSB/CW radio amateur communications in the H.F. bands. Controlled by a programmable logic integrated circuit, the Digimit 2002 features full direct digital synthesis, from microphone up to R.F. With tuning steps of 1 Hz, 10 Hz, 100Hz or 1 KHz.

The programmable logic chip integrates the most demanding digital signal processing circuits required to synthesize a spectrally pure, SSB modulated RF signal, and two 8-bit microprocessor units which control the transmitter functionality, making Digimit 2002 the first "Transmitter on a chip" available to radio amateurs.

Digital readout of the operating frequency, the operating mode, the power output level and the transmitter status is provided by an high quality, bright vacuum fluorescent display which allows easy monitoring of the transmitter under any observation angle and light condition.

The front panel of Digimit 2002 is equipped with a rotary knob for frequency tuning, a seven pole microphone connector which features a PTT switch, UP/DOWN tuning controls and power supply output, and five buttons which select the operating band, the modulation, the tuning step, the CW keyer speed and the output power level.

Digimit 2002 features an internal Tx/Rx switch which allows the connection of an external receiver to the antenna via a BNC connector available on the rear panel, and a bi-directional remote interface by means of which the transmitter can either control or be controlled by other communication equipments.

Among the convenience features of Digimit 2002 are its ease of use and its very highly integrated single chip digital modulator/synthesizer system, by means of which the transmitter requires virtually no maintenance and alignment procedures.

Please, read carefully this manual, so as to discover all the unique features of the Digimit 2002, a digital milestone among radio amateur communication equipments.

With compliments,
Nico Palermo - IV3NWV
Microtelecom

SPECIFICATIONS

Frequency coverage:
1.6-2.0, 3.5-4.0, 7.0-7.3,
10.0-10.2, 14.0-14.5, 18.0-18.2
21.0-21.6, 24.8-25.0, 28.0-28.8 MHz*

Modes of operation:
SSB SC(USB, LSB),
CW,
TUNE (with internal 2 tones generator)

Tuning steps:
1 Hz, 10 Hz, 100 Hz, 1 KHz

Frequency accuracy:
+/- 2 ppm typ.
(+25°C, after 10 min from cold start)

Frequency stability:
+/-10 ppm
(-10°C / + 60°C)

Power requirements:
13.8 Vdc, negative ground
reverse polarity protection

Current consumption:
0.8 A, stand by
2.2 A, SSB (10Wpep output)
3.5 A, CW (10W output)

Transmit duty cycle:
100 %
(SWR 1:1, Tamb < 40°C)

Output power:

SSB/TUNE	10 , 5, 2, 1, 0.5, 0.2 and 0.1Wpep
CW	10, 5, 2, 1, 0.5, 0.2 and 0.1W continuous

Antenna impedance:
50 Ohm

Antenna load tolerance:
2:1 or better SWR recommended

Carrier and unwanted sideband suppression (SSB):
Better than 70 dB

Audio frequency response (SSB):
- 0.5 dB (300 – 2700 Hz), phase linear
> -70 dB (0 – 3000 Hz)

Audio input impedance and sensivity:
10 Kohm**

Spurious emissions:
Better than –60 dBc

Harmonic emissions:
Better than –50 dBc

Audio sampling:
1-bit, 6 MHz ΣΔ-ADC

RF sampling:
14-bit, 90 MHz DAC

CW Keyer:
Speed: programmable from 10 to 50 WPM
Mode:
Auto: slap
Manual/External keyer supported

Size:
Cabinet: 6.2 H x 16.5 W x 18.5 D cm
Overall: 6.2 H x 16.5 W x 22.0 D cm

Weight:
980 g

Notes: *Digimit 2002 covers the entire HF range from 0 MHz up to 30MHz. Performances are granted only on specified bands.

** Dynamic 600 Ohm microphones are suggested for better operations. The internal audio AGC provides adequate insensivity to speech level.

