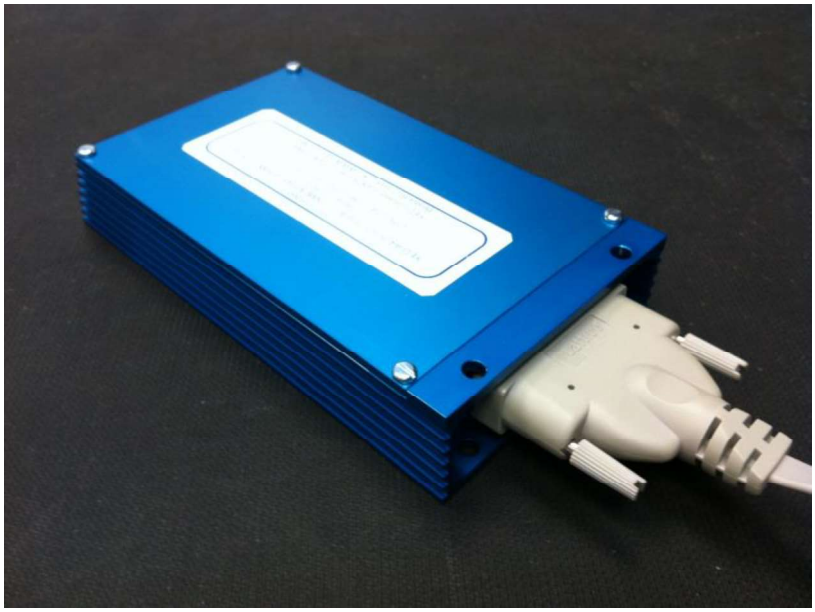
YED Limited

Documentation for:

YED/NMEAR1/A429T1/STM32

RS232/RS422 NMEA0183 to ARINC 429 Converter ($GPRMC, $GPGGA)



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Amendment Page

Version	Date of Issue	Change Reference	Remarks
1.0	29 Dec 2011	N/A	Original Issue
1.1	1st May 2012	N/A	Additional labels added to complement existing ones.
1.2	12th Jul 2013	N/A	D9 changed to D15 plug. Enclosure changed for new CNC vers.
1.3	23rd July 2013	N/A	Serial Baud rate DIP switches ARINC 429 TX Speed DIP switches

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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/NMEA-R1/A429-T1/STM32, NMEA 0183 to ARINC-429 Converter.

This converter is in use by many companies who have a requirement to extract navigational data from a NMEA 0183 data source and translate it onto an ARINC 429 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 NMEA 0183 messages and output a variety of ARINC 429 labels. The typical NMEA 0183 messages and ARINC 429 labels processed by this converter are shown in the table below.
Reception of NMEA 0183 serial data can currently be accommodated from baud rates of 4800, 9600, 19200 and 38400 as standard and are selected by the setting of a DIP switch mounted on the PCB.
The converter can transmit high or low speed ARINC 429 depending upon the state of a small DIP switch mounted on the PCB.
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/NMEA-R1/A429-T1/STM32, NMEA 0183 to 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/NMEA-R1/A429-T1/STM32 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/NMEA-R1/A429-T1/STM32 has the following features: -

Physical

The YED/NMEA-R1/A429-T1/STM32 attaches to the airframe via four mounting holes. See paragraph titled “Enclosure Outline Drawing” for further details.
The enclosure is a CNC machined box with Anodised and Alocrom finish.

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……	40mA maximum at 28V DC
Reverse polarity protected	
Electrically fused ……	500mA (non-resettable)
Thermally fused ……	102 Degs. C. (non-resettable)

Serial Input

Format……	RS232 & RS422, NMEA 0183, 8 data-bits, 1-Stop, No Parity.
NMEA 0183 messages……	$GPRMC, $GPGGA.
Baud Rates……	4800, 9600, 19200, 38400 (other baud rates available to order)
NMEA 0183 Update rate……	1Hz
NMEA 0183 to ARINC conversion time……	< 100uS (Typ.)

ARINC 429 Output

Output is via an industry standard ARINC 429 line Driver.
Bit Rate …… 12.5kHz or 100kHz.

ARINC 429 Output Labels

L010 : Present Position Latitude ……	BCD	180N-180S Degrees
L011 : Present Position Longitude ……	BCD	180E-180W Degrees
L012 : Ground Speed (GPS) ……	BCD	Knots
L014 : Track Magnetic……	BCD	0-359.9 Degrees
L076 : Altitude (MSL) ……	BNR	Feet (Position Sense UP)
L110 : Present Position Latitude ……	BNR	Degrees (Position Sense N)
L111 : Present Position Longitude ……	BNR	Degrees (Position Sense E)
L112 : Ground Speed (GPS) ……	BNR	Knots
L125 : Time ……	BCD	0-23.59.9
L147 : Magnetic Variation ……	BNR	+/- 180.00

ARINC 429 Output Labels, continued…

L150 : UTC (GPS) ……..	BNR	Hr:Min:S (23:59.59)
L203 : Altitude (MSL) ……..	BNR	Feet (Position Sense UP)
L204 : Altitude (MSL) ……..	BNR	Feet (Position Sense UP)
L260 : Date (GPS) ……	BCD	Dy:Mo:Yr (dd:mm:yr)
L273 : Sensor Status(No. of Sats Tracked) ……	DIS	
L310 : Present Position Latitude ……..	BNR	Degrees (Position Sense N)
L311 : Present Position Longitude ……..	BNR	Degrees (Position Sense E)
L312 : Ground Speed (GPS) ……..	BNR	Knots
L314 : Track Magnetic……	BNR	Degrees (Position Sense CW - N)

Environmental

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

2 Operation

2.1 Received NMEA0183 data

Serial data (RS232 or RS422 dependent upon option ordered) is received and processed at a rate of once per second (1 Hz) at a default baud rate of 4800. There is no hardware handshake and no parity.

