TT21 / TT22 Minor Change for CS-23 Aircraft

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1. Preface

1.1 Purpose

To document the Minor Change to replace a Mode A/C transponder with a Trig Avionics TT21/TT22 Mode S transponder.

1.2 Scope

This Minor Change applies to unpressurised single engine piston aeroplanes with fixed landing gear and 14 Volt or 28 Volt DC electrical systems, having an existing certified Mode A/C transponder installation.

The applicable aircraft are:

Cessna 150A	TCDS USA3A19
Cessna 150 B	TCDS USA3A19
Cessna 150D	TCDS USA3A19
Cessna 150E	TCDS USA3A19
Cessna 150F	TCDS USA3A19
Cessna 150G	TCDS USA3A19
Cessna 150H	TCDS USA3A19
Cessna 150J	TCDS USA3A19
Cessna 150K	TCDS USA3A19
Cessna 150L	TCDS USA3A19
Cessna 150M	TCDS USA3A19
Cessna A150K	TCDS USA3A19
Cessna A150L	TCDS USA3A19
Cessna A150M	TCDS USA3A19
Cessna 152	TCDS USA3A19
Cessna A152	TCDS USA3A19
Bölkow BO207	TCDS Germany 643
Bölkow BO207T	TCDS Germany 643
Bölkow BO208	TCDS Germany 644
Bölkow BO208C	TCDS Germany 644
Bölkow 209 Monsun	TCDS Germany 680
Bölkow 209S	TCDS Germany 680

This Minor Change applies to both US manufactured and French manufactured aircraft.

1.3 Changes from Previous Issue

The changes from Issue 2.0 to Issue 3.0 are as follows;

SECTION	SUMMARY DETAILS
1.2	Aircraft types added
1.5.3	Approval traceability table added
3.1	Wording changed to apply to incorporate installation into new aircraft types
3.2	Wording changed to apply to incorporate installation into new aircraft types
3.3	Wording changed to clarify periodic maintenance requirements.
4.3.3	Wire type recommendation of tefzel hook-up wire added to paragraph
4.3.3.1	Extra picture added to illustrate a panel mounted controller
4.3.3.2	Wording changed and extra picture added to incorporate installation into new aircraft types
5. Section 12.2 of table	Wording changed to clarify periodic maintenance requirements.
6. Section 4 of table	Wording changed to clarify maintenance requirements.

1.4 Changes Forecast

None.

1.5 Document Cross-References

1.5.1 Internal Documents

00560-00	TT21/TT22 Installation Manual	Issue AH
DEV/TT21/008	TT21 Declaration of Design Performance	Issue 3.0
DEV/TT22/008	TT22 Declaration of Design Performance	Issue 2.0
DEV/TC20/005	TC20 Declaration of Design Performance	Issue 3.0

1.5.2 External Documents

CS-23 (Amdt 1)	Certification Specifications for Normal, Utility, Aerobatic, and Commuter Category Aeroplanes	EASA
CAP747	Mandatory Requirements for Airworthiness	CAA
CAP766	Light Aircraft Maintenance Programme	CAA
ED-73B	MOPS for SSR Mode S Transponders	Eurocae
TGL 13 Rev 1	Certification of Mode S Transponder Systems for Elementary Surveillance	JAA

1.5.3 Approval Traceability

Document	Additional Aircraft	Document Changes	EASA Minor Change Approval
SUP/TT2x/003 Issue 1.0	Cessna	Original Document	N/A
SUP/TT2x/003 Issue 2.0	None	Internal changes	10030098
SUP/TT2x/003 Issue 3.0	Bölkow	Additional applicable aircraft	10035083

1.6 Abbreviation and Acronyms

The following abbreviations and acronyms are used in this document:

AFM	Aircraft Flight Manual
DC	Direct Current
DDP	Declaration of Design Performance
EASA	European Aviation Safety Agency
ETSO	European Technical Standards Order
MOPS	Minimum Operational Performance Standard
POH	Pilots Operating Handbook

2. Introduction

The TT21/TT22 Mode S transponder system is an ED-73B compliant Mode S level 2els datalink transponder, with support for ADS-B extended squitter, elementary surveillance and SI codes, which also meets the relevant environmental requirements of ED-14F. The TT21 has a nominal power output of 125 Watts, and meets the power output requirements for Class 2. The TT22 has a nominal power output of 250 Watts, and meets the power output requirements for Class 1. The ADS-B function meets DO-260A class B0. The TT21/TT22 is certified to ETSO 2C112b and ETSO C166a.

The TT21/TT22 transponder is controlled using a separate front panel controller, called the TC20. This allows the transponder to be mounted separately from the instrument panel, and reduces the amount of panel space taken by the transponder. The TC20 includes an altitude encoder. The TC20 is certified to ETSO 2C112b and ETSO C88a.

This minor change describes the process of upgrading an existing Mode A/C transponder to a TT21 or TT22.

