BRITISH MICROLIGHT AIRCRAFT ASSOCIATION

TECHNICAL INFORMATION LEAFLET

NO: 104 **ISSUE 7** **SEPT 2019**

STANDARD MINOR MODIFICATION - FITTING A TRANSPONDER

Introduction.

This leaflet contains the required information to permit straightforward fitment of a transponder in a microlight aeroplane. All the requirements must be checked on each individual aircraft installation, since often the cable routings, connections or positioning of components vary between aircraft.

Issue 3 of this leaflet enabled the fitment of Mode S transponders to aircraft.
Issue 4 updates the advice with regards continued installation of Mode A and C units.
Issue 5 update of approved Transponder list.
Issue 6 Charges update.
Issue 7 Updated for Owner Check Flights and general update of web links and approved lists.

It permits only certain ways of doing this; these are known to be safe and hassle free. This ensures the safety and legality of the installation, and provides the pilot with assurance that when turned on it should work as advertised (the latter is not a legal requirement because transponders are not *currently* mandatory equipment in microlights: note that should Mode S units become mandatory, the advice in this leaflet is likely to change). If you want to do something that isn't covered by this TIL, it's not necessarily impossible, but you will need to submit full details on a modification application form BMAA/AW/002.

Only units approved for use in UK airspace may be fitted. Approved units are listed in the following places:

www.caa.co.uk – search "radio equipment approval"

www.easa.europa.eu – aircraft & products - ETSO authorisations – List of ETSO Authorisations (https://www.easa.europa.eu/download/etso/etsoa.pdf)

The BMAA Technical Office will check that the units have suitable approval when processing the application (see notes below on appropriate Mode S units).

Transponders are usually designed to be panel-mounted (although fairly inevitably in microlight aircraft they end up being mounted with suitable brackets to pod and cockpit walls through lack of space), although a few handheld transponders do exist. There are three types of transponder unit currently used in UK airspace:

- Mode A transponders, which transmit an identifying code	The identifying code is a four-digit number consisting of digits between 0 and 7 and is generally set to 7000 unless ATC request a different 'squawk' to be set.
- Mode C transponders, which transmit encoded altitude information as well as an identifying code	
- Mode S transponders, which transmit encoded altitude information as well as an identifying code and a unique ICAO aircraft code	The identifying code is as above. In addition, a six-digit number (known as the "24-bit address") consisting of numbers and letters representing a 'hexadecimal' number. This code is unique to each aircraft. E.g. 40AAAA

The units also usually have an "IDENT" button which allows a single aircraft to stand out on a controllers radar screen. The transponder will normally consist of a separate control box and antenna, with the necessary power and RF (Radio Frequency) cables. It may also have a separate altitude encoder.

Most modern airliners will also be fitted with a device called TCAS (Traffic Collision Avoidance System), which will automatically detect the transponder in another aircraft (particularly if the transponder is altitude encoding) and instruct the commander to take avoiding action.

STANDARD MINOR MODIFICATION - FITTING A TRANSPONDER

Note that in order for a transponder to be operated in an aircraft, the operator (i.e. pilot) must have a valid Flight Radiotelephony Operators Licence (FRTOL), even if a radio is not fitted.

Additional information on Mode S, including developments on mandatory carriage requirements, can be found on the CAA's Mode S site: www.caa.co.uk/modes

It is still legal to fit non-Mode S transponders, but their use is limited.

- The use of Mode A or C is acceptable where it is being carried on a voluntary basis.
- A Mode A or C unit installed after 31 March 2008 does not provide compliance with schedule 'E2' of the equipment carriage requirements of the Air Navigation Order. The E2 item (as relevant to microlights) is required for IFR flights in controlled airspace and flights at or above FL100.
- Mode S units are required for flight in airspace notified accordingly: e.g. Transponder Mandatory Zones (currently only parts of the Scottish TMA) and Mode S Enhanced Surveillance airspace (currently the London TMA). It may be possible to obtain permission to cross these zones without a Mode S transponder: details can be found in the AIP Gen 1-5-3 (accessible from www.ais.org.uk).

