UC10x Installation Manual

UC100, UC101, UC102 and UC103

DRAFT

145 E Jewett Blvd STE 301
White Salmon, WA 98672

p. 509-493-XXXX

info@ucflight.com
www.ucflight.com

Contact Information

Urban Canyon Flight, Inc.

145 E Jewett Blvd STE 301

White Salmon, WA 98672 U.S.A.

Phone: (509) 493-XXXX - 8:00 AM – 5:00 PM (Pacific Time) Monday – Friday

Urban Canyon Flight Technical Support available 7:00 AM – 4:00 PM (Pacific Time) Monday – Friday

info@ucflight.com

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1 Document

1.1 Revision History

Table 1. Document Revision History

Revision	Date	Description	Author
00	01 Oct 2016	Initial Draft	A. Hasegawa
01	08 Sep 2017	Updated part number, TSO disclaimer for draft release, FCC information, basic interconnect diagram	C. Peckham
02	26 Sep 2017	Incorporated feedback from TCB: removed FCC logo from labels, fixed MPE 20cm typo, changed “contains module” to ”contains certified transmitter”	C. Peckham

1.2 Product Documents

Table 2. Documents Related to UC10x Products

Doc#	Title
UC10x-001-IM	UC10x Installation Manual
UC10x-001-DS	UC10x Datasheet
UC10x-001-ICD	UC10x Interface Control Document
UC10x-001-UG	UC10x User Guide

2 Limited Warranty

This Urban Canyon Flight product is warranted to be free from defects in materials or workmanship for a period of two (2) years from the date of purchase. Urban Canyon Flight will—at its sole option—refund, repair, or replace any components that fail in normal use during the warranty period. Such repairs or replacement will be made at no charge to the customer for parts or labor, provided that the customer shall be responsible for all costs related to transportation. This warranty does not cover failures due to abuse, misuse, accident or unauthorized alteration or repairs. To determine failure root cause, customer may be required to provide information regarding the interface, including but not limited to electrical block diagrams/schematics, mounting drawings and fasteners, cable drawings, and production and assembly techniques used. Providing this information will help to determine if failure occurred under normal use, and will help with product improvement.

The warranties and remedies contained herein are exclusive and in lieu of all other warranties express or implied or statutory, including any liability arising under any warranty of merchantability or fitness for a particular purpose, statutory or otherwise. This warranty gives you specific legal rights, which may vary from state to state. In no event shall Urban Canyon flight be liable for incidental, special, indirect or consequential damages, whether resulting from the use, misuse, or inability to use this product or from defects in the product. Some states do not allow the exclusion of incidental or consequential damages, so the above limitations may not apply to you.

Urban Canyon Flight retains the exclusive right to repair or replace the unit or software or offer a full refund of the purchase price at its sole discretion. Such remedy shall be your sole and exclusive remedy for any breach of warranty. To obtain warranty service, contact Urban Canyon Flight Authorized Service Center. For assistance in locating a Service Center near you, call Urban Canyon Flight Customer Service at one of the numbers shown below.

Urban Canyon Flight
145 E Jewett Blvd STE 301
White Salmon, Washington 98672 U.S.A.
Phone: 509-493-XXXX
Fax: 509-493-XXXX

2.1 Unpack and Inspect Before Use

Unpack the unit with caution. Before installation, visually inspect for transport damages. If the unit is damaged, notify the shipping company to file a claim for the damage. To justify the claim, save the original packaging materials and shipping container. Store packing material within shipping container for reshipment, if necessary.

2.2 Do not disassemble

This product is not intended to be disassembled. Do not attempt to open the enclosure.

WARNING: Any attempt to disassemble or open the enclosure will void the warranty and may result in personal injury or permanent product damage.

3 Software License Agreement

By using an Urban Canyon Flight Transponder, you agree to be bound by the terms and conditions of the following license agreement. Please read this carefully.

Urban Canyon Flight grants you a limited license to use the software embedded in this device (the “Software”) in binary executable form in the normal operation of the product. Title, ownership rights and intellectual property rights in and to the Software remain in Urban Canyon Flight.

You acknowledge that the Software is the property of Urban Canyon Flight and is protected under the United States of America copyright laws and international copyright treaties. You further acknowledge that the structure, organization and code of the Software are valuable trade secrets of Urban Canyon Flight and that the Software in source code form remains a valuable trade secret of Urban Canyon Flight. You agree not to decompile, disassemble, modify, reverse assemble, reverse engineer or reduce to human readable form the Software or any part thereof or create any derivative works based on the Software. You agree not to export or re-export the Software to any country in violation of the export control laws of the United States of America.

4 Safety and Security

4.1 For your safety

To prevent damage to your product or injury to you or to others, please read the following safety precautions in their entirety before using the product and visit our website at www.ucflight.com to obtain further / current safety and security information.

4.2 Safe Exposure Limits

It is the responsibility of the UC10x owner to ensure the maximum radiofrequency (RF) radiation exposure limits are not exceeded.

WARNING: A separation distance of 40 cm must be provided between the antenna and all persons.

4.3 Use only provided and/or recommended cables & accessories

Only use cables, antennas, and power sources provided with the Product, or recommended herein, or as required in appropriate regulatory documents such as applicable TSO(s) / MOPS.

4.4 Licensing

It is the responsibility of the UC10x owner to obtain proper licensing before using the transponder.

WARNING: This equipment has received an FAA transmit license for manned aircraft and a license for unmanned aircraft operating above 500 ft. AGL.

4.5 Professional Installation Disclaimer

The purpose of this document is to assist OEMs in integrating the UC10x family into their equipment designs.

The UC10x family is intended to be professionally integrated by OEMs into their equipment designs.

WARNING: Changes or modifications not expressly approved by the manufacturer could void the user's authority to operate the equipment. The installer shall be responsible for ensuring that the proper antenna is employed so that the antenna requirements of TSO-C112E (RTCA/DO-181E §2.215) or TSO-C74d (RTCA/DO-144A §2.2.11) or TSO-C66c (RTCA/DO-189 §2.2.17), as applicable, are met and limits of 47 CFR 87.131 are not exceeded.

4.6 Design Approval

The conditions and tests required for the TSO approval[1] of the UC10x (UC100, UC101, UC102 and UC103) Transponders are minimum performance standards. The TSO identifies the minimum performance standards, tests, and other conditions applicable for issuance of design and production approval of the article. TSO approval is the responsibility of the aviation authority (FAA) and is in progress for UC10x[2].

4.7 Installation Approval

The equipment should be installed in the aircraft in a manner consistent with acceptable workmanship and engineering practices and in the accordance with the instructions set forth in this publication. To ensure that the system has been properly and safely installed in the aircraft, the installer should make a thorough visual inspection and conduct an overall operational check of the system on the ground prior to flight.

The TC or STC provides installation approval from the FAA. This installation manual (IM) is intended to assist with installation and integration, but does not provide FAA-certified installation approval. This is a separate process.

[1] FAA certifications in progress

[2] TSO approval is for design and manufacturing. Thus, customers requiring TSO-approved units, will be required to purchase new units. In other words, there is no way to "retrofit" a non-TSO unit into a TSO unit at a later date, it is simply not practical.

5 FCC Certification and Compliance

This section provides warning statements/disclaimers required by the FCC. Additionally, this section provides operating requirements and labeling requirements that comply with FCC requirements.

Compliance with this section does not guarantee authorization of use. Requirements of other regulatory bodies (such as FAA and ICAO), discussed in part elsewhere in this document, will be required depending on the specific use case. Understanding the regulations are the sole responsibility of the end user.

Changes or modifications not expressly approved by the manufacturer could void the user's authority to operate the equipment.

5.1 FCC ID

The UC10x family FCC ID is 2ANAE-UC10X

5.2 FCC Radiation Exposure Statements

This equipment complies with FCC radiation exposure limits set for an uncontrolled environment. This equipment should be installed and operated with a minimum distance of 40 cm maintained between the radiator and any persons when the transponder is powered on and the radio in an active mode.

The antenna(s) used for this transmitter must not be co-located (within 40 cm) or operating in conjunction with any other antenna or transmitter.

5.3 FCC Interference Statements

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

This device complies with Part 15 of the FCC Rules [and with Industry Canada (IC) license-exempt RSS standard(s)]. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

FCC CAUTION: Any changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate this equipment.

5.4 FCC OEM Labeling Requirements for End-Product

The device is labeled with its own FCC ID Certification Number. In the event that the device is installed within another device, and the FCC ID Certification Number is not visible, the end device into which the device is installed must display a label referring to the enclosed certified transmitter. The final end product must be labeled in a visible area with the following:

"Contains Certified Transmitter FCC ID: 2ANAE-UC10X"

or

"Contains FCC ID: 2ANAE-UC10X"

The OEM must only use approved antenna(s) listed above, which have been certified with the device.

5.5 FCC OEM End-Product User Manual Statements

The OEM integrator should not provide information to the end user regarding how to install or remove this RF certified transmitter or change RF related parameters in the user manual of the end product.

Other user manual statements may apply.

Compliance statement only valid if used with certified/approved antenna or antenna types. See list of approved antenna(s)/antenna characteristics.

Label must be placed on enclosure exterior and must be clearly visible.

5.6 FCC-Compliant Antenna & Cable

5.6.1 Minimum Cable Loss

The minimum cable loss is 0 dB (direct connection to antenna).

No external amplifier is allowed.

5.6.2 Maximum Cable Loss

The maximum cable loss is 1.5 dB.

5.6.3 Antenna Gain

Antenna Information: 1030-1090 MHz, linearly-polarized antenna, Gain: 5.2 dBi max[3].

[3] See section 11.4 Antenna for more information on antenna requirements.

5.7 Product Label

Figure 1. UC10x Product Labels (SCALE 2:1)

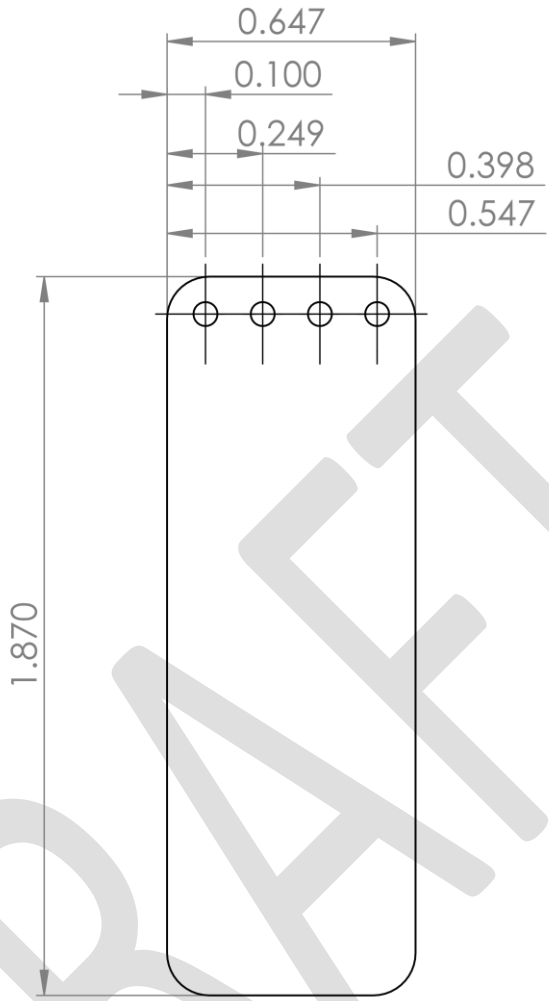

Figure 2. UC10x Product Label Mechanical Drawing (SCALE 2:1)

5.7.1 Product Label Location

Figure 3. UC10x Mechanical Drawing with Label Location (SCALE 1:1)[4]

[4] NOTE: this is a simplified drawing. Contact us for ASME Y14.5 / ISO 16792 fully-specified drawing appropriate for ISO9001/AS9100 Quality Management Systems (QMS) (in progress).

5.7.2 Product Box Label

Figure 4. FCC Part 15 Declaration of Conformity – Location on 4 x 3 x 1" Product Box

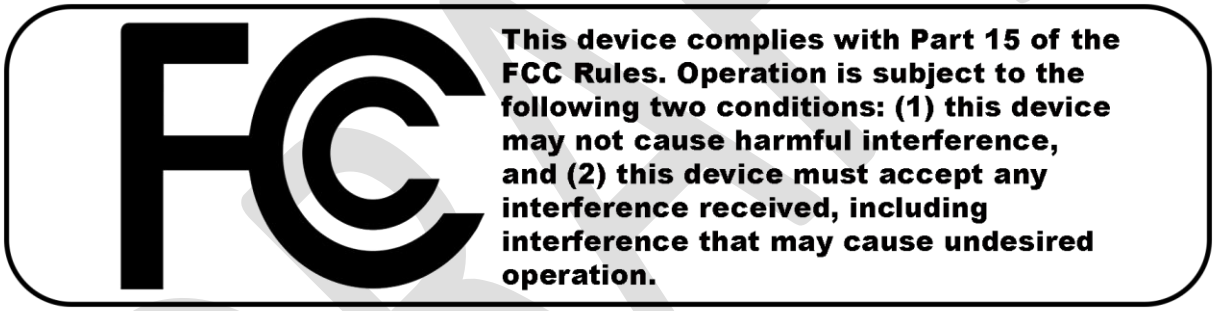

Figure 5. FCC Part 15 Declaration of Conformity – Language on Product Box

5.8 Electronic Labeling (E-Label)

The E-LABEL Act of 2014[5] allows manufacturers to display labeling electronically, using a display.

The UC10x is an incomplete system, and does not include a physical display.

OEMs integrating the UC10x into their equipment designs are required to provide a human interface to the pilot / remote pilot, and must provide an electronic label consistent with FCC requirements[6] [7]. Figure 6, Figure 7, Figure 8, and Figure 9 below provide example electronic label for UC100, UC101, UC102, and UC103, respectively.

