**CHAPTER 6**

**EXPLANATION OF DATA GENERATION IN DIFFERENT EQUIPMENTS**

**6.1 Calculation for data generation of every equipment:**

Every equipment generates digital data every second and it passes through the databus. In order to obtain the reliability and error rate in our proposed databus we need to calculate generated data in every second.

Range of the equipments means the difference between the largest and the smallest value that equipments can measure. In our proposed databus for transmitting data we have 14 bits & data transmitted in the bus in binary format. So binary value of the range of any equipment is represented in 14 bits. We have converted the decimal value of range into binary by 2’s complement used , one for magnitude and one for decimal. If one set of 14 bit fails to represent the magnitude, then 2 sets of 14 bit will be used. Precision plays an important factor in data generation. For more precise value we need more number after decimal as well as more bits. For the highest value of the equipment we don’t need numbers after decimal . But maximum use of 14 bits will be occur when the penultimate unit with decimal value will be represented. So that value will be the maximum value represented in 14 bits. Like if the highest range of airspeed indicator method. If the range is too big to represent in 14 bits , then two sets of 14 bits are is160 knots and its binary representation is 10100000 then the maximum value represented by the 14 bits will be 159.99 knots represented in 1001111.111111. In 1st case only 7 bits out of 14 are used to convert it in binary but in last case 14 out of 14 bits are used. Then the found binary value within 14 bits are converted into decimal again and found difference between the actual maximum decimal value. It is called the maximum error in conversion.

In order to calculate the throughput of the system we need to work with operating frequency of the equipments, their sampling rate and then we get total generated bits. Operating frequency of a equipment is the rate of information it generates in every second.  sample rate, or sampling frequency defines the number of [samples](http://en.wikipedia.org/wiki/Sample_%28signal%29) per unit of [time](http://en.wikipedia.org/wiki/Time) (usually [seconds](http://en.wikipedia.org/wiki/Second)) taken from a [continuous signal](http://en.wikipedia.org/wiki/Continuous_signal) to make a [discrete signal](http://en.wikipedia.org/wiki/Discrete_signal). No. of samples must be ≥ 2 × operating frequency. We have 14 digits for representing the binary data. So generated bits per second of every equipments will be 2×no. of digit(14) ×operating frequency.

Data characteristics , conversion error and data generation of every equipments are given bellow:

**6.2 Master Computer**

Address: 0000

Total bits generated per second:

Assuming Operating frequency 10 MHz

So generated bits : 14×10×10^6 =140 Mbps

**8.9.2Backup Master Computer**

Address: 0001

All thing s are same as master computer.

**8.9.3.Initial Navigation Platform**

Address: 0010

Equipment: Laser Gyro

Range of the equipment: ±300 degree [8]

We need 2 values after decimal to represent the data of laser gyro. If we represent the maximum value of equipment in 14 bits with two digits after decimal the conversion error is big (.03o). In order to minimize the error we assign 14 bits for magnitude whose 1st bit is positive or negative sign bit and another 14 bits for decimal value representation.

Minimum & Maximum value at all 14 bits: ±299.99o

Minimum value in binary representation: 10000100101011.11111101011100

Maximum value in binary representation: 00000100101011.11111101011100

Maximum error in conversion: .01o

Total bits generated per second:

Assuming Operating frequency 300 Hz (100Hz for each 3 axis)

Sampling rate 2×300Hz

So generated bits 14×2×300 = 84Kbps

**8.9.4.Air data computer** [9][11]

Address : 0011

Parameter: 1. Air speed indicator

Range of the operation: 0 to 160 knots

We need 2 values after decimal to represent the data of air speed. If we represent the maximum value of equipment in 14 bits with two digits after decimal, there will be 8 digits for magnitude and rest 6 bits for decimal value representation

Minimum & Maximum value at all 14 bits: 0 to 159.99 knots.

Minimum value in binary representation: 00000000.000000

Maximum value in binary representation: 10011111.111111

Maximum error in conversion: .01 knots

Total bits generated per second:

Assuming Operating frequency 100 Hz

Sampling rate 2×100 Hz

So generated bits 14×2×100 = 2.8Kbps

Parameter: 2 True Air Speed

Range of the operation: 0 to 300 knots

We need 2 values after decimal to represent the data of true air speed. If we represent the maximum value of equipment in 14 bits with two digits after decimal, there will be 8 digits for magnitude and rest 6 bits for decimal value representation

Minimum & Maximum value at all 14 bits: 0 to 299.99 knots.