Notes on Mode S units

As well as having general approval (as noted above), all Mode S units must conform to the 'Elementary Surveillance' standard (ELS). When purchasing your unit, you should confirm with the manufacturer/supplier that the unit conforms to this standard and is 'TGL13' compliant. Further details of these standards can be found on the CAA's website: www.caa.co.uk/modes. Generally speaking, the unit must be approved to 'level 2s' or a higher 'level'. Note that the minimum requirement for flight in current UK 'Notified Mode S airspace' (currently only the London TMA, but soon to be extended) is a 'level 2es' unit. 'Level 2' refers to the communication protocol the unit uses; 'e' refers to 'extended squitter' capability (ability to transmit GPS position and other information); 's' refers to the ability to transmit the 'surveillance interrogator' code. It is worth noting that the minimum European requirement is for 'level 2s' equipment, but future requirements may demand 'level 2es' equipment in certain areas or categories of airspace. A list of equipment that we believe to be approved at the time of print is appended to this TIL (this list will be updated without up-issuing this TIL as new equipment becomes available).

Mode S transponders are not mandatory equipment on microlight aircraft, this leaflet therefore assumes that any Mode S unit installed on a microlight in non-essential equipment. At the time of writing, Mode S transponders are not mandatory equipment on microlight aircraft. As such, the only periodic check that needs to be made on these units is that the unique code is correctly programmed into the unit: failure to do so could result in potentially dangerous erratic behaviour of the Controller's radar display. *It is therefore mandatory, and a condition of this modification approval, that at the annual inspection the Inspector checks that the 6-digit code (24-bit address) for this aircraft is correctly set.* This can be done in one of two ways:

- The inspector should check that code displayed on the unit is the correct code as noted in G-INFO for that aircraft, or
- A receiving device or other test equipment should be used to check the code transmitted by the unit.

[Note that the former method must not be used if the only way to display the code is by accessing the function that changes the code, as there is a large risk of inadvertently altering the code in the process of checking it.]

It is recommended that Mode S units be serviced periodically by a suitably equipped organisation to check the calibration of the transmission circuits. It is also recommended that the equipment manufacturer's service and maintenance guidelines are followed.

A unique identifier code (24-bit address) for your aircraft has already been allocated by the CAA. This can be

viewed by referring to the CAA's 'G-INFO' database: www.caa.co.uk - safety regulation – aircraft register – G-INFO UK register database – G-INFO database search, or by contacting the Aircraft Registration Section on 020 7453 6666.

Notes on effectiveness of transponders

The effective range of the transponder is dependent on many factors. These include the power available from a unit to radiate via its antenna, and the orientation and location of the antenna. The latter is important in transmitting this energy from the aircraft to where it is required: the radar head or other aircraft fitted with TCAS units. The manufacturer's advice is very important in this regard. Metallic ground planes help focus the energy of the signal in the correct direction. The signal can be reduced in certain directions if parts of the aircraft block the path from the antenna: undercarriage legs, etc.

Notes on radiation hazards

It should be noted that at the current time, the health risks from non-ionising radiation transmitted by devices such as transponders are not fully understood. This TIL addresses the airworthiness aspects of transponder installations and does not guarantee any levels of protection from radiation emitted from the antenna (although the following report may be of interest: https://www.gov.uk/government/publications/emfs-exposure-from-lightweight-aviation-transponders).

Any effects of radiation on the human body can be minimised by placing the antenna as far as possible from the cockpit and by positioning an earthed ground plane between the antenna and occupants. Metal skinned aircraft generally offer more protection in this regard than composite or fabric covered aircraft.

Notes on altitude encoders

Certain types of Mode C and Mode S units use external height encoders that transfer the altitude information to the control unit by means of 'Gillham' or 'Grey' coding. There are known failure modes of this system whereby the control unit thinks it's seeing a valid height, but in fact a wrong height is being transmitted. The height information received by the control unit from the altitude encoder should be checked on a regular basis (at least every other year) to ensure that it matches the external altimeter (set to 1013mb) within about 100ft.