FCC CAUTION: It is the responsibility of the installer to confirm this label meets all requirements for their application and local regulatory requirements

5.8.1.1 Example UC100 E-Label

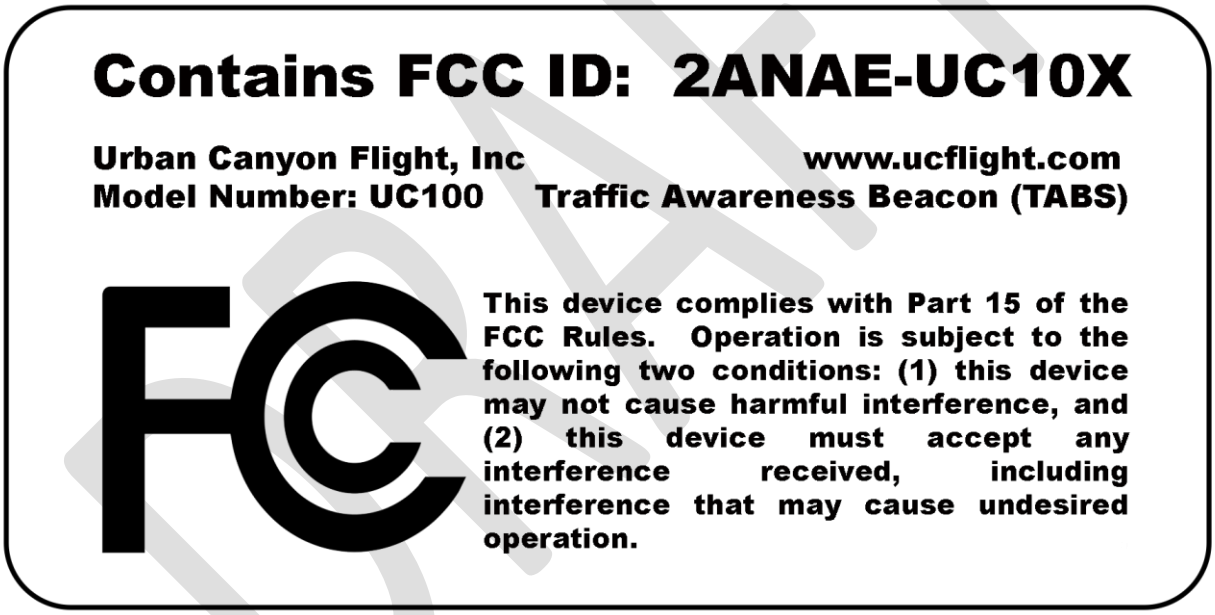

Figure 6. Example Electronic Label for Model Number UC100

[5] For more background information on this relatively recent legislation, see H.R.5161 – E-LABEL Act, Public Law 113-197, and FCC 15-92 NOTICE OF PROPOSED RULEMAKING, Adopted July 17, 2015.
[6] See FCC Electronic Labeling Guidance contained in KDB 784748 D02 e labelling v01
[7] This section focuses on human interface requirements for compliance with FCC regulations. Additional human interface requirements can be found in the TSO(s) and MOPS, and other locations, depending on product and use case. This is not intended to be a comprehensive list of requirements pertaining to the UC10x human interface.

5.8.1.2 Example UC101 E-Label

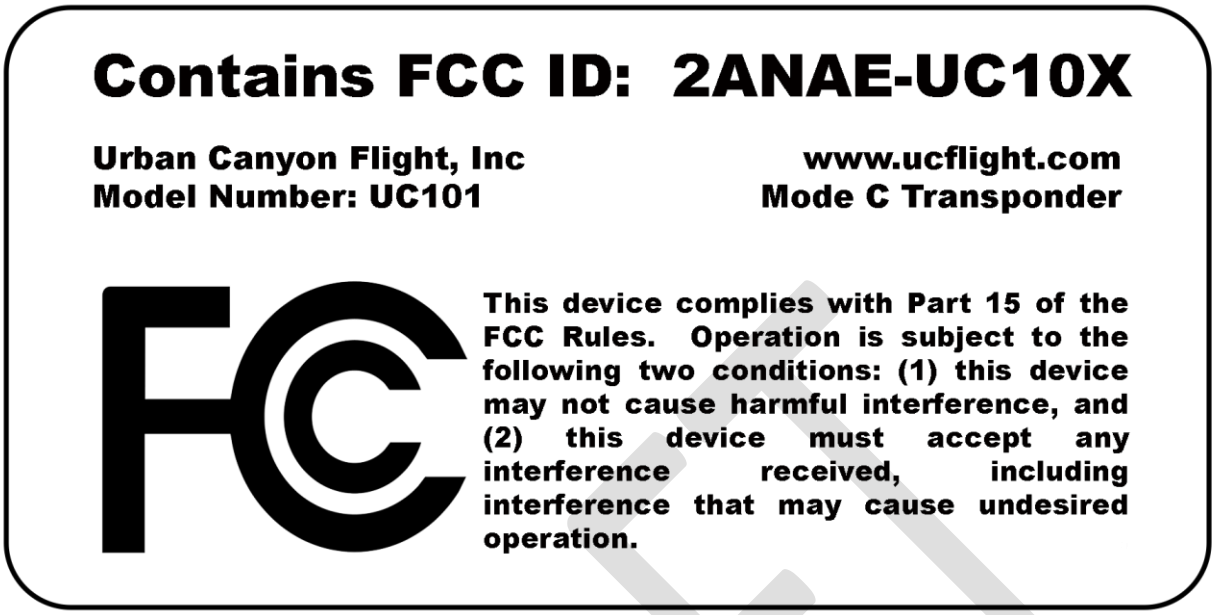

Figure 7. Example Electronic Label for Model Number UC101

5.8.1.3 Example UC102 E-Label

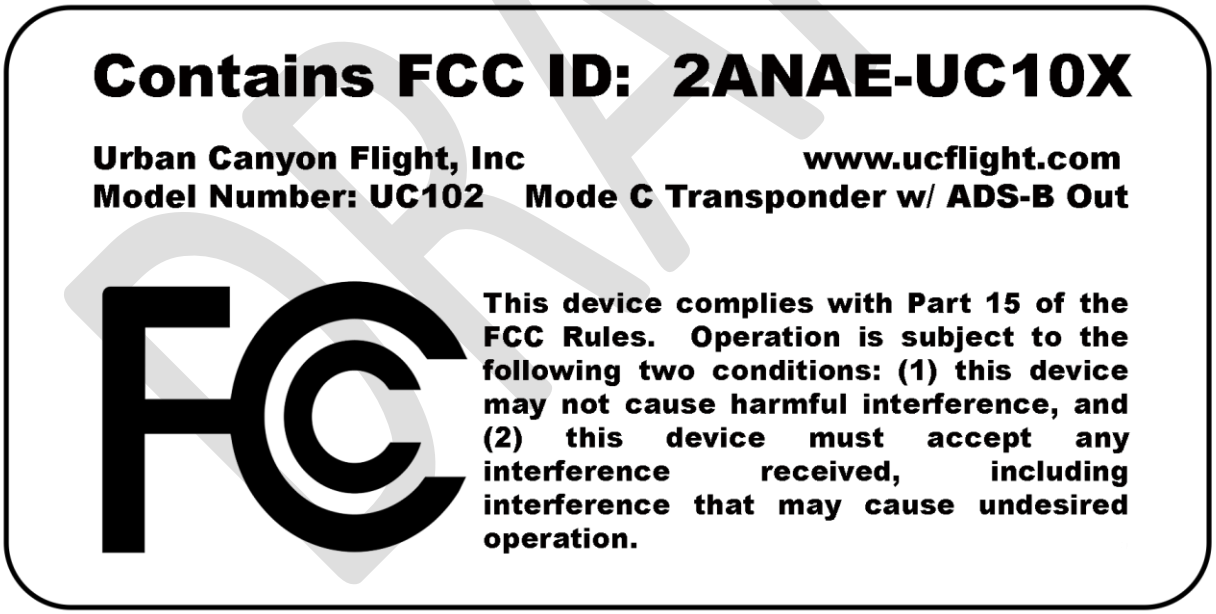

Figure 8. Example Electronic Label for Model Number UC102

5.8.1.4 Example UC103 E-Label

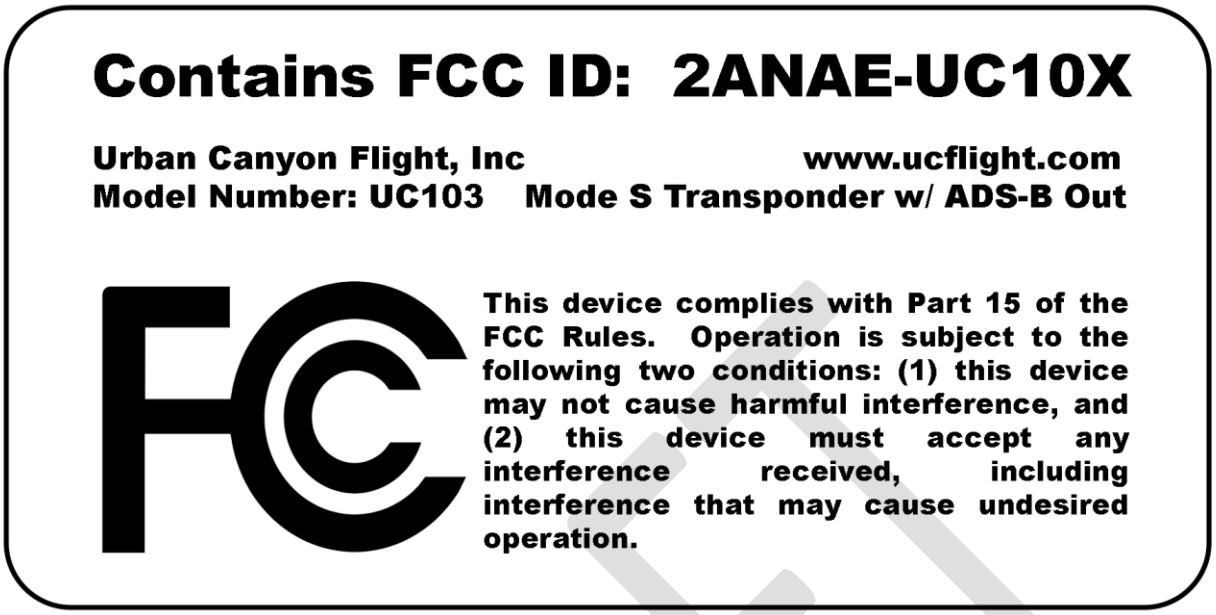

Figure 9. Example Electronic Label for Model Number UC103

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6 Regulatory & Technical Overview

6.1 UC100 Traffic Awareness Beacon System (TABS)[8]

Specification	Characteristics
Compliance	TSO-C199 Class A
FCC ID	2ANAE-UC10X
Applicable Documents	RTCA/DO-181E, RTCA/DO-260B (requirements modified directly in TSO-C199)
Software	RTCA/DO-178C Level C
Hardware	RTCA/DO-254 Level C
Power Requirements	10-38 VDC. Typical 0.5 watt @ 28V (
Altitude	100,000 ft.
Humidity	95% @ 50°C for 6 hours; 85% @ +38°C for 16 hours Tested to RTCA/DO-160G §6.0 Category A
Operating Temperature	-20°C to +70°C (DO-160G Categories A2, C1)
Transmit Frequency	1090 MHz ± 1 MHz
Transmitter	53 dBm (200W) nominal at RF connector (SMA) 51 dBm (125W) minimum at antenna Provides for 1.5 dB loss in cable + connectors
Transmitter Modulation	5M65M1D
Receiver Frequency	1030 MHz
Receiver Sensitivity	-74 dBm ± 3 dB (TCAS Replies), -71 dBm ±3 dB (Ground Replies)

[8] FAA certifications in progress

6.2 UC101 Mode C Transponder[8]

Specification	Characteristics
Compliance	TSO-C74d Class 1A
FCC ID	2ANAE-UC10X
Applicable Documents	RTCA/DO-144A
Software	RTCA/DO-178C Level C
Hardware	RTCA/DO-254 Level C
Power Requirements	10-38 VDC. Typical 0.8 watt @ 28V
Altitude	100,000 ft.
Humidity	95% @ 50°C for 6 hours; 85% @ +38°C for 16 hours Tested to RTCA/DO-160G §6.0 Category A
Operating Temperature	-20°C to +70°C (DO-160G Categories A2, C1)
Transmit Frequency	1090 MHz ± 1 MHz
Transmitter	53 dBm (200W) nominal at RF connector (SMA) 51 dBm (125W) minimum at antenna Provides for 1.5 dB loss in cable + connectors
Transmitter Modulation	5M65M1D
Receiver Frequency	1030 MHz
Receiver Sensitivity	-74 dBm ± 3 dB

6.3 UC102 Mode C Transponder with ADS-B Out[8]

Specification	Characteristics
Compliance	TSO-C74d Class 1A, TSO-C166b Class B0
FCC ID	2ANAE-UC10X
Applicable Documents	RTCA/DO-144A, RTCA/DO-260B w/ Corrigendum 1
Software	RTCA/DO-178C Level C
Hardware	RTCA/DO-254 Level C
Power Requirements	10-38 VDC. Typical 1.0 watt @ 28V
Altitude	100,000 ft.
Humidity	95% @ 50°C for 6 hours; 85% @ +38°C for 16 hours Tested to RTCA/DO-160G §6.0 Category A
Operating Temperature	-20°C to +70°C (DO-160G Categories A2, C1)
Transmit Frequency	1090 MHz ± 1 MHz
Transmitter	53 dBm (200W) nominal at RF connector (SMA) 51 dBm (125W) minimum at antenna Provides for 1.5 dB loss in cable + connectors
Transmitter Modulation	5M65M1D
Receiver Frequency	1030 MHz
Receiver Sensitivity	-74 dBm ± 3 dB

6.4 UC103 Mode S Transponder with ADS-B Out[8]

Specification	Characteristics
Compliance	TSO-C112e Class 2A els, TSO-C166b Class B1S
FCC ID	2ANAE-UC10X
Applicable Documents	RTCA/DO-181E, RTCA/DO-260B w/ Corrigendum 1
Software	RTCA/DO-178C Level C
Hardware	RTCA/DO-254 Level C
Power Requirements	10-38 VDC. Typical 1.3 watt @ 28V
Altitude	100,000 ft.
Humidity	95% @ 50°C for 6 hours; 85% @ +38°C for 16 hours Tested to RTCA/DO-160G §6.0 Category A
Operating Temperature	-20°C to +70°C (DO-160G Categories A2, C1)
Transmit Frequency	1090 MHz ± 1 MHz
Transmitter	53 dBm (200W) nominal at RF connector (SMA) 51 dBm (125W) minimum at antenna Provides for 1.5 dB loss in cable + connectors
Transmitter Modulation	5M65M1D
Receiver Frequency	1030 MHz
Receiver Sensitivity	-74 dBm ± 3 dB

