

**Note to Manufacturers Regarding TSO-C112c Mode S Transponder Labeling Scheme, and
14 CFR Part 43 Appendix F Cross-reference.**

The TSO-C112c labeling scheme does not match the labeling called out in Appendix F of 14 CFR Part 43. The new TSO labeling is based on RTCA Document DO-181D, Section 1.4.6, rather than the labeling that had been defined previously in TSO-C112.

To assist operators in complying with 14 CFR Part 43, the following table shows the relationship between the TSO-C112c labeling scheme and the Part 43 Appendix F requirement. Equipment approved under previous versions of TSO-C112 are not affected, and may continue to use the label from the equipment directly. Manufacturers of TSO-C112c equipment are encouraged to include this cross-reference information in their operating guide and maintenance instructions until such time that Appendix F is revised. In addition, the DO-181D labeling scheme (Sections 1.4.3 through 1.4.6) is repeated below in **Table 2** as a courtesy to operators and repair stations.

If you have any questions regarding this note to manufacturers, please contact: Charles Sloane, (202) 385 4641, charles.sloane@faa.gov, Aircraft Certification, Avionic Systems AIR-130.

Table 1 – Cross-Reference between TSO-C112c and Appendix F to Part 43:

ATC Mode S Transponder Equipment Labeling Cross-Reference	
If... labeling on the TSO-C112c Transponder¹ is:	Use... requirements in Appendix F to 14 CFR Part 43² for:
Level 1, Class 1	Class 1A
Level 1, Class 2	Class 1B, with optional 1090 ± 1 MHz reply frequency
Level 2, Class 1	Class 2A
Level 2, Class 2	Class 2B, with optional 1090 ± 1 MHz reply frequency
Level 3, Class 1	Class 3A
Level 3, Class 2	Class 3B, with optional 1090 ± 1 MHz reply frequency
Level 4, Class 1	Class 4
Level 4, Class 2 ³	Class 4, except for RF peak output power and suppression which should apply Class 3B ³
Level 5, Class 1	Class 4
Level 5, Class 2 ³	Class 4, except for RF peak output power and suppression which should apply Class 3B ³
¹ Per RTCA Document DO-181D, Section 1.4.6 – with options noted in Section 1.4.4 ² Labeling requirements are found in TSO-C112 ³ The development of these low power Level 4 and 5 transponders is discouraged. While it is supported in RTCA Document DO-181D, it is unlikely the next version of TSO-C112 will make any provision for these level and class of transponders.	

Table 2 – Excerpt from RTCA Document DO-181D (reprinted with the permission of RTCA, Inc.):**1.4.3 Mode S Transponder Levels**

Mode S transponders provide for both ground-to-air and air-to-air surveillance.

The data link function of Mode S transponders provides for information transfer in both directions between ground and air and between airborne units. Data link implementation varies and depends on the amount of information to be exchanged.

Possible implementation configurations and additional transponder features are summarized in the following paragraphs.

1.4.3.1 Level 1 Transponders

The Level 1 Transponder supports the surveillance functions of both ATCRBS and Mode S ground sensors and the surveillance functions of airborne interrogators. This transponder can also reply to an airborne interrogator thereby making its presence known; to do this, it need only handle short interrogations and replies.

Level 1 Transponders **shall** have the capabilities prescribed for:

- a. Mode A identity and Mode C pressure-altitude reporting,
- b. ATCRBS/Mode-S and Mode S all-call transactions,
- c. Addressed surveillance altitude and identity transaction,
- d. Lockout protocols,
- e. Basic data protocols except data link capability reporting, and
- f. Air-to-air service and squitter transactions.

Note: *Level 1 permits SSR surveillance based on pressure-altitude reporting and the Mode A identity code. In an SSR Mode S environment, technical performance relative to a Mode A/C transponder is improved because of Mode S selective aircraft interrogation.*

1.4.3.2 Level 2 Transponders

Level 2 Transponders **shall** have the capabilities of §1.4.3.1 and additionally support the receipt of long interrogations and the generation of long replies. The Level 2 Transponder supports all of the surveillance functions and also supports:

- a. Bi-directional air-to-air information exchange
- b. Ground-to-air data uplink, Comm-A
- c. Air-to-ground data downlink, Comm-B
- d. Multisite message protocol
- e. Data link capability reporting
- f. Aircraft identification reporting
- g. TCAS/ACAS crosslink capability

The ground-air-ground data link capability comprises a multitude of services and can be implemented according to the number and kind of services available, depending on the mission requirements of the aircraft. Protocols provide a means of reporting to the

ground the specifics of each individual installation.

Specific capabilities of a Level 2 or higher transponder have been defined for operation in European airspace. Requirements for Elementary Surveillance (ELS) and Enhanced Surveillance (EHS) compliant transponders are included in this document (§2.2.24 and §2.2.25). Specific data registers and content appropriate for these capabilities are provided.

1.4.3.3 Level 3 Transponders (Uplink ELM Capability)

In addition to the capabilities of the Level 1 and Level 2 Transponders, the Level 3 transponder is able to receive ELMs from the ground. ELMs are received in the Comm-C format and consist of a burst of uplink transmissions that need not be replied to individually but are acknowledged in a reply containing a summary of the received interrogations.

Level 3 Transponders **shall** have the capabilities of §1.4.3.2 and also those prescribed for ground-to-air Extended Length Message (ELM) communications.

Note: *Level 3 permits extended length data link communications from ground-to-air and thus may provide retrieval from ground-based data banks and receipt of other air traffic services which are not available with Level 2 transponders.*

1.4.3.4 Level 4 Transponders (Full ELM Capability)

In addition to all the capabilities of a Level 3 Transponder, the Level 4 Transponder can generate ELMs for transmittal to the ground by using the Comm-D format.