Permitted Options

1. Location
   1.1 The transponder control box (and altitude encoder if fitted or separate) must be inside the cockpit
2 Transponder Type (must be an approved type)
   2.1 The transponder may be "Mode A", and/or
   2.2 The transponder may be "Mode C", and/or
   2.3 The transponder may be "Mode S"
3 Power Supply
   3.1 The transponder can use an integral battery, or
   3.2 The transponder can be powered from the aircraft power supply.

Essential Safety Checks

1 Before signing for the installation of the transponder, the aircraft inspector must satisfy him or herself that the installation meets all of the following requirements:
   1.1 The installation must comply with all of the supplier's or manufacturer's instructions.
   1.2 The pilot must be able to easily reach the ON/OFF switch (if fitted) and control box in flight. All switches must be clearly placarded and toggle switches must be DOWN=OFF.
   1.3 If the transponder is only of the "Mode A" type, a placard must be fitted on or close to the control box and in sight of the pilot stating "MODE A ONLY - NOT ALTITUDE ENCODING".
   1.4 The switches and cables must have appropriate electrical ratings. Account must be taken of information

provided by the component supplier or manufacturer, especially with regard to the electrical rating of components and wiring.

1.5 There must be protection for the primary power supply in the form of a correctly rated fuse or circuit breaker, in accordance with the equipment supplier's instructions.

1.6 Generally, the antenna must be mounted on the underside of the aircraft with metal above it to act as a ground plane and pointing straight down in the flying attitude. The manufacturer's guidelines with respect to the antenna type, position and cabling must be followed.

1.7 The transponder antenna must be no closer than 1 metre from the radio or GPS antenna.

1.8 The antenna must be no closer than 1 metre from the control box, unless otherwise instructed by the manual for the device.

1.9 Do not route the cables around sharp bends, close to engine electrical generators (magneto, coil, distributor), close to strobes, or where they can interfere with flying controls. Cables must be secured at no more than 150mm / 6" intervals and without over-tightening.

1.10 Aircraft primary structure must not be altered. Mechanical attachment should not involve drilling or altering any part of the aircraft structure (including stressed aircraft skins), other than non-primary pod walls or fairings. If this is required, full details must be included in a full modification application, and this standard minor modification is not appropriate. It is recommended that this is done before cutting. Use of existing bolt/rivet holes is acceptable.

1.11 For panel-mount units, if a new cutout in the instrument panel is required, this is only acceptable if the panel is not load-bearing primary structure. If unsure, make certain first and cut later. There must be enough space around the unit such that there is adequate mechanical strength left in the panel to carry the additional weight. Obviously this means that with a thick metal panel the unit can be far closer to other instruments than with a thick GRP panel for example (instruments with backing plates that are screwed into the panel are unlikely to have a significant weakening effect). In addition to the load test of check 5 (below), test the panel in the area of the unit with 9 times the combined weight of the unit and its adjacent instruments forward (spread the load over an area when performing this test). If there is any question as to whether the whole panel can cope with the additional weight, repeat the test with 9 times the combined weight of all the instruments. TIL027 should be used for general advice regarding panel-mount instruments.

2 With the exception of lightweight components (such as cabling) all parts must be load tested to show compliance with BCAR S597, to ensure that they will not come away from the aircraft and cause injury in the case of crash or hard landing. The individual part (such as the battery or control unit) must be weighed. The item must be pushed or pulled to the loads listed below (using scales or a spring balance) without causing damage or coming away from the aircraft:

a. Forwards: 9 x weight (9g).
b. Upwards and downwards: 4½ x weight (4.5g).
c. Towards both port and starboard: 3 x weight (3g).

3 Aircraft Weight and Balance

a. The last weight and balance report must be checked to ensure that the additional weight of the installation won't put the aircraft overweight (maximum permitted empty weight [zero fuel weight] is shown in Section 5 of the TADS/HADS).
b. (3-axis machines only) The inspector must calculate, from the known weight and position of the transponder parts, the empty CG change and satisfy themselves that this will not in any condition make the aircraft go outside the permitted CG limits. If a W&CG report is not held for the aircraft, one must be prepared or BMAA HQ contacted for the file copy.
c. The inspector must make an amended weight and balance entry in the aircraft logbook. (Note: it is an ANO requirement that whenever an aircraft is weighed, details of the weighing are included in the aircraft logbook).
d. If the aircraft potentially can go overweight with the transponder fitted, then it will probably be necessary to fit a fuel/passenger trade-off placard. The rules for this are in BMAA TIL 026.