6.5 Environmental Qualification Form

Test Conditions	DO-160G	Test Description[9]
Temperature and Altitude	4.0	Equipment tested to Categories A2, C1
Low Temperature Ground Survival	4.5.1	-55°C (Category A2 and C1)
Low Temperature Short-Time Operating	4.5.1	-40°C (Category A2 and C1)
Low Temperature Operating	4.5.2	-20°C (Category C1)
High Temperature Operating	4.5.4	+70°C (Category A2 and C1)
High Temperature Short-Time Operating	4.5.3	+70°C (Category A2 and C1)
High Temperature Ground Survival	4.5.3	+85°C (Category A2 and C1)
Loss of Cooling	4.5.5	Testing not required (unit does not require cooling, +70°C operating without cooling air) (Category A2 and C1)
Altitude	4.6.1	100,000 feet (Category C1)
Decompression	4.6.2	8,000 to 100,000 feet in 15 seconds (Category A2)
Overpressure	4.6.3	-15,000 feet (Category A2)
Temperature Variation	5.0	Equipment tested to Category B
Humidity	6.0	Equipment tested to Category A
Operational Shocks	7.2	Equipment tested to Category B Three 6g, 11ms shock in each orthogonal direction
Crash Safety	7.3	Equipment tested to Category B One 20g, 11ms shock in each orthogonal direction
Vibration	8.0	Aircraft zones 1 (including 1a and 1b) and 2; aircraft type 3, 4, 5 to Category S Level L; aircraft type 1 (Helicopters) to Category U2 Level F1
Explosion	9.0	Equipment identified as Category X – no test required
Waterproofness	10.0	Equipment identified as Category X – no test required
Fluids Susceptibility	11.0	Equipment identified as Category X – no test required
Sand and Dust	12.0	Equipment identified as Category X – no test required
Fungus	13.0	Equipment identified as Category X – no test required
Salt Spray	14.0	Equipment identified as Category X – no test required
Magnetic Effect	15.0	Equipment tested to Category Z

[9] Planned tests

Test Conditions	DO-160G	Test Description[9]
Power Input	16.0	Equipment tested to Category BXX for 28 V • Normal Operation: 18.0 to 32.2 V • Surge (high): 60 VDC for 100 ms + 40 VDC for 1 second • Surge (low): 17 VDC for 30 ms
Voltage Spike	17.0	Equipment tested to Category B • Voltage spike with 56 V peak for 10 microseconds (approx. trapezoidal shape). Test source output impedance 50 ohm (see DO-160F Figure 17-1)
Audio frequency conducted susceptibility	18.0	Equipment tested to Category B
Induced signal susceptibility	19.0	Equipment tested to Category AC • Magnetic Fields Induced in the UUT • Magnetic Fields Induced into interconnect cables • Electrical Fields Induced into interconnect cables • Induced Voltage Spikes into interconnect cables
Radio frequency susceptibility	20.0	Equipment tested to Category T • Conducted: between 10 kHz to 400 MHz • Radiated: 100 MHz to upper limit (10 GHz?)
Radio frequency emission	21.0	Equipment tested to Category B • Conducted: 150 kHz to 152 MHz • Radiated: 100 MHz to 6 GHz • Measurement Bandwidth: 150kHz to 6GHz
Lightning induced transient susceptibility	22.0	Equipment identified as Category XXXXX – no test required
Lightning direct effects	23.0	Equipment identified as Category X – no test required
Icing	24.0	Equipment identified as Category X – no test required
Electrostatic Discharge	25.0	Equipment identified as Category X – no test required
Fire, Flammability	26.0	Per AC 25-16F Paragraph 7(h), we shall conduct these tests in accordance with Appendix F of 14 CFR Part 25 (FAA does not accept DO-160F for this section of testing)

7 General Information

7.1 Introduction

This manual contains information relative to the physical, mechanical and electrical characteristics and installation requirements for the Urban Canyon Flight Series of Transponders.

7.2 General Description

Urban Canyon Flight Series of Transponders are remote mounted transponders. The transponder is a radio transmitter and receiver that operates on radar frequencies. Functionality includes replying to ATCRBS, Mode A, C and S interrogations. The Urban Canyon Flight Series of transponders are also capable of Automatic Dependent Surveillance – Broadcast (ADS-B) operations which allows an aircraft or surface vehicle to transmit position, altitude, vector and other information for use by other aircraft, surface vehicle or ground facilities. The family also includes a Traffic Awareness Beacon System (TABS) device, which is similar in function to a Mode S Transponder w/ ADS-B Out, but with significant reduction in functionality (and thus airspace availability).

7.3 Technical Standard Order (TSO) Approvals[10]

The table below show the following TSO manufacturing authorizations for the UC10x family[10].

Table 3. UC10x TSO Authorizations by Product[10]

Part No.[11]	Model No.	Nomenclature	TSO-C199 TABS	TSO-C74d Mode C	TSO-C112e Mode S	TSO-C166b ADS-B
10-000-()	**UC100**	UC100 Traffic Awareness Beacon (TABS)	Class A			
10-010-()	**UC101**	UC101 Mode C Transponder		Class 1A		
10-020-()	**UC102**	UC102 Mode C Transponder w/ADS-B Out		Class 1A		Class B0[12]
10-030-()	**UC103**	UC103 Mode S Transponder w/ADS-B Out			Class 2A els[13]	Class B1S[14]

[10] FAA certifications in progress. Units without TSO, but with FCC and FAA approval, are available. TSO and non-TSO units are intended to be form, fit, and function equivalent.

[11] Per 14 CFR 21.603(b), we anticipate a series of minor changes, which will be denoted in suffix change numbers shown in open brackets after the part number. When ordering, omit the suffix to receive the latest product version

[12] **Stand-alone 1090ES transmitters**. Also known as a non-transponder-device (NTD) when not integrated with a Mode S transponder. RTCA/DO-260B §2.2.2.2 only allows Class A0 and B0 NTD devices. Uses Extended Squitter Downlink Format 18 (DF=18).

[13] 14 CFR 43 Appendix F allows abbreviated marking Class 2A as equivalent to RTCA/DO-181E Class 1 Level 2 els

[14] **1090ES transmitters integrated with a Mode S transmitter**. Uses Extended Squitter Downlink Format 17 (DF=17).

7.4 FAA NextGen / 2020 Mandate

The FAA NextGen 2020[15] mandate / ADS-B Out Rule, specified in 14 CFR §91.225 and 14 CFR § 91.227, applies to General Aviation (GA) aircraft flying in the NAS[16]. Put simply, all GA aircraft are required to equip with ADS-B Out.

Table 4 below summarizes the UC10x product line compliance with the FAA 2020 mandate.

Table 4. FAA NextGen / 2020 Mandate Compliance by Product

Part No.[17]	Model No.	Nomenclature	Transponder	ADS-B	2020 Mandate
10-000-()	**UC100**	UC100 Traffic Awareness Beacon (TABS)	Partial[18]	Partial[19]	-
10-010-()	**UC101**	UC101 Mode C Transponder	YES	-	-
10-020-()	**UC102**	UC102 Mode C Transponder w/ADS-B Out	YES	YES	-
10-030-()	**UC103**	UC103 Mode S Transponder w/ADS-B Out	YES	YES	YES

UC103 will fully comply with the FAA 2020 Mandate / ADS-B Out Rule (contained in 14 CFR § 91.225 and 14 CFR § 91.227), when paired with appropriate GPS/GNSS position[20] and barometric altitude[21] sources.

UC102 will not meet the 2020 Mandate. Despite being ADS-B Out, and meeting the requirements of DO-166b, the UC102 is a Class B0 device, which does not comply with 14 CFR § 91.227. Put simply, the 2020 Mandate requires Mode S. However, the UC102 will be displayed on ADS-B-In systems compliant to TSO-C195a.

UC101 is not an ADS-B device, and will not meet the FAA's 2020 mandate.

UC100 is a TABS device, intended for intercompatibility with ADS-B systems, but does not comply with the FAA ADS-B Out Rule (contained in 14 CFR § 91.225 and 14 CFR § 91.227) and thus IS NOT compliant with FAA NextGen / 2020 Mandate. Furthermore, per DO-317A (TSO-C195a), a TABS device is a non-performing emitter (NPE), and not displayed on ADS-B-In systems compliant to TSO-C195a, and thus IS NOT an ADS-B device. Lastly, TABS does not meet the definition of an ATC transponder (per 47 CFR § 91.215), and NOT appropriate to call it a "transponder".

[15] Officially takes effect January 1, 2020.

[16] Airspace identified in 14 CFR § 91.225

[17] Per 14 CFR 21.603(b), we anticipate a series of minor changes, which will be denoted in suffix change numbers shown in open brackets after the part number.

[18] UC101, UC102, and UC103 meet the definition for an ATC transponder per 47 CFR § 91.215. UC100 does not meet the definition, and thus is not a "transponder".

[19] Per DO-317A (TSO-C195a), any ADS-B emitter broadcasting SDA=0, NACv=0, or NACp<5 will not be displayed on TSO-compliant ADS-B-In systems. TABS is a non-performing emitter (NPE) with SDA=0, SIL=0, NIC<5, NACv=0 or NACp<5, and will not display on a TSO-C195a compliant systems.

[20] FAA AC 20-165B recommends TSO-C145 or TSO-146 position sources to maximize availability and ensure access to the airspace identified in 14 CFR § 91.225. However, TSO-C129 and TSO-C196 are also acceptable, as are non-TSO'd GPS that comply with the performance requirements of 14 CFR § 91.225.

[21] FAA AC 20-165B recommends TSO-C10 or TSO-C106 barometric altitude sources (or TSO-C88 with a digitizer), with pilot and ADS-B data correspondence of ±125 feet per 14 CFR § 91.217.

7.5 Incomplete System

The UC10x is a remote system, and thus an incomplete system, as it does not include the items required for a fully-functioning system.

- **Antenna.** UC10x does not include an antenna or antenna cable.
- **Head Unit.** UC10x does not include a display (head unit), and thus does not comply with the human interface aspects.

7.6 Non-TSO Functions

The UC10x series do not have any Non-TSO functions.

7.6.1 TSO Deviations

Table 5 below lists the deviations for each TSO by section, and provides a justification for the deviation. Note that all of these deviations are commonplace and are mostly due old regulatory documents. Once the TSOs are renewed, most deviations below will not be necessary.

Table 5. TSO Deviations

TSO		Deviation
Number	Section	
TSO-C74d	4.c	Electronic part marking is used for hardware and software identification, which is stored in non-volatile memory[22]
TSO-C166b	4.d	
TSO-C74d	3.d	TSO requires DO-160F; DO-160G will be used instead[23]
TSO-C74d	3.e	TSO requires DO-178B; DO-178C will be used instead
TSO-C112e	3.e	
TSO-C166b	3.e	
TSO-C74d	4.a	Per guidance in FAA Order 8150.1C, the appliances are marked with the primary TSO along with a reference to the Installation Manual for the other TSO information (other applicable TSOAs, deviations, etc.)[24].
TSO-C112e	4.a	
TSO-C166b	4.a	

Table 5 above lists all deviations, all of which are commonplace in the industry, and do not affect form, fit, or function of the device.

The deviations in Table 5 above are typically automatically accepted, many IM would list “No TSO Deviations”, though we’ve decided to include these minor deviations for completeness.

[22] Unlike TSO-166b (ADS-B) and TSO-C74d (Mode C), TSO-C112e (Mode S) explicitly allows electronic part marking.

[23] Latest revision DO-160G used in all cases

[24] Basic requirement is to mark each article according to 14 CFR 45.15(b), and as specified in the TSO

7.6.2 Failure Condition Classifications

Table 6 summarizes the potential hazards associated with the UC10x functions and the associated failure condition severity classifications per FAA AC 23.1309-1E.

Table 6. Failure Condition Classifications

Functional Description	Hazard Classification	Failure Condition
Mode S Transponder Response to SSR and TCAS Interrogations	*MAJOR* TSO-C112e § 3.b	Incorrect reply to an SSR or TCAS interrogation. Significant reduction in safety margins or functional capabilities
ADS-B Output	*MAJOR* AC 20-165B § A.2.29 TSO-C166b § 3.b	Incorrect position or velocity data reported to ground surveillance system providing aircraft separation services. Significant reduction in safety margins.
Mode C Transponder Failure of function	*MINOR* TSO-C74d § 3.b	Loss of function

8 Equipment Description

The Urban Canyon Flight Series of Transponders are the best-in-world size (3 in^3) weight (50 grams) and power consumption (1 W average). UCF Transponders feature an all solid-state transmitter. Mode and code selection are controlled remotely. Functions including flight level, 4096 code, and aircraft address are presented on remote graphic user interface. The transponders series uses data and power from various external devices. These external devices include GPS/GNSS sensor, direction instrumentation (magnetic and non-magnetic), airspeed sensors, barometric altimeters and altitude encoders, external power, antenna, and antenna cabling, through the user interface or autopilot/flight computer. Note that not all sensors are required for all installations, and that there may be additional sensors capable of providing equivalent data

8.1 Systems Overview and Planning

The transponder requires connection of multiple external devices. The UC10x family only includes the radio itself (transponder, ADS-B, and/or TABS). UC10x does not include the antenna, antenna cable, sensors (GPS/altitude encoder), or human interface aspects (i.e. no display/controller/autopilot/flight computer).

Figure 10 below provides an example installation configuration with the sensor data multiplexed through a single interface with the display or autopilot.