Although the TT21/TT22 Mode S transponder system adds support for ADS-B extended squitter, EASA AMC20-24 compliance cannot be claimed as a direct result of this minor change. EASA AMC20-24 compliance requires the installation of a certified GPS receiver and AFM change, neither of which is included in this minor change.

3. Change Details

3.1 Description of Change

This change involves removing a Mode A/C transponder, and replacing it with a Trig Avionics TT21 or TT22 Mode S transponder.

The processes involved in the change includes pre-testing of the installation; verification of the suitability of the existing power supply wiring; installing the TC20 and the TT21/TT22 transponder; transponder commissioning; and post-installation testing. These processes are described in detail in the accomplishment instructions in this document.

The existing transponder mounting tray will need to be removed and a new panel installed to mount the controller or install a blanking panel if a conventional 57mm instrument cut-out will be used. The connectors will need to be replaced. If there is an existing altitude encoder fitted it should be removed as it is not required for correct operation of the TT21/TT21. The existing antenna and circuit breaker will be re-used.

3.2 Mechanical Details

The TT21/TT22 uses aTC20 head unit to control the transponder, it has a combination of knobs and press buttons to set transponder codes and control the functions of the unit. The operating mode, squawk code and altitude are displayed on an LCD. The panel location should allow the screen to be visible to the pilot and have reasonable access to the knobs and buttons.

The TT21/TT22 is compatible with any TSO approved antenna.

The TT21/TT22 combined with the TC20 has a total weight of 440 grams. The effect on weight and balance of the aircraft will be small due to the low weight of the transponder equipment. After the installation a weight and balance check should be calculated or performed in accordance with the manufactures instructions.

3.3 Continued Airworthiness Instructions

An approved aircraft maintenance program will normally include periodic functional checks of the transponder installation using a test set including frequency tolerance, side lobe suppression, and Mode C and Mode S performance. The Mode S checks should confirm that the aircraft assigned Mode S address is correct. Please refer to Appendix 1 for an example of Continued Airworthiness Instructions based on compliance with CS-23..

Other than for periodic functional checks required by the regulations, the TT21/TT22 Mode S transponder has been designed and manufactured to allow “on condition maintenance”. This means that there are no periodic service requirements necessary to maintain continued airworthiness, and no maintenance is required until the equipment does not properly perform its intended function. When service is required, a complete performance test as detailed in section 4.5 of these instructions should be accomplished following any maintenance action.

3.4 Installed Equipment Suitability

3.4.1 ETSO

The TT21 is certified to ETSO 2C112b and ETSO C166a under ETSOA EASA.21O.1056, REV. A.

The TT22 is certified to ETSO 2C112b and ETSO C166a under ETSOA EASA.21O.1277

The TC20 is certified to ETSO 2C112b and ETSO C88a under ETSOA EASA.21O.1112, REV. A

3.4.2 Deviations

The environmental standard tested against was RTCA DO-160F rather than DO-160D which is referenced by ETSO 2C11b, ETSO C166a and ETSO 88a.

3.4.3 Environmental

The environmental testing conducted for the TT21/TT22 and TC20 is appropriate for this installation.

Key aspects of the TT21 and TT22 environmental qualification are summarised here:

DO-160F reference	Qualification	Applicability
Temperature & Altitude	Category A2 and C1	Equipment intended for installation in a partially controlled temperature but pressurised location and installed is a non-pressurised but controlled temperature location.
Loss of Cooling	+70C without cooling air	Forced air cooling not required.
Temperature Variation	Category C	Temperature controlled internal section of the aircraft.
Humidity	Category A	Standard humidity environment.
Operational Shock & Crash Safety	Category B type 5	Equipment generally installed in fixed-wing aircraft or helicopters, VLA's and sailplanes tested for standard operational shock and crash safety.
Vibration	Aircraft zone 2; type 3, 4, 5 to category S level M, type 1	Single engine fixed wing reciprocating or turboprop. Multi engine less than 5700Kg. Helicopters, reciprocating and turbojet engines. Equipment fitted to instrument panel, console or equipment rack.
Magnetic Effect	Category Z	Equipment and or its connecting cable harness may be mounted within 0.3m of magnetic compass. All verified during ETSO environmental qualification testing.
Power Input	Category BX	DC equipment intended for use on aircraft electrical system supplied by engine driven alternator or generator, where a battery of significant capacity is on the DC bus at all times.
Voltage Spike	Category B	Installation where a lower standard of protection is acceptable.
Audio Susceptibility	Category B	DC equipment intended for use on aircraft electrical system supplied by engine drive alternator or generator, where a battery of significant capacity is on the DC bus at all times.
Induced Signal Susceptibility	Category AC	Equipment intended for operation where interference-free operation is desirable and installed on aircraft whose primary power is constant frequency or DC.
RF Susceptibility	Category TT	Specified in the HIRF rules; representative of the internal EMI environment from aircraft equipment.
RF Emission	Category B	Basic emission control.

