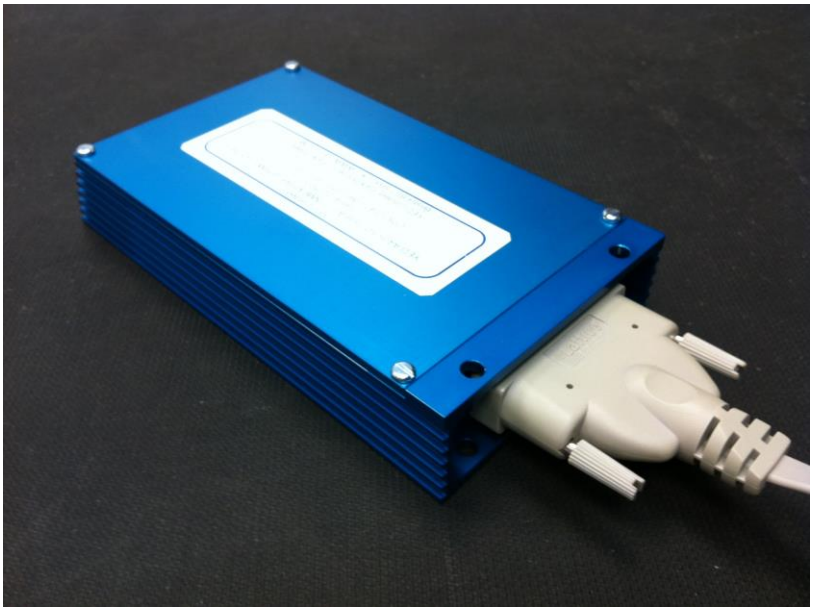
YED Limited

Documentation for:

YED/A429R1/NMEAT1/STM32 (NMEA0183)

ARINC429 to RS232/RS422 Converter ($GPRMC, $GPGGA, $GPVTG)



YED Limited

Park House
10, Park Street
Bristol
Avon BS1 5HX
UK

Tel: *+44 (0) 117 907 4761*
E-mail: support@yed.com
Web: www.yed.com

Amendment Page

Version	Date of Issue	Change Reference	Remarks
1.0	24 May 2013	N/A	Original Issue
1.1	31 May 2013	N/A	L125 changed to L150. Built-in firmware update Boot Loader. Multiple NMEA 1083 baud rates. Baud rate switch settings.
1.2	21 June 2013	N/A	NMEA 0183 string output content corrected. Explosive decompression data added. LED indicators

Original Author: G.S. Brownett
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Firmware Version: N/A

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1 Introduction

This manual contains specification data, installation and instructions for the YED/A429R1-Serial-T1/STM32 ARINC-429 Converter.

This converter is in use by many companies who have a requirement to extract navigational data from an ARINC429 data bus and translate it onto an RS232 or RS422 serial data bus. The exact format for the converted data is NMEA 0183 - a marine GPS ASCII format. Depending upon the software version installed, the converter can process a variety of ARINC 429 labels and output a variety of NMEA 0183 message strings. The typical labels processed by this converter are shown in the table below. The converter adapts automatically to high or low speed (12.5/100kHz) ARINC429 data and the inputs are opto-coupled for electrical isolation purposes. The unit is powered from an external 28 VDC (18-72V) nominal supply with internal current and thermal (102 ºC) fuse. The power inputs are also reverse polarity protected.

1.1 Software

The software for the the YED/A429R1-Serial-T1/STM32 ARINC-429 Converter is written in accordance with RTCA/DO-178B to criticality level E.

This new hardware has a built-in Boot Loader that allows the internal firmware to be updated via RS232. A GUI program downloads the new firmware file to the internal FLASH ROM on the processor thus removing the requirement to return the unit to YED for upgrading.

1.2 Environmental, Airworthiness and EMC

The YED/A429R1-Serial-T1/STM32 ARINC-429 Converter has been designed to meet DO-160D test categories listed later in this manual.

The unit has also been subjected to an Explosive Decompression test from 15,000 feet to 50,000 feet in a period of less than 100mS without effect. See Annex 1.

1.3 Specifications

The YED/Serial-R1-RS485/A429-T1 has the following features: -

Physical

The YED/Serial-R1-RS485/A429-T1 attaches to the airframe via four mounting holes. See paragraph titled "Enclosure Outline Drawing" for further details.

Height……..	28.0mm
Width……..	68.0mm
Length……..	136.0mm
Weight…….	300 grams (approx.)

Electrical

Input Voltage……..	28V DC (15 to 72V DC operational)
Input Current……..	30mA maximum at 28V DC
Reverse polarity protected	
Electrically fused ……	500mA (non-resettable)
Thermally fused ……..	102 Degs. C. (non-resettable)

ARINC 429 Input Labels

L147 : Magnetic Variation …….	BNR	
L150 : UTC (GPS) …….	BNR	Hr:Min:S (23:59.59)
L260 : Date (GPS) …….	BCD	Dy:Mo:Yr (dd:mm:yr)
L310 : Present Position Latitude ……	BNR	Degrees (Position Sense N)
L311 : Present Position Longitude …….	BNR	Degrees (Position Sense E)
L312 : Ground Speed (GPS) ……..	BNR	Knots
L313 : True Track ……..……	BNR	Degrees (Position Sense CW - N)
L314 : Track Magnetic……	BNR	Degrees (Position Sense CW - N)
L273 : Sensor Status(No. of Sats Tracked) ……	DIS	
L203 : Pressure Altitude (MSL) …….	BNR	Feet (Position Sense UP)

Bit Rate ……...	12.5kHz or 100kHz Automatic detection

Serial Output

Format…….	RS232 & RS422, NMEA 0183, 8 data-bits, 1-Stop, No Parity.
NMEA 0183 messages……	$GPRMC, $GPGGA and $GPVTG
Baud Rates……..	4800, 9600, 19200, 38400 (other baud rates available)
NMEA 0183 Update rate……..…….	1Hz

Environmental

Operating temperature range…..…..……	-40 to +85 degrees C.