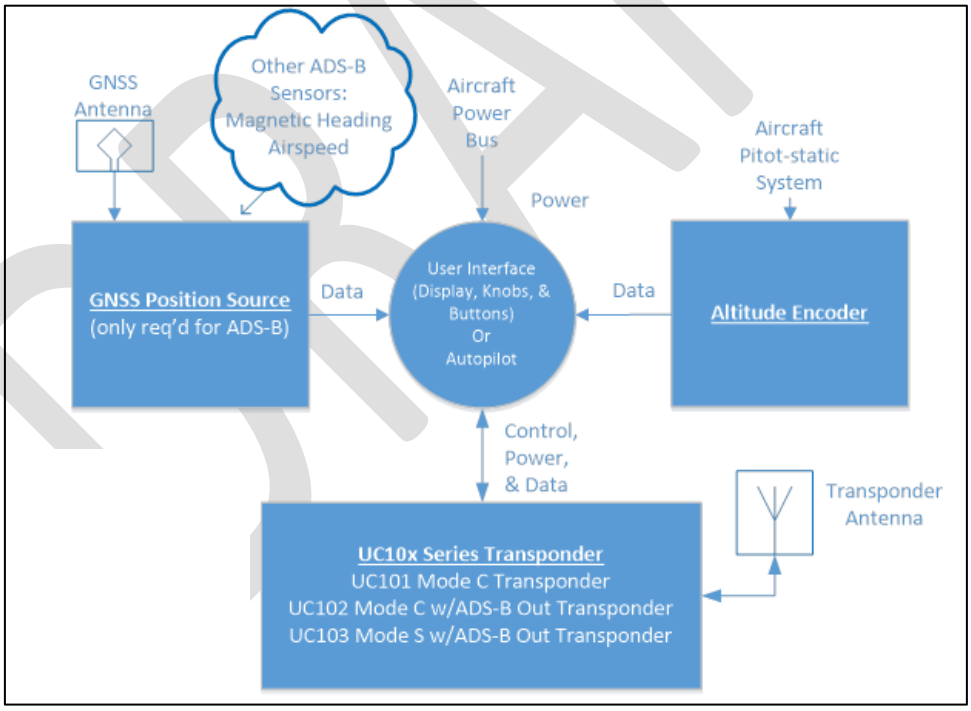

Figure 10. System-Level Block Diagram

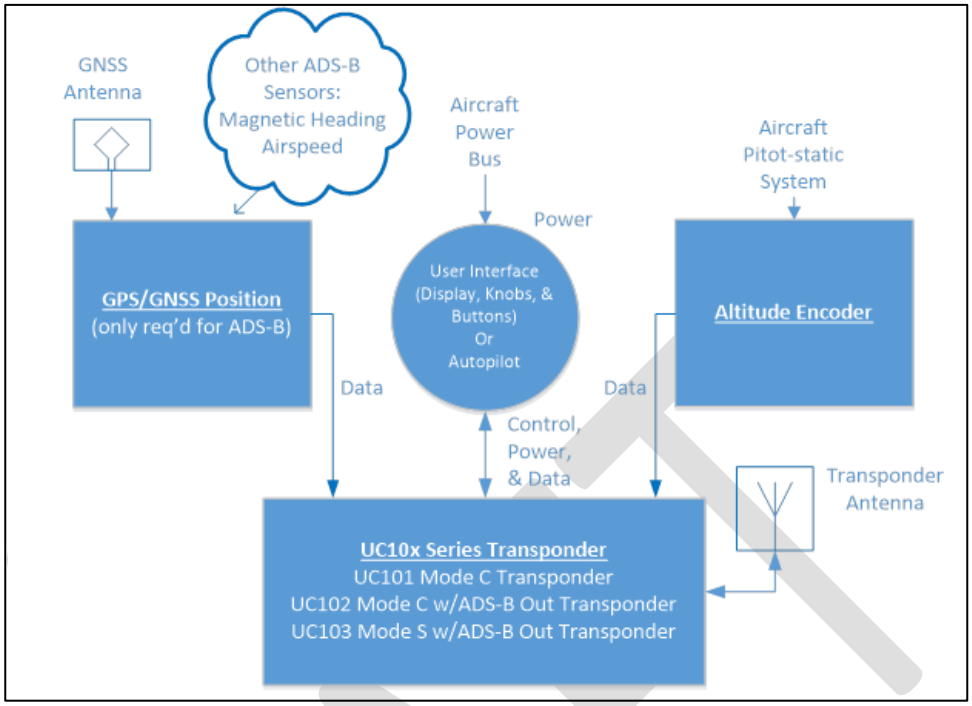

Figure 11. Alternate System-Level Block Diagram

Figure 11 above shows an alternate connection of data flow, with sensor data going directly to the transponder (e.g. through RS-232 Port 1) and control data separate (e.g. on RS-232 Port 0). The physical sensors would be identical to sensors shown in Figure 10, the difference of note is that Figure 11 shows the sensors connected directly to the transponder, instead of through the flight computer.

8.2 Input and Output Interfaces

8.2.1 Input Power

The unit is designed to operate from 10V to 38V, without requiring any change to the configuration. Thus, it can be operated from standard aircraft 14V or 28V DC power bus. The unit is most efficient at 28V.

The unit has two positive power input pins, both of which must be connected. Additionally, both grounds must be connected for power.

The input power interface includes common- and differential-mode filtering for EMC (conducted emissions and conducted susceptibility). Additionally, ESD and transient voltage suppression (TVS) diodes, suitable for aircraft electrical systems supplied by engine-driven alternators/rectifiers, or DC generators where a battery of significant capacity is floating on the DC bus at all times. The input power interface also includes reverse polarity protection to -60V max (non-conducting) and under voltage lockout for power input voltages below 9V. Lastly, the power input interface is short duration operational for voltages between 38V to 63V typical, consistent with a Category B device as defined in DO-160G § 16.0 Power Input.

The maximum power consumption is 6 W[25] (worst-case condition for Mode S w/ ADS-B out). The typical power consumption is 0.5 W (STBY), and 1 W (ALT mode, 235 PRF, 1090ES enabled). On average, the UC10x consumes one-fifth as much power as competitive devices.

8.2.2 RS-232 Serial Communication

The unit has two bi-directional RS-232 ports. Both ports are fully compliant with the industry standard[26] physical layer implementation. Both RS-232 ports operate at 57.6 kbps 8N1 default, though they are easily reconfigurable for other standard baud rates summarized in Table 7 below.

Table 7. Supported Baud Rates for RS-232 Communication

Baud
2.4 kbps
4.8 kbps
9.6 kbps
19.2 kbps
38.4 kbps
57.6 kbps
115.2 kbps

ADS-B UNCOMPENSATED LATENCY WARNING: Modifying default baud rate for sensor data requires re-evaluation of uncompensated and total system latency, and—depending on the sensor data format and other factors—may result in data transfer that is too slow to meet ADS-B data latency requirement. See Section 9.2.4 Uncompensated Latency for more details.

The two RS-232 ports (Port 0 and Port 1) are completely redundant with each other, and allow for all sensor and control data to come from either port.

[25] This is the maximum average power consumed by the device. The instantaneous (short-term) power consumption will be more.
[26] Industry standard defined by ANSI Electronic Industries Association/Telecommunication Industry Association TIA/EIA-232-F and ITU V.28

8.2.3 Acceptable FAA-Certified Data Sources

Table 8. Summary of acceptable data sources

Sensor Type	TSO[27]	Description	Rev
Baro	TSO-C10b	Altimeter, Pressure Actuated, Sensitive Type	Any
	TSO-C106	Air Data Computer	Any
	TSO-C88b	Automatic Pressure Altitude Reporting Code-Generating Equipment	Any
Heading	TSO-C5f	Direction Instrument, Non-Magnetic (Gyroscopically Stabilized)	Any
	TSO-C6e	Direction Instrument, Magnetic (Gyroscopically Stabilized)	Any
Vertical Rate	TSO-C8e	Vertical Velocity Instruments	Any
GPS	TSO-C129a[28]	Supplemental GPS	Any
	TSO-C145d	**(FAA Recommended)** GPS with WAAS	Any
	TSO-C146d	**(FAA Recommended)** GPS with WAAS, Stand-Alone	Any
	TSO-C196b	Supplemental GPS Augmented by Aircraft	Any

8.3 GPS/GNSS Input

UC102 and UC103 support Extended Squitter ADS-B out, and both are DO-260B (ADS-B "Version 2") compliant broadcast participant. UC100 supports a TABS-compliant broadcast. In all cases, to function properly, a GPS/GNSS sensor must be connected.

8.3.1 Certification Level

To support an SDA of "2", the UC10x must be connected to GPS/GNSS with DAL of C or higher for both DO-178() and DO-254.

8.3.2 Protocols

The GNSS input format is compliant with NMEA 0183. However, NMEA 0183 does not provide all data necessary for ADS-B "out", most notably the integrity data. Additional proprietary messages fill the gap.

[27] Current TSO revision level shown in this table, as of the writing of this document. However, any revision of the TSO from the table above is acceptable.

[28] TSO-C129 is cancelled. ADS-B "out" equipment that us this as the position source may need to conduct a position and velocity latent analysis

NMEA 0183 and the Freeflight / Accord NexNav GPS are the only standard protocol implemented. The following protocols are also in progress.

- Industry standard "Aviation" protocol
- Freeflight and Accord NexNav GPS proprietary protocols
- Urban Canyon Flight ADS-B protocol, including ADS-B plus
- Trig ADS-B protocol
- C199 TABS compliant GPS using NMEA protocol

8.3.3 GPS for FAA NextGen / 2020 Mandate

The UC103 can be connected to the following GPS/GNSS units to form the basis of a 14 CFR 91.227 or AMC 20-24 compliant ADS-B installation:

- Trig TN70 GPS Sensors
- Freeflight 1201 & 1204 WAAS/GPS Sensors
- NexNav MINI & NexNav MAX WAAS/GPS Sensors
- Garmin GNS 400W/500W series navigators
- Garmin GTN 600/700 series navigators

The bulleted list above represents long-term compatibility plan. Of the list above, we will down select to one or two units, in order to provide the lowest-cost 14 CFR 91.227 or AMC 20-24 solution possible. Table 9 below is the "short list" of products we are considering.

Table 9. GPS products for 2020 Mandate (14 CFR 91.227 or AMC 20-24 compliant system)

TSO	Class	Manfr	Manfr PN	MOPS	DO-178()	DO-254	Price	Interface	Rate
TSO-C145c	Beta-1	Trig	TN70	DO-229D	Level C	Level C	$3,250	RS-232	5 Hz
TSO-C145c	Beta-1	Freeflight	1201	DO-229C	Level C	N/A	$2,989	RS-232	???
TSO-C145c	Beta-1	Accord Technology	NexNav mini CCA	DO-229D	Level C	Level C	???	RS-232	5 Hz
TSO-C145c	Beta-1	Accord Technology	NexNav mini LRU	DO-229D	Level C	Level C	???	RS-232	5 Hz
NOT TSO'd	N/A	Dynon	SkyView SV-GPS-2020	14 CFR 91.225	N/A	N/A	$579	RS-232	4 Hz

The plan is to finalize the decision on which GPS unit(s) to support prior to finalizing our requirements.

8.3.4 GPS for TSO-C199 TABS Compliance

The Traffic Awareness Beacon System (TABS) is intended for voluntary equipage on aircraft exempted from carrying Automatic Dependent Surveillance - Broadcast (ADS-B) equipment, such as gliders, balloons and aircraft without electrical systems. TABS GPS devices do not meet the ADS-B requirements defined in 14 CFR § 91.227 or AMC 20-24.

UC103 is a TSO-C166b and TSO-C112e compliant ADS-B transmitter. When connected to an appropriate TSO-C199 Class B GPS position source, all transmitted ADS-B data complies with section A1.2.5 of TSO-C199.

UC100 is a TABS device, compliant with TSO-C199. When connected to an appropriate TSO-C199 Class B GPS position source, all transmitted ADS-B data complies with section A1.2.5 of TSO-C199.

Table 10 below is a list of compatible TABS-compliant GPS source.

Table 10. GPS products for TABS (TSO-C199) compliant system

TSO	Class	Manfr	Manfr PN	MOPS	Price	Interface	Rate
TSO-C199	Class B	Accord Technology / Aspen	NexNav Micro-i	TSO-C199	$800	??	1 Hz or 4 Hz

8.4 Altitude Input

The unit does not support a Gillham (gray code) input.

Barometric altitude must be provided via one of the RS-232 serial ports.

8.5 RF Suppression Bi-Directional Bus

The mutual suppression input/output is used to provide suppression of L-band equipment on the aircraft.

The transponder uses the signal as an input to inhibit all transmission activities and decoding of receiver signals when other equipment on the aircraft is transmitting. When the transponder transmits, it asserts the output to provide the suppression to other systems on the airplane.

The duration of the asserted output is variable (20 µs min / 130 µs max), depending if the transmission is Mode A/C (28 µs typical), Mode S short (67 µs typical), or Mode S long / 1090ES (123 µs typical). Per DO-181E § 2.2.11(b), the suppression output signal shall precede the transponder RF transmission by no more than 10 µs, and return to the inactive state no later than 10 µs after transmission. Furthermore, per DO-181E § 2.2.11(a), the UC10x will regain sensitivity, within 3dB, not later than 15 µs after the end of the applied mutual suppression pulse.

The physical implementation (the “PHY” layer) of the RF suppression bus is proprietary (e.g. does not conform with standards such as ARINC 735B Attachment 8).

The RF suppression output is open drain, driven by an N-channel MOSFET with an internal 1kΩ pullup to 3.3V.

When used as an input, the RF suppression bus is designed to operate directly with external devices capable of driving 3.3V TTL and CMOS logic standards. Alternatively, the interface also works with devices capable of an open collector output drive. In all cases, the external interface must be capable of sinking up to 5 mA.

Regardless of input/output state, the RF suppression connection is ESD and transient voltage protected, tolerant to operate with voltages up to 5V max. The latency of the RF suppression bus, both input/output, is maximum 1 µs.

8.6 Automatic Air/Ground Determination

The unit is designed to interface with an automatic weight-on-wheels (WOW) sensor, also known as a squat switch, which is a device that automatically provides On Ground / In Air status, through this single pin. Connection of a WOW switch is optional, for aircraft that do not have a WOW sensor, squat switch detection can be disabled via either serial port.

8.7 Antenna Port

UC10x has an SMA female antenna connector. UC10x system does not include an antenna or antenna cable. See 11.4 Antenna for antenna and antenna cable guidance.

9 Supported Registers and Parameters

9.1 Mode S

9.1.1 Uplink Formats (UF)

Table 11 below summarizes UF (interrogations), that the Mode S transponder can receive wirelessly.

Table 11. Mode S Uplink Formats (UF) Supported

UF	Description	Interrogation Length	Level	DO-181E
0	Short Special Surveillance	56 bits	Level 1	§ 2.2.18
4	Surveillance, Altitude Request	56 bits	Level 1	§ 2.2.18
5	Surveillance, Identity Request	56 bits	Level 1	§ 2.2.18
11	Mode S-Only All-Call	56 bits	Level 1	§ 2.2.18
20	Comm-A, Altitude Request	112 bits	Level 2	§ 2.2.19
21	Comm-A, Identity Request	112 bits	Level 2	§ 2.2.19

9.1.2 Downlink Formats (DF)

Table 12 below summarizes the Downlink Formats (DF) that the Mode S transponder can transmit wirelessly.

Table 12. Mode S Downlink Formats (DF) Supported

DF	Description	Reply Length	Level	DO-181E
0	Short Special Surveillance	56 bits	Level 1	§ 2.2.18
4	Surveillance, Altitude Reply	56 bits	Level 1	§ 2.2.18
5	Surveillance, Identity Reply	56 bits	Level 1	§ 2.2.18
11	All-Call Reply	56 bits	Level 1	§ 2.2.18
17	Extended Squitter	112 bits	Level 2	§ 2.2.19
20	Comm-B, Altitude	112 bits	Level 2	§ 2.2.19
21	Comm-B, Identity	112 bits	Level 2	§ 2.2.19

All the messages in Table 12 are transmitted in response to an interrogation defined in Table 11, except for Extended Squitter (DF=17), which is transmitted unsolicited.