4 A check flight will be required with the co-operation of a radar ATC unit who can confirm operation of the device. This may be carried out by any suitably qualified pilot holding an RT licence and is a BMAA member.

The flight must be carried out in communication with a suitable ATC service. The pilot is advised to confirm with the duty controller by phone what will be done beforehand. This flight must meet the following requirements:

a. The ATC service must be able to accurately identify the aircraft.
b. If the transponder is Mode C or S, the ATC service must report an altitude transmitted within 100ft of that indicated by the aircraft altimeter with 1013mb set. At least two altitudes must be checked, with at least 1,000ft between the two altitudes.
c. During flight with the transponder operating, it must not interfere with the radio or any flight/engine instruments.

Notes:

- Inspectors should not take responsibility for inadequate information: if further information is required, it is the applicant's responsibility to obtain this.
- If the restrictions in this TIL mean that it is not possible to use this TIL to fit a transponder to your aircraft, then you may make a normal modification application using form BMAA/AW/002 with full details/justifications of what you propose to do and the Technical Office will consider it individually.

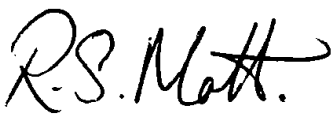
It is acceptable to send in the form with your permit renewal form, noting in the modifications box 'TIL 104 submitted'.

List of Mode S transponder units currently considered approved for installation

(Note that this list is not guaranteed to be accurate or up to date: consult with the equipment manufacturer/supplier before purchase.)

Make	**Model(s)**
ACSS	XS-950
Becker	ATC5401, AR4201, BXP6401-1, 6401-2, 6402-1, 6402-2, 6403-1
Filser / Funkwerk/Funke	TRT800, 800A, 800H, ZTRT800H
Garmin	GTX330, 330D, 327, 328, 320/A, VT-01, VT-02, SL70R
Narco	UAT-1, AT-50, AT-150, AT-200, AT6-A, AT5-A
Garrecht Avionik	VT-02
Microair	T2000SFL
Rockwell	TDR-94, -94D
TQ Avionics (formerly Dittel)	KXT2
Trig Avionics	TT21, TT22, TT31

Checked by:



R Mott
Chief Inspector / DAE
British Microlight Aircraft Association

Approved for Issue:

R Pattrick
Chief Technical Officer
British Microlight Aircraft Association

BMAA – STANDARD MINOR MODIFICATION CHECKLIST: TIL 104

Reg: G-_ _ _ _	Aircraft type:	Serial No:
Owners name:		Owners BMAA No:

Installation Details

Transponder Make & Model	
Alt. Encoder Make & Model (if fitted)	
Antenna Make & Model	

Transponder Weight	g
Alt. Encoder Weight	g
CAA/JAA/EASA approval number	
24-bit address - Hex Code	

1. Transponder	Handheld		4. Power Supply	Integral Battery	
	Panel Mount			Aircraft Power Supply	
2. Transponder location	Keel Tube		5. Ground Plane	Airframe	
	Inside Side of Pod			Metallic Plate	
	Instrument Panel			Metallic Tape	
3. Antenna Location	Trike Frame		7. Ground plane area		
	Fuselage tube				
	Bottom of Pod		8. Mode	A	
	Bottom of fuselage			C	
				S	

