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M48A MODEM PRELIMINARY 07 September 2009

M48A modem chip – for narrow band wireless data link

The M48A is a half-duplex serial modem controller suitable for use with narrow band receivers, transmitters and transceivers. It supports a maximum transparent data throughput of 4800baud while baseband modulation frequencies do not exceed 3.2KHz. The device supports (programmable) long startup/preamble durations sometimes required for synthesized narrow band devices.

Figure 1: M48A-000-DIL modem IC

The M48 provides a half duplex link, but provided no two devices attempt to transmit at one time (a 'low' on RX_flow may be used as a primitive 'CTS' indication) no further restrictions on data transmission need be made, as all transmit timing, valid data identification and data stream buffering is conducted by the device.

This unit supports a range of user interface data rates, in asynchronous data format: 1 start bit, 8 data bits, 1 stop bit. The supplied default (and the maximum transparent throughput) is 4800 baud

To connect to a true RS232 device, inverting level shifters must be used (MAX232 type are ideal, but simple NPN transistor switches often suffice). With typical microcontrollers and uarts, direct connection is usable. Note that TXD has no internal pullup.

Features

- Operating voltage (temperature):
  5V for standard version (-40°C to +85°C)
- Maximum usage of the range capability of an RF module
- Compatible with fast or slow transmitter power up timing requirements
- 5kbps pulse duration coded protocol
- Synchronisation codes and checksum to reduce false triggering on noise
- Programmable transmit address and four receive addresses
- Programmable timing parameters (preamble length, etc)
- Programmable auxiliary serial output (to program radio modules)
- Programmable serial modem baud rate (1200 - 76800 bps, half-duplex)
- Suitable to be used with Narrow Band FM radio modules
- Addressable point-to-point and point to multi point
- Packet acknowledge/resend (ACK) mode
- Store and forward repeater function

Applications

- PDAs, organisers & laptops
- Handheld / portable terminals
- Remote operated vehicles
- Data loggers
- In-building environmental monitoring and control
- Industrial (SCADA) telemetry and M2M systems
- Fleet management, vehicle data acquisition

User Interface

M48A is an 18pin PIC16F648A, running proprietary software. It requires a 4.5v minimum supply.

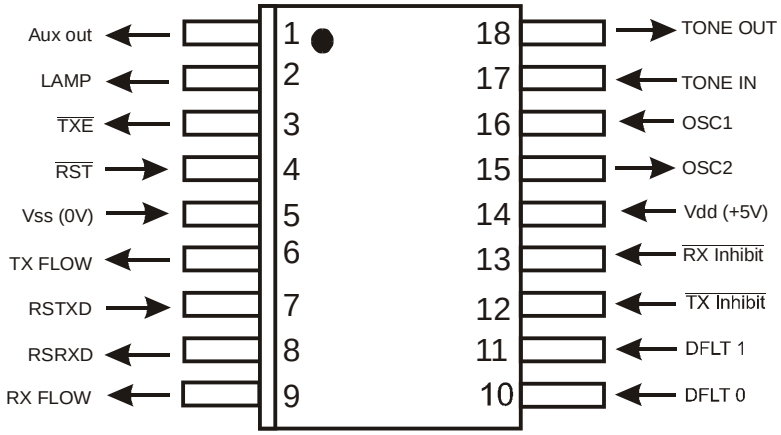


Figure 2: package type, 18-Lead Plastic Dual In-line (PDIP - 300mil wide body)

Pin description:

Pin	Name	I/O	Function
1	AUX OUT	out	Serial output to radio module (1200/2400/4800/9600 baud true RS232)
2	LAMP	out	High when in transmit
3	TXE	out	Low = enable transmitter
4	RST	in	Drive low to reset device. Otherwise pullup to Vcc
5	0V	supply	Supply ground
6	TX FLOW	out	Low indicates tx buffer near full (3/4 full)
7	RSTXD	in	Inverted RS232 datastream in
8	RSRXD	out	Inverted RS232 datastream out
9	RXFLOW	out	Low indicates data received or in rx FIFO buffer
10	DFLT_0	in	Default timing set
11	DFLT_1	in	Default timing set
12	TX inhibit	in	high = normal mode, low = inhibits transmit (data in still goes to buffer)
13	RX inhibit	in	high = normal mode, low = prevents serial data being output
14	Vcc	supply	5V (regulated power supply); Decouple with 100nuF close to IC
15	OSC2	out	Connect to 19.6608MHz crystal via 100Ω resistor
16	OSC1	in	Connect to 19.6608MHz crystal
17	TONE IN	in	Baseband input from receiver data output
18	TONE OUT	out	Baseband output to transmitter data input