Received NMEA0183 data is in ASCII format and conforms to NMEA 0183 data format standards. Two sentence headers are currently supported, "$GPRMC" and "GPGGA". Each Sentence string begins with a '$' and terminates with a Carriage Return (0x0d) and Line Feed Character (0x0a). The ',' comma delimiters are used to separate each particular field.

PLEASE NOTE: Where identical parameters exist in both $GPRMC and $GPGGA, parameters received from $GPRMC will take precedence over parameters received from $GPGGA.

Typical inputs are shown below:-

$GPRMC,115536,A,13659.99,N,09000.00,E,123.0,045.0,060411,045.0,E*40
$GPGGA,115536,13659.99,N,09000.00,E,1,08,,03048.0,M,,M,,*41
{1 second GAP}
$GPRMC,115536,A,13659.99,N,09000.00,E,123.0,045.0,060411,045.0,E*40
$GPGGA,115536,13659.99,N,09000.00,E,1,08,,03048.0,M,,M,,*41
{1 second GAP}
$GPRMC,115536,A,13659.99,N,09000.00,E,123.0,045.0,060411,045.0,E*40
$GPGGA,115536,13659.99,N,09000.00,E,1,08,,03048.0,M,,M,,*41
{1 second GAP}

2.2 Conversion formats for the following NMEA 0183 parameters:

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

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

RMC Recommended Minimum Navigation Information

```
$GPRMC,hhmmss.ss,A,llll.ll,a,yyyyy.yy,a,x.x,x.x,ddmmyy,x.x,a*hh
       |         | |       | |        |  |   |  |      |   | |
       1         2 3       4 5        6  7   8  9      10 11 12
```

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

```
eg2. $GPRMC,220516,A,5133.82,N,00042.24,W,173.8,231.8,130694,004.2,W*70
             |      | |       | |        | |     |     |      |     | |
             1      2 3       4 5        6 7     8     9      10    11 12
```

ASSOCIATED ARINC 429 LABELS

L125/150	1 = UTC of position fix
	2 = Data status (V=navigation receiver warning)
L010/110/310	3 = Latitude of fix
	4 = N or S
L011/111/311	5 = Longitude of fix
	6 = E or W
L012/112/312	7 = Speed over ground in knots
L014/314	8 = Track made good in degrees True
L260	9 = UT date
L147	10 = Magnetic variation degrees (Easterly var. subtracts from true course)
	11 = E or W
	12 = Checksum

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

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

```
$GPGGA,hhmmss.ss,llll.ll,a,yyyyy.yy,a,x,xx,x.x,x.x,M,x.x,M,x.x,xxxx*hh
       |         |       | |        | | |  |   |   | |   | |   |    |
       1         2       3 4        5 6 7  8   9  10 11 12 13  14   15
```

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

ASSOCIATED ARINC 429 LABELS

L125/150	1	= UTC of Position
L010/110/310	2	= Latitude
	3	= N or S
L011/111/311	4	= Longitude
	5	= E or W
	6	= GPS quality indicator
L273	7	= Number of satellites in use [not those in view]
	8	= Horizontal dilution of position
L076/203/204	9	= Antenna altitude above/below mean sea level (geoid)
	10	= Meters (Antenna height unit)
	11	= Geoidal separation (Diff. between WGS-84 earth ellipsoid and mean sea level.
	12	= Meters (Units of geoidal separation)
	13	= Age in seconds since last update from diff. reference station
	14	= Diff. reference station ID#
	15	= Checksum

2.5 ARINC429 transmission

Transmission of the following ARINC429 Labels:-

ARINC 429 Label	Description	Numeric format
147	Magnetic Variation	BNR
125,150	Time	BCD/BNR
260	Date	BCD
076,203,204	Altitude	BNR/BNR/BNR
010,110,310	Latitude	BCD/BNR/BNR
011,111,311	Longitude	BCD/BNR/BNR
012,112,312	Ground Speed	BCD/BNR/BNR
014,314	Magnetic Heading	BCD/BNR
273	Sensor Status	Discrete

High or low speed ARINC data is output dependent upon a DIP switch on the PCB. Transmitted ARINC429 data words have Odd Parity and the correct SSM (bits 30 & 31) field status when valid NMEA0183 data has been received. Otherwise, the SSM is set to NCD or similar status.

2.5.1 ARINC429 transmission order and repetition rates

50mS Transmission frame:
Labels: 203, 204, 312, 314.

100mS Transmission frame:
Labels: None.

200mS Transmission frame:
Labels: 076, 110, 111, 112, 125, 150, 273, 310, 311.

500mS Transmission frame:
Labels: 147, 260, 010, 011, 012, 014.

2.5.2 ARINC429 Label code definitions

The following sections define the various transmitted ARINC 429 label definitions.