2 Operation

2.1 ARINC429 reception

High or low speed ARINC data is receivable without user intervention. ARINC429 data words must have Odd Parity and the correct SSM (bits 30 & 31) field status otherwise the data will not be included in the serial output data stream.

2.2 Serial transmission (NMEA 0183) of received (ARINC 429) data

Serial data will be transmitted at a rate of once per second (1 Hz) and at the specified baud rate. There is no hardware handshake and no parity. Transmitted data is in ASCII format and conforms to NMEA 0183 data format standards. The Sentence header will consist of three ASCII strings "$GPRMC", "GPGGA" and $GPRMA. Each line will begin with a '$' and terminate with a Carriage Return (0x0d) and Line Feed Character (0x0a). The ',' comma delimiters are used to separate each particular parameter field.

The various outputs are as follows:-

(i) No ARINC429 data being received:-

```
$GPRMC,,V,,,,,,,,,*31
$GPGGA,,,,,,,,,,M,,M,,*56
$GPVTG,,T,,M,,N,,K*4E
```

The lines show the comma delimiters for each of the missing parameters.

(ii) If all the ARINC429 parameters are being correctly received then the following data will be available at the serial output port:-

```
$GPRMC,121131.00,A,10059.99,N,09000.00,W,190.0,135.0,250113,099.8,E*7C
$GPGGA,121131.00,10059.99,N,09000.00,W,,,,03048.0,M,,M,,*45
$GPVTG,100.0,T,135.0,M,190.0,N,351.9,K*4E
```

(iii) The following line shows the UTC time parameter missing. This could be due to the label being unavailable, or the SSM is incorrect, or if the parity is incorrect:-

```
$GPRMC,,V,10059.99,N,09000.00,W,190.0,135.0,250113,099.8,E*44
$GPGGA,,10059.99,N,09000.00,W,,,,03048.0,M,,M,,*6A
$GPVTG,100.0,T,135.0,M,190.0,N,351.9,K*4E
```

(iv) The following lines show the typical output when all parameters are present.

```
$GPRMC,121131.00,A,10059.99,N,09000.00,W,190.0,135.0,250113,099.8,E*7C
$GPGGA,121131.00,10059.99,N,09000.00,W,,,,03048.0,M,,M,,*45
$GPVTG,100.0,T,135.0,M,190.0,N,351.9,K*4E
{1 second GAP}
$GPRMC,121131.00,A,10059.99,N,09000.00,W,190.0,135.0,250113,099.8,E*7C
$GPGGA,121131.00,10059.99,N,09000.00,W,,,,03048.0,M,,M,,*45
$GPVTG,100.0,T,135.0,M,190.0,N,351.9,K*4E
```

…. Etc.

2.3 Conversion to the following NMEA 0183 Values:

Time (UTC)	hhmmss.ss
Date	ddmmyy
Latitude	llll.ll
Longitude	yyyyy.yy
Track (True)	Degrees
Speed over ground	knots
Altitude	meters (MSL)
Magnetic Variation	Degrees

Creation of the following NMEA 0183 Strings:

Blue : Fixed constant
Red : From ARINC 429 data

2.3.1 The arrangement of the transmitted parameters is as follows for $GPRMC:-

RMC Recommended Minimum Navigation Information

```
       1         2 3       4 5        6  7   8  9     10 11 12
       |         | |       | |        |  |   |  |     |  |  |
$--RMC,hhmmss.ss,A,llll.ll,a,yyyyy.yy,a,x.x,x.x,xxxx,x.x,a*hh
1)  Time (UTC)
2)  Status, V = Navigation receiver warning
3)  Latitude
4)  N or S
5)  Longitude
6)  E or W
7)  Speed over ground, knots
8)  Track made good, degrees true
9)  Date, ddmmyy
10) Magnetic Variation, degrees
11) E or W
12) Checksum
```

The arrangement of the transmitted parameters is as follows ($GPRMC):-

	ARINC 429 Label	
1)	150	UTC(GPS)
2)		V or A
3)	310	Present Position Latitude
4)		North South indicator
5)	311	Present Position Longitude
6)		East West indicator
7)	312	Ground Speed (GPS) Knots
8)	314	Course over ground, degrees
9)	260	Date (GPS)
10)	147	Magnetic Variation, degrees
11)		East West indicator
12)		Checksum