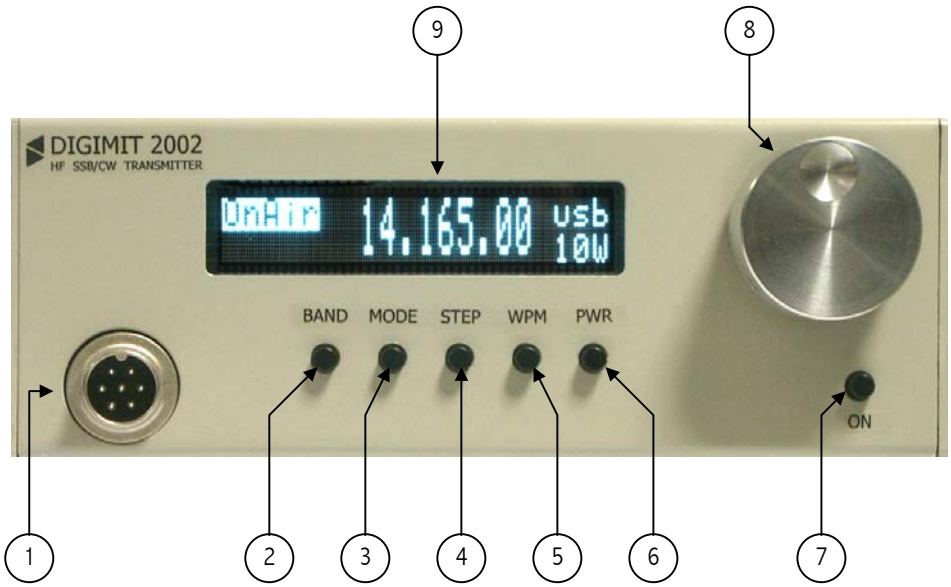
SEMICONDUCTORS

IC:	
AD9754AR	1
AT17LV010-10PC	1
L7805CV	1
LD1086DT3.3	1
OPA2340UA	3
XC2S100-5TQ144C	1
FET:	
BSN20	12
MTD20P0HDL	1
TRANSISTOR:	
AT31625	1
BC808-16	1
BCP54	2
2SC1971	2
DIODE:	
BAV99	15
MBRD650CTT4	1

ACCESSORIES AND OPTIONS

1. Microphone Plug
2. Power Cord
3. In System EEPROM Programming Kit
4. RS-232 Remote control adapter for PC

FRONT PANEL CONTROLS AND SWITCHES



The Digimit 2002 is very easy to operate. However, the operator may not be familiar with some controls. Be sure you thoroughly understand the function of each control and indicator before operating this equipment.

(1) MIC
The MIC jack is used for audio input, PTT control, UP/DOWN tuning control lines and preamplified microphones +5Vdc power supply.

(2) BAND
The BAND button is used to select between the various amateur bands where it displays the lowest frequency of the band selected. When this button is pushed Digimit 2002 jumps to the lower limit of the amateur band which follows the actually selected band.

(3) MODE
The MODE button is used to cycle the operating mode through USB, LSB, CW, and TUNE operations. The CW keyer is active only in CW mode and disabled in USB, LSB and TUNE. When TUNE mode is selected and PTT is activated, Digimit 2002 transmits a continuous 2 tone signal (750Hz and 2250 Hz) useful to monitor antenna SWR and actual transmitter output power with an external SWR/Power meter.

(4) STEP
The STEP button controls the tuning resolution of the main dial in10 Hz, 100 Hz or 1 KHz increments.

(5) WPM
The WPM button controls the speed of the internal keyer when it is operated in automatic mode. Holding down the button, the speed rate is cycled between 10 and 50 words per minute.