NOTES:

1. M48 is intended for use with USX/UHX, RMX and LM series radios.
   If other radios are used, then to reliably recover the data format an external peak sampling data recovery circuit is recommended, such as QR96.
2. All conncetions are 5v cmos logic level except TXE, which is a an open drain
   (but do not exceed +5v on this pin)
3. Some Radiometrix transmitters require 3v logic levels on their transit data inputs:
   In such cases a divider (4K7 series, 10K to ground) on the RXD pin is needed
4. In RX operation, Tone_out becomes a high impedance
5. After pulling TXE low (active), the coder allows about 50mS for TX to power up and settle
   (this, and other timings, can be modified via the setup mode)
6. RSTXD (pin 7) has no pullup. If the device is only used for transmit, then tie this pin to VCC
7. Vcc must be a 5v regulated supply (4.5 - 5.5v).
   At this oscillator frequency the pic will not operate reliably at 3v
8. An approximately 5.1kbps multiphase coded comms protocol is used
9. Without external loads the chip draws less than 5mA from 5v
10. tx_FLOW goes low when the tx buffer is 3/4 full.
    it returns to high state when the buffer is empty
11. rx_FLOW goes low whenever valid data is present in the receive buffer.
12. A simple addressing structure is included in the datastream.
    Units may be programmed onto one of 254 addresses

Address 0 is a broadcast 'all units' address
Address 255 is reserved (Units are supplied set to adr1 = 0, adr2,3,4 and adr_tx =1)

13. OSC1, 2 require a 19.6608MHz fundamental mode crystal, a series 100 ohm resistor from OSC2, and a pair of 15pF caps : from the crystal pins to 0V
14. **DFLT0 DFTL1**
    high high : slow timing (20mS, 50mS, 20mS)
    low high : tba
    high low : tba
    high high : tba
    These pins have internal pullups. They are only read at power-up, if the unit has not been already programmed. They are also read on execution of a DEFAULT command
15. TX_inhibit is only sampled as the transmitter is initialising (and before a carrier is being emitted). It is ignored during constantly streaming data (ie: once the transmitter has activated)

The Radio / datastream interface

A 128 byte software fifo is implemented on transmit (64 bytes on receive). At the transmit end this is used to allow for the transmitter start up time (nominally 50mS), and to buffer data where the user interface baud rate is set to more than 4800 baud. On receive it buffers arriving packets to the constant output data rate.

All timing and data formatting tasks are handled by the software. The user need not worry about keying the transmitter before sending data: the link is entirely transparent.

For transmission across the radio link data is formatted into packets, each comprising up to 16 bytes of payload data, a framing/sync code, an address byte and a checksum.

A simple P/N based scrambler algorithm is applied to the data payload, to 'whiten' the data, although the data stream is not guaranteed to have a strictly 50:50 mark space. A peak sampling data recovery circuit (such as QR96) is recommended

In transparent (normal) mode the entire 16 bytes of payload are used for data. In this mode, data can be streamed at 4800 baud (or slower), without restrictions. The unit has, however, other "expanded" modes.

In expanded mode, the normal address byte is set to FF, and the first two bytes of the payload contain an address byte and a mode byte, followed by up to 14 bytes of data.

The mode byte operates as a special function code (80-FF) or a burst identifier (01-7F). It is never a zero.

Burst identifier is an arbitary number incremented after each transmission. It is used to prevent the reception of multiple copies of the same burst when in AKN or repeater operation

If less than 16 bytes are in the transmit end fifo then a shorter packet is still sent. When the transmit end fifo has completely emptied, then the transmitter is keyed off. A link latency (first byte in to tx to first byte out of rx) of about [preamble period + 40mS] is achievable..

Transmit operations have precedence over receive. If a byte is received on the TXD pin the unit immediately switches into transmit mode, and any data in the the receiver buffers is lost. (for LBT applications this precedence can be modified by using the N_TX_inhibit input)

To prevent un-necessary transmission of short packets, a programable delay (usually 20mS) is applied between the arrival of a byte on TXD and the unit commencing it's transmit sequence. Unfortunately, during this delay period, the receiver decoder functions are off-line and data already in the rx buffer is still lost.

Raw data is not fed to the radios. A coding operation in the transmit software, and decoding in the receiver, isolate the AC coupled, potentially noisy baseband radio environment from the datastream.

