

URSI AP-RASC 2019, New Delhi, India, 09 - 15 March 2019

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Heat and Power Management of new era Electronic Systems

With the developments in Electronics device technology and software based modern design tools, signal processing systems are becoming compact and powerful. These developments along with the advent of high speed computers and software based signal processing, the per cubic feet power consumption and heat generation in modern signal processing systems has thrown up new challenges to designers. Dissipating the generated heat, needs special efforts and planning to continue to use the systems with their maximum capacity. Accomodating multiple systems in a small room makes it necessary to use the specially designed electronic cabinets with suitable arrangements for signal, power distribution while allowing free flow of cold air to take away the generated heat within the units.

During the development of the upgraded GMRT Backend systems, we also faced the task of supporting continued observations using the legacy backend systems and develop and instal the new systems without affecting the old receivers. It is also challenging to meet the electric power requirements of these systems in safe, secure and disciplined way. In the GMRT receivers sytem, the legacy 32MHz bandwidth digital backend and the new 400 Mhz digital backend consume about 15 KWatts of power each generating a heat of 4,30,000 calories/minute. We have modified the standard 19” racks to make them suitable for handling this heat generated within the racks. We have developed a cost effective solution to provide a cool air supply through the circuits and maintain the temperature.

Here we present the details of the system developed, analysis and test results. As part of this activity an automatic calculator is also developed to calculate the heat genetated in calories/minute and the amount of cooling needed to maintain the temperature.

User Parameters :

PowerConsumption in Watts -->
 Difference in Temperature -->
 Volume of Cool Air in ft³ /inlet in corr.-->
 Heat to be absorbed in watts -->
 Temperature Difference in deg. Cel.permitted -->

INPUTS

30000
 15
 600
 3,650
 15.00

Output Parameters

Total Heat Energy in calories/minute -->
Heat Absorption of Cool Air cal/min -->
Number of cool air inlets required..

OUTPUTS

4,30,025
69,042
6.23

Volume of Cool Air in ft³ to absorb the heat : **455**

Constant Parameters :

1 Joule equal to --> Calories
 1 Cubic feet equal to --> Cubic mtr
 Air Density kg/mtr³ @ 25dC & 1 Pascal
 Specific Heat of Air cal/kgdC @ 20dC & 1 Pascal

Constant Values

0.2389029576
 0.02832
 1.128666667
 240

Intermittent Calculation Parameters :

Volume of Cool Air in mtr³ -->
 Mass of cool air in kg/minute -->

int'nt. results

16.992
 19.178304006

Tables :**Total Heat Energy in Cal./min.**

| | |
|---|--------|
| For 1000 watts of Power Consumption --> | 14,334 |
| For 1500 watts of Power Consumption --> | 21,501 |
| For 2000 watts of Power Consumption --> | 28,668 |
| For 2500 watts of Power Consumption --> | 35,835 |
| For 3000 watts of Power Consumption --> | 43,003 |
| For 3500 watts of Power Consumption --> | 50,170 |
| For 4000 watts of Power Consumption --> | 57,337 |
| For 4500 watts of Power Consumption --> | 64,504 |
| For 5000 watts of Power Consumption --> | 71,671 |

Volume of Cool Air in ft³ @1KW heat if :

| | |
|---|-------|
| Temperature difference of 3 deg. Cel. | 2,273 |
| Temperature difference of 3.5 deg. Cel. | 1,949 |
| Temperature difference of 4 deg. Cel. | 1,705 |
| Temperature difference of 4.5 deg. Cel. | 1,516 |
| Temperature difference of 5 deg. Cel. | 1,364 |

Heat Absorption of Cool Air in cal./min.

| | |
|--|--------|
| For Temperature difference of 1 deg.Cel. | 4,603 |
| For Temperature difference of 1.5 deg.Cel. | 6,904 |
| For Temperature difference of 2 deg.Cel. | 9,206 |
| For Temperature difference of 2.5 deg.Cel. | 11,507 |
| For Temperature difference of 3 deg.Cel. | 13,808 |
| For Temperature difference of 3.5 deg.Cel. | 16,110 |
| For Temperature difference of 4 deg.Cel. | 18,411 |
| For Temperature difference of 4.5 deg.Cel. | 20,713 |
| For Temperature difference of 5 deg.Cel. | 23,014 |
| For Temperature difference of 5.5 deg.Cel. | 25,315 |
| For Temperature difference of 6 deg.Cel. | 27,617 |
| For Temperature difference of 6.5 deg.Cel. | 29,918 |
| For Temperature difference of 7 deg.Cel. | 32,220 |
| For Temperature difference of 7.5 deg.Cel. | 34,521 |
| For Temperature difference of 8 deg.Cel. | 36,822 |
| For Temperature difference of 8.5 deg.Cel. | 39,124 |
| For Temperature difference of 9 deg.Cel. | 41,425 |
| For Temperature difference of 9.5 deg.Cel. | 43,727 |
| For Temperature difference of 10 deg.Cel. | 46,028 |

For 1000ft³/min. Cool air