2.3.2 The arrangement of the transmitted parameters is as follows for $GPGGA:-

GGA Global Positioning System Fix Data. Time, Position and fix related data for a GPS receiver

```
       1         2       3 4        5 67  8 9  1011 121314 15
       |         |       | |        | ||  | |  | |  | |  | |
$--GGA,hhmmss.ss,llll.ll,a,yyyyy.yy,a,,xx,,x.x,M, , M,  , *hh
1)  Time (UTC)
2)  Latitude
3)  N or S (North or South)
4)  Longitude
5)  E or W (East or West)
6)  GPS Quality Indicator,
      0 - fix not available,
      1 - GPS fix,
      2 - Differential GPS fix
7)  Number of satellites in view, 00 - 12
8)  Horizontal Dilution of precision
9)  Antenna Altitude above/below mean-sea-level (geoid)
10) Units of antenna altitude, meters
11) Geoidal separation, the difference between the WGS-84 earth
    ellipsoid and mean-sea-level (geoid), "-" means mean-sea-level below
    ellipsoid.
12) Units of geoidal separation, meters
13) Age of differential GPS data, time in seconds since last SC104
    type 1 or 9 update, null field when DGPS is not used
14) Differential reference station ID, 0000-1023
15) Checksum
```

The arrangement of the transmitted parameters is as follows ($GPGGA):-

```
ARINC 429 Label

1)     150    UTC (GPS)
2)     310    Present Position Latitude, (GPS)
3)            North South indicator
4)     311    Present Position Longitude, (GPS)
5)            East West indicator
6)            -Blank-
7)     273    Number of satellite in view
8)            -Blank-
9)     203    GPS Altitude (MSL) convert to meters
10)           M (meters)
11)           -Blank-
12)           M (meters)
13)           -Blank-
14)           -Blank-
15)           Checksum
```

2.3.3 The arrangement of the transmitted parameters is as follows for $GPVTG:-

VTG Track Made Good and Ground Speed

```
        1  2  3  4  5  6  7  8 9
        |  |  |  |  |  |  |  | |
$--VTG,x.x,T,x.x,M,x.x,N,x.x,K*hh
```

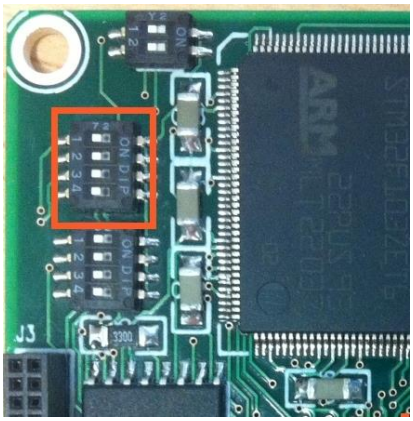
1) Track Degrees
2) T = True
3) Track Degrees
4) M = Magnetic
5) Speed Knots
6) N = Knots
7) Speed Kilometers Per Hour
8) K = Kilometres Per Hour
9) Checksum

The arrangement of the transmitted parameters is as follows ($GPVTG):-

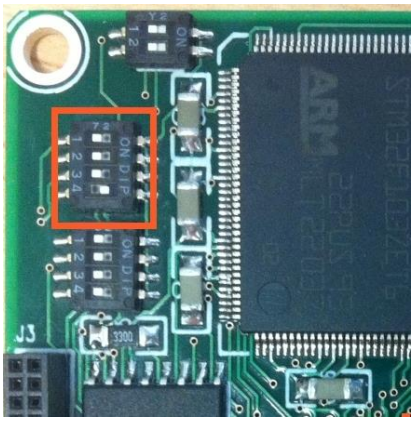
	ARINC 429 Label	
1)	313	Track Degrees
2)		T = True
3)	314	Track Degrees
4)		M = Magnetic
5)	312	Speed Knots
6)		N = Knots
7)	312	Speed Kilometers Per Hour
8)		K = Kilometres Per Hour
9)		Checksum

