ATMOSPHERE

The atmosphere in which a resonator is hermetically sealed must be dry and chemically inert with reference to all materials inside the unit. The atmosphere is also a factor in determining the rate with which the unit dissipates the heat generated by the oscillating quartz plate, and in the viscous loading of the unit.

Thermal Conductivity

(Quantity of heat in calories, transmitted per second through a section one centimeter thick across an area of one square centimeter when the temperature difference is one degree centigrade.)

Air	0.0000568
Helium	0.000339
Hydrogen	0.000327
Nitrogen	0.0000524

Quartz resonators designed to dissipate appreciable heat (high drive level) are not sealed in a vacuum.

Atmospheric Loading

The atmosphere in which a quartz-resonator plate vibrates increases the motional resistance. The equation is

$$R_{Ln} = \frac{.412\sqrt{\rho\eta}}{nC_n\sqrt{f_n}} \times 10^{-6} ,$$

where:

ρ = density of gas
η = viscosity of gas
n = overtone order
C_n = motional capacitance (farads)
f_n = frequency (cps)

The values of $\sqrt{\rho\eta}$ at 20°C are:

air	4.68×10^{-4}
nitrogen	4.52×10^{-4}
helium	1.795×10^{-4}
hydrogen	0.853×10^{-4}

Most military units are sealed in dry nitrogen. Vacuum is permitted for a few units, and helium is permitted for certain glass-enclosed units.

FIGURE 52

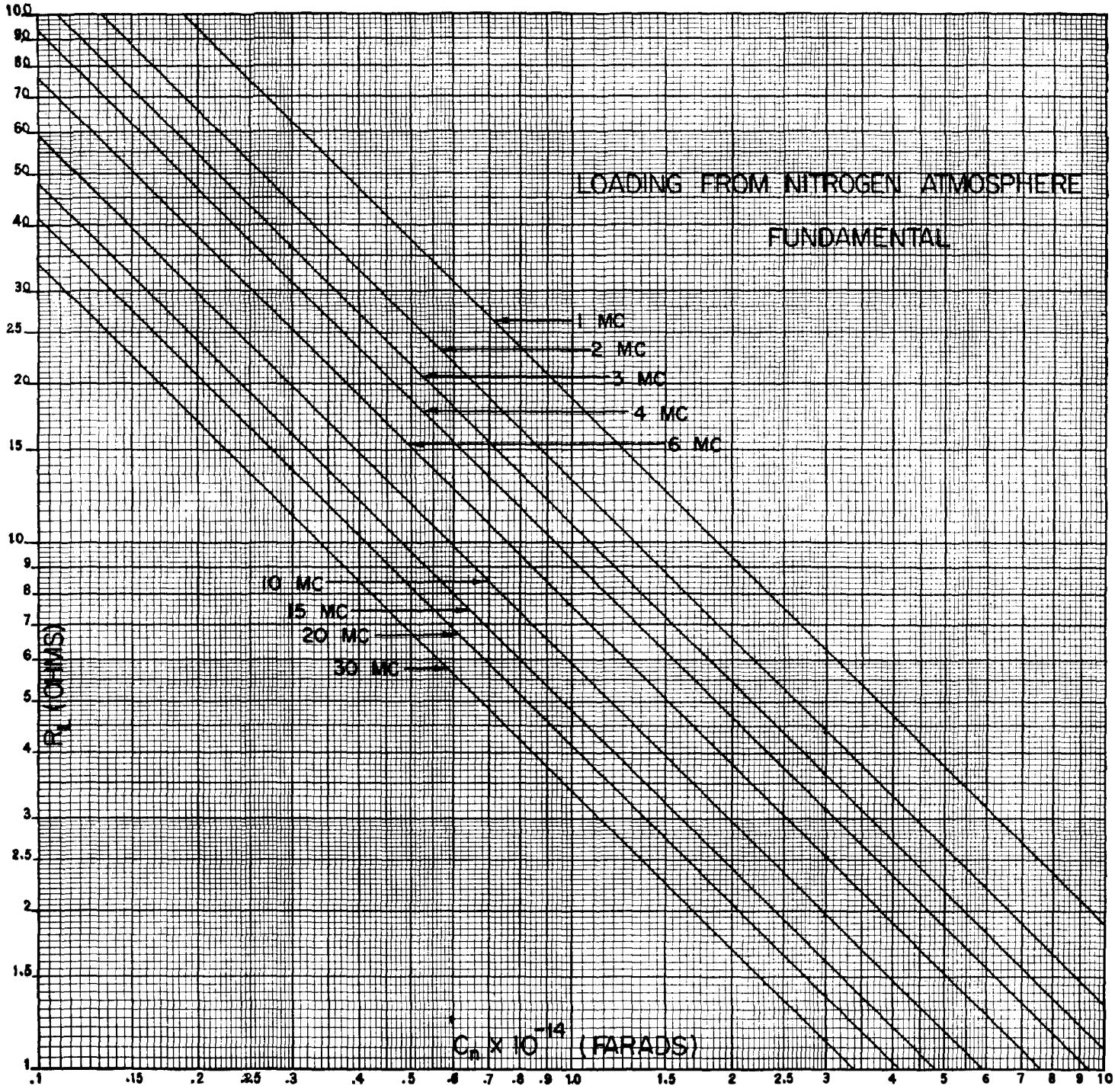
LOADING FROM NITROGEN ATMOSPHERE
FUNDAMENTAL
1 MC
2 MC
3 MC
4 MC
6 MC
10 MC
15 MC
20 MC
30 MC
Q (OHMS)
$C_n \times 10^{-14}$ (FARADS)
100
90
80
70
60
50
40
30
25
20
15
10
9
8
7
6
5
4
3
2.5
2
1.5
1
.1
.15
.2
.25
.3
.4
.5
.6
.7
.8
.9
1.0
1.5
2
2.5
3
4
5
6
7
8
9
10