Programming the M48

In order to use all the functions embedded in the M48, the user must be aware of the setup/programming facility, which allows user customisation of the device's operating modes.

The device is programmed through the same RS232 port that is used for sending/receiving data. An RS232 terminal emulator (such as Aterm or HyperTerminal) is an ideal tool.

To enter program mode, a 'BREAK' character (a long 'space' condition that triggers a stop bit framing error in the UART) must be sent to the unit.

The unit then 'replies' with an @ character, followed by a random character (ascii code between 48 and 79). The user must then send this random value back to the unit within a five second timeout period (after which the M48 reverts to normal operation)

Reception of a CTRL-A (ascii 1) will cause a new random value to be calculated and another @ and random sequence is output (and the timeout counter is reset)

On reception of the correct byte, the M48 enters ‘command’ mode and sends the string “M48 SETUP”

In command mode the radio link is disabled, but characters sent to the unit (at the programmed baud rate, as normal) are echoed back on the RXD pin.

The unit will only respond to certain command strings:

Upper case characters are used for all commands
Spaces are echoed, but are ignored by the parser

Keyboard entry

COMMANDS	FUNCTION
carriage return (ascii 13)	processes the input buffer contents (and clears the buffer)
Escape (ascii 27)	terminates setup mode and returns to normal 'data' operation
? or / (ascii 63 or 47)	prints the current contents of the input buffer
- (ascii 54)	shortcut for the STATE command
& (ascii 38)	shortcut for the RX command
delete (ascii 127)	clears the input buffer

Address setup

These commands set up the addresses. An M48 will only communicate with a unit set to the same address. The M48 supports four receive addresses (of which ADR1 is usually set to zero) and a separate transmit address

COMMANDS	FUNCTION
ADR1 aa	set receiver address 1
ADR2 aa	set receiver address 2
ADR3 aa	set receiver address 3
ADR4 aa	set receiver address 4
ADTX aa	set transmitter address
ADDR aa	set rx address 1 to zero and set tx address and rx addresses 2, 3 and 4 to aa

Notes:

1. aa is a two digit hexadecimal value (00 to FE)
2. Addresses are stored in volatile memory.
3. On power-up the M48 reverts to the defaults in EEPROM (as supplied these are tx addr=1, rx addr1 = 0 and rx addr 2-4 =1)

Operating mode setup

COMMANDS	FUNCTION
DIAG	Enter a diagnostic mode, where the address, length, checksum and decoder status byte for every received burst are printed
MEXT	The unit now operates in extended mode (burst ID on, multiple transmissions set by TRIES)
AKN	The unit now operates in aknowledge/resend (extended) mode
STAF	Operate as a store and forward repeater (with MEXT set, or not)
NORM	The unit returns to standard, transparent mode
PROM <CR>	Writes the current volatile settings (addresses and operating mode) into EEPROM as the new defaults.

MEXT is used for multiple packet send operations, and (with TRIES set to one) to communicate with repeater networks. This mode enables extended 14 byte packet format with burst identifier handling, but without AKN burst generation"

It also allows listening in on AKN mode packets, without generating AKN transmissions.

In extended mode the data throughput is slightly reduced, as only 14 bytes are sent per packet. Fully transparent 4800 baud operation is not supported.

STAF initialises the "store and forward" repeater mode.
In this mode, when a packet is received it, it is buffered and re-sent immediately.

Care must be taken by the user to control overflow issues when using the store and forward mode, as the repeater only has a 16 byte (one packet) buffer, and cannot re-send two consecutive packets
(We recommend setting the TXOFF delay on the sending unit to a time greater than a burst length, so permitting the repeater to clear it's buffer before the next packet can arrive. DELAY should also be set so as to maximise the length of each transmit packet)

STAF can be used in extended (MEXT) mode, in which case multiple reception of the same burst by the recipient (via repeater, and direct from sender) is handled by the embedded burst id code (and the same tx and rx addresses are programmed into all units)
Alternatively (in normal mode) by manually setting the repeater's transmit address / recipient receive address and sender's transmit / repeater receive to different values, the recipient can be made to respond only to packets from the repeater.

Timing and baud rate setup

Take great care when setting timing parameters and baud rates. It is possible to upset the correct operation of the unit, or lose communication with it altogether. In the worst case, where an unknown BAUD rate has been set, then remember that the character following a 'break' is always an ascii 64 (the @ character) and that on a scope this easily allows the bit-period to be measured

As supplied, the M48 is set to 4800 baud main interface, and 2400 baud on the aux-port

These setup parameters are immediately stored in EEPROM, and take effect right away.