2.5.3 Label 147 – Magnetic Variation

Format : BNR
Range: +/- 180.00
Transmit Interval: 500mS

Magnetic Variation 275 Deg .	(147)	0	1	1	1	1	0	0	0	0	1	1	1	0	0	1	0	P	P	P	P	P	P	0	0	1	0	1	1	0	0	1	0

2.5.4 Label 125 – GMT

Format : BCD
Range: 0-23.59.9
Transmit Interval: 200mS

Universal Time Constant 1545.5 Hr.	(125)	1	0	0	0	0	1	0	1	0	1	0	1	0	0	0	1	0	1	0	1	0	1	0	0	1	0	1	0	1	0	1	0

2.5.5 Label 150 – GMT

Format : BNR
Range: 23:59:59
Transmit Interval: 200mS

UTC (18:57:20)	(150)	0	1	1	0	1	0	0	1	0	1	1	1	0	0	1	0	1	0	1	0	0	0	0	0	0	0	0	1	0	1	1	0

2.5.6 Label 260 – Date

Format : BCD
Range: 1 Day
Transmit Interval: 1000mS

32	31 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
P	SSM	Day		Month		Year		SDI	Date Label 260G
		10s	1s	10s	1s	10s	1s		

2.5.7 Label 076 – Altitude

Format : BNR
Range: 131072 Feet
Transmit Interval: 200mS

32	31 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
P	SSM [2]	S	ALTITUDE	LABEL (076)
0	1 1	0	0 0 1 0 1 0 0 1 0 0 1 0 0 0 0 1 1 0 0 0 MSB LSB	0 1 1 1 1 1 0 0 LSB MSB
			21059	6 7 0

2.5.8 Label 203 & 204 – Altitude

Format : BNR
Range: 131072 Feet
Transmit Interval: 50mS

32	31 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
P	SSM [2]	S	ALTITUDE	ALT [1]	PAD	LABEL (203)
0	1 1	0	0 0 1 0 1 0 0 1 0 0 1 0 0 0 0 1 1 MSB LSB	0	0 0	1 1 0 0 0 0 0 1 LSB MSB
			21059	1		3 0 2

2.5.9 Label 010 – Latitude

Format : BCD
Range: 180N-180S
Transmit Interval: 500mS

2.5.10 Label 011 – Longitude

Format : BCD
Range: 180E-180W
Transmit Interval: 500mS

BCD ENCODING OF LATITUDE AND LONGITUDE

Bit No.	32	31 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
PARAMETER (Label)		SSM	DATA FIELD (MSC … LSC)		LABEL
			1 8 4 2 1 | 8 4 2 1 | 8 4 2 1 | 8 4 2 1	8 4 2 1	1 2 4 | 1 2 4 | 1 2
Present Position (Lat.) N 75 Deg 59.9' (010)	1	0 0	0 | 0 1 1 1 | 0 1 0 1 | 0 1 0 1 | 1 0 0 1	1 0 0 1	0 0 0 | 1 0 0 | 0 0
Present Position (Long) W 169 Deg 25.8' (011)	0	1 1	1 | 0 1 1 0 | 1 0 0 1 | 0 0 1 0 | 0 1 0 1	1 0 0 0	1 0 0 | 1 0 0 | 0 0

2.5.11 Label 110 – Latitude

Format : BNR
Range: 180N-180S
Transmit Interval: 200mS

2.5.12 Label 111 – Longitude

Format : BNR
Range: 180E-180W
Transmit Interval: 200mS

Present Pos. Lat. N 81.5 Deg	(110)	1	1	1	0	0	1	1	0	0	0	1	1	1	1	1	0	1	0	1	0	1	0	0	0	0	0	1	0	0	1	0
Present Pos. Long. W 100.25	(111)	0	1	1	1	0	1	1	1	0	0	0	1	0	1	1	0	1	1	0	0	0	0	0	0	1	0	0	1	0	0	1	0

2.5.13 Label 310 – Latitude

Format : BNR
Range: 180N-180S
Transmit Interval: 200mS

2.5.14 Label 311 – Longitude

Format : BNR
Range: 180E-180W
Transmit Interval: 200mS

Present Pos. Lat. N 81.5 Deg	(310)	1	1	1	0	0	1	1	0	0	0	1	1	1	1	1	0	1	0	1	0	1	0	0	0	0	0	1	0	0	1	1
Present Pos. Long. W 100.25	(311)	0	1	1	1	0	1	1	1	0	0	0	1	0	1	1	0	1	1	0	0	0	0	0	0	1	0	0	1	0	0	1	1

2.5.15 Label 012 – Ground Speed

Format : BCD
Range: 7000 Knots
Transmit Interval: 500mS

Ground Speed 650 Knots	(012)	1	0	0	0	0	0	0	1	1	0	0	1	0	1	0	0	0	0	P	P	P	P	0	0	0	1	0	1	0	0	0	0

2.5.16 Label 112 – Ground Speed

Format : BNR
Range: 4096 Knots
Transmit Interval: 200mS

Ground Speed 650 Knots	(112)	1	1	1	0	0	0	1	0	1	0	0	0	1	0	1	0	0	0	0	P	P	P	0	0	0	1	0	1	0	0	1	0

