Theory of Operation.

Introduction

The T2000 series of transponders are designed to operate within the Air Traffic Control radar environment. The design criteria was for a high performance unit that was lightweight, low power consumption and suited a range of aircraft. The chassis is split into 3 cavities , the main , the transmitter and the micro controller. Chassis construction is off CNC milled aluminium.

Receiver.

Signals are received via the BNC antenna input socket and passed into the RX / TX port of the circulator. As the receive port is first off the circulator this signal is then fed into the band pass filter for filtering the resultant 1030 Mhz signal. This signal is then fed into the receiver board which consists of an LNA , receiver chip , 5 volt regulator and op amp. The LNA is programmed to boost the filtered 1030 signal a further 10 DB before passing it on to the Receiver chip. The receiver chip uses logarithmic amplifiers to detect the signal over a –73 dbm range , the output has a swing from .6 of a volt (least sensitivity) to + 2 volts (maximum sensitivity) and is linear. The following op amp acts a buffer / edge detector before presenting the analog voltage to the micro processor . An additional comparator provides pulse width measurement which is fed into the input compare port on the micro controller, as well as a start of conversion pulse for the flash A to D converter.

Transmitter.

The transmitter consists of 3 stages :

Oscillator
Buffer / Driver
Power Amplifier

The oscillator consists of a tuned resonator at 1090 Mhz , volts are applied (pulsed) at the emitter via a monastable triggered by the micro controller.The resonator sets the transmit frequency .The base is biased, also a variable capacitor at the base provides frequency adjustment. The collector of the oscillator is also switched at the same time , this provides 52 volts. The resultant 1090 signal (approximately 12 watts) is then fed into the buffer amplifier and final P.A . Both stages are in class C. A series of ¼ wave matching stubs on the output provide 2^{nd} , 3^{rd} , 4^{th} and 5^{th} harmonic suppression.

Power Supply.

The power supply has 2 onboard regulators, one running in Boost mode to switch the 10 to 33 volts D.C input up to 52 volts (transmitter volts) and the other is a 8 volt regulator which supplies power to the receiver. The input is over voltage and reverse power protected. 5 volts for the micro controller is derived from an onboard (main micro board) switchmode regulator which is not switched of from the power in (live to the input) . The switch mode for the 8 and 50 volts is switched on and off by the main micro controller.

Micro processor (Main board)

The micro controller is a 17c756 OTP , an econ reset power monitor will reset the micro controller should an unstable supply voltage be detected. A watchdog timer which is internal to the micro controller provides software and hardware monitoring and reset should there be a failure, also an external power watchdog provides a clean reset should the volts to the micro drop by 10%. The receiver analog volts is fed into a 10 bit , A to D chip. The output is then fed into the 8 bit port (Port F) on the micro controller. The signal is then processed and a valid reply sent should the A or C interrogation be received. Additional to processing the receiver , the micro also sends the transmit pulses to the monostable at the transmitter oscillator. Gillham altitude information is processed by the micro controller as 10 bit data received at port C and D. This is then displayed on the ALT DISP and also transmitted in the mode C transmission.. Other inputs and outputs include:

Remote ID – An input to this pin going low will initiate an ID transmission (SPI Pulse).
Remote standby- An input to this pin going low will initiate a standby condition on the T2000 , the S symbol will be displayed.
Suppression In – and high input (5 to 33 volts) will suppress the T2000 transmit pulses for the duration of the high status.
Suppression out – The T2000 will toggle this pin high every time a transmission occurs. The pulse is low going high (TTL – 5 volts).
Encoder volts – A switched output for driving an external altitude encoder , volts out follow volts in at the power input , i.e A 28 volt input will provide 28 volts out to the encoder, 14 volts in will provide 14 volts out.
RS-485 + and - - RS-485 data line for connection to external displays and MFD’s (future development).

A to D monitoring of the power input provides BUS voltage display , also a to d monitoring of the receiver volts provides a diagnostic tool for monitoring the receiver volts. The internal communications from the display to the main micro is via an RS – 232 link.

Micro controller (SF Display)

The display can be used as a master or remote. Communications is provided by RS –232 (for internal connection).The micro controller is a 17c756 OTP , an econ reset power monitor will reset the micro controller should an unstable supply voltage be detected. Also this reset IC acts as a watchdog timer which provides hardware monitoring and reset should there be a failure. 2 x 8 line Alphanumeric displays are serially addressed by the micro controller. The displays have their own drivers and character generators. LED display brightness levels are controlled by a photo resistor which is monitored by the micro controllers A to D.
Keyswitch inputs are scanned by the micro and initiated when depressed. These inputs are:

On/OFF – Sends the on / off request to the main micro controller , also provides the keypad backlight command.
Mode: Selects various mode commands (see user manual)
Enter: Enter key
ID – Sends SPI (IDENT) command to main micro controller.
VFR – Sends stored VFR code to main micro controller
Transfer – Transfers the standby code to the active screen.

Mode select rotary switch selects standby , On (mode A and C , C with no altitude data) Alt (mode a and C with altitude data) and display alt (mode A and C with altitude encoding , plus altitude display)

Code select , is a rotary up down encoder with push button on switch . Selects the 4 digit ident code , this is connected to a 14490 IC to provide de bounce of the contacts before going to the micro inputs.

10 Backlight LEDs are positioned behind the membrane key switches and are switched on during the startup and when the on button is depressed momentarily (key switch backlighting).

Micro controller (SFL Display)

The display is housed with the main unit and communicates with the master micro via a high speed RS-232. Future developments will include an external display option (remote) with high speed RS-485, provision for this is on the PCB but not implemented in software. The micro controller is a 17c756 OTP , an econ reset power monitor will reset the micro controller should an unstable supply voltage be detected, also it has a watchdog timer which is external to the micro controller and provides hardware monitoring and reset should there be a failure. 2 x 8 line Alphanumeric displays are serially addressed by the micro controller. The displays have their own drivers and character generators. LCD display Contrast levels are controlled by a fixed variable resistor which is adjusted at production.
Key switch inputs are scanned by the micro and initiated when depressed. These inputs are:

On/OFF – Sends the on / off request to the main micro controller , also provides the keypad and display backlight command.
Mode: Selects various mode commands (see user manual)
Enter: Enter key
ID – Sends SPI (IDENT) command to main micro controller.
VFR – Sends stored VFR code to main micro controller
Transfer – Transfers the standby code to the active screen.

Mode select rotary switch selects standby , On (mode A and C , C with no altitude data) Alt (mode a and C with altitude data) and display alt (mode A and C with altitude encoding , plus pressure altitude display)

Code select , is a rotary up down encoder with push button on switch . Selects the 4 digit ident code , this is connected to a 14490 IC to provide de bounce of the contacts before going to the micro inputs.

10 Backlight LED’s are positioned behind the membrane key switches and are switched on during the startup and when the on button is depressed momentarily (key switch backlighting). Also the LCD backlighting is controlled by the ON / OFF button , 2 levels of adjustment, hit on once , low level LED backlighting , hit button again , high level LED backlighting , hit button again , both the keypad and LED backlight reset to off.