COMMANDS	FUNCTION	NOTES
BAUD b1	Set main port baud rate	b1, b2 are baud rates
BAUX b2	set aux port baud rate	Only the first two digits are needed, i.e. BAUD 12 iss valid

Main port (b1) supports 1200, 2400, 4800, 9600, 19200, 38400, 57600, 76800
Aux port (b2) supports 1200, 2400, 4800, 9600 only

COMMANDS	FUNCTION
DELAY dd	Set the initial delay between first byte arrival and transmit start (20mS default)
PREAM pp	Set the number of (620uS long) preamble bits (80 its / 50mS default)
TXOFF oo	Set the tx ramp-down period (20mS default)
TRIES rr	Number of transmissions attempts allowed in AKN and MULT modes
TIMEOUT tt	Duration of AKN resend timeout (tt x 0.41mS)

Note: Variables dd, pp, oo, rr and tt are all two digit hexadecimal values (00 to FF)

General commands

COMMANDS	FUNCTION
DEFAULT	The unit self-reprograms with ALL original factory preset values
STATE	Prints out the current operating parameters (a single minus sign, ascii 54, does the same)
LOCK	The unit now defaults to setup (rather than data) mode on power up
EXIT	Return to data mode (same effect as an escape (ascii 27) byte) If a LOCK command is in force, an escape byte has no effect, but EXIT overrides LOCK
TEST	Turns on the transmitter, and outputs a continuous 200Hz tone This mode is disabled by any activity on the TXD input
RX	Turn on the receiver/decoder (as if in data mode) and output received packets as normal This mode is disabled, and command mode re-entered, by any activity on the TXD input

A Carriage Return '<CR>' (ascill 13) should be entered after each command sequence to execute it. (with a few exceptions among the single key commands and the string operations)

An **incorrect** command string will elicit an '**ERR'** reply
A **correct** string is answered with an '**OK'** (after all EEPROM programming has been completed)
If the buffer is empty, only the <cr> will be echoed

'String' commands

There are special commands which allow whole strings of characters to be sent via the transmitter, or the auxilliary serial port (usually connected to the radio module programming input)

Auxilliary port output (to allow programming of an attached radio module)

[(1-30 byte data string)] (ascill 91, 93) outputs the text string between the [ ] characters, to the AUX pin
[(1-30 byte data string) <cr> (ascii 91, 13) as above, but with an added CR (13) appended to the end

Special 'transmit a packet from command mode' function.

$ (length byte) (1-16 byte data string) ($ is ascii 36)

This function output a data packet to the transmitter, then returns to setup mode.

'Length byte' is a single hex character.
It sets the length of a transient data buffer (the actual buffer length is one more than the value of length, so 0-F corresponds to a buffer between 1 and 16 bytes long)
After the length byte, the M48 sends back a colon character (ascii 58)
'data string' is a string of bytes equal in number to length+1

When the final byte is received, the modem goes into transmit, and sends a packet

Note: By careful use of the & and $ command bytes, the M48 can be used in a non-transparent mode, without ever leaving command mode. This is especially useful for the master node in point to multi-point operation.

Timings

The data throughput of the M48 is limited by the radio path. In continuously streaming (transparent) mode a baud rate of 4800 baud is supported without any buffer overflows.

Byte latency is influenced by the switching performance of the radio (and the programmed DELAY and PREAM values).

In default mode (20mS delay, 50mS preamble) the single byte in to out latency is of the order of 110mS (20+50+40mS burst length and processing delays) although in streaming data this is reduced to around 30mS

If radio switching times are faster, then the preamble duration and the tx off delay can be reduced (crystal controlled radios such as NiM2 work well with 15mS of preamble, 5mS tx off) and latency falls to around 40mS

In ANK mode, the switching speed of the radios, and the time absorbed in sending and decoding the acknowledge burst dominate the data throughput. The acknowledge in itself requires only 20mS, but the requirement to switch both radios between receive and transmit (to send the data packet, and then the akn packet) adds a significant overhead.