2.4 Baud rate switches.

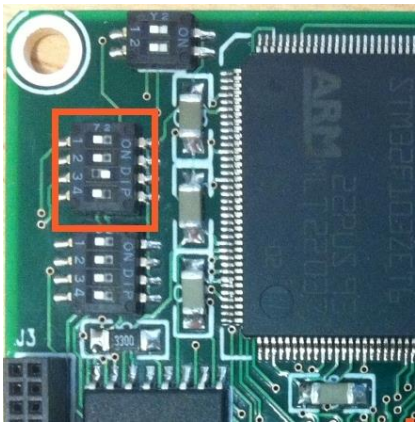
4800



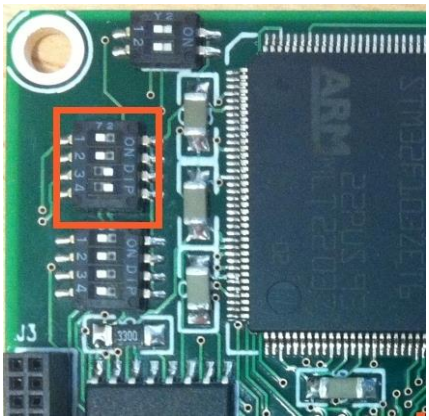
9600



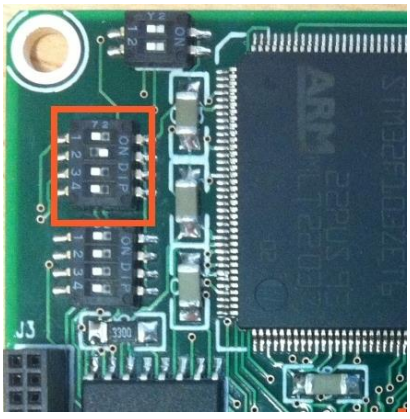
19200



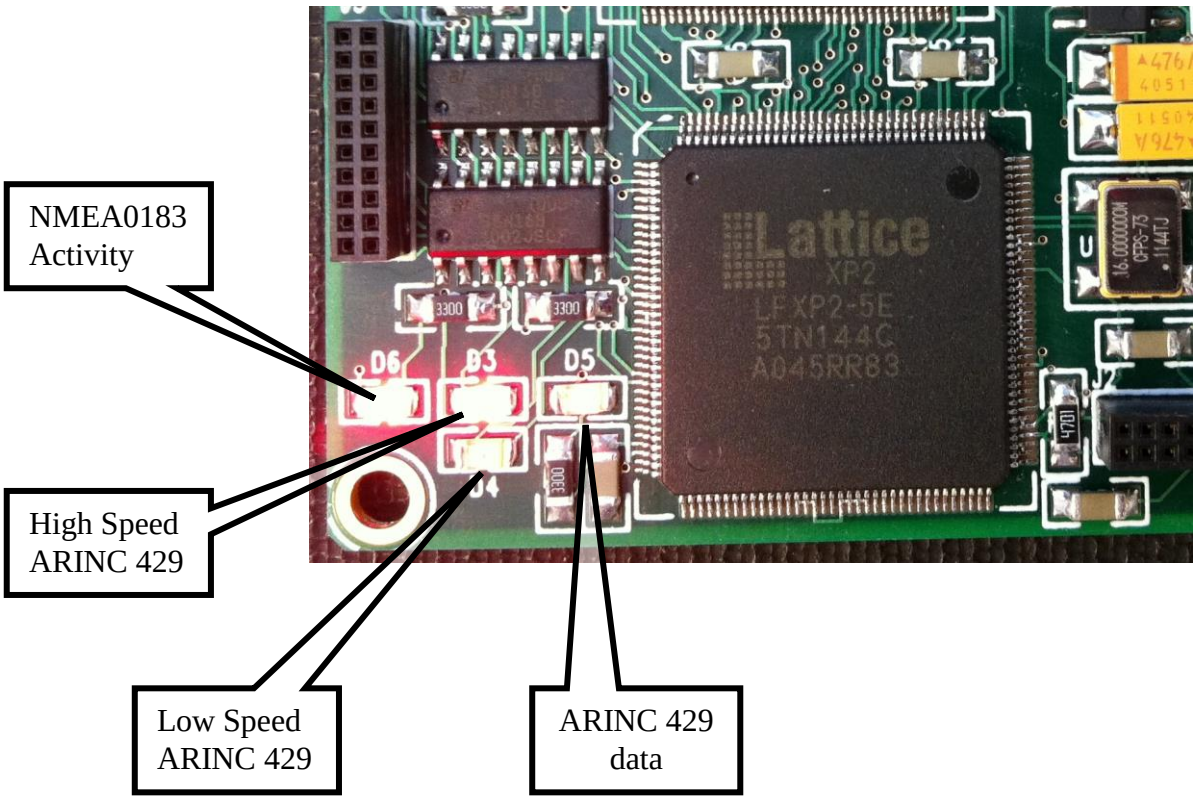
38400



115200



2.5 LED Indicators.



3 Installation

This section provides details for the installation of the YED/A429R1-Serial-T1/STM32 Converter, including configuration and mounting procedures. Follow the procedures and recommendations found in this section to assure a successful installation.

3.1 Electrical considerations

A circuit breaker such as a Klixon 7277-2-1 or equivalent should be considered for connecting the power from the aircraft supply to this converter – even though the converter is internally fused.

3.2 Materials not supplied

- Wire: MIL-W-22759/16 or equivalent
- Shielded wire: MIL-C-27500 or equivalent
- Mounting Screws, 4 each.

3.3 Mounting considerations

The YED/A429R1-Serial-T1/STM32 can be mounted in the avionics bay, shelf or other suitable structure. It can be mounted in any orientation.

3.4 Wiring

Use 22 to 24 AWG wire for all connections.
Fabricate wiring harness, and test all wiring for continuity and for shorts. Ensure aircraft power is present on the correct pins of J1; refer to Table 1.

3.5 Removal and replacement

3.5.1 Removal

1. Open the circuit breaker powering the YED P/N YED/A429R1-Serial-T1
2. Remove the connector.
3. Remove four (4) screws securing the converter to the airframe.

3.5.2 Replacement

1. Open the circuit breaker powering the YED/A429R1-Serial-T1/STM32
2. Secure the converter to the airframe with four (4) screws.
3. Attach the connector and secure
4. Close the circuit breaker.
5. Perform operational test of the YED/A429R1-Serial-T1/STM32

3.6 Continued Airworthiness

3.6.1 Scheduled Maintenance

- Recommended periodic scheduled servicing…….. None
- Recommended periodic scheduled preventative maintenance tests……. None
- Recommended periodic inspections……... None
- Recommended period overhaul period…… None
- Special inspection requirements……. None

There are no Airworthiness limitations associated with the installation of this converter.

