TABLE OF CONTENTS

PART I

THE QUARTZ RESONATOR

PART II

DESIGN DATA

APPENDICES

III Process Notes

IV Graphs and Tables

FIGURES

TABLES

SYMBOLS

AT	adjective describing a rotated Y cut plate operating on the thickness-shear mode, the plane of the plate making an angle of approximately 35° with the Z crystallographic axis (pp. 16, 77-79)
C	capacitance
$C_{1,3,5...n}$	equivalent motional capacitance, usually written C_n if general, for any harmonic order. Numerical subscript designates harmonic order (p. 8)
C_A	load capacitance as used in series with resonator unit for purpose of measurement (pp. 164, 166)
C_e	capacitance created by electrodes, $C_e = C_o - C_h$ (p. 8)
C_h	shunt capacitance resulting from holder and mount, $C_h = C_o - C_e$ (p. 8)
C_o	total shunt capacitance of resonator, $C_o = C_e + C_h$ (p. 8)
d, D	diameter of circular quartz plate
d_e	diameter of circular electrode
d_e^2/t	ratio of the square of the diameter of the electrode to the thickness of the quartz plate, in inches, proportional to the area/thickness ratio in inches and approximately proportional to C_e
d/t	ratio of diameter of quartz plate to its thickness
F, f	frequency. Capital F is used when there is a change of units, as $\Delta f/F^2$, where f is in kilocycles and F in megacycles. Except for such special cases f is in cycles per second (cps) Subscripts 1,3,5...n,s,a, indicate frequency on fundamental, third harmonic, fifth harmonic .... fundamental or any harmonic, at series resonance, at antiresonance
f_{max}	frequency at the temperature point of an AT resonator which is called the low temperature turning point, or T_{max} (p. 82)

f_{min} frequency at the temperature point of an AT resonator which is called the high temperature turning point, or T_{min} (p. 82)

ft frequency times thickness of an AT cut plate, the frequency-thickness coefficient, usually in inches and kilocycles or inches and megacycles

g gravitational acceleration

h henry, unit of inductance

ID inside diameter

k, K constants, defined as used

kc kilocycles per second

$L_1, L_3, L_5 \ldots L_n$ equivalent motional inductance on fundamental, 3rd harmonic, fifth harmonic ....fundamental or any harmonic (p. 8)

mc megacycles per second

n harmonic order, including 1 for fundamental, used as a subscript for identification of such parameters as motional capacitance, inductance, and resistance, or as a quantity. In the second or third place of the three digit system (p. 17), the inharmonic order

OD outside diameter

PEM Production Engineering Measures

ppm parts per million

Q figure of merit, $Q = \frac{1}{\omega CR}$, or more precisely

$Q = Q_s = \frac{1}{\omega_s C_n R_n}$, where subscript s indicates series resonance (pp. 1-2)

$R, R_1, R_3, R_5 \ldots R_n, R_s, R_a$, equivalent resistance, on fundamental, third harmonic, fifth harmonic, fundamental or any harmonic, at series resonance, at anti-resonance; with numerical subscripts, series resonance is understood; usually used loosely for equivalent resistance of entire unit, which includes equivalent motional resistance and resistance of holder, mount, etc. (R_m) (p. 8)

r — radius of curvature of a spherically contoured quartz plate (p. 59) [$r = C_o/C_1$ or $r = C_e/C_1$ is not used in this book]

R_m — "metallic" resistance, resonator is measured as a capacitor near but not at resonance (p. 167)

s — subscript for "at series resonance"

S.A.O. — synthetic aluminum oxide

T, T_a, T_b, T_c, T_d, T_i, T_{max}, T_{min}, Temperature; for definition of subscripts see pp. 82-83

X — reactance

X — polar or electrical crystallographic axis

Y — mechanical crystallographic axis

Z — impedance

Z — optic crystallographic axis

ZZ' — the "AT" angle or the angle which the plane of the quartz plate makes with the Z crystallographic axis

$\Delta f/F^2$ — ratio of change in frequency in kilocycles to square of nominal frequency in megacycles

$\Delta f/f$ — ratio of change in frequency to nominal frequency, same units, parts per million

η — viscosity of gas (p. 116)

$\mu\mu f$ — micromicrofarad

ρ — density of gas (p. 116)

ϕ_a — used in Appendix I, same as d

ϕ_e — used in Appendix I, same as d_e (ϕ_e^2/t in Appendix I is in mm)

ω — $2\pi f$