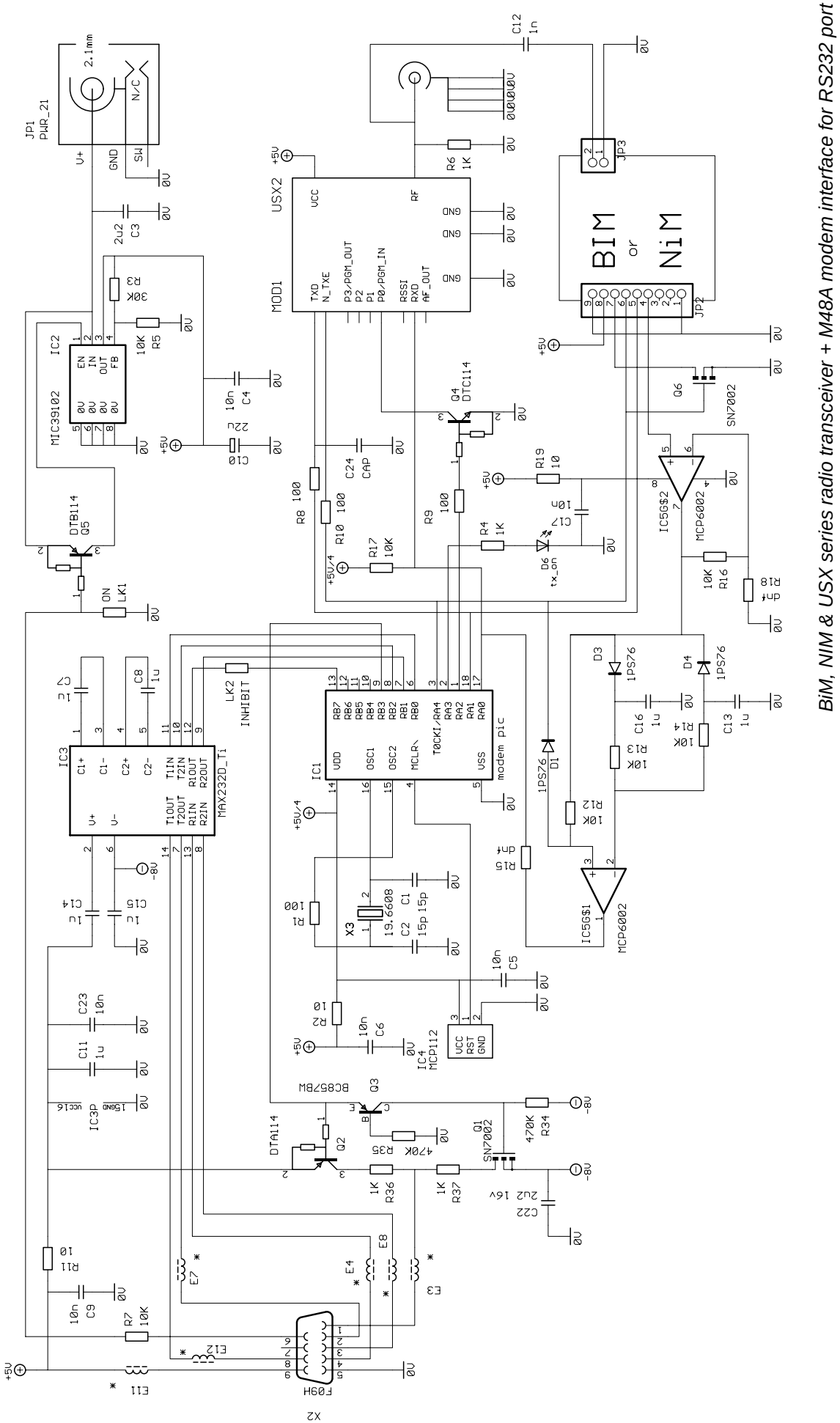
Referring to the default timing setup this results in 1 packet per 150mS, and a peak data througput of only 900 baud, although if radios with faster switching performance are used then this is significantly increased. (With NiM2 or BiM1 radios, the preamble duration can be significantly reduced, and an aknowledged mode data rate of well over 1200 baud is achievable)

Unless only short data bursts are used, we recommend the use of CTS flow control if AKN is selected

Ordering Information:

M48A-000-SS - Shrink Small Outline
M48A-000-SO - Small Outline
M48A-000-DIL - Plastic Dual In Package

Application circuit



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The Intrastat commodity code for all our modules is: 8542 6000.

R&TTE Directive

After 7 April 2001 the manufacturer can only place finished product on the market under the provisions of the R&TTE Directive. Equipment within the scope of the R&TTE Directive may demonstrate compliance to the essential requirements specified in Article 3 of the Directive, as appropriate to the particular equipment.
Further details are available on The Office of Communications (Ofcom) web site:
http://www.ofcom.org.uk/radiocomms/ifi/

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