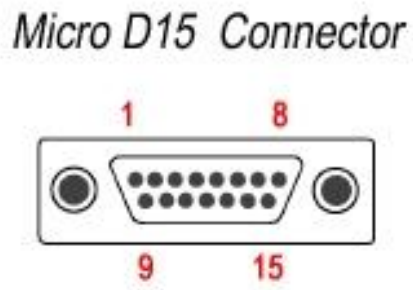
4 Environmental & EMC

The YED/A429R1-Serial-T1/STM32 has been designed to meet the environmental test categories detailed below in accordance with RTCA DO-160D, Environmental Conditions and Test Procedure for Airborne Equipment.

Section	Category	Remarks
4.0 Temperature and Altitude	A1, A2	25,000 feet.
5.0 Temperature and variation	B, C	
6.0 Humidity	A	
7.0 Operational Shock and Crash Safety	B	
8.0 Vibration	C,M	
9.0 Explosion Proofness	X	Not tested – See Annex 1
10.0 Waterproofness	X	Not tested
11.0 Fluids susceptibility	X	Not tested
12.0 Sand and Dust	X	Not tested
13.0 Fungus Resistance	X	Not tested
14.0 Salt Spray	X	Not tested
15.0 Magnetic Effect	Z	
16.0 Power Input	A	
17.0 Voltage Spike	B	
18.0 AF Conducted Susceptibility – Power Inputs	A	
19.0 Induced Signal Susceptibility	A, Z	
20.0 Radio Frequency Susceptibility (Radiated and Conducted)	T, V	
21.0 Emission of Radio Frequency Energy	A, Z	
22.0 Lightening Induced Transient Susceptibility	X	Not tested
23.0 Lightening Direct Effects	X	Not tested
24.0 Icing	X	Not tested
25.0 ESD	X	Not tested

5 Connector Pin Out (D15 Plug)

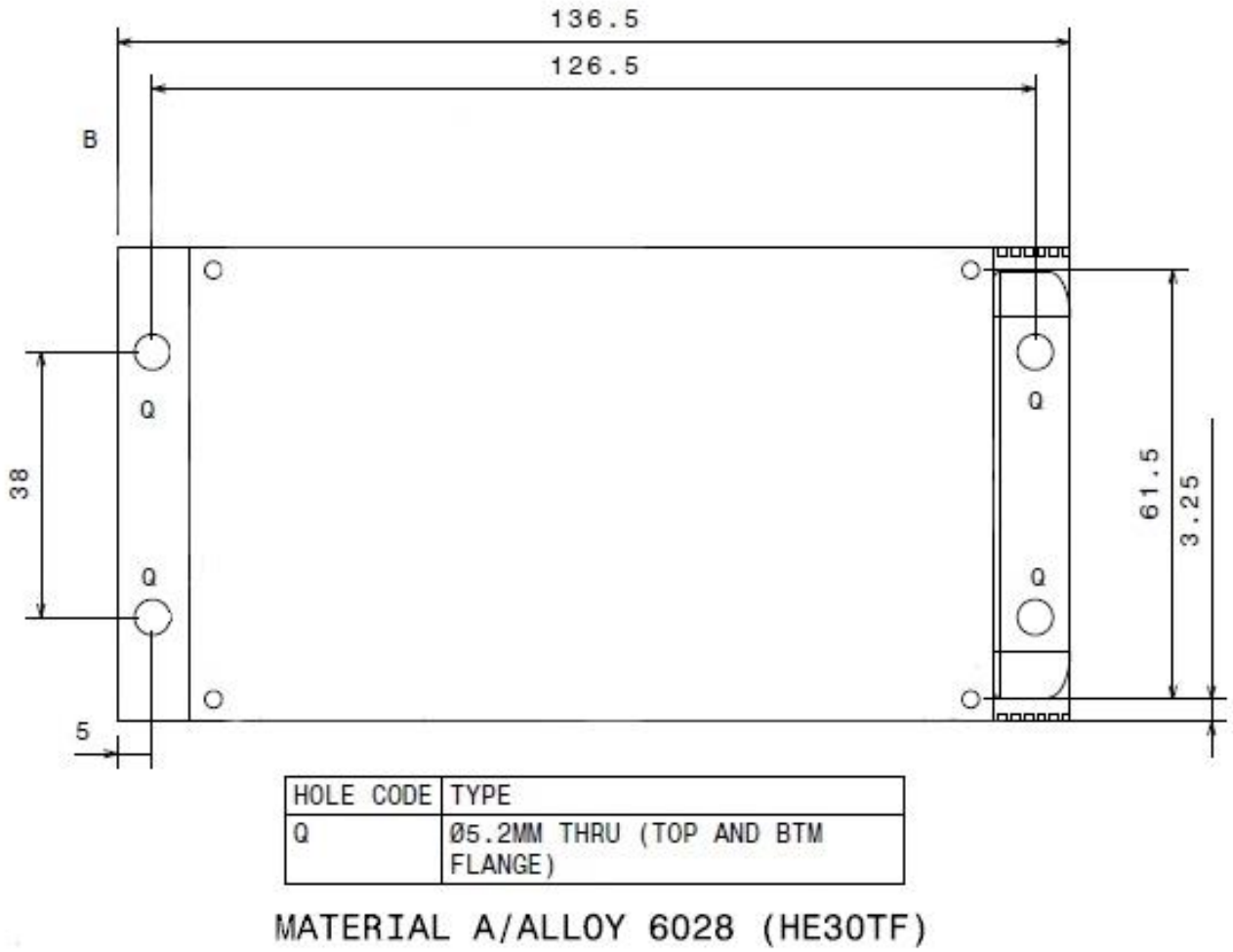
The YED/A429R1-Serial-T1/STM32 contains a single 15-pin filtered male connector, J1, per MIL-C-24308.