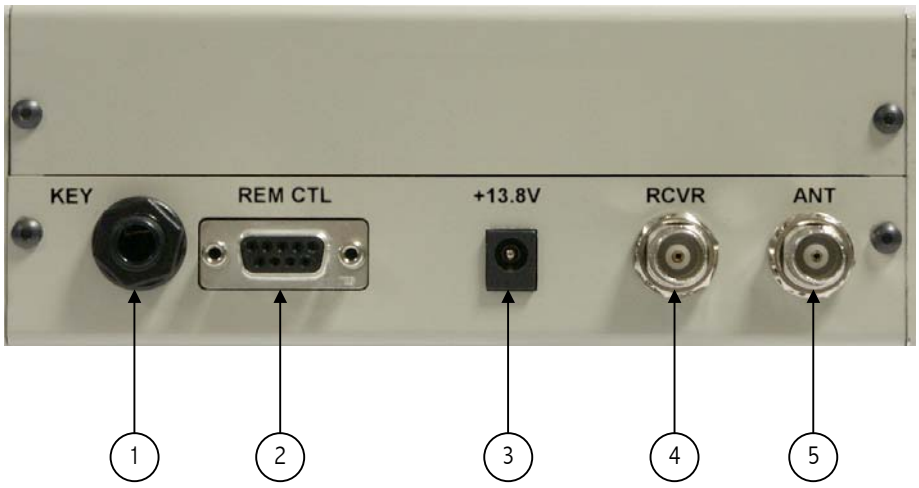
(6) PWR
This button is used to cycle the transmitters output power levels of 10, 5, 2, 1, 0.5, 0.2 or 0.1 W.

(7) ON
This control is the main ON/OFF switch for the transmitter. To turn the transmitter on keep the ON button pressed until the display brights with the Digimit logo and then release it. The transmitter will turn off after the ON button is pressed and released again.

(8) MAIN TUNING KNOB
The tuning knob is used to control the transmit frequency.

(9) DIGITAL VFT DISPLAY
The digital, vacuum fluorescent tubes display indicates the operating frequency, modulation, RF power level, tuning step and keyer speed. When the transmitter is initially turned on, the display will indicate 14.000.00 MHz, USB modulation and 10W output power level. A bright OnAir indication lights up when PTT or CW keyer are activated.

REAR PANEL CONNECTIONS



(1) KEY
This is the key jack for CW operation, with two separate inputs for dashes and dots levers. Use a 6mm stereo plug to connect the key levers contacts to these inputs. The transmitter activates when either input is shorted to ground.
The internal automatic keyer operates in "slap" mode (dashes and dots levers operated exclusively and are never squeezed). To disable the internal keyer and operate manually with a straight key or with an external automatic keyer, wire the dash and the dot inputs togheter, and connect them to the straight key/automatic keyer contact.

