ROTAX®

Technical Document

Pilot Display Interface Specification for ROTAX i-Series

Status:	Revision:	Department:	Document number:	Date:
Revision	*Rev1*	*Technical Documentation*	d06365	*02.10.2017*

Change Record

Rev.	Description	Date
00	Initial issue	10.02.2014
01	add ROTAX 915 i Series	02.10.2017

Table of Contents

1. Purpose

This document defines the CAN aerospace based Pilot Display interface for the ROTAX i-Series.

1.1. Applicability

The information given in this document describes the CAN signal interface for all Engine Control Units (ECU's) of the ROTAX i-Series with following ROTAX part numbers:

- 665567 (for 912 iS/iSc)
- 665568 (for 912 iS/iSc Sport)
- 665562 (for 915 iS/iSc)

2. Scope

This document defines the signal formats, protocols, and associated data formats for all CAN signal interfaces to the Engine Control Unit.

3. Definitions, Acronyms, and Symbols

This section provides definitions for all terms, acronyms, and symbols required to interpret this document.

3.1. Acronyms

BUDS	BRP Utility and Diagnostic Software
CAN	Controller Area Network
ECU	Engine Control Unit
EGT	Exhaust Gas Temperature
IDS	Identification Service
ISO	International Organization for Standardization
NSH	High Priority Node Service Data
N/A	Not Applicable
VNQ	Version Number Query Service

3.2. Unit Symbols

Table 1: Units of measure (lists the symbols for units used in this document)

Unit	Symbol	Notes
bitmap	bitmap	collection of individual bits which allow compression into a single variable
Pascal	Pa	SI unit of pressure
hour	h	h: = 3600 seconds
Hertz	Hz	SI unit of frequency
Kelvin	K	SI unit of thermodynamic temperature
Liter per hour	L/h	
Ohm	Ω	SI unit of electric resistance
percent	%	
revolution per minute	r/min	
Volt	V	SI unit of electric potential

4. References

CAN Aerospace Interface Specification for Airborne CAN applications – Version 1.7 available at http://www.stockflightsystems.com/

5. ECU CAN Overview

The ECU is a dual lane design where two independent Lanes can each operate the engine. In normal operation mode both Lanes actively control the engine and both transmit the system status and operational parameters from various engine sensors.

Each Lane has two CAN bus interfaces; one is dedicated to the Pilot Display and the other to Maintenance activities. The focus of this document is the Pilot Display interface.

Service functions are performed using the Maintenance Bus such as retrieving data logs and updating software packages. This interface is not covered by this document. Refer to the BRP Utility and Diagnostic Software (B.U.D.S. Aircraft) for further information.

WARNING:

Do not attempt to use the Maintenance Bus for any application deviating from the original purpose.

5.1. Pilot Display CAN Interface

The Pilot Display CAN Interface on the ECU is used to communicate with a cockpit mounted Pilot Display. Each Lane of the ECU transmits data independently to the Pilot Display. If a Lane is turned off only the powered Lane will be sending messages.

5.2. CAN Physical Interface

Table 2: ECU Pilot Display CAN Interface Description (describes the CAN interface characteristics)

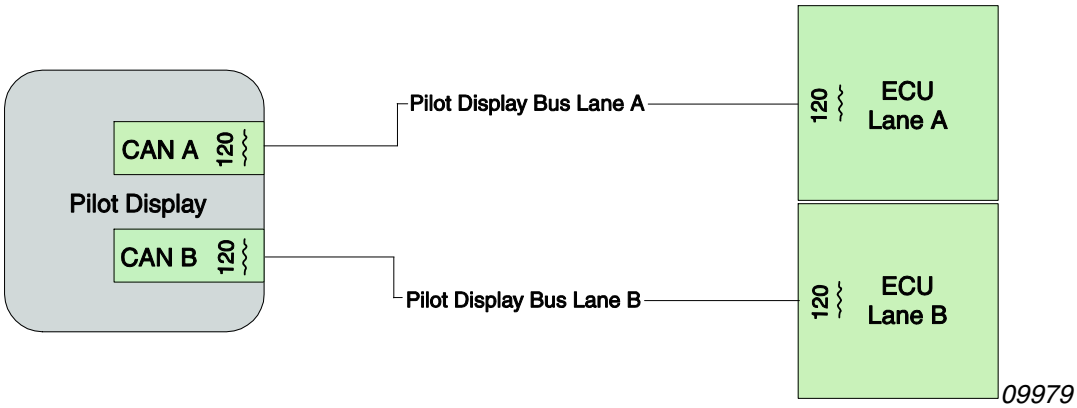
Parameter	
Type	ISO Standard 11898-2
Baud Rate	125 kbps
Protocol	CAN aerospace v1.7
Detailed Protocol Description	see section 6

5.3. CAN Bus Connections

CAN buses on the ECU are electrically isolated from the ECU power return but share the same ground on a particular Lane. On Lane A, the Pilot Display Bus shares common ground with the Maintenance Bus on Lane A, but is electrically isolated from the CAN bus connections on Lane B.