2.5.17 Label 312 – Ground Speed

Format : BNR
Range: 4096 Knots
Transmit Interval: 50mS

Ground Speed 650 Knots	(312)	1	1	1	0	0	0	1	0	1	0	0	0	1	0	1	0	0	0	0	P	P	P	0	0	0	1	0	1	0	0	1	1

2.5.18 Label 014 – Magnetic Heading

Format : BCD
Range: 0-359.9 Deg
Transmit Interval: 500mS

Magnetic Heading (014) 165.5 Deg.	1	0 0	0 0 1	0 1 1 0	0 1 0 1	0 1 0 1	P P P P	0 0	0 0 1 1 0 0 0 0

2.5.19 Label 314 – Magnetic Heading

Format : BNR
Range: +/-180
Transmit Interval: 250mS

Magnetic Heading (314) 275 Deg	0	1 1 1	1 0 0 0 0 1 1 1 0 0 1 0 0 0 0 P P P	0 0	0 0 1	1 0 0	1 1

2.5.20 Label 273 – Sensor Status

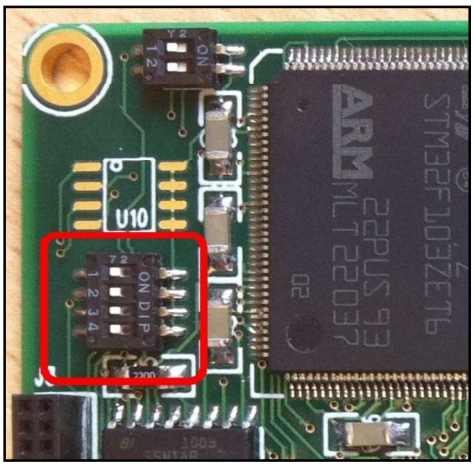
Format : BNR
Range: 0-15
Transmit Interval: 250mS

Sensor Status (273) 273	0	1 1	0 **S**	0 0 0 0 0	1 1 1 0 **SATS**	P P P P P P P P P	0 0	1 1 0	1 1 1	0 1

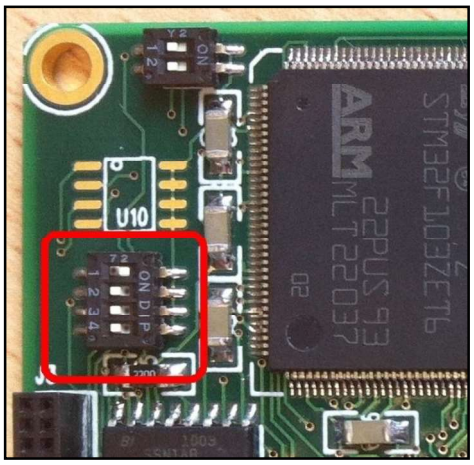
SATS = Number of Satellites Tracked from 0-15.
S = 0 when number of tracked satellites is 0-15.
S = 1 when number of tracked satellites is > 15.

