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LINK BUDGET ANALISYS OF NATIONAL PAYLOAD ROCKET TELEMETRY COMPETITIONIN PAMENGPEUK GARUT WEST JAVA

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Abstract

Communication system on telemetry payload rocket competition has been built in order to transfer data between payload and the ground station. The transmitter and receiver frequencies were set up into 432.0325MHZ, 433.0325 MHZ, 434.0325 MHZ, and 435.0325 MHZ with their 20 dBmoutput power. Link budget analysis of this system show that the system would have 33 km maximum distance communication with the link margin value was 18 dB which 99% communication availability. It is quite enough for payload rocket competition at PamengpeukGarut West Java due to trajectory rocket predicted only as far as 1 km or below.

Key Words:*Telemetry, link budget, payload rocket*

Nomenclature

C	: Received power
G_R	: Gain receiver
P_T	:Power Transmitter
R	: Distance
Λ	: wave length

1. Introduction

Telemetry has been very importance in rocket and aircraft research. Many sensors data will be transmitted to the base station through radio frequency modem so that human user can see the attitude of their rocket and aircraft on computer screen display real-time and log the data for analysis purposes offline. Payload rocket will have inertia sensors such as accelerometer and gyro meter to measure rocket translation acceleration and angular rate movement. In addition heading sensor such as magnetometer or compass will be very important in determining payload rocket direction or heading.

Experimental Rocket at this competition usually launch from land to the sea where line of sight communication occur between payload and ground station. Payload rocket contest has been held in Pamengpeuk, Garut at June 2013, it has very clear free of sight on the payload rocket contest area. At this event, the payload used 4 frequencies RF modem 432.0325MHZ, 433.0325 MHZ, 434.0325 MHZ, and 435.0325 MHZ with their 20 dBm output power to do wireless communication data.

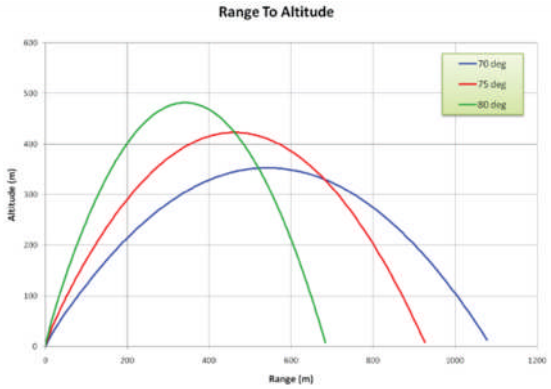

Fig. 1.Prediction of Trajectory RUM Rocket

It is very important to analyze the link budget of radio communication system to ensure payload data will be received successfully by ground station. Radio modem power of transmitter will be reduced since the distance between rocket and the ground station increase. At payload rocket contest, the rocket trajectory has been predicted as Fig. 1 above. From Fig. 1, it is clear that payload will have around 1 km maximum distance communication between transmitter and receiver.

2. Free Space Link Budget Method

Link budget or more precisely link power budget is totaling of all the gains and losses incurred in operating a communication link[1]. The link budget measurement was done to know the telemetry system capability which was used in national surveillance payload rocket competition.

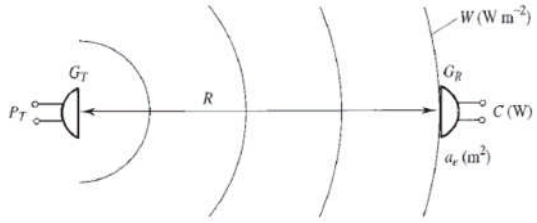

Fig.2.Free Space Propagation[2]

Measurement began from getting a value which describes transmitted power from antenna called EIRP (*Effective Isotropic Radiated Power*). When sending data process occur through atmosphere, there was some radio power reduction happen which called as Free Space Path Loss (FSPL).