9.1.3 BDS Registers

Table 13. Mode S BDS Registers Supported

Register	Assignment	Category	Max Update Interval[29]
10_{16}	Data Link Capability Report	Level 1	4.0 s
17_{16}	Common Usage GICB Capability Report	Level 1	5.0 s
18_{16} – $1C_{16}$	Mode S Specific Services GICB Capability Report	Level 1	5.0 s
20_{16}	Flight ID	Level 2	5.0 s
21_{16}	Aircraft Registration	Level 2	15.0 s

[29] Maximum update interval per RTCA/DO-181E Table B-2-1

9.1.4 Parameters

Table 14. Mode S Fields/Parameters Supported

Field	Description	Length (bits)	UF						DF							Content	Protocol
			0	4	5	11	20	21	0	4	5	11	17	20	21		
AP	Address/Parity	24	X	X	X	X	X	X	X	X	X			X	X	2.2.14.4.4	2.2.18.2.1 2.2.18.2.2
UF	Uplink Format	5	X	X	X	X	X	X								2.2.14.4.40	N/A
RL	Reply Length	1	X													2.2.14.4.34	2.2.19.1.4
AQ	Acquisition Special	1	X													2.2.14.4.5	2.2.18.2.6
DS	Comm-B Data Selector	8	X													2.2.14.4.14	2.2.19.1.18
PC	Protocol	3		X	X		X	X								2.2.14.4.29	2.2.18.2.4 2.2.19.1.12
RR	Reply Request	5		X	X		X	X								2.2.14.4.35	2.2.19.1.12.2 2.2.19.1.12.4 2.2.19.1.13
DI	Designator Identification	3		X	X		X	X								2.2.14.4.11	2.2.18.2.5 2.2.19.2.1.1 2.2.19.1.12
SD	Special Designator (SD), and IIS Subfield in SD[30]	16		X	X		X	X								2.2.14.4.36	2.2.19.1.12.2 2.2.19.2
PR	Probability of Reply	4				X										2.2.14.4.31	2.2.18.2.2.i
IC	Interrogator Code	4				X										2.2.14.4.16	2.2.14.4.16
CL	Code Label	3				X										2.2.14.4.9	2.2.14.4.9
MA	Message, Comm-A	56					X	X								2.2.14.4.20	2.2.19.1.10
DF	Downlink Format	5							X	X	X	X	X	X	X	2.2.14.4.10	2.2.18.2.3 2.2.19.1.4
PI	Parity/Interrogator Identity	24										X	X			2.2.14.4.30	2.2.18.2.1
VS	Vertical Status	1							X							2.2.14.4.42	2.2.18.2.10
CC	Crosslink Capability	1							X							2.2.14.4.7	2.2.14.4.7
SL	TCAS Sensitivity Level Report	3							X							2.2.14.4.40	N/A
RI	Reply Information, Air-To-Air	4							X							2.2.14.4.33	2.2.18.2.10
AC	Altitude Code	13							X	X				X		2.2.14.4.2	2.2.18.2.10
FS	Flight Status	3								X	X			X	X	2.2.14.4.15	2.2.18.2.7
DR	Downlink Request	5								X	X			X	X	2.2.14.4.13	2.2.20.2.1.1.1 2.2.19.1.12.4
UM	Utility Message[30]	6								X	X			X	X	2.2.14.4.40	None given
ID	Identification (4096 code)	13									X				X	2.2.14.4.17	2.2.18.2.10
CA	Transponder Capability	3										X	X			2.2.14.4.6	2.2.18.2.8
AA	Address, Announced	24										X	X			2.2.14.4.1	2.2.18.2.10
ME	Message, Extended Squitter[30]	56											X			2.2.14.4.24	2.2.14.4.24
MB	Comm-B and BDS B-Definition Subfield[30]	56												X	X	2.2.14.4.21	2.2.19.1.12 2.2.22.1.2.3
	TOTAL BITS	**56**	**56**	**56**	**56**	**56**	**112**	**112**	**56**	**56**	**56**	**56**	**112**	**112**	**112**		

9.2 ADS-B

9.2.1 BDS Registers

Table 15. ADS-B BDS Registers Supported[31]

Register	Assignment	Category	Max Update Interval[29]
05_{16}	Extended Squitter Airborne Position	ADS-B	0.2 s
06_{16}	Extended Squitter Surface Position	ADS-B	0.2 s
08_{16}	Extended Squitter Identification & Category	ADS-B	15.0 s
09_{16}	Extended Squitter Airborne Velocity	ADS-B	1.3 s
61_{16}	Emergency / Priority Status	ADS-B	1.0 s
65_{16}	Aircraft Operational Status	ADS-B	2.5 s

9.2.2 Parameters

Table 16. ADS-B Parameters Supported[32] [31]

Parameter		BDS Register
SPI		05_{16}
Emergency Indicator		05_{16}
Barometric Altitude		05_{16}
Quality Indicator (NIC)		05_{16}
Airborne Position	Latitude	05_{16}
	Longitude	05_{16}
Quality Indicator (NIC)		06_{16}
Surface Position	Latitude	06_{16}
	Longitude	06_{16}
Surface Ground Speed		06_{16}
Surface Ground Track		06_{16}
Aircraft Identification		08_{16}
Airborne Ground Velocity		09_{16}
Geometric to Barometric Altitude Difference		09_{16}
Geometric Vertical Rate		09_{16}
Squawk Code		61_{16}
Emergency Status		61_{16}
Quality Indicator (NACP)		65_{16}
Quality Indicator (NACV)		65_{16}
Quality Indicator (SIL)		65_{16}
Version Indicator		65_{16}
Surface Length/Width		65_{16}
Surface Antenna Offset		65_{16}

[30] Subfield(s) omitted for brevity. See DO-181E Figure 2-7 for additional information on subfields.
[31] UC100 & UC103 use DF=17 and UC102 uses DF=18 for this same ADS-B data
[32] When connected to appropriate GPS/GNSS receiver

9.2.3 Time Mark

UC10x does not accept the Time Mark[33] from the GPS/GNSS, thus the "Time" (T) subfield is always set to "0".

9.2.4 Uncompensated Latency

Uncompensated latency due to the transponder is less than 10 milliseconds. Analysis of the system latency should add this to the latency of the GPS system and the transmission time of the position data from the GPS to the transponder to determine overall latency.

RTCA/DO-260B Appendix U provides a great description of the total and uncompensated latency in 1090ES ADS-B.

[33] Time Mark refers to the 0.2 second UTC epochs

10 Electrical Connections

UC10x have two electrical connectors: an SMA connector for the antenna connection, and a low-profile 17-position interface connector for power and communication. Power connections, voltage requirements and circuit breakers requirements are shown on the interconnect diagrams. (Figure 12, Figure 13 and Table 17)

When cables are installed in the aircraft, they must be supported firmly enough to prevent movement and should be carefully protected against chaffing. Additional protection should also be provided in all locations where the cable may be subjected to abuse. In wire bundles, the cabling should not be tied tightly together as this tends to increase the possibility of noise pickup and similar interference. When routing cables through the aircraft the cables should cross other RF lines at right angles.

Prior to installing any equipment, make a continuity check of all wires and cables associated with the system. Then apply power and check for proper voltages at system connectors, and then remove power before completing the installation.

1. The installing facility will supply and fabricate all external cables. The required connectors are supplied as part of the installation kit
2. The length and routing of the external cables must be carefully planned before attempting the actual installation. Avoid sharp bends or locating the cable near aircraft control cables. When possible, the cables should be of a length to allow for a “maintenance loop”. That is, the length should be adequate to access and extend the connectors aft of the panel for future maintenance purposes. Excess cabling should be secured and stowed by tie-wrapping until such maintenance is required.
3. The cables should be supported firmly enough to prevent movement. They should be carefully protected wherever one may chafe against another or against some other object. Extra protection should be provided in all locations where the cables may be subject to abuse. Shields on shielded wires should be grounded as shown on the system interconnection diagrams.
4. Shields should be carried through any obstruction via a thru-bulkhead connector. If shielding cannot be carried through by use of a bulkhead/connector pin, precautions should be taken to ensure each segment of the shielded lead be grounded at only one point. A ground connection of not more than two inches in length should be used. The preceding discussion does not apply to coaxial cable.
5. Avoid cabling near high noise and high-power sources.

Note:

The total losses in the coaxial cable run and interconnects between the antenna and the transponder must not be less than 0 dB and must not be more than 1.5 dB over the range of 1030-1090 MHz

10.1 Power / Data Connector Pinout & Descriptions

The right-angle PCB-mount connector on the transponder is Hirose DH60-17P. The mating connector for the cable is DH30B-17S (IDC crimp) or DH40-17S (solder cup). Figure 12 shows the connector pinout as viewed looking into the transponder, and Figure 13 shows the pinout as viewed into the cable.

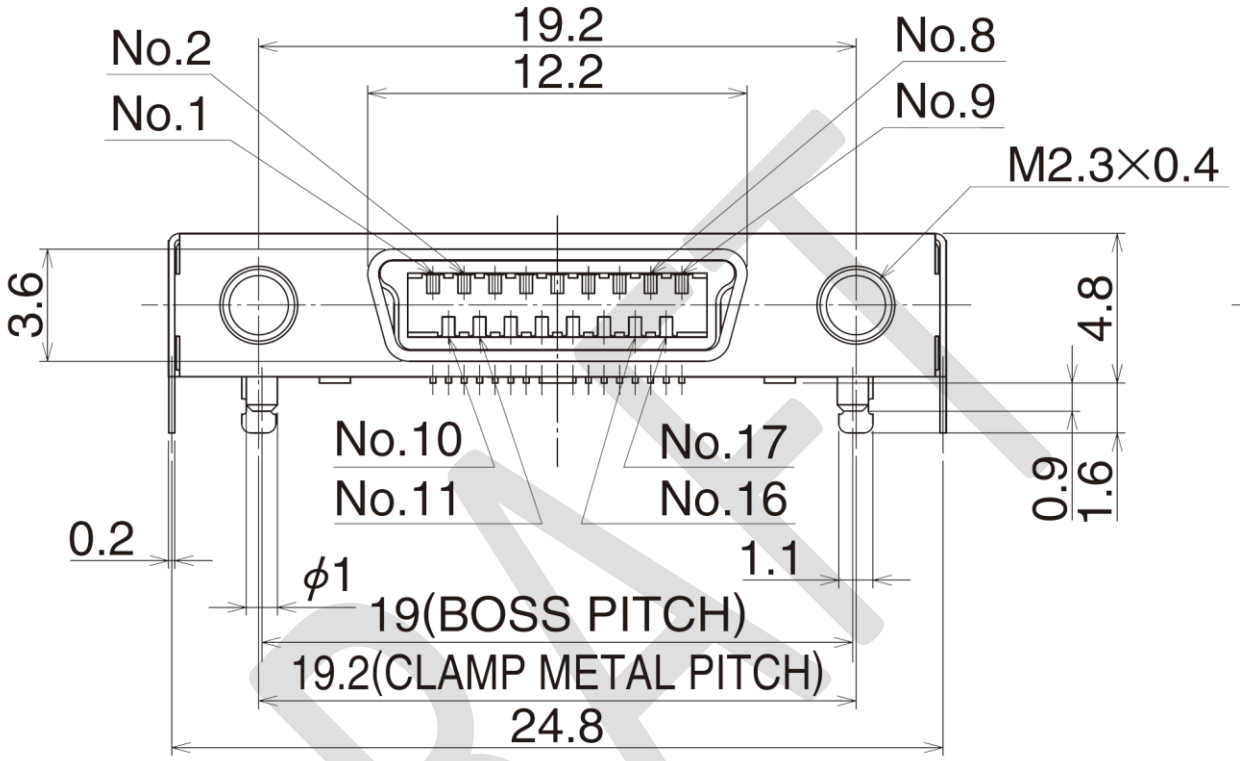

Figure 12. Connector Pinout (as viewed into transponder)

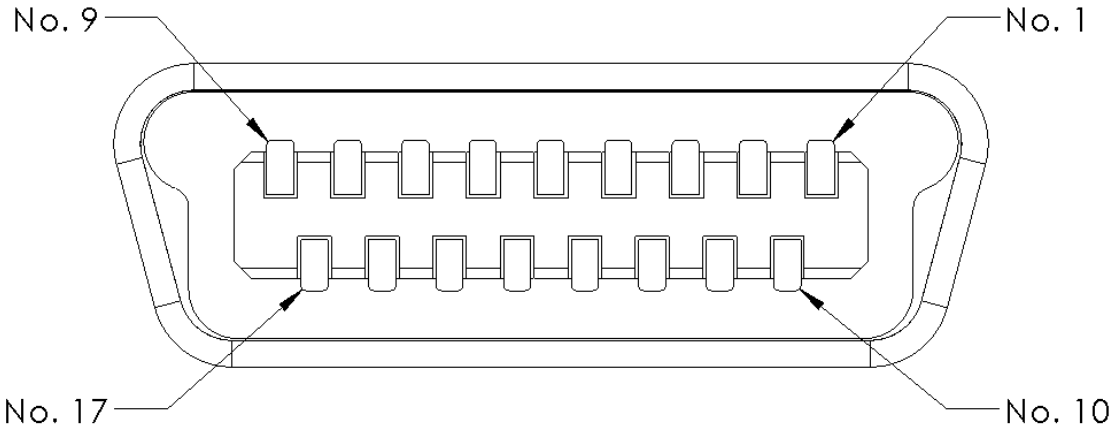

Figure 13. Connector Pinout (as viewed into the cable)

Table 17. Interface Pinout

Pin#	Description	Dir	Type	Level	Notes	If Not Used
1	VIN	I	PWR	10 - 38 VDC	Power Input	Must be implemented
2	GND	I	GND	0 VDC	Power Return	Must be implemented
3	RSVD	DNC	-	-	Reserved for future use	No connection
4	RSVD	DNC	-	-	Reserved for future use	No connection
5	SUPPRESS	I/O	Open Drain[36]	LVTTL	Drive with open drain	No connection
6	RSVD	DNC	-	-	Reserved for future use	No connection
7	RSVD	DNC	-	-	Reserved for future use	No connection
8	TXD1	O	RS-232	TIA-232-F[34]	57.6 kbps 8N1	Must be implemented[35]
9	TXD0	O	RS-232	TIA-232-F[34]	57.6 kbps 8N1	Must be implemented[35]
10	VIN	I	PWR	10 - 38 VDC	Power Input	Must be implemented
11	GND	I	GND	0 VDC	Power Return	Must be implemented
12	RSVD	DNC	-	-	Reserved for future use	No connection
13	RSVD	DNC	-	-	Reserved for future use	No connection
14	SQUAT	I	Open Drain[36]	LVTTL	Drive with open drain	No connection
15	PWR_DOWN	I	Open Drain[37]	TTL	0: normal; 1: power down	No connection
16	RXD1	I	RS-232	TIA-232-F[34]	57.6 kbps 8N1	Must be implemented[35]
17	RXD0	I	RS-232	TIA-232-F[34]	57.6 kbps 8N1	Must be implemented[35]

Table 18. Key for Pinout Table

Dir	Explanation
I	Input to transponder
O	Output from transponder
I/O	Logical bi-directional input/output
DNC	Do not connect

Type	Explanation
PWR	Input power to device
GND	Ground
Open Drain	Drive with open drain/collector
RS-232	Communications to/from device

Level	Explanation
LVTTL	Low-voltage (3.3V) transistor-transistor logic
TTL	5V Transistor-transistor logic (compatible with LVTTL)
TIA-232-F	Telecommunications Industry Association (TIA) defining RS-232

[34] Designed to meet EIA/TIA-232 and V.28/V.24 Specifications. Note that if a given output is unused, the RS232 Converter IC will automatically disable, and read 0V (instead of the RS-232 idle line negative voltage). THIS IS NORMAL. The RS-232 output will automatically re-enable once its input is connected.