5.4. CAN Bus Termination and Bus Cabling

The following figure shows the proper connection to the Pilot Display. The CAN Bus must be terminated properly to guarantee reliable operation. All CAN Buses in the ECU are internally terminated with a 120 Ω resistor between CAN H and CAN L at the transceiver as shown in the following figure. The Pilot Display also needs a 120 Ω resistor at each CAN Bus.



CAN Bus connectivity with dual bus Pilot Display

WARNING:

To guarantee maximum reliability of the Pilot Display it is necessary to implement the display with two separated CAN interfaces and CAN controllers (as shown in figure above). When combining the CAN buses of both Lanes, the Pilot Display will receive no data as far as the single CAN Interface of the Pilot Display (or the connector, wiring etc.) fails.

6. Pilot Display Interface CAN Data Formats

The following sub-sections provide detailed descriptions of the CAN data formats and protocols associated with the Pilot Display Interface, which is based on CAN aerospace version 1.7 (see section 4).

As described in section 6.1 below, each Lane of the ECU will transmit its respective messages. For example, both Lanes send out measured engine speed in normal operation. However, Lane A uses message ID = 500 for engine speed while Lane B uses message ID = 564 to send out its engine speed.

Data from sensors that are Lane specific is shared internally between Lanes and is independently sent to the Pilot Display. For example, the coolant temperature sensor is only an input to Lane A, but Lane A will send the measurement internally to Lane B and both Lanes will report the same measurement (ID = 548 on Lane A and ID = 612 on Lane B).

***Note**: If the data is not available due to the Lane being turned OFF or a fault exists in the system, the Lane sends out 0xFFFFFFFF. As an example, Lane B would send out 0xFFFFFFFF if coolant temperature data was not received from Lane A.*

Beside the messages in Table 3, the ECU also provides basic status messages to report the current state of the system as described in Table 4.

The ECU will also respond to a number of service messages received from the operator as described in section 6.2.

6.1. Normal Operation Data Messages

Table 3 and Table 4 show the messages implemented for the ECU to send engine operational data to the Pilot Display. Unique message ID's for each Lane are defined for Engine 1 as shown in the tables below. It is recommended that all the messages defined below are implemented as default as part of the Pilot Display Interface.

If the ECU is configured for a twin-engine application as Engine 1 or 2, the ID number in the data message is the base ID number in the tables below[1)], or the base ID value plus 1[2)]. For example, the Engine 1 message ID would be 954 and the Engine 2 message ID would be 955.

[1)] for Engine 1

[2)] for Engine 2

Table 3: Pilot Display Messages

ID	Name	Type	Expected Operating Range	Units	Data Rate[Hz]	Ascertained by	Sent by
500	Engine Speed	FLOAT	0-8000	r/min	10	Lane A	Lane A
524	Fuel Flow Rate[4)]	FLOAT	0-50	L/h	10	Lane A	Lane A
528	Manifold Air Pressure	FLOAT	0-1500[6)] 0-2000[5)]	hPa	10	Lane A	Lane A
532	Oil Pressure, Absolute	FLOAT	0-10000	hPa	10	Lane B	Lane A
536	Oil Temperature	FLOAT	200-425	K	10[6)] 1[5)]	Lane B	Lane A
548	Coolant Temperature	FLOAT	200-425	K	10[6)] 1[5)]	Lane A	Lane A
564	Engine Speed	FLOAT	0-8000	r/min	10	Lane B	Lane B
588	Fuel Flow Rate[4)]	FLOAT	0-50	L/h	10	Lane B	Lane B
592	Manifold Air Pressure	FLOAT	0-1500[6)] 0-2000[5)]	hPa	10	Lane B	Lane B
596	Oil Pressure, Absolute	FLOAT	0-10000	hPa	10	Lane B	Lane B
600	Oil Temperature	FLOAT	200-425	K	10[6)] 1[5)]	Lane B	Lane B
612	Coolant Temperature	FLOAT	200-425	K	10[6)] 1[5)]	Lane A	Lane B
628	EGT Cylinder 1	FLOAT	200-1400	K	10[6)] 1[5)]	Lane A	Lane A
630	EGT Cylinder 2	FLOAT	200-1400	K	10[6)] 1[5)]	Lane A	Lane A
632	EGT Cylinder 3	FLOAT	200-1400	K	10[6)] 1[5)]	Lane A	Lane A
634	EGT Cylinder 4	FLOAT	200-1400	K	10[6)] 1[5)]	Lane A	Lane A
640	Manifold Air Temperature	FLOAT	200-425	K	10[6)] 1[5)]	Lane A	Lane A