Pin	Signal	Function
1	+28V DC	Primary power
2	0V Ground	28V DC Return
3	A429 Tx +Ve	ARINC429 Transmit TXA
4	A429 Tx -Ve	ARINC429 Transmit TXB
5	A429 Rx +Ve	ARINC 429 Receive (input) RXA
6	A429 Rx -Ve	ARINC 429 Receive (input) RXB
7	A429 Ground (0V)	ARINC 429 Screen
8	FLASH Enable	Enable reprogram of FLASH ROM code
9	RS232 Tx Out	RS232 transmitter output
10	RS232/RS422 Gnd (0V)	RS232 / RS422 Signal/Screen ground
11	RS232 Rx In	RS232 receiver input
12	RS422 Tx +Ve Out	RS422 Tx output +Ve
13	RS422 Tx –Ve Out	RS422 Tx output –Ve
14	RS422 Rx +Ve In	RS422 Rx input +Ve
15	RS422 Rx –Ve In	RS422 Rx input -Ve

Table 1 – J1 Pin Description

6 Enclosure outline drawing

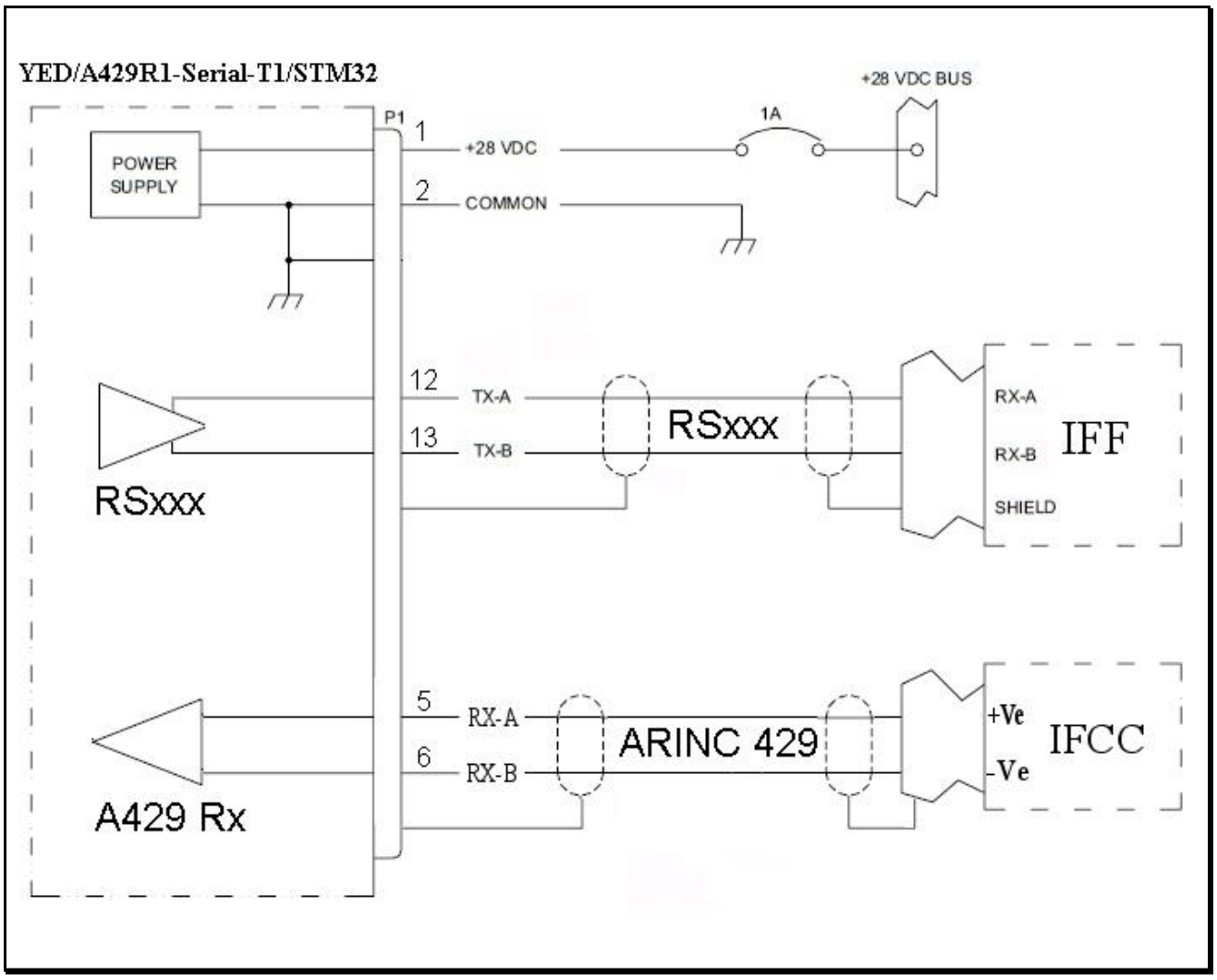


HOLE CODE	TYPE
Q	Ø5.2MM THRU (TOP AND BTM FLANGE)

MATERIAL A/ALLOY 6028 (HE30TF)

All dimensions are in mm.