[35] At least one set of RS-232 must be connected (TXD0/RXD0 OR TXD1/RXD1), the other should be left floating if unused to minimize power consumption. Port 0 and Port 1 are identical and can be used interchangeably.

[36] Pullup resistor to 3.3V

[37] Pulldown resistor to GND

10.2 Basic Interconnect Diagram – With Options

Figure 14 below provides an example installation with all options shown.

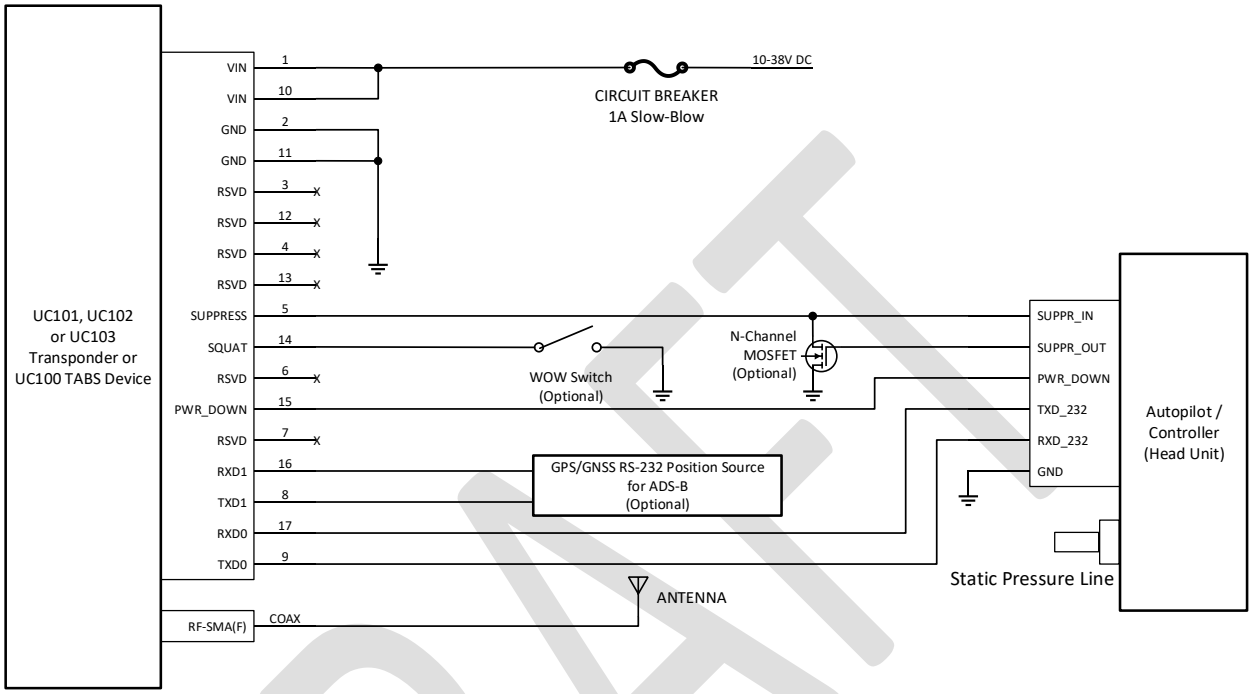

Figure 14. UC10x Basic System-Level Interconnect Diagram (with options)

Notes on Figure 14:

- Port 0 (RXD0/TXD0) and Port 1 (RXD1/TXD1) are interchangeable
- 1A circuit breaker is appropriate over the entire operating voltage range. For operation at higher voltages (e.g. 28V), 500mA slow-blow may be preferred.
- Functions /external hardware provided in customer circuit: controller, GPS, antenna, antenna cable, altitude encoder, Weight-on-Wheels (WOW) switch, suppress interface, circuit breaker

10.3 Basic Interconnect Diagram – Minimum Connections

The minimum connections are the antenna, power, ground, and one set of RS-232 communication lines. Be sure to connect two pins for power, and two for ground. An example of the minimum connections shown in Figure 15 below.

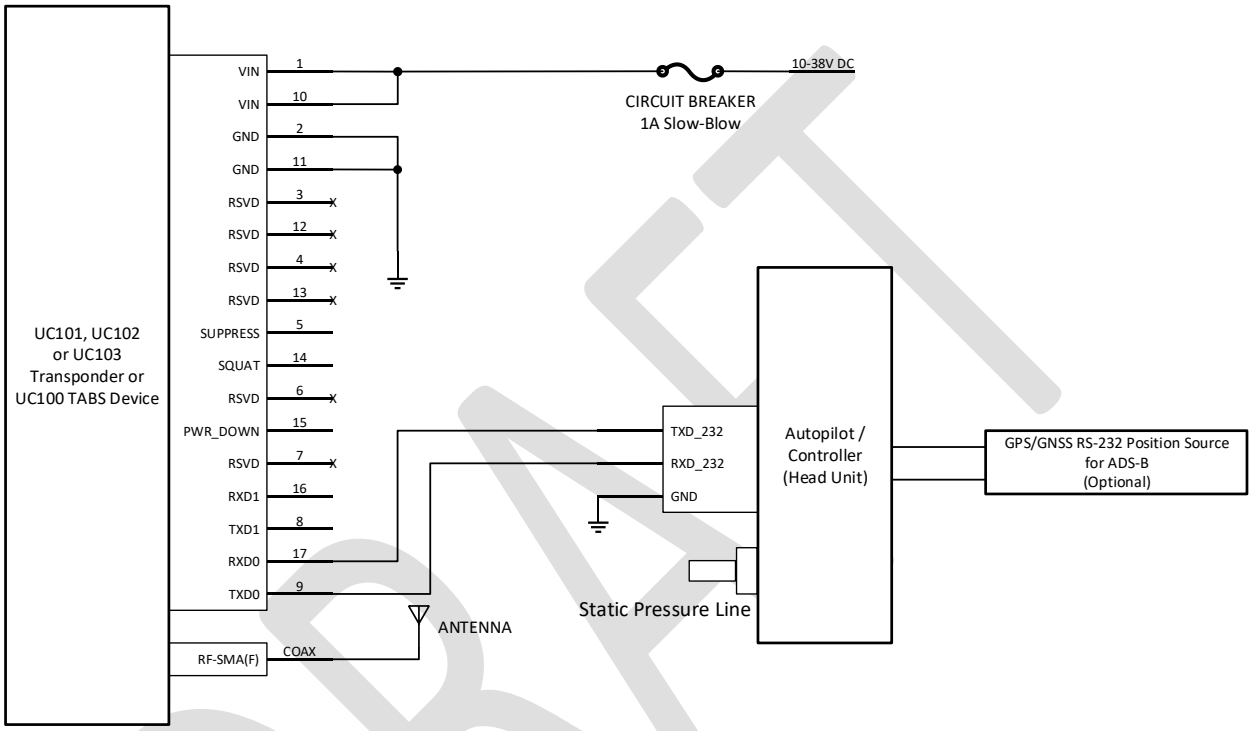

Figure 15. UC10x Basic System-Level Interconnect Diagram (minimum connections)

Notes on Figure 15:

- Port 0 (RXD0/TXD0) and Port 1 (RXD1/TXD1) are interchangeable
- 1A circuit breaker is appropriate over the entire operating voltage range. For operation at higher voltages (e.g. 28V), 500mA slow-blow may be preferred.
- Functions /external hardware provided in customer circuit: controller, GPS, antenna, antenna cable, altitude encoder, circuit breaker

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11 Equipment Installation

11.1 General

The equipment should be installed in the aircraft in a manner consistent with acceptable workmanship and engineering practices and in accordance with the instruction set forth in this publication. To ensure that the system has been properly and safely installed in the aircraft, the installer should make a through visual inspection and conduct an overall operation check of the system on the ground prior to flight.

> **Caution**:
>
> After installation of cabling and before installation of the equipment, a check should be made with the aircraft primary power supplied to the mounting connector to ensure that power is applied only to the pins specified in the interconnection drawings.

The TSO identifies the minimum performance standards, tests, and other conditions applicable for issuance of design and production approval of the article. The TSO applicant is responsible for documenting all limitations and conditions suitable for installation of the article. An applicant requesting approval for installation of the article within a specific type or class of product is responsible for determining environmental and functional compatibility.

11.2 Unit and Accessories Supplied

11.2.1 UC100 Traffic Awareness Beacon System (TABS)

Unit Description	Qty.	Model Number
Traffic Awareness Beacon (TABS)	1	UC100
Interface Cable	1	UC10x-CBL-XXX
RF Cable	1	UC10x-CBL-XXX
Mounting Kit	1	UC10x-HDW-XXX

11.2.2 UC101 Mode C Transponder

Unit Description	Qty.	Model Number
Mode C Transponder	1	UC101
Interface Cable	1	UC10x-CBL-XXX
RF Cable	1	UC10x-CBL-XXX
Mounting Kit	1	UC10x-HDW-XXX

11.2.3 UC102 Mode C Transponder with ADS-B Out

Unit Description	Qty.	Model Number
Mode C Transponder w/ ADS-B Out	1	UC102
Interface Cable	1	UC10x-CBL-XXX
RF Cable	1	UC10x-CBL-XXX
Mounting Kit	1	UC10x-HDW-XXX

11.2.4 UC103 Mode S Transponder with ADS-B Out

Unit Description	Qty.	Model Number
Mode S Transponder w/ ADS-B Out	1	UC103
Interface Cable	1	UC10x-CBL-XXX
RF Cable	1	UC10x-CBL-XXX
Mounting Kit	1	UC10x-HDW-XXX

11.3 UC10x Installation

11.3.1 Avionics Cooling Requirements

The greatest single contributor to increased reliability of all modern-day avionics is to limit the maximum operating temperature. While modern day individual circuit designs consume much less electrical energy, the watts per cubic inch dissipated within avionics units remains much the same because of high density packaging techniques utilized. Consequently, the importance of providing avionics stack cooling is essential to the life span of the equipment.

11.3.2 Installation Location

The transponder is to be fitted in a suitable place on the aircraft. This is usually the avionics compartment. The mounting place shall be at least 30 cm from the magnetic aircraft compass, to avoid any interference to the magnetic compass by the transponder. For installation in a more severe electromagnetic environment use shielded cable connectors and a common shielding for the transponder wiring. Select a position that is not too close to any high external heat source. The transponder itself is not a significant heat source and does not need to be kept away from other devices for this reason.

11.3.3 Mounting Hole Pattern

Mounting fasteners (when provided) are included for convenience and may not be suitable for all installations. You should reference individual equipment chapters for information regarding installation instructions.

The appropriate mounting pattern hole size and spacing will vary depending upon mounting plate/surface material and method of drill (machine or hand). The pattern below will be appropriate for most installations, which uses a 0.101" hole (ANSI drill size 38)[38]. Some customers may need to increase the hole size to 0.104" (ANSI drill size 37)[39] or 0.110" (ANSI drill size 35)[40], depending on the tolerance of the machine (or person) performing the drill operation.

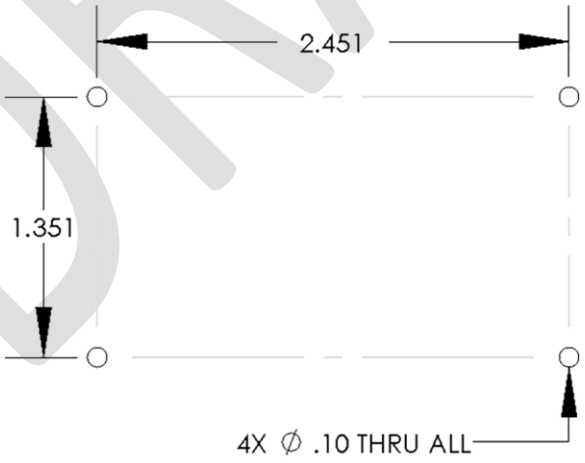

Figure 16. Mounting Hole Pattern Drawing (SCALE 1:1)

[38] Approximate metric equivalent for ANSI drill size 38 (0.101") is ISO 2.6mm drill size
[39] Approximate metric equivalent for ANSI drill size 37 (0.104") is ISO 2.7mm drill size
[40] Approximate metric equivalent for ANSI drill size 35 (0.110") is ISO 2.8mm drill size

11.4 Antenna & Antenna Cable Installation

11.4.1 Disclaimer

This subsection contains guidance on antenna and antenna cable requirements, advice on product selection, troubleshooting, and recommended best practices for installation. UCF does not sell antennas or antenna cables. This section provides general guidance on the antenna and cable. If this information conflicts with the antenna/cable manufacturer's instructions, the antenna/cable manufacturer's instructions should supersede information contained herein.

WARNING: The installer shall be responsible for ensuring that the proper antenna is employed so that the antenna requirements of 47 CFR 15.203 and TSO-C112E (RTCA/DO-181E §2.215) or TSO-C74d (RTCA/DO-144A §2.2.11) or TSO-C66c (RTCA/DO-189 §2.2.17), as applicable, are met and limits of 47 CFR 87.131 are not exceeded.

11.4.2 Antenna Requirements (Simplified)

A transponder antenna approved to TSO-C112e , TSO-C74d, or TSO-C66c[41] (or previous versions), that has been installed to meet the requirements of the installation manual may be approved for use with the UC10x.

For specific technical requirements for the antenna can be found in TSO-C74d (RTCA/DO-181E §2.2.15) (UC100, UC103) or TSO-C112e (RTCA/DO-144A §2.2.11) (UC101, UC102) or TSO-C66c (RTCA/DO-189 §2.2.17). The antenna requirements contained in the TSO and associated MOPS are equivalent for all intents and purposes, and can be used interchangeably. Table 19 provides a simplified summary of antenna requirements.

Table 19. Simplified Interpretation of MOPS Antenna Requirements

Description	Type	Min Gain	Max Gain	Freq	Z_0	VSWR	Ground
TSO Antenna	λ/4 Monopole[42]	2.19 dBi	5.19 dBi	1030-1090MHz	50Ω	1.5 max	4’ dia.