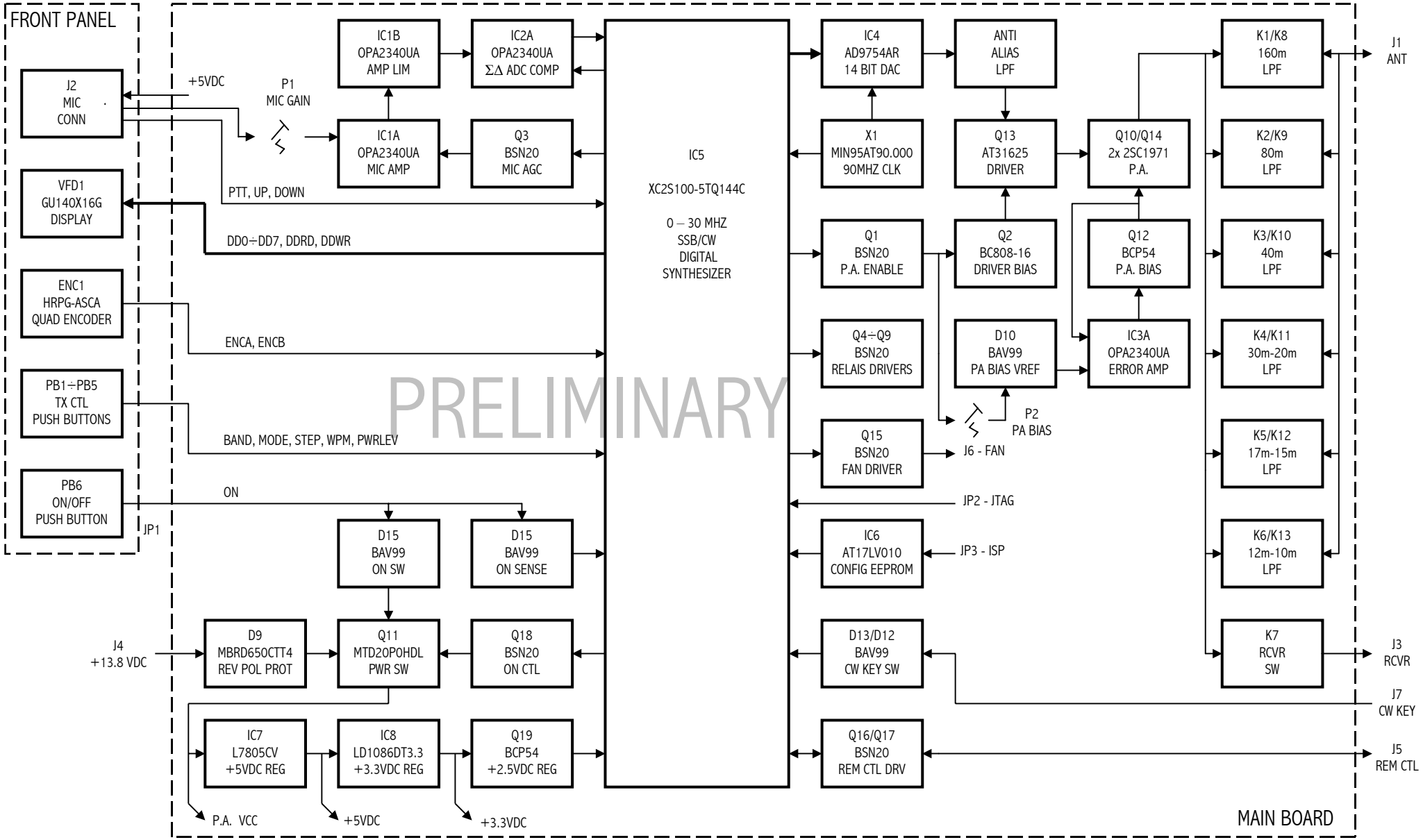
(2) REM CTL
This is the Remote Control connector. Digimit 2002 may either control or be controlled by external equipment and/or a proper PC adapter and software.

(3) +13.8V
The main power supply of the transmitter is applied to this connector. The positive voltage is applied to the central pin.

(4) RCVR
This BNC connector is provided for the receiver antenna input. The transmitter includes a Tx/Rx switch which isolate the receiver input from the antenna when the transmitter is keyed.

(5) ANT
This is the main antenna connector.

DIGIMIT 2002 Rev. A
BLOCK DIAGRAM



The block diagram, the schematic diagrams and the circuit description to follow will provide a better understanding of this transmitter.

MIC AMP

When Digimit 2002 is operated in SSB, the audio input signal from the microphone is amplified by the operational amplifier IC1A (OPA2340UA). The audio level can be adjusted by P1 to accommodate a large choice of audio sources.

The operational amplifier IC1B provides additional audio gain and limits the audio to approx. 1 Vpp to avoid the overdrive of the SSB modulator.

MIC A/D CONVERTER

The audio signal is converted to the digital domain by a sigma-delta analog to digital converter, formed by the operational amplifier IC2A (OPA2340UA) and IC5 (XC2S100-5TQ144C). IC2A acts as the summing junction/integrator of a sigma delta modulator and computes the integral error between the analog audio signal and its digital pulse train representation. IC5 samples and quantizes the polarity of the integral error at 6 Msps and generate the digital pulse train which is feedback to IC2A. IC5 decimates this 1-bit quantized digital audio by a factor of 500 and provides a 12 KSPS, 10-bit digital audio stream which feeds a digital SSB modulator/synthesizer.

MIC AGC

The gain of the operational amplifier IC1A is controlled by the MOS FET Q3 (BSN20), which is operated as a voltage controlled resistor. The gain control voltage is generated by IC5 and is applied to the gate of Q3. IC5 compares the digital audio level and discharges quickly the capacitor C50 whenever the audio level is above a fixed threshold, thus increasing the dynamic resistance of the channel of Q3 and reducing the gain of the amplifier IC1A.