2.6 Baud rate switches.

4800



9600



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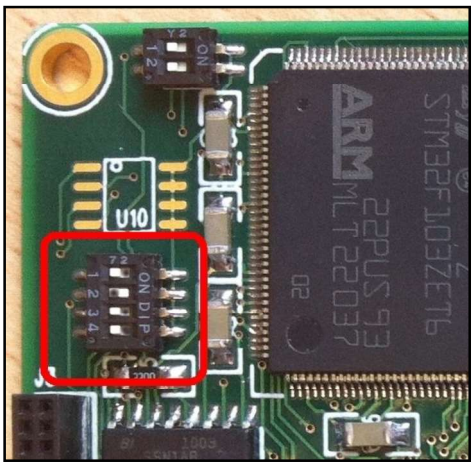
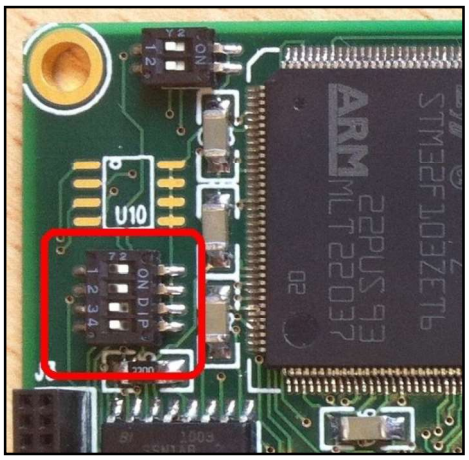
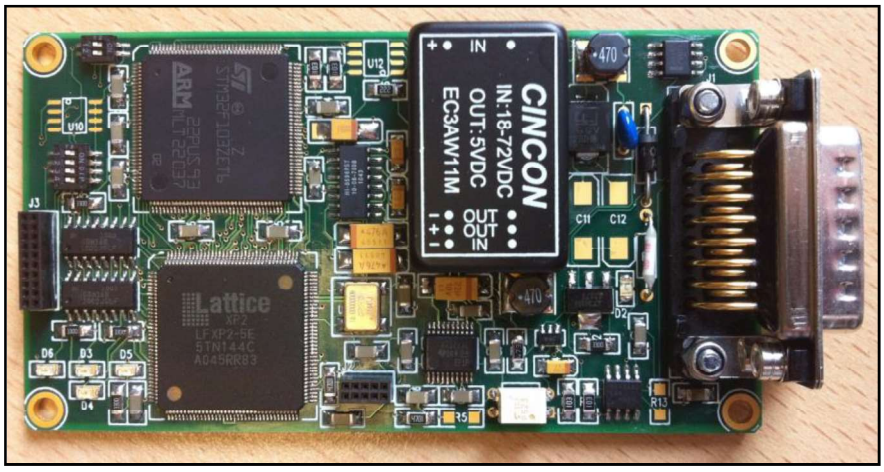
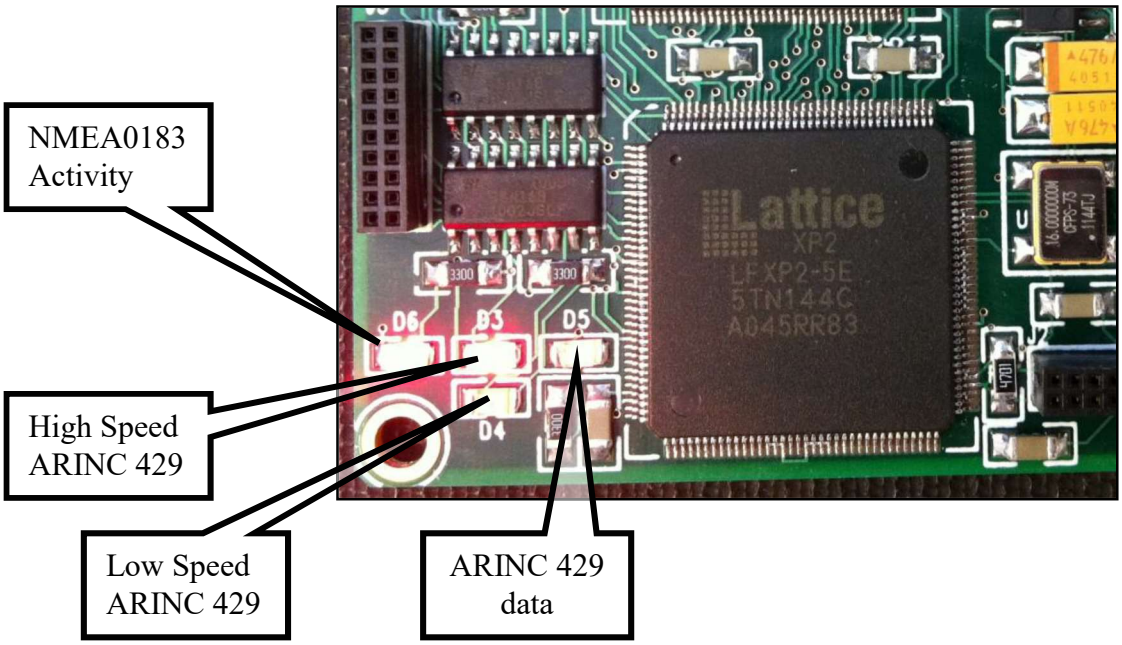


38400



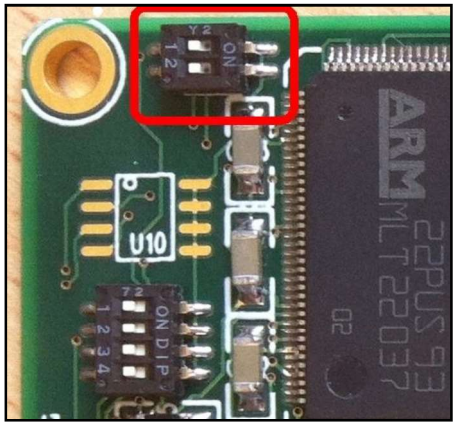


2.7 LED Indicators.

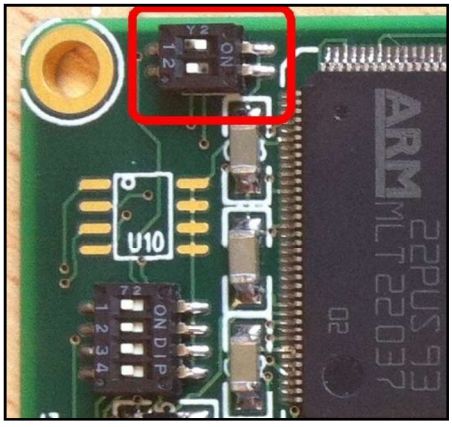


2.8 ARINC 429 Tx Speed setting

Low Speed



High Speed



3 Installation

This section provides details for the installation of the YED/NMEA-R1/A429-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/NMEA-R1/A429-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/NMEA-R1/A429-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/NMEA-R1/A429-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.

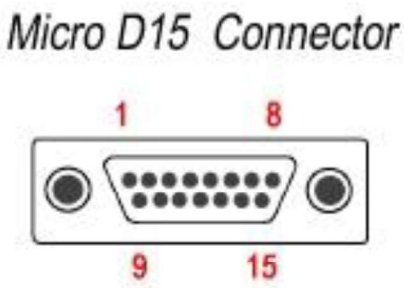
4 Environmental & EMC

The YED/NMEA-R1/A429-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/NMEA-R1/A429-T1/STM32 contains a single 15-pin filtered male connector, J1, per MIL-C-24308.