FIGURE 53

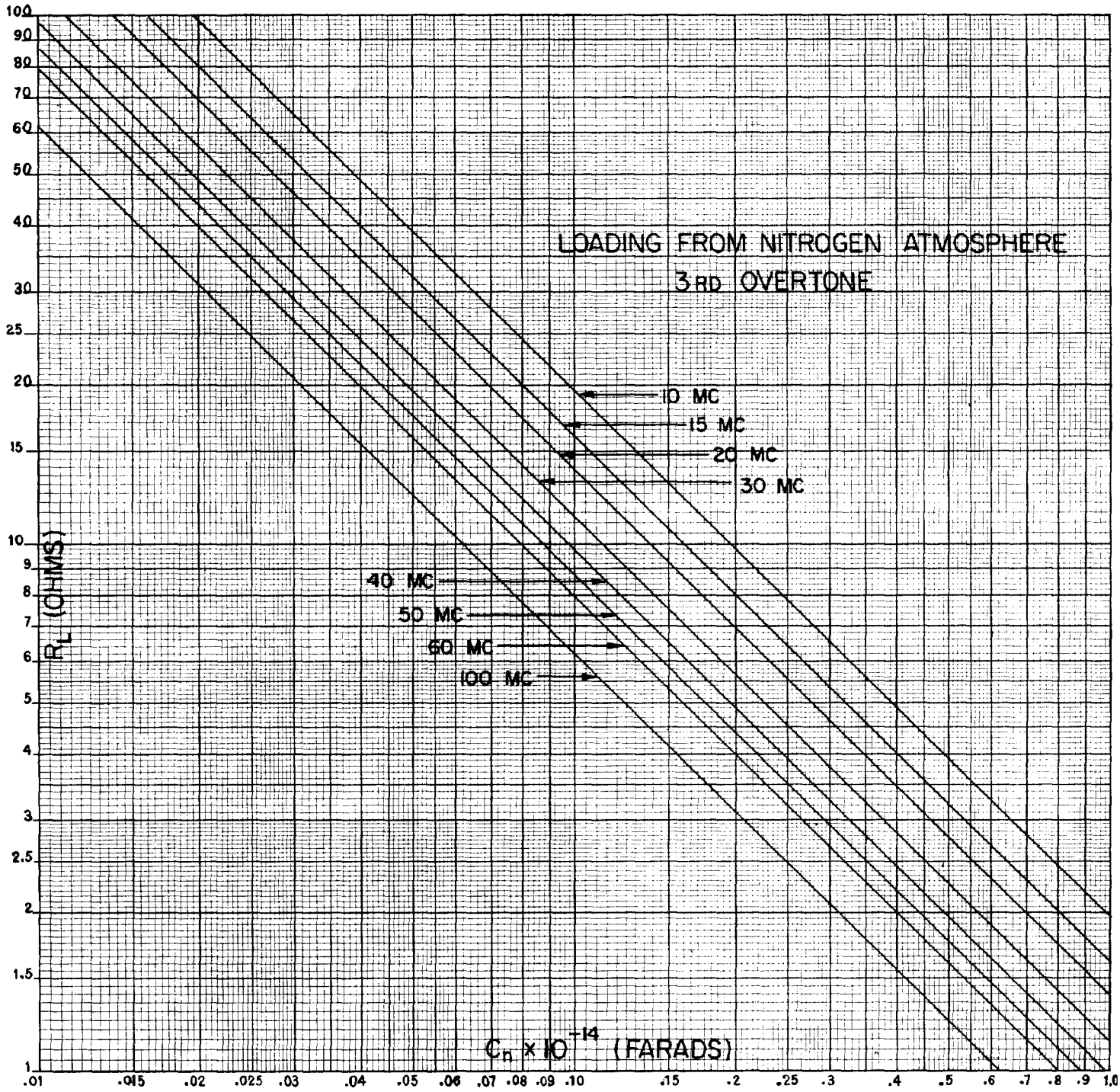

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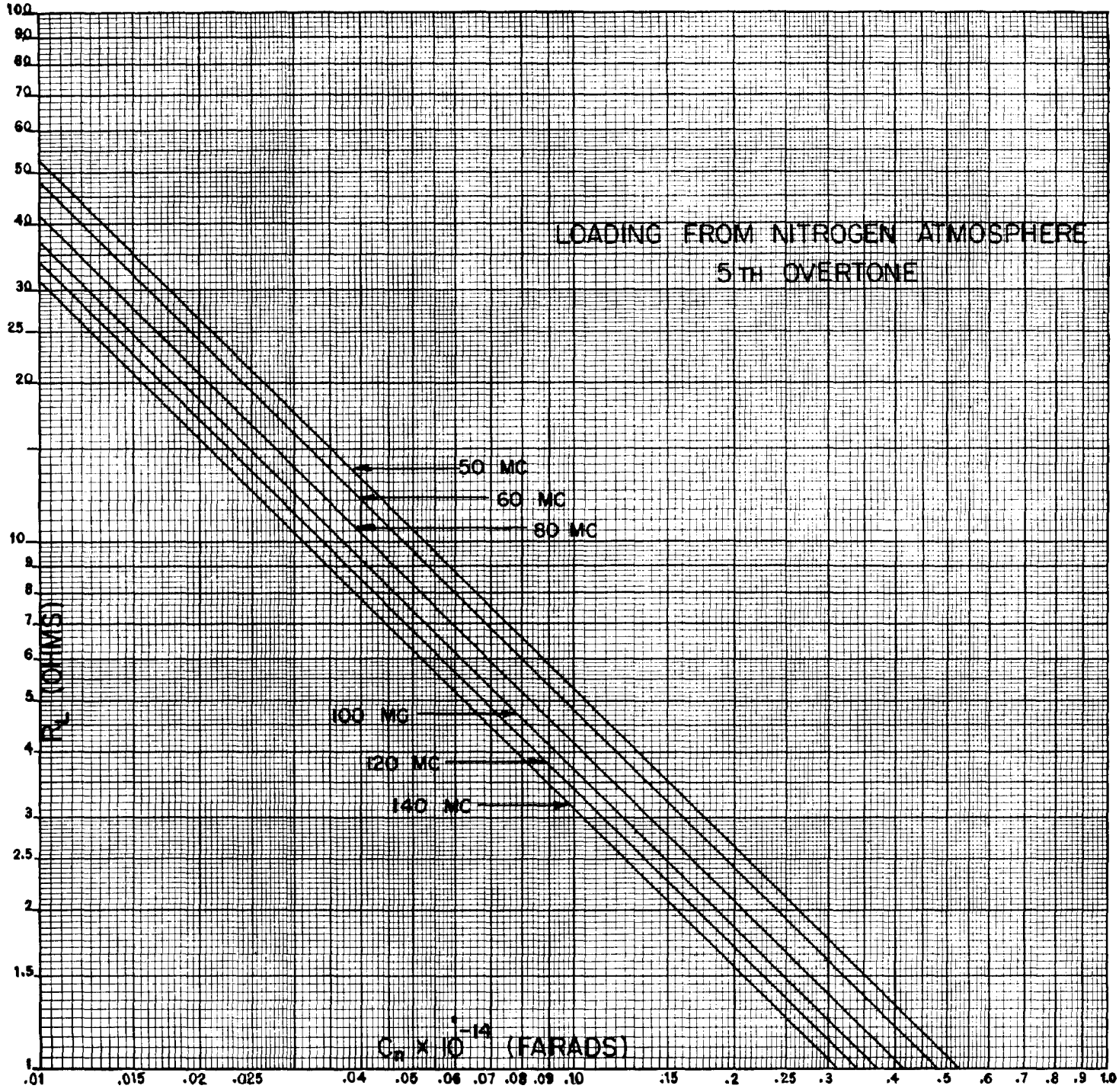
FIGURE 54


LOADING FROM NITROGEN ATMOSPHERE
5TH OVERTONE
50 MC
60 MC
80 MC
100 MC
120 MC
140 MC
R_s (OHMS)
$C_m \times 10^{-14}$ (FARADS)
100
90
80
70
60
50
40
30
25
20
10
9
8
7
6
5
4
3
2.5
2
1.5
1
.01
.015
.02
.025
.04
.05
.06
.07
.08
.09
.10
.15
.2
.25
.3
.4
.5
.6
.7
.8
.9
1.0