Key aspects of the TC20 environmental qualification are summarised here:

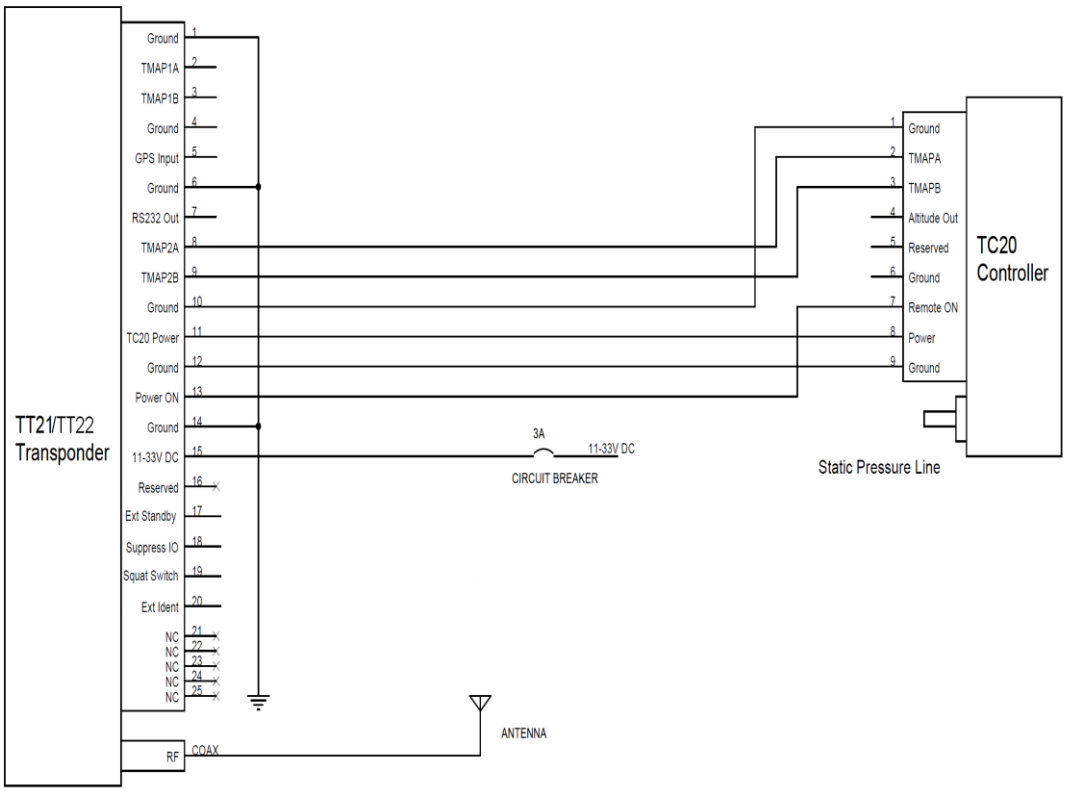
DO-160F reference	Qualification	Applicability
Temperature & Altitude	Category A4 and C2	Equipment intended for installation in a controlled temperature and pressurized location. Equipment intended for installation in non-pressurised and non- controlled temperature location.
Loss of Cooling	+70C without cooling air	Forced air cooling not required.
Temperature Variation	Category A	Equipment external to the aircraft or internal to the aircraft.
Humidity	Category A	Standard humidity environment.
Operational Shock & Crash Safety	Category B type 5	Equipment generally installed in fixed-wing aircraft or helicopters, tested for standard operational shock and crash safety.
Vibration	Aircraft zone 2; type 3, 4, 5 to category S level M, type 1 (Helicopters) to category U level G	Single engine fixed wing reciprocating or turboprop. Multi engine less than 5700Kg. Helicopters, reciprocating and turbojet engines. Equipment fitted to instrument panel, console or equipment rack.
Magnetic Effect	Category Z	Equipment and or its connecting cable harness may be mounted within 0.3m of magnetic compass. All verified during ETSO environmental qualification testing.
Power Input	Category X	Equipment identified as Category X – no test required
Voltage Spike	Category X	Equipment identified as Category X – no test required
Audio Susceptibility	Category X	Equipment identified as Category X – no test required
Induced Signal Susceptibility	Category BC	Equipment intended for operation in systems where interference would be controlled to a tolerable level and is installed on aircraft whose primary power is constant frequency or DC.
RF Susceptibility	Category TT	Specified in the HIRF rules; representative of the internal EMI environment from aircraft equipment.
RF Emission	Category B	Equipment and interconnected wiring located in areas where apertures are electro-magnetically significant and not directly in view of radio receivers antenna.

In each case the environmental qualification is appropriate to the installation in the instrument panel of a light piston engine aircraft with a DC electrical system.

3.5 Wiring Diagram

3.5.1 General Wiring Arrangement

The wiring diagram is the same in 14V and 28V aircraft.



Note 1: Suppress I/O is only required in aircraft with DME.

Note 2: External Ident feature is optional and not present on most aircraft.

Note 3: The squat switch is not connected.

Note 4: The GPS Input is not required as part of this minor change, and is shown here not connected.