ID	Name	Type	Expected Operating Range	Units	Data Rate[Hz]	Ascertained by	Sent by
642	Engine Ambient Temperature	FLOAT	200-425	K	10[6)] 1[5)]	Lane A	Lane A
644	EGT Cylinder 1	FLOAT	200-1400	K	10[6)] 1[5)]	Lane A	Lane B
646	EGT Cylinder 2	FLOAT	200-1400	K	10[6)] 1[5)]	Lane A	Lane B
648	EGT Cylinder 3	FLOAT	200-1400	K	10[6)] 1[5)]	Lane A	Lane B
650	EGT Cylinder 4	FLOAT	200-1400	K	10[6)] 1[5)]	Lane A	Lane B
656	Manifold Air Temperature	FLOAT	200-425	K	10[6)] 1[5)]	Lane B	Lane B
658	Engine Ambient Temperature	FLOAT	200-425	K	10[6)] 1[5)]	Lane A	Lane B
692	Throttle Position	FLOAT	0-100	%	10	Lane A	Lane A
694	Engine Ambient Pressure	FLOAT	0-1200	hPa	10	Lane A	Lane A
696	Throttle Position	FLOAT	0-100	%	10	Lane A	Lane B
698	Engine Ambient Pressure	FLOAT	0-1200	hPa	10	Lane A[6)] Lane B[5)]	Lane B
950	ECU Bus Voltage	FLOAT	0-30	V	10	Lane A	Lane A
954	ECU Bus Voltage	FLOAT	0-30	V	10	Lane B	Lane B
1300	Oil Pressure, Compensated[3)]	FLOAT	0-10000	hPa	10	Lane B	Lane A
1302	Boost Pressure[5)]	FLOAT	0-2000	hPa	10	Lane A	Lane A
1304	Oil Pressure, Compensated[3)]	FLOAT	0-100000	hPa	10	Lane B	Lane B
1306	Boost Pressure[5)]	FLOAT	0-2000	hPA	10	Lane B	Lane B
1308	Air Flow[5)]	FLOAT	0-8000	g/min	10	Lane A	Lane A
1312	Boost Pressure Error[5)]	FLOAT	-2000 to 2000	hPa	10	Lane A	Lane A

ID	Name	Type	Expected Operating Range	Units	Data Rate[Hz]	Ascertained by	Sent by
1316	Target Wastegate Position[5)]	FLOAT	-300 to 300	%	10	Lane A	Lane A
1320	Air Flow[5)]	FLOAT	0-8000	g/min	10	Lane B	Lane B
1324	Boost Pressure Error[5)]	FLOAT	-2000 to 2000	hPa	10	Lane B	Lane B
1328	Target Wastegate Position[5)]	FLOAT	-300 to 300	%	10	Lane B	Lane B

[3)] The Compensated Oil Pressure message will contain the value of the Compensated Oil Pressure only if Oil Pressure and Ambient Pressure are both valid. Otherwise, this message will contain the value of the Absolute Oil Pressure. Please see the ECU Sensor Status Word in Table 6 to determine the validity of Oil Pressure and Ambient Pressure as they are contained in messages 1500,1504 (Lane A Sensor Status) and 1516,1520 (Lane B Sensor Status).

[4)] Total engine fuel flow is sum of Metered Lane A (ID 524) and Metered Lane B (ID 588) fuel flow rate.

[5)] 915 i-series only.

[6)] 912 i-series only.

***Note**: The Node ID's can be set by using the B.U.D.S. Aircraft Software. Default ID = 1 stands for Lane A and ID = 2 for Lane B.*