From Fig. 2, EIRP can be calculated as given below[2] :

$$C = EIRP - FSPL + G_R(dBW) \quad (1)$$

$$EIRP = 10\ log_{10}P_T + \ 10\ log_{10}G_T \ \ (dBW) \quad (2)$$

$$FSPL = 20log_{10}\left(\frac{4\pi R}{\lambda}\right) \ \ (dB) \quad (3)$$

If distance value was represented in km and the frequency in MHz unit, another form of FSPL can be written as below[3]:

$$FSPL = 20log_{10}(d) + \ 20log_{10}(f) + 32.45 \quad (4)$$

In a wireless communication system, the **link margin**, measured in dB, is the difference between the receiver's sensitivity and the actual received power [3].

$$LinkMargin = ReceivedPower - Receiver'sSensitivity \quad (5)$$

The availability of data received by RF receiver will be known by the value of link margin. Some literature in wireless communication explains about link margin and how to know the availability of data communication using link margin value. Table1shows the availability and link margin value correlation and this table will be used to define the availability of telemetry system in national rocket competition in Pamengpeuk, Garut, West Java.

Table 1.Link Margin Vs Availability[3]

Availability (%)	Link Margin (dB)
90	8
99	18
99.9	28
99.99	38
99.999	48

3. Result and Discussion

The specifications of telemetry system used in national payload rocket competition were given as below:

- Frequency 1 : 432.0325 MHz
- Frequency 2 : 433.0325 MHz
- Frequency 3 : 434.0325 MHz
- Frequency 4 : 435.0325 MHz
- Tx Power : 100 mW (20dBm)
- Antenna Transmitter : Omnidireksional
- TX Antenna gain : 2.5 dB
- TX Cable loss : 0.8 dB
- Antenna Receiver : Omnidireksional
- RX Antenna gain : 6 dB
- RX Cable loss : 1 dB
- RX Sensitifity : -137 dB

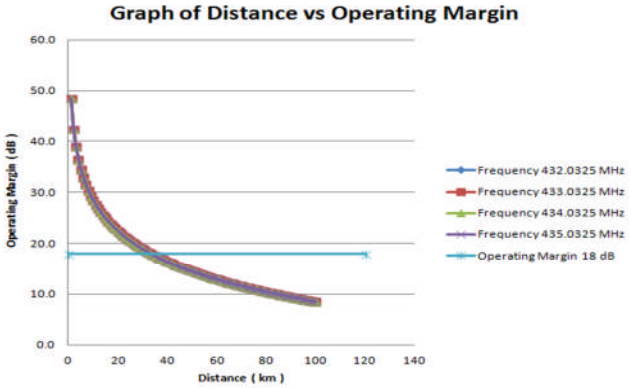

Fig. 3.Link Margin Vs Distance

From the specification and equation above, the graph at Fig. 3 will be produced to show the capability of the telemetry system. We have chosen 18 dBm operating margin or link margin in order to have 99% availability as shown in Table 1. At this point, It will be found the maximum distance of available communication as mention on Table 2 below:

Table 2.Maximum distance of available communication

Frequency (MHz)	Maximum Distance (km)
432.0325	33
433.0325	33
434.0325	33
435.0325	33

Table 2 show the same distance between 4 different working frequencies because they have only small different. Therefore all the telemetry system will work until33 km line of sight. This range is very enough to cover payload rocket communication to the ground station in Pamengpeuk, Garut, West Java.

4. Conclusion

It is very important to analyze link budget of radio modem telemetry for payload rocket competition in order to ensure continuously data streaming from payload to ground station. From the result and discussion above, at PamengpeukGarut link budget for radio modem particularly have 33 km distance maximum. Communication availability on trajectory payload rocket competition at 1 km is very enough using 100 miliWatt radio modem at -137 dB receiver sensitivity.

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Discussion

uestion:

100 MW was what was not too small and sensitive because it is feared there Jaming fuek? (Romi W, Untirta)

How to overcome the bandwidth limitations of the radio used in KOMURINDO?Jaming fuek? (Romi W, Untirta)

nswer:

Based on the calculation of the link budget of 100 milliwatts with a sensitivity of-117dBm radio we use the results are quite satisfactory for use on rocket mileage KOMURINDO 1 km or less. so are the results of the experimental test data communication is successful without reduction of speed data at 115200 BPS. the frequency Jaming it should not happen because we've done 4 different frequency settings for 4 channels, if there are participants in the field with the same frequency it will actually transmit data on the screen caught the race committee, and the jury will be instructed that the frequencies used for competitions made clear that first (no other participants who turn the payload data transmission).

receive radio bandwidth can be set according to the data manually radio manufacturer that is of 30-620 kHz so there is no problem, in our experiments using the default from the manufacturer.