Note 5: The Altitude Out from the TC20 Controller is not required as part of this minor change, and is shown here not connected.

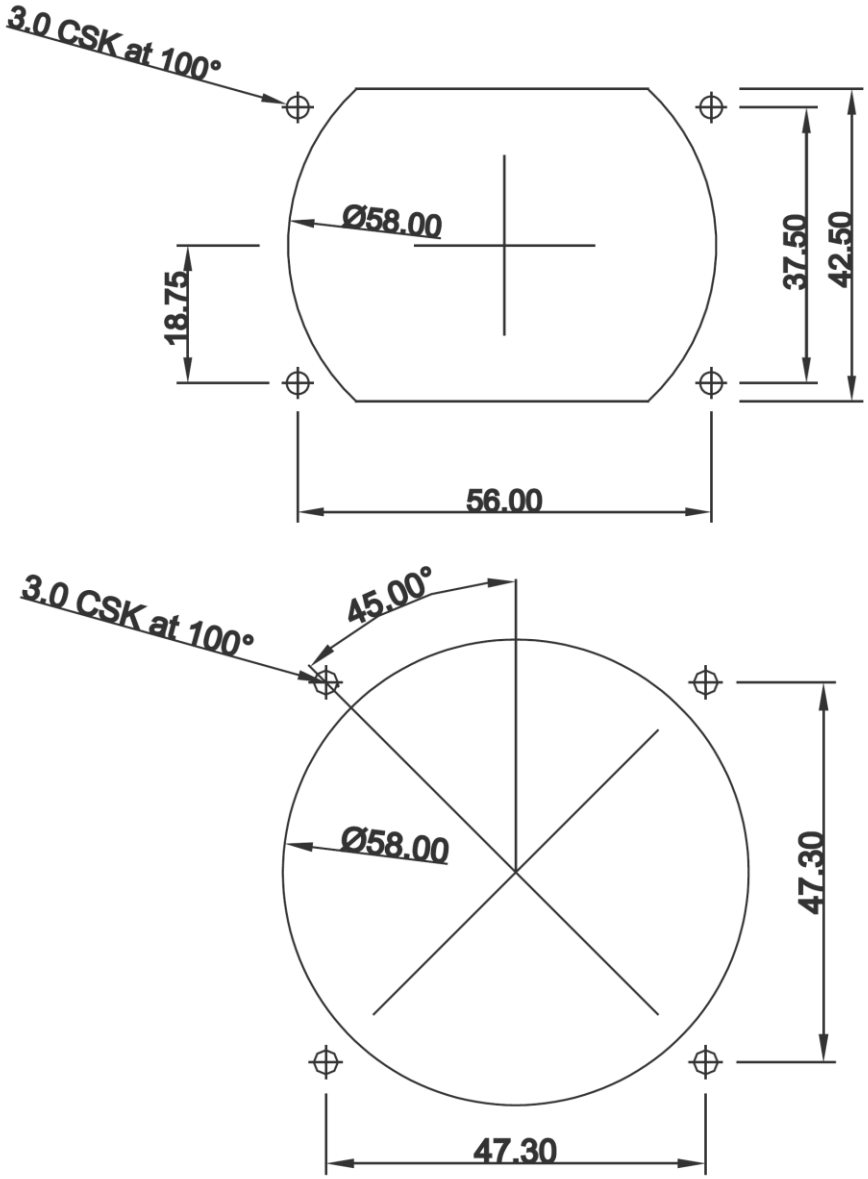
3.5.2 Voltage Conversion in 28 Volt Aircraft

Some existing Mode A/C transponders are 14 Volt only devices. When installed in a 28 Volt aircraft, these transponders will be fitted with a voltage converter. This is typically a passive resistive dropper, but may be an active voltage regulator such as the KA39. The TT21/TT22 will NOT meet the certification low voltage requirements when installed with the dropper resistor in place and the resistor should therefore be removed or bypassed. Active voltage regulators need not be removed.