Level 4 transponders **shall** have the capabilities of §1.4.3.3 and also those prescribed for air-to-ground extended length message (ELM) communications.

Note: *Level 4 permits extended length data link communications from air to ground and thus may provide access from the ground to airborne data sources and the transmission of other data required by air traffic services which are not available with Level 2 transponders.*

1.4.3.5 Level 5 Transponders (Enhanced Data Link Protocol Capability)

In addition to the full ELM capability, the Level 5 Transponder can support the enhanced data link protocols. The protocols provide for increased data link capacity by permitting data link transactions with more than one Mode S interrogator at a time without the need for multisite coordination. These protocols are fully conformant to the data link transponder protocols description of §2.2.19.1 to §2.2.20.2.1 (the standard protocols) and are therefore compatible with interrogators that are not equipped for the enhanced protocol.

Level 5 transponders **shall** have the capabilities of §1.4.3.4 and also those prescribed for enhanced Comm-B and extended length message (ELM) communications.

Note: *Level 5 permits Comm-B and extended length data link communications with multiple interrogators without requiring the use of multisite reservations. The Level 5 Transponder has a higher minimum data link capacity than the other transponder levels.*

1.4.4 Optional Additional Features

Some transponder installations may support additional features:

- **TCAS Compatibility** – TCAS compatible transponders will have the capabilities described in §1.4.3.2, §1.4.3.3, §1.4.3.4 or §1.4.3.5, (see §2.2.22).
- **Antenna Diversity** – in aircraft with gross mass in excess of 5700 kg or a maximum cruising true airspeed capability in excess of 324 km/h (175 kt), or co-installation with airborne collision avoidance systems may require the transponder to operate in the diversity mode, i.e., the use of two antennas, receivers and transmitting channels.
- **Extended Squitter** – Extended squitter transponders will have the capabilities of §1.4.3.2, §1.4.3.3, §1.4.3.4 or §1.4.3.5 also in addition to those prescribed for extended squitter operation (see §2.2.23). The requirements for Extended Squitter message formats and information content are contained in the *Minimum Operational Performance Standards for 1090 MHz Extended Squitter Automatic Dependent Surveillance – Broadcast (ADS-B) and Traffic Information Services – Broadcast (TIS-B)* (RTCA DO-260A or latest version).
- **Dataflash Application** – transponders implementing Dataflash mode will adhere to the requirements contained in Appendix C.
- **Hijack Mode Capability** – Transponders implementing the Hijack mode will adhere to the requirements contained in Appendix D.
- **Elementary Surveillance** – elementary surveillance transponders will have the capabilities of §1.4.3.2, §1.4.3.3, §1.4.3.4 or §1.4.3.5 in addition to those requirements prescribed for elementary surveillance operation (see §2.2.24).
- **Enhanced Surveillance** – enhanced surveillance transponders will have the capabilities of §1.4.3.2, §1.4.3.3, §1.4.3.4 or §1.4.3.5 in addition to those requirements prescribed for enhanced surveillance operation (see §2.2.25).
- **Surveillance Identifier Code (SI)** – transponders with the ability to process SI codes have the capabilities of §1.4.3.1, §1.4.3.2, §1.4.3.3, §1.4.3.4 or §1.4.3.5, (see §2.2.14.4.36).

These additional features and corresponding identification codes are summarized in the Table 1-1.

Table 1-1: Transponder Optional Additional Features

Additional Features	ID Code
TCAS Compatibility	a
Antenna Diversity	d
Extended Squitter	e
Dataflash	f
Hijack Mode Capability	h
Elementary Surveillance (only)	l
Enhanced Surveillance (including Elementary Surveillance)	n
Surveillance Identifier Code (SI)	s

Note: *SI capability is included by meeting the requirements in these MOPS.*

1.4.5 Minimum Output Power Level Designation

Two minimum peak output power levels are supported by this version of these MOPS, 125 watts (21.0 dBW), which is designated as Class 1 equipment, and 70 watts (18.5 dBW), which is designated as Class 2 equipment. For more information on output power levels, see §2.2.3.2.

Class 1 equipment is intended for use in aircraft that operate at altitudes above 15000 ft, or have a maximum cruising true airspeed in excess of 175 kt (324 km/h).

Class 2 equipment may be used in aircraft that operate at altitudes not exceeding 15000 ft, and have a maximum cruising true airspeed not exceeding 175 kt (324 km/h).

1.4.6 Transponder Labeling

Each transponder **shall** be clearly labeled with its actual functional level, minimum peak output power, and its optional additional features. The label **shall** contain the word “Level” followed by one digit between 1 and 5. (see §1.4.3.1 through §1.4.3.5), followed by the ID Codes for the incorporated optional additional features as shown in Table 1-1, followed by the transponders’ minimum peak output power designation as “Class 1” or “Class 2” (see §1.4.5).

Example 1 – For a Level 2 transponder that incorporates Extended Squitter, Elementary Surveillance and SI capabilities with a minimum peak output power of 70 watts (18.5 dBW): the transponder would be labeled “Level 2els, Class 2.”

Example 2 – For a Level 4 transponder that incorporates TCAS compatibility, antenna diversity, Extended Squitter, Enhanced Surveillance and SI capabilities, with a minimum peak output power of 125 watts (21.0 dBW), the transponder would be labeled “Level 4adens, Class 1.”

The label should be clearly visible when the transponder is mounted on the aircraft. In the case of a change of transponder level or capability, the label must be changed appropriately.

Note: *For transponders where “Level” or “additional features” might be changed through an approved software update, a means to display the labeling electronically would meet the above intent.*