WARNING: It is the responsibility of the end user to know the regulatory requirements for their application / use case. This is an oversimplified interpretation intended to facilitate understanding of the antenna requirements. There are other antenna types that could meet all requirements. There may also be antennas that fall within the description above that do not meet all requirements. See regulations pertinent to your use case (MOPS, TSO, etc.) for details and to make your own determination.

[41] TSO-C66c is the TSO for distance measuring equipment (DME), which uses the same frequency band, and thus the same antenna, as transponders

[42] Transponder MOPS do not explicitly state monopole, but extrapolating from the required minimum vertical beamwidth (25°), horizontal beamwidth (360°), and ground plane size (4’ Ø), is an ideal monopole.

11.4.3 Antenna Cable Design / Selection

UC10x system does not include an antenna.

The UC10x family is designed to meet high power (unrestricted altitude) requirements with an allowance of 0 dB min (UC10x directly connected to antenna) to 1.5 dB maximum insertion loss in the connectors and cables used to connect it to the antenna. Excessive loss will degrade both transmitter output power and receiver sensitivity.

An acceptable cable:

- Has power rating of 3W average at 1GHz minimum (10+ W preferred)
- Has voltage rating of 300 VRMS minimum (1,000+ VRMS preferred)
- Has less than 1.5 dB loss for the required cable run length (1 dB preferred)
- Has a characteristic impedance (Z_0) of 50 Ω ± 5 Ω
- Has double-braided screens consisting of a combination foil and braid screen
- For installations that require frequent disassembly/reassembly, select connectors rated for number of mating cycles
- Uses an SMA male on one end (for the UC10x), and mates with the antenna on the other (depends on antenna selected)

Once the cable run length is known, a cable type with low enough loss per meter that meets the above requirements can be chosen. Longer runs require lower loss (usually physically thicker) cable. Consider moving the transponder closer to the antenna to minimize the losses in the antenna cable – subject to the limits identified above, the transponder can be at any distance from the control head without affecting performance in any way.

Table 20 below is a guide to the maximum usable lengths for various common cable types. This table uses typical cable loss data to calculate maximum cable length assuming 1.5dB cable loss. Actual cable loss will vary between manufacturer and may change after use (e.g. due to repeated cable bending) and should always be verified through measurement by the end user / installer.

Table 20. Example maximum cable length by cable type

Type	Jacket Dia.	Insertion Loss (dB/ft)	Max Cable Length (ft)	Insertion Loss (dB/m)	Max Cable Length (m)
RG58-TPX	0.190" [4.83mm]	0.58	**2.6**	1.90	**0.8**
RG178B/U	0.072" [1.83mm]	0.44	**3.4**	1.46	**1.0**
PE-047SR	0.047" [1.19mm]	0.40	**3.8**	1.31	**1.1**
RG316/U	0.098" [2.49mm]	0.38	**3.9**	1.25	**1.2**
RG316-DS	0.114" [2.90mm]	0.26	**5.7**	0.86	**1.8**
RG58C/U	0.195" [4.95mm]	0.20	**7.5**	0.66	**2.3**
RG58-P	0.159" [4.04mm]	0.17	**8.7**	0.57	**2.6**
RG8X	0.242" [6.15mm]	0.14	**11.1**	0.44	**3.4**
RG141A/U	0.190" [4.83mm]	0.13	**11.5**	0.43	**3.5**
RG213/U	0.405" [10.29mm]	0.08	**18.8**	0.26	**5.7**
RG218/U	0.870" [22.1mm]	0.04	**39.5**	0.12	**12.0**

WARNING: The cable losses / and calculated cable lengths in Table 20 are representative of typical values, and do not include connector losses. Use this table as a maximum cable length for a given cable type for cable design / product selection. The installer should verify cable loss is acceptable through measurement (e.g. using a network analyzer[43])

11.4.4 Antenna Installation Considerations

The antenna should be installed according to the manufacturer's instructions. The following considerations should be taken into account when determining appropriate installation location for the antenna.

- The antenna should be well removed from any projections, engine(s) and propeller(s). It should also be well removed from landing gear doors, access doors or other openings which will break the ground plane for the antenna.
- The antenna should be mounted on the bottom surface of the aircraft and in a vertical position when the aircraft is in level flight.
- Where practical, plan the antenna location to keep the cable lengths as short as possible and avoid sharp bends in the cable to minimize the VSWR.

Electrical connection to the antenna should be protected to avoid loss of efficiency as a result of the presence of liquids or moisture. All antenna feeders shall be installed in such a way that a minimum of RF energy is radiated inside the aircraft.

11.4.5 Antenna Cable Routing

When routing the cable, ensure that you:

- Route the cable away from source of heat.
- Route the cable away from potential interference sources such as ignition wiring, 400 Hz generators, fluorescent lighting and electric motors.
- Keep the run as short as possible
- Avoid routing the cable around tight bends.
- Avoid kinking the cable even temporarily.
- Secure the cable so that it cannot interfere with other systems.

11.4.6 Antenna Ground Plane

When a conventional aircraft monopole antenna is used it relies on a ground plane for correct behavior. For ideal performance, the ground plane should be large compared to the wavelength of the transmission, which is 275mm. In a metal-skinned aircraft this is usually easy to accomplish, but is more difficult in a composite or fabric skinned aircraft. In these cases, a metallic ground plane should be fabricated and fitted under the antenna.

The ground plane should be as large as practical. Because it is a function of the wavelength of the transmission, the smallest practical ground plane for a transponder is a square around 120mm per side; as the size increases the

[43] One example of an inexpensive network analyzer for cable loss measurement: Hewlett Packard (Keysight) 8753D

performance improves until the ground plane is around 700 mm on each side. Anything much larger than that size is unlikely to show significant further improvement.

The thickness of the material used to construct the ground plane is not critical, providing it is sufficiently conductive. A variety of proprietary mesh and grid solutions are available. For example, heavyweight cooking foil meets the technical requirements, but obviously needs to be properly supported.

For designs that wish to meet requirements of TSO, a ground plane with 4 ft. (1.2 meter) diameter should be used.

11.4.7 Interference Troubleshooting

Aircraft with composite skin can be susceptible to emissions from the transponder antenna coupling to and reradiating from interconnecting cables and electrically conductive materials in close proximity to the antenna. This issue can be exacerbated with an undersized antenna ground plane due to increased backwards radiation. One component primarily prone to coupling with antenna emissions is the outer shield surface of the antenna coaxial cable. When this coupling occurs, the antenna cable serves as an antenna, radiating to other components within the aircraft. To help mitigate this issue, a ferrite bead can be clamped over the antenna cable and installed as close to the antenna end of the cable as practical. For longer cable runs, additional ferrite beads spaced at intervals of approximately a quarter wavelength at 1090 MHz maybe required. A hinged ferrite is convenient for field troubleshooting, though a solid cylindrical ferrite is more mechanically robust. These can be purchased at Digi-Key or other suppliers. Figure 17 below shows examples of various ferrite types.

Figure 17. Example over-the-cable ferrite beads to troubleshoot “reradiating” issue

12 Installation Setup and Test

12.1.1 Overview

This section provides an overview of information required to configure a unit at time of install. These functions should be provided by head unit (display) manufacturer for manned aircraft installations, or through a GUI for unmanned installations. For details, see ICD.

12.1.2 VFR Flight ID

The default Flight ID for an aircraft not on an IFR flight plan should be the aircraft registration.

12.1.3 Aircraft Address Programming

The Mode S Address is a 24-bit number issued to the aircraft by the registration authority for the aircraft. These addresses are usually written as a 6-digit hexadecimal number, although you may also encounter one written as an 8-digit octal number.

12.1.4 VFR Squawk Code

When the pilot presses the VFR button, a pre-programmed code will replace the current squawk code. The pre-programmed code is set up here; the choice of code will depend on the normal location of the aircraft. In the USA, the VFR squawk code is 1200. In most parts of Europe, the VFR squawk code should be set to 7000.

NOTE: default VFR Squawk Code is not implemented directly on the transponder. This should be implemented in the head unit or GUI, for convenience to the pilot, but is not required.

12.1.5 Airspeed Category

Mode S transponders can transmit their maximum airspeed characteristics to aircraft equipped with TCAS. This information is used to help identify threats and to plan avoiding action by the TCAS equipped aircraft.

12.1.6 Aircraft Category

To assist ATC tracking of aircraft, an aircraft category can be transmitted by Mode S transponders. Select the aircraft category that most closely matches the aircraft the transponder is installed in. If the transponder is fitted to a vehicle rather than an aircraft, select “Surface Vehicle”.

12.1.7 GPS Input

If a GPS is connected for ADS-B position reporting, select the appropriate interface protocol.

12.1.8 GPS Certification Level

An important metric for ADS-B ground system behavior is the System Design Assurance (SDA) level. It is intended to reflect the probability that the GPS position source is providing erroneous information, and is based on the certification standard that was used by the GPS vendor. This will be indicated in the form of a letter code (A to D) on the data plate or installation documentation for the GPS in accordance with the standards DO-178B and DO-254, for example “DO-178B level C”. If both standards are reported but at different levels, use the standard with the lower SDA level. Standards (or SDA levels) descend in reverse alphabetical order.

12.1.9 GPS NAC velocity

Another metric that the ADS-B ground system uses to help it track the aircraft is NACv. NACv is the Navigational Accuracy Category for velocity, and is a design feature of the GPS receiver. It represents the error bound for velocity that the GPS may report in acceleration/deceleration or turning maneuvers. You can find this information from your GPS installation manual.

12.1.10 Aircraft Length and Width

On the ground, ADS-B transmits encoded aircraft size information which is used by ATC to identify taxiing routes and potential conflicts. When configured for ADS-B, the UC10x will require aircraft length and width (wingspan) information, in meters, for proper configuration.

12.1.11 GPS Antenna Offset

The GPS antenna offset is used together with the aircraft length and width to manage taxiway conflicts. A typical GPS installation does not report the geographic position of the center of the aircraft, or even the tip of the nose of the aircraft; instead it usually reports the location of the actual GPS antenna (not the GPS receiver). During normal flight operations, this distinction is of no practical importance at all, but if ADS-B is used to manage taxiway conflicts, a significant offset in antenna position could mean that the aircraft is not in the same place as the ADS-B reported position. Although primarily intended for position correction on large transport aircraft, General Aviation aircraft can also have a significant offset. For example, if the aircraft has a long tail boom and the GPS antenna is on the top of the tail, the GPS position could be 4 meters or more from the nose of the aircraft. Enter the position of the GPS antenna relative to the nose of the aircraft. The position is stored and transmitted to the nearest 2 meters; great accuracy in measurement is not required.

12.1.12 1090 MHz Receiver Installed

The ADS-B transmissions include an indication to the ground stations of whether your aircraft includes a 1090 MHz ADS-B receiver. This is then used by ground stations to manage the RF spectrum for uplink of traffic data. If you have a 1090 MHz ADS-B receiver installed, be sure to indicate it so that you receive appropriate traffic data.

12.1.13 UAT Receiver Installed

The ADS-B transmissions include an indication to the ground stations of whether your aircraft includes a UAT ADS-B receiver. This can be used by the ground stations to manage the uplink of traffic, weather, pilot data, etc. If you have a UAT receiver installed, be sure to indicate it so that you receive appropriate data uplink.

12.2 Test and Calibration Items

12.2.1 Altitude Encoder Calibration

The Altitude Encoder is not provided with the UC10x. However, altitude encoder data—sourced from a static pressure sensor—must be provided.

Altitude encoder calibration is typically performed every 24 months, as part of the altimeter checks on the aircraft. Altitude encoder calibration ensures that the altitude transmitted by the transponder corresponds to the altitude seen by the pilot on the primary altimeter. The maximum allowed difference between the primary altimeter and the altitude encoder is 125 ft. (per ETSO-C88a and TSO-C88b).

The altitude encoder calibration can be performed with the ATC transponder tests and inspections defined in 14 CFR Part 43 Appendix F, which are also required every 24 months.

Note: The purpose of calibrating the encoder is to make the output correspond to the primary altimeter. In the event that the sensor used for the encoder is the same sensor used as the primary altimeter, no calibration should be necessary. Any offset required should be applied to the altitude encoder / altimeter itself, or in the autopilot (not stored in the transponder). It is always the responsibility of the installer to ensure compliance with relevant standards.

12.3 Calibration Equipment

To calibrate the encoder, you will need to be able to power up the transponder subsystem, and you will need a pitot-static test set with the appropriate adapters to connect to the static port on the aircraft. The pitot-static test set should be able to drive the altitude down to sea level, and above the service ceiling of the aircraft.

12.4 Post Installation Checkout and Operation

Post installation checks should be carried out in accordance with your certification requirements. These checks should include:

- Mode S interrogations to verify correct address programming.
- Verification of the reported altitude using a static pressure tester.
- Where installed, verification of correct squat switch ground/airborne indications. In an aircraft with a squat switch, setting the mode to ALT when the aircraft is on the ground should cause the transponder to GND mode; when the aircraft becomes airborne, the mode should switch automatically to ALT.
- Interrogations to verify the receiver sensitivity. A Mode S transponder should have a minimum triggering level (MTL) of between -77 dBm and -71 dBm. Failure to meet this requirement usually indicates antenna or coaxial cable problems.
- Interrogations to verify the transmitted power. A Class 1 installation should have no less than 125 Watts at the antenna (and no more than 500 Watts). A Class 2 installation should have no less than 71 Watts at the antenna (and no more than 500 Watts). Failure to meet this requirement is also generally due to antenna or wiring issues.
- Where installed, verification of the GPS position source and ADS-B outputs. Whenever a valid position is received by the transponder and the transponder is in any mode other than OFF, ADS-B Extended Squitters should be observed on the transponder test set.

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13 Instructions for Continued Airworthiness

13.1 Scheduled Maintenance

The UC10x series is a transponder device and must be tested and inspected every 24 months subject to the requirements of 14 CFR Part 43 Appendix F – ATC Transponder Tests and Inspections.

13.2 Service Life

The instructions for continued airworthiness given in the TC or STC approvals for this product supplements or supersedes the instructions for continued airworthiness in this manual.

Urban Canyon Flight products are designed and manufactured such that there are no periodic service requirements necessary to maintain continued airworthiness. Outside of inspections required by regulatory agencies, no maintenance is required until the equipment does not properly perform its intended function. When service is required, the unit should be returned to manufacturer for RMA.

13.3 Repairability

The UC10x is not field repairable, and must be returned to the manufacturer.

13.4 Field Firmware Updates

Field updates are not supported. The unit must be returned to the manufacturer.

13.5 ADS-B

The installed ADS-B OUT system must be shown to meet the equipment requirements of 14 CFR 91.227 or equivalent.