7 Typical interconnect drawing



8 Annex 1 – Explosion Decompression tests

DECOMPRESSION TESTING OF NAVIGATION UNIT

1. QinetiQ Building 800 Hypobaric Facility (Boscombe Down) were tasked to carry out decompression testing of a TACAN Converter unit . The reason for this testing, in conjunction with other required testing, is to enable clearance to be given for the equipment to be fitted and operated on-board RAF aircraft.

2. The equipment to be tested was supplied on 22nd May 2013 and comprised:

   - YED TACAN Converter unit. Local Serial No. 001.

3. Prior to the decompression test, the manufacturer had verified to the representatives supplying the equipment that the equipment was serviceable. The equipment did not require to be functioning during the testing and was to be returned to the manufacturer for examination post testing.

4. The decompression test was carried out in the Hypobaric Chamber (Building 800) on May 2013 to the following decompression test profile:

   - Chamber ascent to 15,000 ft at a rate of 5,000 ft/min.
   - Hold for a minimum of 1 minute.
   - Rapid decompression to 50,000 ft (To reach 90% of the final altitude within a 0.1-second time period).
   - Hold chamber altitude for a minimum of 5 minutes.
   - Chamber descent to ground level at 5,000 ft/min.

5. The altitude profile within the chamber was recorded on an ADI Instruments Power Lab data acquisition system. Annex A shows the test profile from; ground level (760 mmHg) to 15,000 ft (428 mmHg), explosive decompression to 50,000 ft (87 mmHg) in less than 0.1 second, hold for a minimum of 5 minutes, descent back down to ground level. Chamber ascent from ground level to 15,000 ft and descent from 50,000 ft to ground level was carried out at a rate of 5,000 ft /min. Annex B shows the actual rapid decompression in greater detail during which the chamber reached 90% of the final altitude in a 0.05-second time period. The rates of change of altitude, or pressure, within the chamber are controlled in units of feet per minute (ft/min). For this reason, the pressure recordings show a curvature due to the non-linearity of the altitude/pressure relationship.

6. The chamber decompression test proceeded without incident and as far as could be seen, without any effect on the equipment. The Boscombe Down representative will return the equipment to the manufacturer for examination.