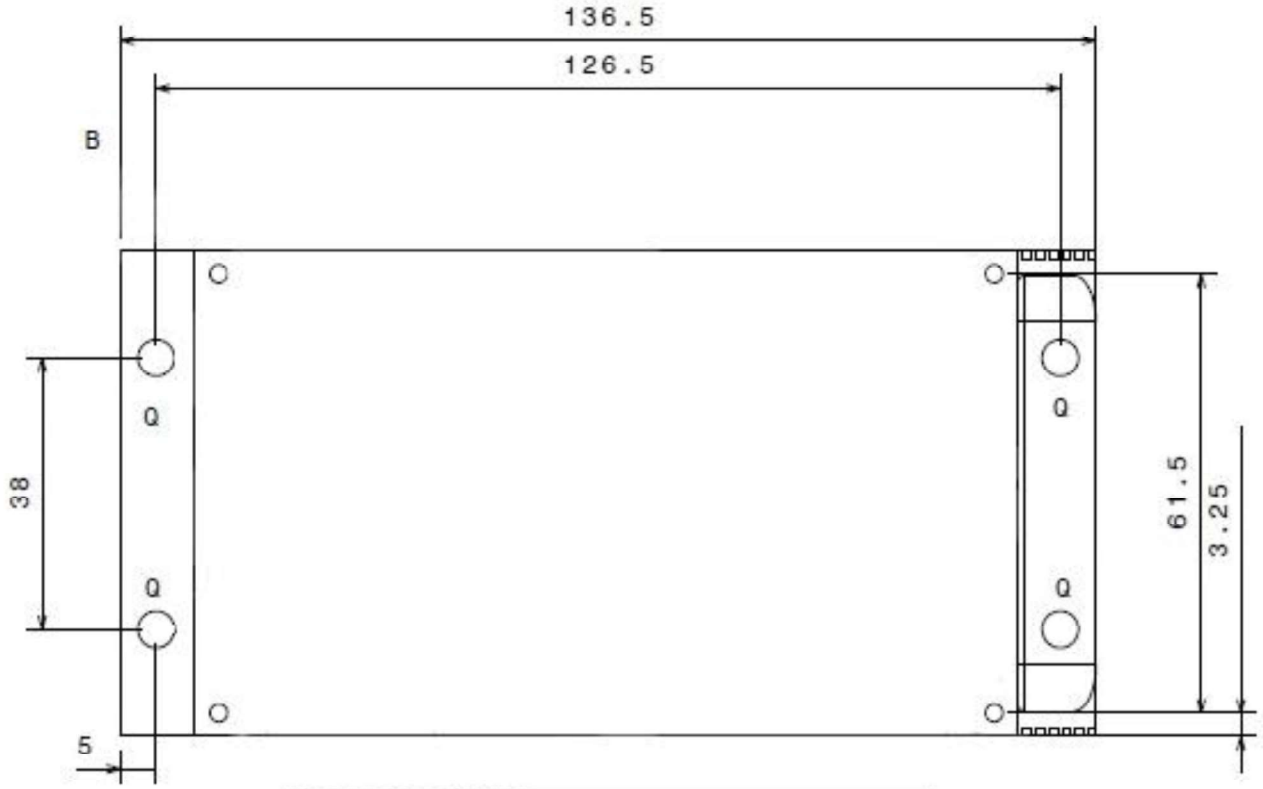


Pin	Signal	Function
1	+28V DC	Primary power
2	0V Ground	28V DC Return
3	A429 Tx +Ve	ARINC429 Transmit TXA
4	A429 Tx -Ve	ARINC429 Transmit TXB
5	A429 Rx +Ve	ARINC 429 Receive (input) RXA
6	A429 Rx -Ve	ARINC 429 Receive (input) RXB
7	A429 Ground (0V)	ARINC 429 Screen
8	FLASH Program Enable **	Enable reprogram 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