SSB/CW MODULATOR/SYNTHESIZER

The RF SSB/CW signal is digitally synthesized by IC5 by means of a digital Weaver modulator.

The digital Weaver modulator is made by three main building blocks:

- the unwanted sideband rejection filter,
- the baseband interpolator,
- the RF frequency converter.

The unwanted sideband rejection filter.

The unwanted sideband rejection filter is operated at 12 Ksps and provides very high suppression of the unwanted sideband and of the carrier. It is made by a 16 bit, CORDIC based quadrature down converter, which shifts the audio spectrum by +/- 1500 Hz and a 127 taps F.I.R. filter pair with 24-bit MAC units. It provides more than 75 dB of attenuation in a 3 KHz stop band and a very flat (+/-0.1dB), phase linear response in a 2.4 KHz pass band.

The baseband interpolator.

The interpolator resamples the base band SSB/CW signal generated by the unwanted sideband rejection filter up to 90 Msps, providing high attenuation of digital images.

The interpolator is made by three interpolation stages.

The first stage interpolates the base band signal from 12 Ksps to 240 Ksps, and includes a 4^{th} order CIC interpolation filter pair which provide >80 dB of rejection to alias images.

The second stage interpolates the 240 Ksps audio stream up to 6 Msps with a 2^{nd} order CIC interpolation filter pair and provides 90 dB of alias images rejection.

The third stage produces the 90 Msps baseband complex signal which feeds the RF frequency converter, and is made by a 1^{st} order CIC interpolation filter, with more than 70 dB alias image rejection.

The RF frequency converter.

The RF frequency converter operates at 90 Msps and tunes the interpolated, baseband signal to the desired operating frequency by means of a 14 stages pipelined CORDIC processor and a 32-bit phase accumulator.

CW SYNTHESIZER

The CW signal is synthesized in a very similar way injecting a constant digital offset at the inputs of the unwanted sideband rejection F.I.R. filters when the transmitter is keyed. The F.I.R. filters pair provides adequate rise/fall time of the transmitter output power and click-free operations.

TRANSMIT D/A CONVERTER

The RF SSB/CW signal synthesized by IC5 is fed to the D/A converter IC4 (AD9754AR) and reconstructed by a 7th order low pass filter which suppresses the images above 30 MHz.

POWER CONTROL

The level of the R.F. signal generated by the transmit D/A converter is digitally controlled by IC5 which integrates a sigma delta D/A converter and provides a variable reference voltage to IC4.

CLOCK OSCILLATOR

The transmitter uses a single 90 MHz clock source, the oscillator X1, which feeds the programmable logic IC5 and the transmission D/A converter IC4. The tolerance of the clock source is compensated by the clock frequency register implemented in the transmitter microcontroller unit contained in IC5.

POWER AMPLIFIER

The R.F. signal from the reconstruction filter of the transmit D/A converter is amplified by a driver amplifier Q13 (AT31625) operated in class A, and a push-pull amplifier, operated in class AB and formed by Q10 and Q14 (2SC1971), delivering approximately 10 watts of output power.

P.A. BIAS

The bias voltage applied to the base of Q10 and Q14 is provided by a low output impedance, adjustable voltage reference regulator. D10 (BAV99) provides a fixed 1.4 Vdc voltage reference, placed in proximity of the P.A. heat sink to provide thermal tracking. The quiescent collector current of Q10 and Q14 is adjusted by P2. The operational amplifier IC3A (OPA2340UA) and the current amplifier Q12 (BCP54) form a feedback amplifier which maintains constant the bias voltage applied to the base of Q10 and Q14 regardlessy of the RF drive level.

P.A. and driver bias is enabled by the MOS FET Q1 (BSN20) and the transistor Q2 (BC808), and controlled by IC5.

LOW PASS FILTERS BANK AND Tx/Rx SWITCH

The transmitter is equipped with six low pass filters which rejects the harmonic emissions of the power amplifier. The filters are switched accordingly to the selected operating frequency by IC5 through the relays drivers Q4÷Q9 (BSN20). The receiver antenna connector is connected to the main antenna connector through the low pass filters bank, which provide additional filtering of the receiver front-end, and is highly isolated from the P.A. output when the transmitter is keyed.