Minimum value in binary representation: 00000000.000000

Maximum value in binary representation: 100101011.111111

Maximum error in conversion: .02 knots

Total bits generated per second:

Assuming Operating frequency 100 Hz

Sampling rate 2×100 Hz

So generated bits 14×2×100 = 2.8Kbps

Parameter: 3. Computed Air speed

Range of the operation: 50 to 300 knots

We need 2 values after decimal to represent the data of air speed. If we represent the maximum value of equipment in 14 bits with two digits after decimal, there will be 9 digits for magnitude and rest 5 bits for decimal value representation

Minimum & Maximum value at all 14 bits: 49.99 to 299.99 knots.

Minimum value in binary representation: 000110001.11111

Maximum value in binary representation: 100101011.11111

Maximum error in conversion: .02 knots

Total bits generated per second:

Assuming Operating frequency 100 Hz

Sampling rate 2×100 Hz

So generated bits 14×2×100 = 2.8Kbps

Parameter: 4. Static Air Temperature

Range of the operation: -99 oC to 50oC

We need 2 values after decimal to represent the data of static air speed. If we represent the maximum value of equipment in 14 bits with two digits after decimal, there will be 8 digits for magnitude and rest 6 bits for decimal value representation

Minimum & Maximum value at all 14 bits: -98.999 oC to 49.999oC

Minimum value in binary representation: 11100010.111111

Maximum value in binary representation: 00110001.111111

Maximum error in conversion: .01oC

Total bits generated per second:

Assuming Operating frequency 100 Hz

Sampling rate 2×100 Hz

So generated bits 14×2×100 = 2.8Kbps

Parameter: 5*.* Altitude

Range of the operation: -1000ft to 20000 ft

We need 2 values after decimal to represent the data of altitude. We assign one set of 14 bits for magnitude whose 1st bit is positive or negative sign bit and another 14 bits for decimal value representation. If the value is greater than 8191 ft then there will be extra one set of 14 bit for representing magnitude cause in 13 bits(except 1st sign bit) highest we can represent

8191.

Minimum & Maximum value at all 14 bits: -999.99 ft to

Minimum value in binary representation: 10001111100111.11111101011100

Maximum value in binary representation: 01111111111111. 11111101011100

Maximum error in conversion: .01ft

Total bits generated per second:

Assuming Operating frequency 100 Hz

Sampling rate 2×100 Hz

So generated bits 14×2×100 = 2.8Kbps

Parameter: 6. Selected Altitude

Range of the operation: -1000ft to 20000 ft

We need 2 values after decimal to represent the data of selected altitude. We assign one set of 14 bits for magnitude whose 1st bit is positive or negative sign bit and another 14 bits for decimal value representation. If the value is greater than 8191 ft then there will be extra one set of 14 bit for representing magnitude cause in 13 bits(except 1st sign bit) highest we can represent 8191

Minimum & Maximum value at all 14 bits: -999.99 ft to 8191ft

Minimum value in binary representation: 10001111100111.11111101011100

Maximum value in binary representation: 01111111111111. 11111101011100

Maximum error in conversion: .01ft

Total bits generated per second:

Assuming Operating frequency 100 Hz

Sampling rate 2×100 Hz

So generated bits 14×2×100 = 2.8Kbps

Parameter: 7. Pressure Altitude

Range of the operation: -1000ft to 20000 ft

We need 2 values after decimal to represent the data of pressure altitude. We assign one set of 14 bits for magnitude whose 1st bit is positive or negative sign bit and another 14 bits for decimal value representation. If the value is greater than 8191 ft then there will be extra one set of 14 bit for representing magnitude cause in 13 bits(except 1st sign bit) highest we can represent

8191

Minimum & Maximum value at all 14 bits: -999.99 ft to 8191ft

Minimum value in binary representation: 10001111100111.11111101011100

Maximum value in binary representation: 11111111111111. 11111101011100

Maximum error in conversion: .01ft

Total bits generated per second:

Assuming Operating frequency 100 Hz

Sampling rate 2×100 Hz

So generated bits 14×2×100 = 2.8Kbps

Parameter: 8. Vertical Speed

Range of the operation: 0ft /s to 50000 ft/s

We need 2 values after decimal to represent the data of vertical Speed. We assign one set of 14 bits for magnitude and another 14 bits for decimal value representation

Minimum & Maximum value at all 14 bits: 0 ft/s to 4999.99 ft/s

Minimum value in binary representation: 00000000000000.00000000000000

Maximum value in binary representation: 01001110000111. 11111101011100

Maximum error in conversion: .01ft

Total bits generated per second:

Assuming Operating frequency 100 Hz

Sampling rate 2×100 Hz

So generated bits 14×2×100 = 2.8Kbps

**8.9.5. Engine Control Unit** [10]

Address: 0100

Parameter: 1. Engine Temperature

Range of the operation: 0oF to 460oF

We need 2 values after decimal to represent the data of Engine temperature. If we represent the maximum value of equipment in 14 bits with two digits after decimal, there will be 9 digits for magnitude and rest 5 bits for decimal value representation

Minimum & Maximum value at all 14 bits: 0o F to 459.99oF

Minimum value in binary representation: 000000000.00000

Maximum value in binary representation: 111001011.11111

Maximum error in conversion: .02o F

Total bits generated per second:

Assuming Operating frequency 100 Hz

Sampling rate 2×100 Hz

So generated bits 14×2×100 = 2.8Kbps

Parameter: 2. Exhaust Gas Temperature

Range of the operation: 0oF to 1220oF

We need 2 values after decimal to represent the data of exhaust gas temperature. We assign one set of 14 bits for magnitude and another 14 bits for decimal value representation.

Minimum & Maximum value at all 14 bits: 0o F to 1119.99oF

Minimum value in binary representation: 00000000000000.0000000000000

Maximum value in binary representation: 00010010101111.11111101011100

Maximum error in conversion: .01o F

Total bits generated per second:

Assuming Operating frequency 100 Hz

Sampling rate 2×100 Hz

So generated bits 14×2×100 = 2.8Kbps

Parameter: 3. Engine RPM

Range of the operation: 0% to 110%

We need 2 values after decimal to represent the data of engine rpm. If we represent the maximum value of equipment in 14 bits with two digits after decimal, there will be 7 bits for magnitude and rest 7 bits for decimal value representation.

Minimum & Maximum value at all 14 bits: 0% to 109.99%

Minimum value in binary representation: 0000000.0000000

Maximum value in binary representation: 1101101.1111110

Maximum error in conversion: .01%

Total bits generated per second:

Assuming Operating frequency 100 Hz

Sampling rate 2×100 Hz

So generated bits 14×2×100 = 2.8Kbps

**8.9.6.GPS** [2]

Address: 0101

Parameter 1. Latitude

Range of the equipment: ±90o

4 values after decimal is required to represent the data of latitude. . If we represent the maximum value of equipment in 14 bits with two digits after decimal, there will be 8 bits for magnitude and rest 6 bits for decimal value representation

Minimum & Maximum value at all 14 bits: ±89.9999o

Minimum value in binary representation: 1101101.111111

Maximum value in binary representation: 0101101.111111

Maximum error in conversion: .0156 o

Total bits generated per second:

Assuming Operating frequency 100 Hz

Sampling rate 2×100 Hz

So generated bits 14×2×100 = 2.8Kbps

Parameter 2. Longitude

Range of the equipment: ±180o

We need 4 values after decimal to represent the data of pressure longitude. We assign one set of 14 bits for magnitude whose 1st bit is positive or negative sign bit and another 14 bits for decimal value representation.

Minimum & Maximum value at all 14 bits: ±179.9999o

Minimum value in binary representation: 10000010110011.11111111111110

Maximum value in binary representation: : 00000010110011.11111111111110

Maximum error in conversion: .0001 o

Total bits generated per second:

Assuming Operating frequency 1K Hz

Sampling rate 2×1K Hz

So generated bits 14×2×100K = 28Kbps

**8.9.7. Radio Nav-Aid** [2]

Address: 0111

Parameter: 1. VOR

Range of the operation: 0o to 360o

2 values after decimal is required to represent the data of VOR . If we represent the maximum value of equipment in 14 bits with two digits after decimal, there will be 9 bits for magnitude and rest 5 bits for decimal value representation

Minimum & Maximum value at all 14 bits: 0o F to 359.99o

Minimum value in binary representation: 000000000.00000

Maximum value in binary representation: 101100111.11111

Maximum error in conversion: .02o

Total bits generated per second:

Assuming Operating frequency 100 Hz

Sampling rate 2x100 Hz

So generated bits 14×2x100 = 2.8Kbps

Parameter: 2. ILS

Total bits generated per second:

Assuming Operating frequency 100 Hz

Sampling rate 2x100 Hz

So generated bits 14×2x100 = 2.8Kbps

Parameter: 3. ADF

Total bits generated per second:

Assuming Operating frequency 100 Hz

Sampling rate 2x100 Hz

So generated bits 14×2x100 = 2.8Kbps

Now for three types of BIT there will be some bits also. [1][2]

For

 1. Start on need 5× 9× 14=630 bps

2. On demand need 5× 9× 14=630 bps

3. Self check need 10× 9× 14=1260 bps

By calculating we found that there will be 140.1872 Mb data in every second in our proposed architecture.

Assuming 145 Mbps is the maximum throughput in the databus.