3.6 Drawings

3.6.1 Front Panel Cut-out

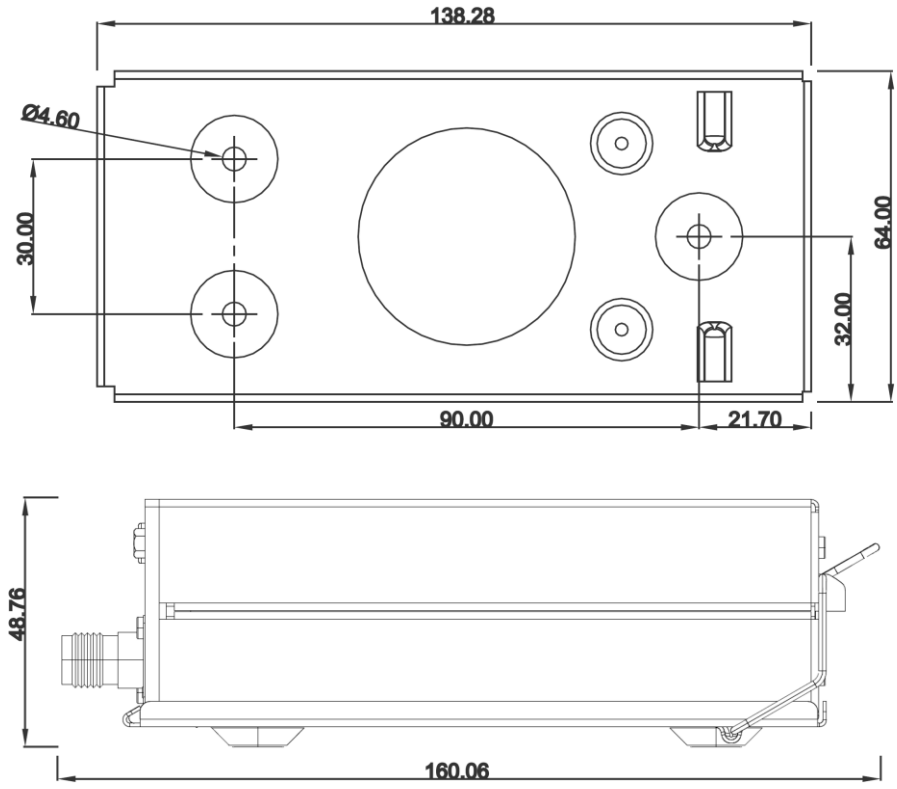
The front panel controller can be fitted to either the compact mounting hole or a conventional 57mm (2¼ inch) instrument cut-out. The compact mounting is a truncated 58 mm opening; please note that the mounting screws are NOT in the same location for the two options.



All dimensions in millimetres. The drawing is not to scale.

(Drawing A)

3.6.2 Mounting tray fixing and overall dimensions



All dimensions in millimetres. The drawing is not to scale

(Drawing B)

3.7 Electrical Load Analysis

Existing Mode A/C transponders draw typically 1.1 Amp from the DC power supply, with currents of up to 1.9 Amp during high activity.

The TT21 draws typically 0.15 Amp from a 14V DC power supply on standby, with currents of around 0.28 Amp during high activity. On 28V supplies the currents are lower.

The TT22 draws typically 0.15 Amp from a 14V DC power supply on standby, with currents of around 0.45 Amp during high activity. On 28V supplies the currents are lower.

Since the current taken by the TT21/TT22 is less than half that of the transponder it is replacing, any systems that were properly sized to support an existing transponder will be adequate to support the TT21/TT22.

On the same basis, it can be concluded that the 30 minute battery requirement of CAP747 GR6 will also be satisfied.

3.8 Testing Details

The test procedure is based on the installation test guidelines in ED-73B, the MOPS for SSR Mode S Transponders.

3.9 Flight manual/POH Amendments

No AFM amendments are required as part of this Minor Change. A pilot operating booklet is provided (reference 00559-00) with the TT21/TT22 and this should be made available to the flight crew.

3.10 Radio Station Licence

Installation of this transponder may require a new or updated aircraft radio licence. For UK registered aircraft the change needs to be reported to the Directorate of Airspace Policy on a Form DAP1902. For other European registered aircraft the relevant national authority should be contacted.

3.11 Mode S Address

Installation of the TT21/TT22 transponder requires allocation of an Airframe Address from the national authority of aircraft registration for the aircraft.

In the case of UK aircraft, Mode S addresses have been allocated to all aircraft, and can be obtained directly from the CAA web site G-INFO database.

4. Accomplishment Instructions

4.1 Equipment and tools required

You will need a Mode S transponder ramp test set, a pitot/static system test set, aircraft aluminium, the TT21/TT22 install kit and standard avionics workshop tooling.

4.2 Preparation

During the installation you will need to program the unique Mode S airframe address into the transponder. Allocation of Mode S addresses comes from the appropriate national authority of aircraft registration; ensure that you have applied for and been issued with a Mode S address before you start.

4.3 Pre-test Existing Installation

This step is optional, but may assist in fault finding if a problem is found later in the process. Pre-testing will not be possible if the reason you are replacing the Mode A/C transponder is because the transponder itself is faulty.

The pre-test activities involve testing the existing installation and noting in particular:

- Transponder receiver sensitivity – Minimum Triggering Level or MTL. The existing transponder MTL should have an MTL between -71 dBm and -77 dBm. Sensitivity below this range may indicate a problem with the antenna or antenna cable, although could also be an indication of a fault in the existing transponder.
- Transponder transmitted power. The existing transponder should provide not less than 125 Watts (Class 1) or 70 Watts (Class 2) at the antenna. Power levels below this may also indicate a problem with the antenna or antenna cable, although could also be an indication of a fault in the existing transponder.
- Altitude indication. Test the altitude indication system, ideally over the service ceiling of the aircraft. A problem with the altitude reporting may indicate a fault in the static system of the aircraft or the aircraft altimeter.