13.5.1 Altimetry Systems and Altitude Reporting Equipment

Altitude reporting equipment connected to the ADS-B system must comply with all applicable 14 CFR 91.217, 14 CFR 91.411, and 14 CFR Part 43 Appendix E test and inspection requirements. Refer to FAA Advisory Circular AC 43-6C. ADS-B installation (or lack thereof) does not alter these requirements.

13.5.2 Maintenance and Design Changes to Interfacing Components

The ADS-B system interfaces with multiple external components, such as position sources and altimetry sources. The installer should list all interfacing components in the instructions for continued airworthiness (ICA). It is important that any future maintenance or design changes to these interfacing components be accomplished in such a way that continued satisfactory performance of the overall ADS-B system is maintained.

13.5.2.1 Maintenance of the ADS-B System

The ADS-B system installation must include ICA that meet the typical requirements for a system installation, which includes how to accomplish a complete functional check of the system.

13.5.2.2 ADS-B Source System Components

The installer may not have access to the specific source system ICA to incorporate changes into those specific documents, the installer must do an analysis of the source systems to determine what maintenance actions on

those source systems would require a functional test of the ADS-B system to verify that the system is operating properly. In particular, those systems providing a dedicated input to the ADS-B system that cannot be verified by other means should be tested as part of the ADS-B system as a whole. Once the installer identifies those actions, they must provide recommended language for the operator to include in their ICA. If the installer determines that removal and replacement of the Global Positioning System (GPS) receiver requires a full functional check of the ADS-B system because the GPS input to the ADS-B cannot be verified by other means.

13.5.2.3 Design Changes to Interfacing Components

Ensuring continued airworthiness of the ADS-B system following upgrades of interfacing components could be problematic if the installer of the ADS-B system is unaware of design changes to interfacing components, or if the installer of the updated interfacing component is unaware of a potential impact to the ADS-B system. To avoid this problem, the ADS-B system installer must update the ICA for each interfacing system with a process that ensures continued airworthiness of the ADS-B system following design changes to the interfacing component.

14 Referenced & Important Documents

Table 21. Referenced & Important Standards & Regulatory Documents

Cat	Org	Doc. No.	Document Title	Date
Mode A/C	RTCA	DO-144A	MOPS for ATCRBS Airborne Equipment	2 Oct 2008
	FAA	TSO-C74d	ATCRBS Airborne Equipment	17 Dec 2008
	CFR	14 CFR 91.413	ATC transponder tests and inspections.	Current
	CFR	14 CFR 91.215	ATC transponder and altitude reporting equipment & use	Current
	ICAO	Annex 10, Volume IV, Fourth Edition	Surveillance and Collision Avoidance Systems[44]	Jul 2007
Mode S	RTCA	DO-181E	MOPS for ATCRBS/Mode S Airborne Equipment	17 Mar 2011
	FAA	TSO-C112e	ATCRBS/Mode S Airborne Equipment	16 Sept 2013
	RTCA	DO-260B with Corrigendum 1	MOPS for 1090ES ADS-B and TIS-B	13 Dec 2011
	ICAO	Annex 10, Volume III, Part 1, Chapter 5, Second Edition	SSR Mode S Air-Ground Data Link[45]	20 Nov 2008
ADS-B	RTCA	DO-260B with Corrigendum 1	MOPS for 1090ES ADS-B	13 Dec 2011
	FAA	TSO-C166b	Extended Squitter ADS-B and TIS-B on RF of 1090 MHz	2 Dec 2009
	FAA	None Provided	Note to Manufacturers Regarding the Use of Geometric Type Codes When In the Altitude Reporting Off Condition	5 Nov 2015
	RTCA	DO-242A	MASPS for ADS-B	25 Jun 2002
	RTCA	DO-242A Change 1	MASPS for ADS-B Change 1	13 Dec 2006
	RTCA	DO-289	MASPS for Aircraft Surveillance Applications (ASA)	09 Dec 2003
	RTCA	DO-289 Change 1	MASPS for Aircraft Surveillance Applications (ASA) Change 1	13 Dec 2006
	FAA	AC 20-165B	Airworthiness Approval of ADS-B OUT Systems	7 Dec 2015
	DOT	14 CFR Part 91	ADS-B Final Rule	28 May 2010

[44] Contains elaboration on ICAO 24-bit Address and Parity Field (AP and PI) Generation for Mode S

[45] Contains elaboration on Mode S packet creation and interpretation

Cat	Org	Doc. No.	Document Title	Date
TABS	RTCA	DO-181E	MOPS for ATCRBS/Mode S Airborne Equipment	17 Mar 2011
	FAA	TSO-C199	Traffic Awareness Beacon System (TABS)	10 Oct 2014
	FAA	None Provided	TSO-C199 TABS Public Review Comments	Current
	FAA	None Provided	Changes to the TIS-B Service Beginning Late 2015	31 Mar 2015
Altitude Encoder	SAE	AS8003	MOPS for Automatic Pressure Altitude Code-Generating Equipment	16 Feb 2008
	FAA	TSO-C88b	Automatic Pressure Altitude Reporting Code-Generating Equipment	06 Feb 2007
	ICAO	Annex 10, Volume I, Part 1, Equipment & Systems	IFF Mark X (SIF)/ATCRBS	
Altimeter	SAE	AS392c	Altimeter, Pressure Actuated Type	16 Feb 2008
	FAA	TSO-C10b	Altimeter, Pressure Actuated, Sensitive Type	01 Sept 1959
	SAE	AS8009C	Pressure Altimeter Systems	24 May 2016
	FAA	TSO-C10c	Pressure Altimeter System	31 Oct 2016
	NACA	Report 1235	Standard Atmosphere Tables to 65,800 ft.	
Alt & Enc	CFR	14 CFR 91.217	Data correspondence between automatically reported pressure altitude data and the pilot's altitude reference.	Current
DME	RTCA	DO-189	MOPS for DME	Sept 1985
	FAA	TSO-C66c	Distance Measuring Equipment (DME) Operating Within 960-1215MHz	18 Jan 1991
TSO	FAA	8150.1C	Technical Standard Order Program	08 Mar 2012
	FAA	8110-3	Statement of Compliance with Airworthiness Standards	18 Mar 2010

Cat	Org	Doc. No.	Document Title	Date
UAS	RTCA	AWP-1	Detect and Avoid (DAA) White Paper	18 Mar 2014
	RTCA	DO-365	MOPS for Detect and Avoid (DAA) Systems	31 May 2017
	RTCA	DO-365 Test Vectors	DO-365 Detect and Avoid (DAA) Test Vectors	31 May 2017
	RTCA	DO-366	MOPS for Air-to-Air Radar for Traffic Surveillance	31 May 2017
	FAA	14 CFR 107	FAA Part 107 Small Unmanned Aircraft Systems	Current
	FAA	AC 107-2	Small Unmanned Aircraft Systems (sUAS)[46]	21 Jun 2016
	FAA	AC 21-12C	Application for US Airworthiness Certificate, FAA Form 8130-6	07 Sep 2012
	FAA	Form 8130-6	Application for US Airworthiness Certificate	Apr 2011
	FAA	AC 91-57A	Model Aircraft Operating Standards	02 Sep 2015
	FAA	AC 91-57A Chg 1	Change1 to AC 91-57A	11 Jan 2016
	DOT	Public Law 112-95, Title III, Subtitle B	FAA Modernization and Reform Act of 2012	2012
	DOT	Public Law 114-90, Title II, Subtitle B	UAS Safety (FAA Extension, Safety, & Security Acot of 2016)	2016
Software	FAA	DO-178C	Software Considerations in Airborne Systems and Equipment Certification	13 Dec 2011
	FAA	AC 20-115C	Airborne Software Assurance	19 July 2013
	FAA	8110.49	Software Approval Guidelines	28 Sep 2011
	RTCA	DO-278A	Software Integrity Assurance Considerations for CNS/ATM Systems	13 Dec 2011
	RTCA	DO-248C	Supporting Information for DO-178C and DO-278A	13 Dec 2011
AEH	RTCA	DO-254	Design Assurance Guidance for Airborne Electronic Hardware	19 Apr 2000
	FAA	AC 20-152	RTCA, Inc., Document RTCA/DO-254, Design Assurance Guidance for Airborne Electronic Hardware	30 June 2005
	FAA	8110.105	Simple and Complex Electronic Hardware Approval Guidance	23 Sep 2008

[46] Includes guidance for airmen (remote pilot) certification, aircraft registration and marking, aircraft airworthiness, and operations of small Unmanned Aircraft Systems (sUAS) in the National Airspace System (NAS).

Cat	Org	Doc. No.	Document Title	Date
Environmental	RTCA	DO-160G	Environmental Conditions and Test Procedures for Airborne Equipment	8 Dec 2010
	RTCA	DO-160G Change 1	Environmental Conditions and Test Procedures for Airborne Equipment	16 Dec 2014
	RTCA	DO-160G Form	Environmental Qualification Form	8 Dec 2010
	RTCA	DO-357	User Guide: Supplement to DO-160G	16 Dec 2014
	FAA	AC 21-16G	RTCA Document DO-160 versions D, E, F, and G, "Environmental Conditions and Test Procedures for Airborne Equipment"	22 Jun 2011
	FAA	AC 25-16	Electrical Fault Fire Prevention and Protection	5 Apr 1991
Interface	ARINC	718A-4	Mark 4 ATCRBS/Mode S ARINC Characteristic	15 Nov 2011
	ARINC	743A-5	GNSS Sensor ARINC Characteristic	29 May 2009
	ARINC	429P1-18	Digital Information Transfer System (DITS) Part 1 Functional Description, Electrical Interfaces, Label Assignments and Word Formats	29 Nov 2012
	ARINC	429P2-16	MARK 33 Digital Information Transfer System (DITS) Part 2 Discrete Word Data Standards	17 Dec 2004
	ARINC	429P3-19	MARK 33 Digital Information Transfer System (DITS) Part 3 File Data Transfer Techniques	25 June 2009
	SAE	ARP4754A	Guidelines for Development of Civil Aircraft and Systems.	21 Dec 2010
	TIA	TIA/EIA-232-F[47]	Interface Between Data Terminal Equipment and Data Circuit-Terminating Equipment Employing Serial Binary Data Interchange	2012
	NMEA	0183 Ver 4.1	Standard for Interfacing Marine Electronic Devices	June 2012
TC/STC	SAE	ARP4761	Guidelines and Methods for Conducting the Safety Assessment Process on Civil Airborne Systems and Equipment.	01 Dec 1996

[47] RS-232 interface standard. TIA/EIA-232 is functionally equivalent with international standards ITU-T V.24, V.28, and ISO/IEC 2110

Cat	Org	Doc. No.	Document Title	Date
FCC	FCC	OET Bulletin 65 Edition 97-01	Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields	Aug 1997
	FCC	KDB 447498 D01	General RF Exposure Guidance v06	23 Oct 2015
	FCC	Part 2	Frequency Allocations; General Rules & Regulations	Current
	FCC	47 CFR 2.1046	Measurements Required: RF Power Output	Current
	FCC	47 CFR 2.1047	Measurements Required: Modulation Characteristics	Current
	FCC	47 CFR 2.1049	Measurements Required: Occupied Bandwidth	Current
	FCC	47 CFR 2.1051	Measurements Required: Spurious Emissions at Antenna Term.	Current
	FCC	47 CFR 2.1053	Measurements Required: Field Strength of Spurious Radiation	Current
	FCC	47 CFR 2.1055	Measurements Required: Frequency Stability	Current
	FCC	Part 15	Radio Frequency Devices	Current
	FCC	Part 15.109(a)	Unintentional Radiators – Radiated Emission Limits	Current
	FCC	Part 87	Aviation Services	Current
	FCC	47 CFR 87.131	Power and Emissions	Current
	FCC	47 CFR 87.133	Frequency Stability	Current
	FCC	47 CFR 87.135	Bandwidth of Emission	Current
	FCC	47 CFR 87.137	Types of Emission	Current
	FCC	47 CFR 87.139	Emission Limitations	Current
	FCC	47 CFR 87.143	Transmitter Control Requirements	Current

15 Acronyms

Table 22. Definition of Acronyms

Acronym	Meaning
TSO	Technical Standards Order
TSOA	TSO approval
TC	Type certificate
STC	Special type certificate
MOPS	Minimum Operational Performance Standard
MASPS	Minimum Aviation System Performance Standard
ATC	Air traffic control
ATCRBS	ATC radar beacon system
SSR	Secondary surveillance radar
PPM	Pulse position modulation
1090ES	1090MHz Extended Squitter
DF	Downlink format
UF	Uplink format
CPR	Compact position reporting
SV	State vector
MS	Mode status
ARV	Air referenced velocity
BDS	Comm-B data selector
GICB	Ground Initiated Comm-B
BER	Bit error rate
BW	Bandwidth
FEC	Forward error correction
ERP	Effective Radiated Power
RF	Radio frequency
MTL	Minimum triggering level
IAS	Indicated airspeed
TAS	True airspeed
IFR	Instrument flight rules
VFR	Visual flight rules
UTC	Universal Coordinated Time
GPS	Global Positioning System
GNSS	Global navigation satellite system
WAAS	Wide Area Augmentation System
SBAS	Satellite-based augmentation system
WGS84	World Geodetic System 1984
NIC	Navigation integrity category
NAC	Navigation accuracy category

Acronym	Meaning
SIL	Source integrity level
HDOP	Horizontal dilution of precision
Mode S	Mode select
ADS-B	Automatic Dependent Surveillance-Broadcast
UAT	Universal Access Transceiver
TCAS	Traffic collision avoidance system
TA	Traffic advisory
RA	Resolution advisory
CDTI	Cockpit display of traffic information
SPI	Special position identification
NOTAM	Notice to Airmen
NAS	National Airspace System
FAR	Federal aviation regulations (Title 14 of CFR)
FAA	Federal Aviation Administration
DoT	Department of Transportation (U.S.A.)
DoD	Department of Defense (U.S.A.)
FCC	Federal Communications Commission
CFR	Code of Federal Regulations
EASA	European Aviation Safety Agency
ICAO	International Civil Aviation Organization
SAE	Society of Automotive Engineers
NMEA	National Marine Electronics Association
DAL	Design assurance level
SDA	System design assurance
AC	Advisory circular
RTCA	Radio Technical Commission for Aeronautics
ARINC	Aeronautical Radio, Incorporated
PTI	Peckham Technology Inc
UCF	Urban Canyon Flight, Inc
MCU	Microcontroller
FPGA	Field-programmable gate array
UUT	Unit under test
PM	Project manager
CM	Configuration Management
QA	Quality Assurance
WOW	Weight on Wheels
LAST	Light Aviation SSR Transponder
TABS	Traffic Awareness Beacon System