Table 4: Pilot Display System Status

ID	Name	Type	Units	Data Rate [Hz]	Ascertained by	Sent by	Notes
556	Engine Status	BLONG	bitmap	1	Lane A	Lane A	Engine Status message is a collection of system status information as described in 9) 915 i-series only. Table 7.
620	Engine Status	BLONG	bitmap	1	Lane B	Lane B	Engine Status message is a collection of system status information as described in9) 915 i-series only. Table 7.
1208	Engine Hours	FLOAT	h	1/60	Lane A	Lane A	Total time the engine has been running.
1212	Engine Hours	FLOAT	h	1/60	Lane B	Lane B	Total time the engine has been running.
1216	ECU Hours	FLOAT	h	1/60	Lane A	Lane A	Total time the ECU has been powered.
1220	ECU Hours	FLOAT	h	1/60	Lane B	Lane B	Total time the ECU has been powered.
1224[7)]	Timestamp	ULONG	ms	10	Lane A	Lane A	Time of Lane A since the last power cycle.
1228[7)]	Timestamp	ULONG	ms	10	Lane B	Lane B	Time of Lane B since the last power cycle.
1500	Lane A Sensor Status	BLONG	bitmap	1	Lane A	Lane A	Sensor Status is a 32-bit sensor fault status word that reports the sensor fault status as described in Table 5.
1504	Lane A Sensor Status	BLONG	bitmap	1	Lane A	Lane B	Sensor Status is a 32-bit sensor fault status word that reports the sensor fault status as described inTable 5.

ID	Name	Type	Units	Data Rate [Hz]	Ascertained by	Sent by	Notes
1508	Lane A Device Status	BLONG	bitmap	1	Lane A	Lane A	Device Status is a 32-bit device fault status word that reports the device fault status as described in Table 6.
1512	Lane A Device Status	BLONG	bitmap	1	Lane A	Lane B	Device Status is a 32-bit device fault status word that reports the device fault status as described in Table 6.
1516	Lane B Sensor Status	BLONG	bitmap	1	Lane B	Lane A	Sensor Status is a 32-bit sensor fault status word that reports the sensor fault status as described in Table 5.
1520	Lane B Sensor Status	BLONG	bitmap	1	Lane B	Lane B	Sensor Status is a 32-bit sensor fault status word that reports thesensor fault status as described in Table 5.
1524	Lane B Device Status	BLONG	bitmap	1	Lane B	Lane A	Device Status is a 32-bit device fault status word that reports the device fault status as described in Table 6..
1528	Lane B Device Status	BLONG	bitmap	1	Lane B	Lane B	Device Status is a 32-bit device fault status word that reports the device fault status as described in Table 6.

[7)] 915 i-series only.

The following Tables 5 and 6 represent the bitmaps of the Sensor and Device Status words. During normal operation, these should report a zero (0), indicating that there are no errors detected. Should an error be detected, the specific bit in the status word will be set to one (1). The bitmap of the Engine Status word (see table 7) provides information on the current status of the engine.

Table 5: Sensor Status Decoder

Bit Position	31 MSB	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Common	Manifold Air Pressure	Manifold Air Temperature	Internal Temperature 1	Internal Temperature 2	Generator Select Voltage	Generator Select Current	Crank Sensor Fault 1	Sensor Drive Voltage 2	Bus Voltage	ECU Current	Boost Pressure Sensor8)	Crank Sensor Fault 2	Reserved	Reserved	Lane Specific Sensors (see below)													Reserved					
Lane A	Common Sensors (see above)														Engine Ambient Pressure	Coolant Temperature	Exhaust Gas Temperature Cylinder 1	Exhaust Gas Temperature Cylinder 2	Exhaust Gas Temperature Cylinder 3	Exhaust Gas Temperature Cylinder 4	Sensor Drive Voltage 3	Sensor Drive Voltage 1	Reserved	Throttle Position	Reserved	Engine Ambient Temperature	Knock Sensor[8)]					
Lane B															Oil Pressure	Oil Temperature	Sensor Drive Voltage 1	Engine Ambient Pressure[6)]	Reserved													

[8)] 915 i-series only.

Table 6: Device Status Decoder

Bit Position	31 MSB	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Lane A / Lane B	Internal Flash	External Flash	Ignition/Injection Driver	Generator Select Switch	Engine Stall	Injector Cylinder 1	Injector Cylinder 2	Injector Cylinder 3	Injector Cylinder 4	Ignition Cylinder 1 / 2	Ignition Cylinder 3 / 4	Engine Speed Limiting Active	No Data Received From Opposite Lane	Warning Lamp Lane A	Warning Lamp Lane B	Lane Synchronization	Interlane Communication Failure	Generator Failure	Internal Logging	Internal Timer	Pilot Display CAN Bus	Maintenance CAN Bus	Reserved	Internal Flash CRC Verification	EGT Injector Cylinder 1	EGT Injector Cylinder 2	EGT Injector Cylinder 3	EGT Injector Cylinder 4	Reset Occurred	Wastegate PCV[9)]	Overboost Relief PCV[9)]	Interlane Keep Alive Discrete[9)]

[9)] 915 i-series only.