If a fault is identified in the pre-testing, you will need to trace the fault cause. If the fault is in the transponder to be replaced, then the upgrade process described here would clear the fault. If the fault is in the existing installation however, upgrading the transponder will not fix it.

4.4 Process

4.4.1 Verify Circuit Breaker Status

Trace and identify the existing transponder circuit breaker. Verify that the circuit breaker is in satisfactory condition and is rated at 3 Amps.

4.4.2 Verify Antenna Status

Trace and identify the existing transponder antenna. The transponder antenna will be a small stub or blade antenna on the bottom of the aircraft. Note that on an aircraft with DME the antenna for the DME will look similar to the transponder antenna; ensure you are looking at the right one. Check the condition of the antenna, including the attachment to the airframe. It is important that the ground plane of the antenna is correctly bonded to the aircraft skin. The antenna should be in a vertical orientation, as clear as possible from other antennae and from airframe obstacles and protrusions, such as landing gear.

4.4.3 Remove Existing Transponder

Remove the existing transponder and mounting tray. If fitted remove the existing altitude encoder, inspect the static line plumbing and retain for reuse.

4.4.4 Inspect Wiring

Inspect the wiring to the interface connector, check general condition and gauge. The power wires should be AWG 22 or heavier; the other signal wires carry only light currents and may be any gauge appropriate to the mechanical environment.

4.4.5 Remove Voltage Converter (28V Only)

If this is a 28 Volt aircraft with a 14 Volt transponder, such as the KT76A, trace the power wire from the transponder connector to determine the method used for voltage conversion. The voltage reduction typically uses a resistive dropper attached to the firewall or other metal aircraft structure. Remove or bypass the resistive dropper; the power supply to the TT21/TT22 must come directly from the 28V aircraft supply.

4.4.6 Replacement of Unit

4.4.6.1 Replace Interface Connector

Before replacing the connector, establish what wires provide power and ground – all other wires should be removed. Manufacture the connectors and wiring looms in accordance with the wiring diagram in section 3.5.1.

Aircraft standard wire should be used for the installation. For example, wire that meets MIL-W-22759/1 to 23, 32 to 35 specifications would be acceptable for this installation. Common wire types include MIL-W-22759/34 or Raychem 55 wire.

Care must be taken to ensure surface damage does not occur to the wires during installation and that all wire looms are appropriately secured to prevent damage during its installed life. Ensure the loom does not chafe on any parts of the aircraft or interfere with any moving parts especially if you are using thin walled insulated wire to save on weight, such as MIL-22759/16, 17, 18 or 19.

The power wires should be AWG 22 or heavier; the other signal wires carry only light currents and may be any gauge appropriate to the mechanical environment.

4.4.6.2 Inspect/Replace Antenna Connector

Inspect the antenna connector removed from the previous transponder tray. As most transponders use a blind-mate BNC connector it will be necessary to replace the existing antenna connector with the supplied TNC connector.

4.4.6.3 Manufacture a Panel Plate

Manufacture a suitable panel from aircraft aluminum to blank the existing transponder hole. If the TC20 is going to be installed in the same location as the original transponder manufacture the panel using the compact mounting hole or conventional round instrument cut out. Refer to drawing A in section 3.6.

4.4.6.4 Installing the TC20 controller

Mount the TC20 in a position that the pilot is able to see the screen and operate the unit. The TC20 can be mounted in the ultra compact mounting hole or in a conventional 57mm (2 ¼ inch) instrument cut out; refer to drawing A, in section 3.6. Before completing the installation of the controller, connect the

9 way, D type connector to the rear of the TC20. If the aircraft had an existing altitude encoder, connect the existing static pressure line to the static port on the rear of the TC20. If necessary extend the static pressure line by using a length of 5mm EPDM rubber tubing. If the aircraft did not have an existing altitude encoder choose a point in the existing static pressure line that is as close as practical to the TC20 mounting location. Cut the static pressure line and use the supplied T fitting with a length of 5mm EPDM rubber tubing supplied in the installation kit to connect to the static pressure port on the rear of the TC20. Install the TC20 IAW the installation manual.

4.4.6.5 TT21/TT22 Transponder Main Unit

Mount the TT21/TT22 to the underside of the flight manual storage box, located on the right of the instrument panel. Secure the mounting tray using the 3 mounting holes in the tray and ensure the tray is supported by the three dimples as well as the three mounting points. Install the transponder in accordance with the installation manual.

4.4.7 Commission Transponder

4.4.7.1 Installation Setup Process

Apply power. The TC20 should light up and – assuming this is the first installation – will automatically start the installation setup process.

Continue with the setup process by entering the Mode S address and other parameters in accordance with the TT21/TT22 Installation Manual.

4.4.7.2 Altitude Encoder Calibration

Using a pitot-static system test set, check and if necessary calibrate the TC20 built in altitude encoder to correspond to the primary altimeter in accordance with the Installation Manual.