P.A. FAN

A power amplifier fan is provided for better heat sink of the transmitter. The fan is activated when the transmitter is keyed by IC5 through the driver Q15 (BSN20).

CONFIGURATION PROM

The programmable ROM IC6 contains the configuration data for the programmable logic IC5. The configuration data is downloaded to IC5 when the transmitter is turned on in a fraction of second. IC6 is mounted on an eight pin DIL socket for ease ROM version upgrade. In system programming kit is available as an option.

POWER ON CIRCUIT

The main power supply is applied to the transmitter by means of the reverse polarity protection diode D9 (MBRD650CTT4) the p-channel MOS switch Q11 (MTD20P0HDL). When the ON/OFF button is pressed, the gate of Q11 is actively biased through D15 (BAV99) and the power supply is applied to the voltage regulators chain formed by IC7 (L7805CV), IC8 (LD1086DT3.3) and Q19 (BCP54). The MOS switch Q18 (BSN20) is activated as soon as the programmable logic IC5 is programmed and latches Q11 to a conducting state.

The status of the ON/OFF button is read by IC5 through D15 (BAV99) which deactivates Q18 and Q11 when the transmitter is turned off.

MAINTENANCE AND ALIGNMENT

If not abused, Digimit 2002 should not require other than the usual attention given to electronic equipment. Service or replacement of a major component may require some realignment and performance checks. Service work must only be performed by experienced personnel using the proper test equipment.

Never align the transmitter without having a suitable 50 ohm dummy load connected to the antenna jack.

PERFORMANCE CHECKS

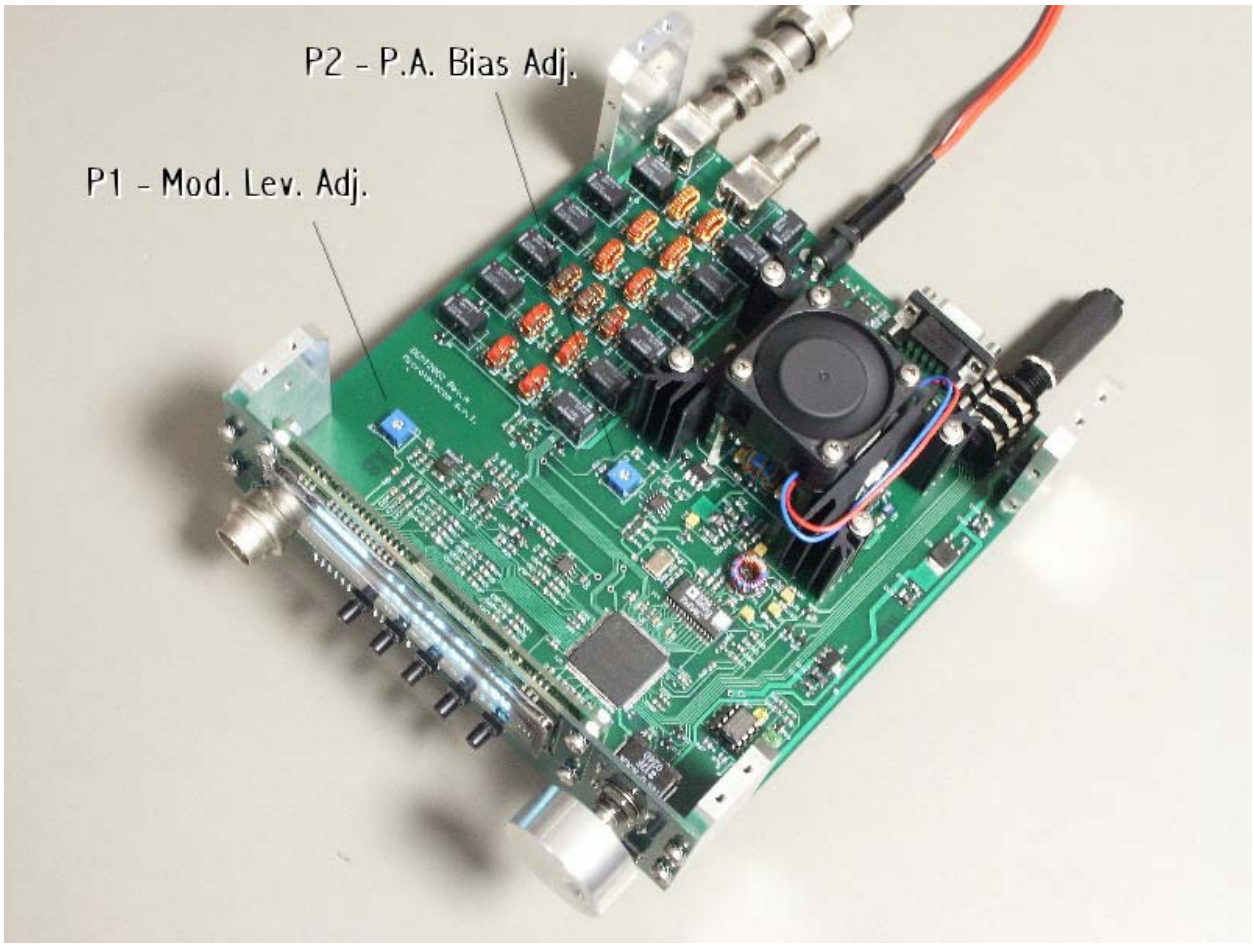
Make all performance checks at 13.8Vdc under load.