Table 7: Engine Status Decoder

Bit Position	31 MSB	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Lane A / Lane B	Reserved	Reserved	Reserved		Reserved	Reserved	Reserved	Reserved	Engine Speed Status				Reserved								Knock Protection enabled[10]	Reserved	Knock State Maximum[10]		Wastegate PCV Test 1 Complete[10]	Wastegate PCV Test 2 Complete[10]	Warning Lamp State		Overboost Relief PCV Actuated[10]	Generator Select Switch State	Power/EconomyMode	This Lane In Control

Bit	Description
0	**This Lane In Control** 1 = Lane is in control of Generator. 0 = Lane is not in control of Generator. If this bit is set, this is the active Lane that is controlling the engine mounted generators.
1	**Power / Economy Mode (PLA mode)** 0 = Power Mode 1 = Economy Mode
2	**Generator Select Switch State** 1 = Lane is commanding Generator A. 0 = Lane is commanding Generator B.
3[10]	**Overboost Relief PCV Actuated** 0x0 = Closed 0x1 = Open
4-5	**Warning Lamp State** 0x2 = Warning Lamp On 0x1 = Warning Lamp Flashing 0x0 = Warning Lamp Off
6[10]	**Wastegate PCV Test 2 Complete** 0= Test not completed 1= Test completed Indicates test completion only. Warning lamp will be activated if a completed test failed.
7[10]	**Wastegate PCV Test 1 Complete** 0= Test not completed 1= Test completed Indicates test completion only. Warning lamp will be activated if a completed test failed.

8-9[10)]	**Knock State Maximum (Greatest state value of all cylinders)** 0x0 = Normal Operation 0x1 = Timing Retarded 0x2 = Unable to mitigate Knock, Maximum Timing Retard Applied 0x3 = Failsafe, Maximum Timing Retard Applied (Knock Sensor Failure)
10	**Reserved**
11[10)]	**Knock Protection Enabled (Engine speed and pressure ratio thresholds are achieved)** 0 = Disabled 1 = Enabled
12-19	**Reserved**
20-23	**Engine Speed Status** 1 – Stall: No crankshaft teeth detected 2 – Waiting for Gap: Teeth detected and awaiting valid sync 3 – Half Sync: ECU is synchronized to crankshaft position 4 – Full Sync: ECU is synchronized to crankshaft position and opposite Lane.
24-31	**Reserved**

[10)] 915 i-series only.

6.2. Node Service Messages

Node Service Messages are implemented for network administration devices to manage the CAN network. The ECU implements only a subset of CANaerospace's NSH as defined below.

WARNING:

Node Service Messages should only be sent while on the ground with the engine off. Node Service Message transmission rate should not exceed one message per second.

Table 8: ECU Implemented Node Service Channels

Node Service Channel	Node Service Request ID	Node Service Response ID
0	128	129

Table 9: ECU Implemented Node Service

Node Service	Service Code	Response	Description
IDS	0	Yes	Identification service
VNQ	100	Yes	Version number query service

Table 10: IDS Message

Message Data Bytes	Data Field Description	Service Request	Service Response
0	Node-ID	<node-ID>	<node-ID>
1	Data Type	NODATA	UCHAR4
2	Service Code	0	0
3	Messa	0	0
4 - 7	Message Data	N/A	Byte 0: 0 Byte 1: 0 Byte 2: 0 Byte 3: 0

Table 11: VNQ Message

Message Data Bytes	Data Field Description	Service Request	Service Response
0	Node-ID	<node-ID>	<node-ID>
1	Data Type	NODATA	see Table 12.
2	Service Code	100	100
3	Message Code	0	see Table 12.
4 - 7	Message Data	N/A	see Table 12.

Table 12: VNQ Response Messages

Message Code	Data Type	Message Data (Bytes 4-7)
0	ULONG	ECU serial number
1	ACHAR4	Software part number character 0-3
2	ACHAR4	Software part number character 4-7
3	ACHAR4	Software part number character 8-11
4	ACHAR	Software part number character 12
5	ACHAR4	ECU model number character 0-3
6	ACHAR4	ECU model number character 4-7
7	ACHAR4	ECU model number character 8-11
8	ACHAR	ECU model number character 12
9	ACHAR4	Engine serial number character 0-3
10	ACHAR4	Engine serial number character 4-7
11	ACHAR4	Engine serial number character 8-11
12	ACHAR	Engine serial number character 12
13	ACHAR4	Engine type character 0-3
14	ACHAR4	Engine type character 4-7
15	ACHAR4	Engine type character 8-11
16	ACHAR	Engine type character 12