4.5 Post-installation Test

4.5.1 Equipment Function

Verify that the proper mechanical and electrical connections have been made. Operate each of the controls and verify that each performs the intended function.

4.5.2 Interference Effects

With the transponder powered on, operate each of the other electrically operated aircraft systems to determine that no significant interference effects are present.

4.5.3 Leak Test

To ensure the installation of the TC20 Controller has not had an adverse effect on the primary altimeter or existing static system, an aircraft pitot/static system sense and leak test must be carried out.

4.5.4 Ramp Test

Using the transponder ramp test set, verify the following parameters. Note that actual procedures may vary according to the test set specific operating instructions; many test sets will execute the tests listed here in a semi-automated sequence, and will report the answers directly or as a Pass/Fail indication.

4.5.4.1 Reply Frequency

Verify that the reply frequency is 1090 ± 1 MHz.

4.5.4.2 Pressure Altitude Transmission

Verify using the pitot/static system test set that altitudes are correctly reported by the transponder. Use at least 10 test points and verify that the altitude reported is within ± 125 feet of the supplied altitude.

NOTE: Precautions must be taken during altitude reporting tests to prevent nuisance ACAS Traffic Advisories and ACAS Resolution Advisories to aircraft flying in the area.

4.5.4.3 Receiver Sensitivity

Verify that for Mode A/C interrogations the receiver sensitivity of the transponder at the antenna is -73 dBm ± 4 dB.

Verify that for Mode S interrogations the sensitivity of the transponder at the antenna is -74 dBm, ±3dB.

4.5.4.4 Transmitter Power Output

Verify that the TT22 transponder has a peak pulse power at the antenna of at least +21 dBW (125 Watts). Verify that the TT21 transponder has a peak pulse power at the antenna of at least +18.5 dBW (71 Watts).

4.5.4.5 Received Reply

Interrogate the transponder with UF=11 (Mode S Only All-Call) and record the announced address in the reply. Verify that the address matches the assigned address for this airframe.

4.5.4.6 Airspeed Fixed Field

Interrogate the transponder to confirm the maximum airspeed reported is correctly set.

4.5.4.7 Aircraft Identification

Interrogate the transponder with UF=4 or 5, and correct address, with RR=18. Verify that the equipment correctly reports the aircraft call sign in the MB field of the reply.

5. Compliance Statement

CS 23 Amdt 1 Para	Requirement	Compliance	References
23.1301 (a)	Installed equipment to be of a design appropriate to its intended function.	TT21/TT22 is approved under ETSO 2c112b. Review of certification basis in DDP completed.	TT21 DDP. TT22 DDP. TC20 DDP.
23.1301 (b)	Be labeled as to its identification, function or operating limitations.	All controls are adequately labeled. No limitations are recorded. ETSO compliance is shown on the product identification label.	TT21/TT22 Installation Manual.
23.1301 (c)	Be installed according to specified limitations	Review of environmental testing, deviations and limitations in DDP completed.	TT21 DDP. TT22 DDP. TC20 DDP.
23.1301 (d)	Function properly when installed.	System tested by ground tests on completion	Section 4.5 of accomplishment instructions
23.1309 (a)	System must not adversely affect existing systems	The system does not interface with any other system. Installation is physically separate from other systems. EMI tests carried out post-installation.	Section 3.5, Wiring Diagram. Section 4.5.2 of accomplishment instructions.
23.1351(a)	Electrical system capacity	Existing 3 A circuit breaker used supplying nominal 0.45A load. Wire gauge 22 appropriate. New equipment replaces load of 1.1A with load of 0.45A. Battery endurance increased as a result.	TT21/TT22 Installation Manual.
23.1357	Circuit Protective Devices	Existing circuit breaker used - inspected as part of this Minor Change.	Section 4.4.1 of accomplishment instructions.
23.1431(a)	Environmental conditions must be considered.	Section 3.4.3, review of environmental testing.	TT21 DDP. TT22 DDP.
23.1431(b)	Not adversely affect simultaneous operation of other radio or electronic systems or units.	EMI tests carried out post-installation.	Section 4.5.2 of accomplishment instructions.

23.1529	Instructions for Continued Airworthiness	Other than for periodic functional checks required by the maintenance program, the TT21/TT22 Mode S transponder has been designed and manufactured to allow "on condition maintenance". This means that there are no periodic service requirements necessary to maintain continued airworthiness, and no maintenance is required until the equipment does not properly perform its intended function.	Section 3.3 Continued Airworthiness Instructions.
CAP747, GR6	Battery duration not less than 30 minutes	New equipment replaces load of 1.1A with load of 0.34A. Battery endurance increased as a result.	TT21/TT22 Installation Manual.

A transponder installation carried out in accordance with this Minor Change will meet the requirements of TGL 13 Rev 1 – Certification of Mode S Transponder Systems for Elementary Surveillance.