** Special GUI Host program and Serial cable required.

6 Enclosure outline drawing

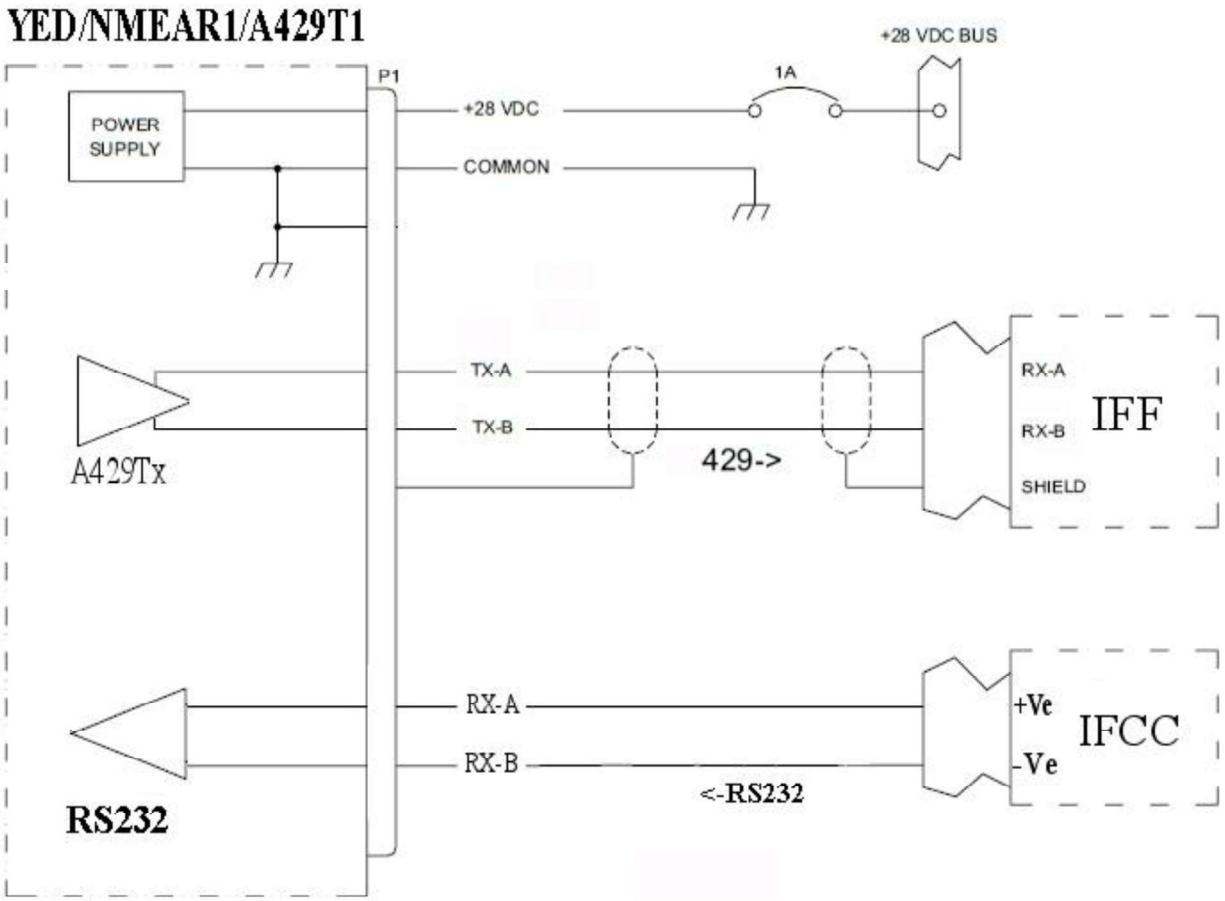


HOLE CODE	TYPE
Q	Ø5.2MM THRU (TOP AND BTM FLANGE)

MATERIAL A/ALLOY 6028 (HE30TF)

All dimensions are in mm.