7. This documented detail of the testing has been produced by Chas Taylor (Air Division). (Boscombe Down).

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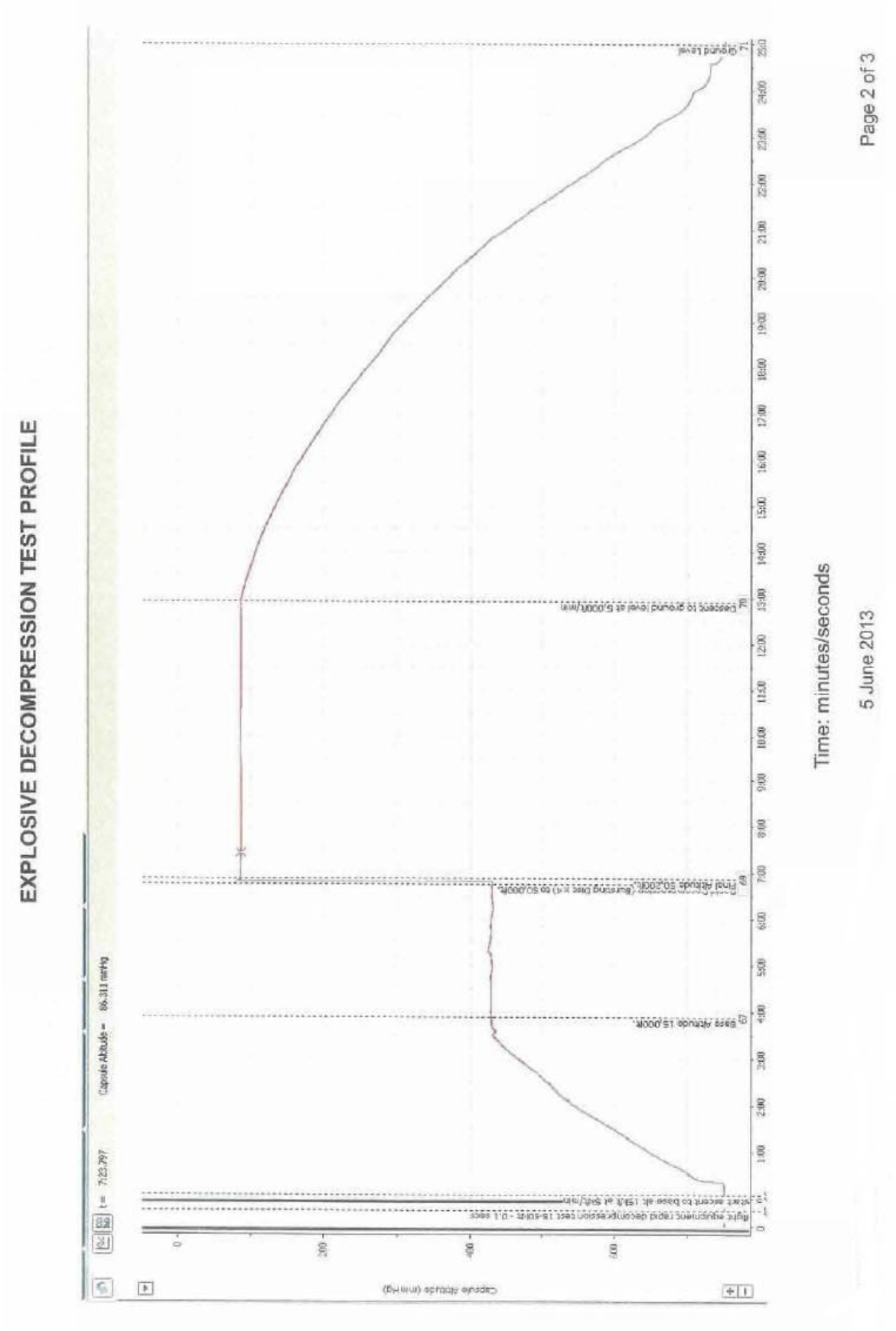
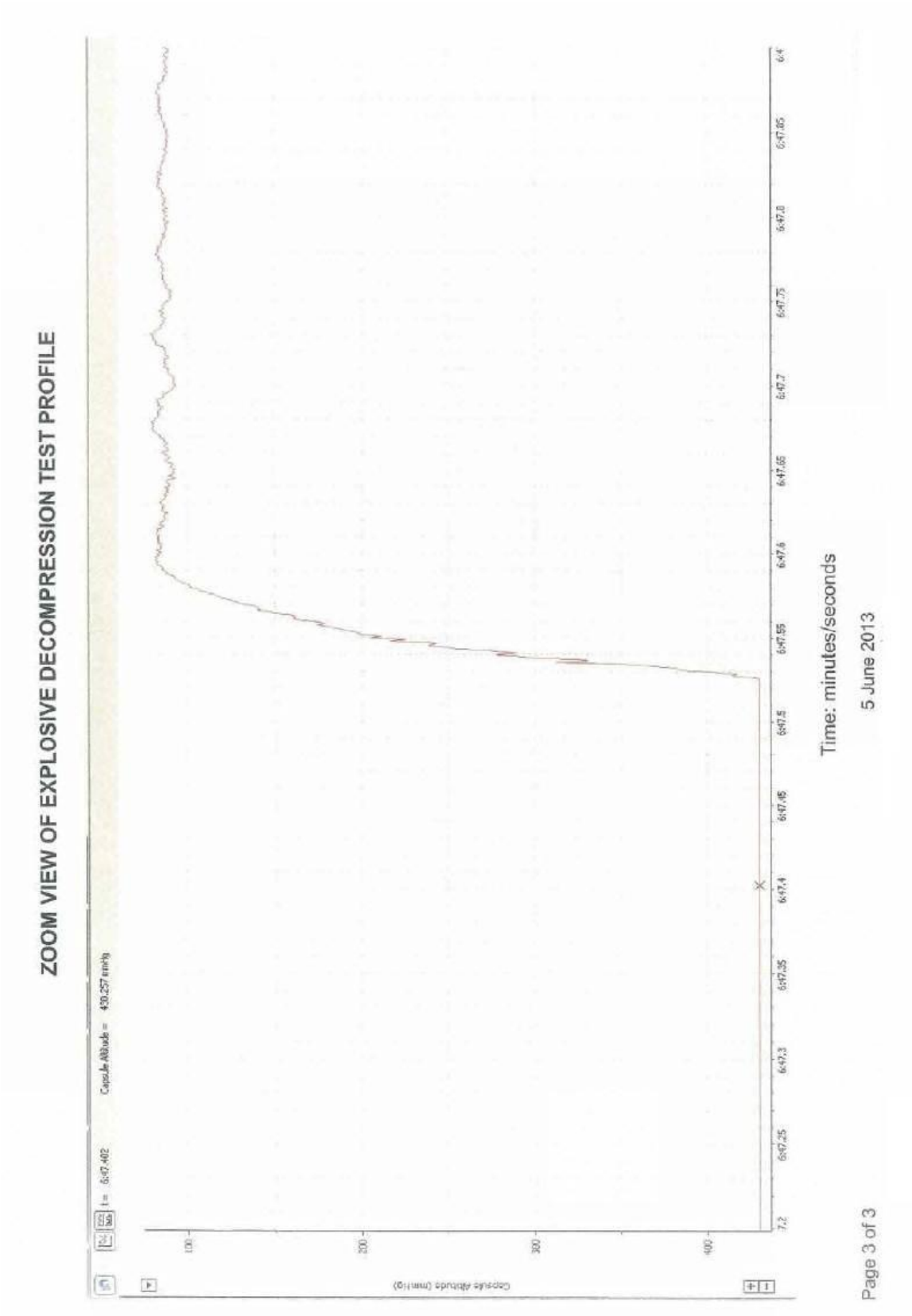

EXPLOSIVE DECOMPRESSION TEST PROFILE
Page 2 of 3
Time: minutes/seconds
5 June 2013


ZOOM VIEW OF EXPLOSIVE DECOMPRESSION TEST PROFILE
Capsule Altitude =
Capsule Altitude (mm Hg)
Time: minutes/seconds
5 June 2013
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