TGL 13 Ref	Requirement	Compliance
Section 7, and Table 1.	Provide Aircraft Identification, Capability Report, Pressure Altitude and Flight Status	**COMPLIANT** All these (including for the avoidance of doubt, the Flight Status requirement) are provided by the TT21/TT22 transponder. Reference; TT21 DDP TT22 DDP TC20 DDP
8.1	Mode S Address	**COMPLIANT** Satisfied by assignment from National Authority of Aircraft Registration.
8.2	Aircraft >5,700kgs or TAS >250kts must operate with transponder antenna diversity	**COMPLIANT** Aircraft MTOW less than 5,700kgs and TAS less than 250kts. Antenna diversity is not required.
8.3	Transponder peak pulse power to be ICAO Annex 10, Volume IV, Amendment 77 compliant.	**COMPLIANT** The TT21 output power is in excess of 18.5 dBW and less than 27.0 dBW. The TT22 output power is in excess of 21.0 dBW and less than 27.0 dBW
8.4	Transponder and ACAS antenna location need to satisfy physical separation limits	**COMPLIANT** Not applicable to this Minor Change.
8.5	Pressure altitude source to be obtained from a monitored air data sensor in either databus or synchro format, ideally the same source as the pilot's cockpit display.	**COMPLIANT** The TC20 controller has a built in Altitude Encoder fed from the same static source as the pilot's altimeter. Encoded altitude readout is available on Transponder display.

8.6	Where Gillham is used a detection of source/encoding failure must be provided.	**COMPLIANT** Gillham code is not used.
8.7	Transponder must indicate the correct altitude resolution according to the altitude source.	**COMPLIANT** The TT21/TT22 correctly reports that the TC20 is a 25 foot encoder.
8.8	Simultaneous operation of both transponders must be prevented.	**COMPLIANT** Only a single transponder is installed in this Minor Change.
9.1	Transponder will meet the minimum requirements for Elementary Surveillance (ELS)	**COMPLIANT** This is a single transponder installation. The TT21/TT22 transponder is ELS compliant.
9.2	Certification standard for transponder is JTSO-2C112a including SI functionality as required by ICAO Annex 10 Amendment 77.	**COMPLIANT** The TT21 and TT22 are certified to ETSO 2C112b, which adopts ED-73B as a Minimum Operational Performance Specification and includes compliance to Annex 10 amendment 77.
9.3	The applicant shall submit: (a) a TGL 13 Rev 1 compliance statement. (b) a statement showing compliance with airworthiness requirements for installation. (c) safety analysis of transponder data source interfaces.	**COMPLIANT** (a) this document (b) refer to the airworthiness compliance matrix for this Minor Change (c) refer to 23.1309 statement in the compliance matrix for this Minor Change
9.4	Following Mode S System functionality must be demonstrated: System operation ICAO 24-bit address in transmitted response Data in transmitted response Function of system fault detectors	**COMPLIANT** Ground testing is described in section 4.5 of this minor change.
12.1	Maintenance of altitude reporting transponders should be suitably screened.	**COMPLIANT** Testing detailed in section 4.5.3.2 recommends appropriate precautions to avoid interference.
12.2	Maintenance should include a periodic check of aircraft derived data including 24-bit address or in the event of a change of registration of the aircraft.	**COMPLIANT** Please refer to your national approved aircraft maintenance program for any periodic functional checks that need to be carried out on the transponder system. The TT21/22 does not interface with any external equipment to operate as a mode S transponder. The 24-bit address is setup during installation and cannot be

		readily changed during normal operation. Therefore, there are no periodic maintenance requirements necessary to maintain continued airworthiness other than the periodic functional checks required by the regulations.
12.4	Testing of Gillham code data should be based on the transition points as defined in Annex 2 of TGL13	**COMPLIANT** Gillham code is not used.

6. Appendix 1

TT21/TT22 Instructions for Continued Airworthiness

1. Description

This document describes the necessary maintenance requirements and instructions necessary to ensure the continued airworthiness of the aircraft following the embodiment of the Minor Change to add the TT21/TT22 Transponder system.

2. Operation

Operating instructions for the Trig Avionics TT21/TT22 Mode S Transponder are detailed in the following documents;

- 00559-00 Operating Manual
- 00560-00 Installation Manual section Normal Operation

3. Servicing

There are no periodic service requirements necessary to maintain continued airworthiness of the TT21/TT22 Transponder.

4. Maintenance Instructions

Please refer to your national approved aircraft maintenance program for any periodic functional checks that must be carried out on the transponder system.

Other than for periodic functional checks required by the regulations, there are no periodic maintenance requirements necessary to maintain continued airworthiness.

If a service is required, a complete performance test as detailed in section 4.5 of these instructions should be accomplished following any maintenance action.

5. Install and Removal Instructions

Please refer to Trig Avionics TT21/TT22 Installation Manual;

- 00560-00 Installation Manual section Installation

6. Required Tools and Test Equipment

- Mode S Transponder Test Set
- Pitot-Static Test Set

7. Airworthiness Limitations

There are no Airworthiness Limitations applicable to the Trig Avionics Minor Change to install a TT21/TT22 Mode S Transponder.