7 Typical interconnect drawing



8 Annex 1 – Explosive 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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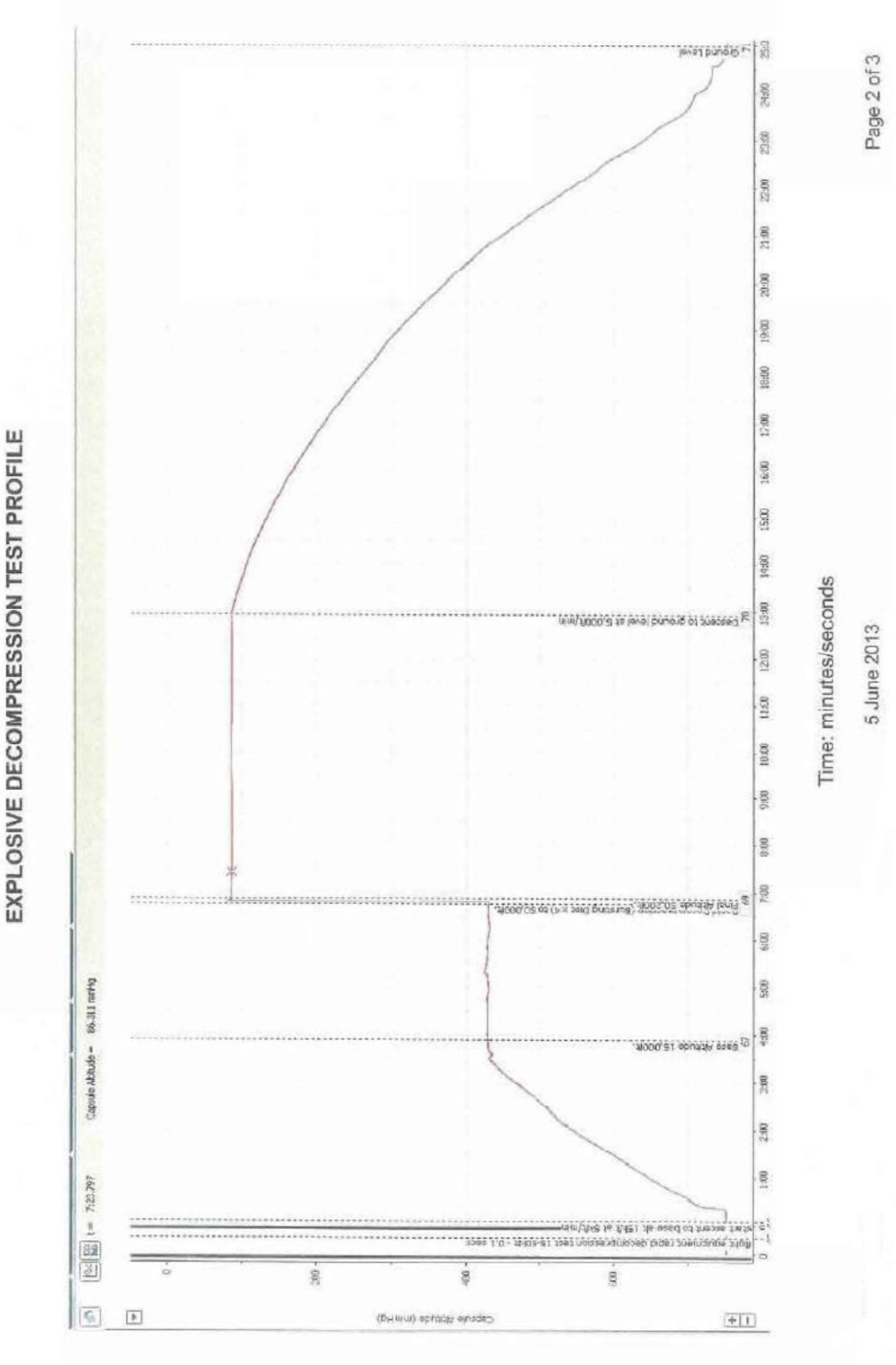
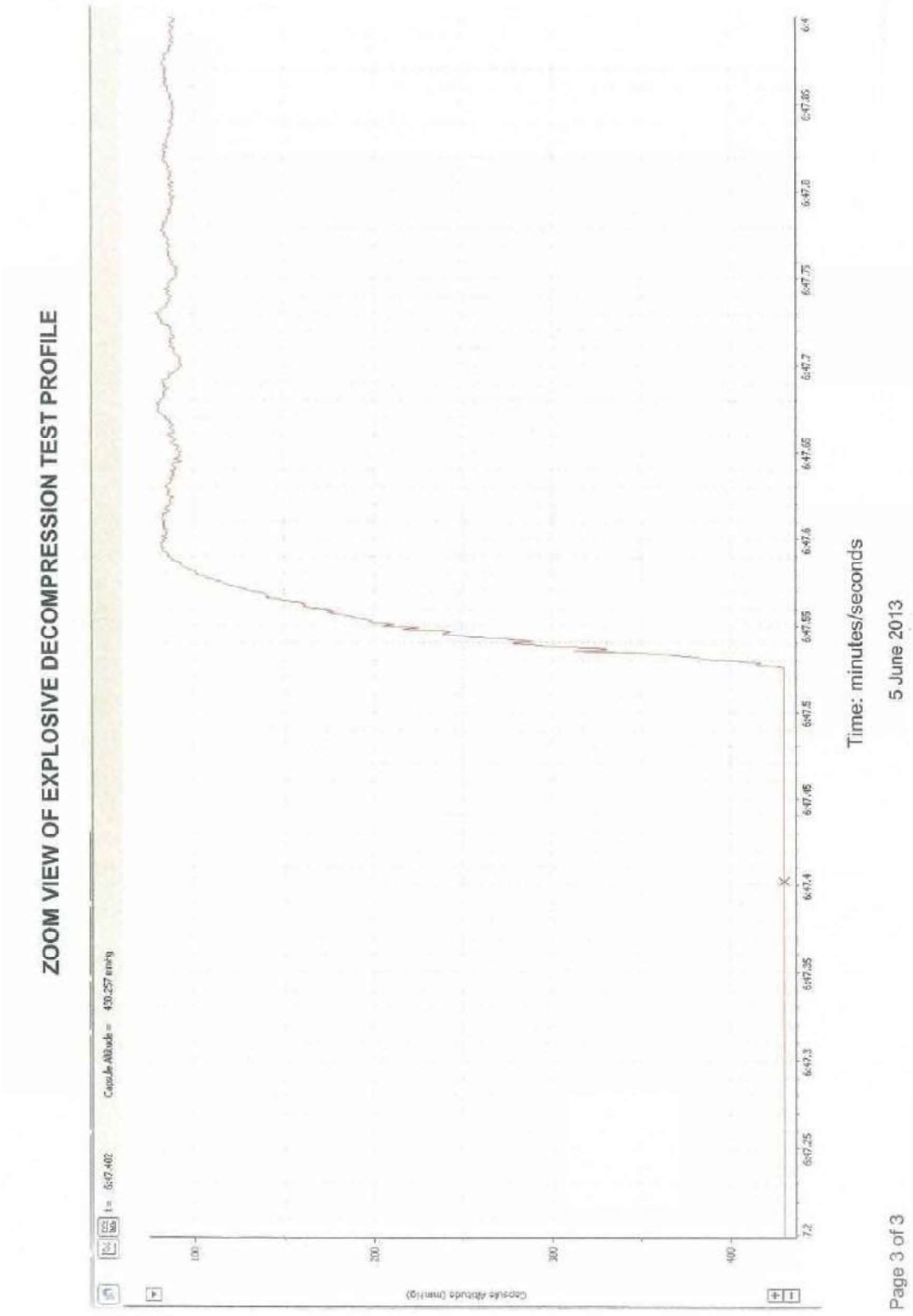

EXPLOSIVE DECOMPRESSION TEST PROFILE
Page 2 of 3
Time: minutes/seconds
5 June 2013


ZOOM VIEW OF EXPLOSIVE DECOMPRESSION TEST PROFILE
Capsule Altitude = 430.257 mmHg
t = 6:47.402
Capsule Altitude (mmHg)
100
200
300
400
7.2
6:47.25
6:47.3
6:47.35
6:47.4
6:47.45
6:47.5
6:47.55
6:47.6
6:47.65
6:47.7
6:47.75
6:47.8
6:47.85
Time: minutes/seconds
5 June 2013
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