Safety Checks

CHECK	ACTION	COMMENTS	INSPECTOR'S INITIALS
1 All transponder types			
1.1	Installation as per manufacturer's instructions		
1.2	Transponder and encoder (if fitted) inside cockpit & outside airflow		
1.3	Installation load tested		
1.4	Cables and other components properly secured		
1.5	Quick-release fasteners used for de-riggable parts of airframe		
1.6	No holes or cuts made in airframe/primary structure		
1.7	Instructions incorporated into aircraft operators manual		
2 Hand-held transponders			
2.1	Lanyard fitted		
2.2	Primary flight instruments not hidden		
2.3	Aircraft controls not restricted		
2.4	Entry and exit of aircraft not impeded		
3 Panel-mount transponders			
3.1	Mounted in instrument panel – panel not primary		

	structure		
3.2	Instrument panel strength satisfactory (see section notes section 4.10)		
4 Mode A units			
4.1	Mode A placard fitted (if required)		
5 Mode S units			
5.1	Mode S aircraft code (24-bit address) correctly programmed.		
5.2	Requirement for annual check of Mode S aircraft code added to aircraft operator's manual.		
6 Mode C and S units			
6.1	Recommendation inserted into operator's manual to check altitude encoding at regular intervals.		
7 Units powered by aircraft power supply			
7.1	Circuit protected by appropriate fuse		
7.2	Fuse rating placarded		
7.3	Power to unit can be switched off by pilot in flight (master switch acceptable)		
7.4	Switch function clearly placarded		
7.5	Switch down for off and placarded as such		
7.6	Switch and wiring suitably rated		
7.7	Multi-strand cable used – adequate cable flexibility and current capacity		
7.8	All cable terminations properly made – no exposed conductor		
8 Antenna installation			
8.1	Secure and clear of propeller & exhaust		
8.2	Minimum 6" ground clearance (if under pod)		
8.3	Antenna orientated as per installation instructions		
8.4	Not in front of pitot, venturi or static source		
8.5	Antenna greater than 1m from GPS and/or radio antennae		
8.6	Ground plane secure (if applicable)		
8.7	Transmission does not affect compass		
8.8	Antenna and RF cable appropriate for installation		
9 Weight and Balance			
9.1	Change to empty weight?	Old: New:	
9.2	Aircraft won't go overweight?		
9.3	Change to empty CG (3-axis only)	Old: New:	
9.4	Aircraft will remain within CG limits (3-axis only)?		
9.5	Logbook entry made.		

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TECHNICAL INFORMATION LEAFLET

NO: 104 **ISSUE 7** **SEPT 2019**

STANDARD MINOR MODIFICATION - FITTING A TRANSPONDER

FLIGHT RELEASE CERTIFICATE		
The transponder installation described has been checked in accordance with the above schedule and TIL 104 and was found to be satisfactory. I release the aircraft as fit for a test flight only within 1 calendar month.		
Signed: (Name Printed:)	BMAA Inspector No.: BMAA Membership No.:	Date:

10 Flight Test Details		Comment	Initial
10.1	ATC Service Used		
10.2	Time and Date		
10.3	ATC Service could identify aircraft		
10.4(a)	ATC Service could identify altitude encoding (if fitted)		
10.4(b)	Altitude within 100ft of altimeter reading – 2 altitudes >1000' apart (1013mb set) (if fitted)		
10.5	ATC Service could receive Mode S data (if applicable)		
10.6	Minimal electronic interference with radio or instruments		

FLIGHT TEST APPROVAL PILOT DECLARATION		
The transponder installation described on this form has been flight tested in accordance with the above schedule and TIL 104 and was found to be satisfactory.		
Signed: Pilot Name Printed:	Licence No.: BMAA No.:	Date:

OWNER'S DECLARATION		
I declare that the foregoing information is correct to the best of my knowledge and I will not change the installation design once approved.		
Signed:	Name.	Date:

This form must be sent with payment as per current fees in MF or www.bmaa.org to*:-
BMAA, The Bullring, Deddington, Banbury, Oxon, OX15 0TT

BMAA Office Approval:	**(signed)**	**(Name)**
Mod No.: G-_ _ _ _ / TIL104 / 20 _ _ /_ _ _ _ _		**(Date)**

**Whilst waiting for this form to be returned by the BMAA the aircraft may be flown for upto one calendar month from the Inspection date above. Once this form is returned to you signed please enter the full modification approval number above in your aircraft logbook and retain this sheet with your aircraft records.*