Output power check

(a) Connect a suitable dummy load/wattmeter to the antenna jack.
(b) Set the operating frequency to 14.000.00 MHz, the mode to TUNE, the output power level to 10 W and key the transmitter while observing the output power which should be approximately 10 Wpep.

Operating frequency check

(a) Connect a suitable attenuator to the antenna jack and a frequency meter to the attenuator output.
(b) Connect a straight key to the CW jack. Connect dash and dot inputs in parallel to disable the internal keyer.
(c) Turn on the transmitter and wait ten minutes to allow for transmitter thermal equilibrium.
(d) Set the operating frequency to 28.000.00 MHz, the mode to CW, the output power level to 0.1 W and key the transmitter.
(e) Observe the frequency meter readout which should be approximately within +/60 Hz from the nominal value of 28.000.00 MHz (25° C ambient temperature).



Operating frequency adjustment

Operating frequency alignment is not required unless the oscillator X1 must be substituted.
When X1 is substituted with a new unit, the maximum frequency error is about +/-20 ppm or +/-600 Hz in the 10 m band and smaller in lower bnads. An accurate alignment of the operating frequency requires the substitution of the transmitter PROM. Once the frequency error is accurately measured, we are able provide you a new matched PROM which will reduce the error within the limits of the specifications.

PA Bias adjustment

(a) Connect a suitable dummy load/wattmeter to the antenna jack.
(b) Connect a ampere meter in series with the +13.8Vdc power supply. Select a 5 A range.
(c) Connect a straight key to the CW jack. Connect dash and dot inputs in parallel to disable the internal keyer.
(d) Turn P2 completely counter clockwise and turn on the transmitter.
(e) Set the operating frequency to 14.000.00 MHz, the mode to CW, the output power level to 10 W while.
(f) Read the current consumption while NOT keying the transmitter.
(g) Turn slowly clockwise P2 until the current consumption rise by 100 mA.
(h) Key the transmitter while observing the current consumption which should peak approximately to 3.5A.

Modulation level adjustment

(a) Connect a suitable dummy load/wattmeter to the antenna jack and the microphone to the MIC jack
(b) Connect an SSB receiver to the RCVR antenna jack and tune it to 14.000.00 MHz, USB.
(c) Set the operating frequency to 14.000.00 MHz, the mode to USB and the power level to 10 W.
(d) Adjust P1 while speaking at the microphone, listening to your modulation with the receiver headphones and observing the output power which should peak to 10 Wpep.