LAURENCE G. COWLES

A Sourcebook of Modern Transistor Circuits

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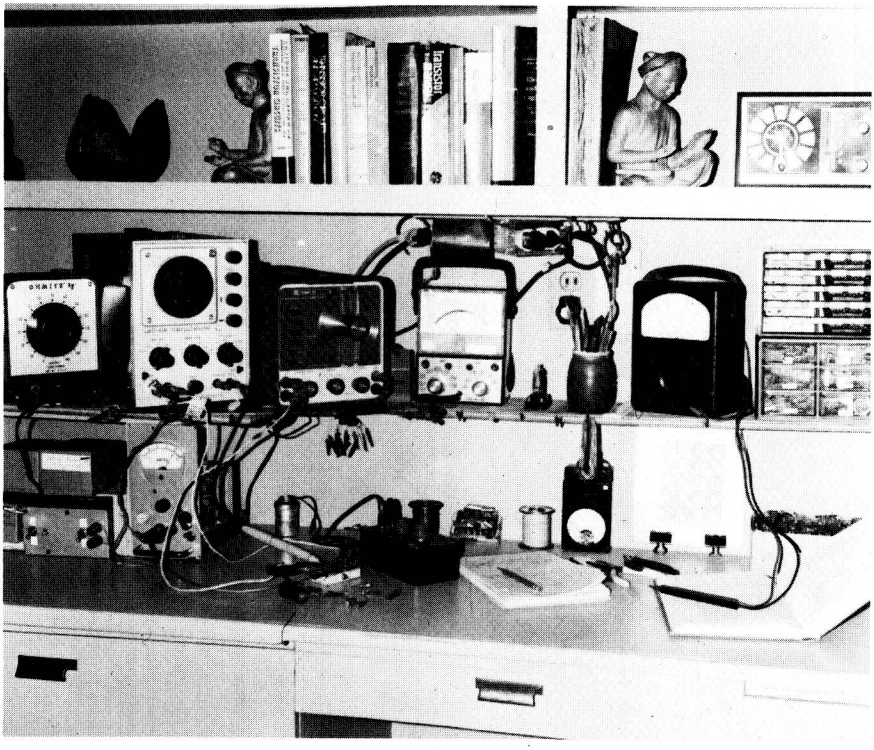

A home electronics laboratory for the experimenter or engineer—the author's. From left to right: a variable-voltage transformer, oscilloscope, oscillator with attenuators, FET volt-ohmyst, ac power jacks, D'Arsonval volt-ohmmeter, and small parts cabinets. Below: power supplies, breadboard circuits, β-tester, reactance chart, and notebook.

When a mathematician engaged in investigating physical actions and results has arrived at his conclusions, may not they be expressed in common language as fully, clearly, and definitely as in mathematical formulae? If so, would it not be a great boon to such as I to express them so?—translating them out of their hieroglyphics, that we also might work upon them by experiment.

Michael Faraday in a letter to James Clerk Maxwell,
Nov. 13, 1857

The Selected Correspondence of Michael Faraday,
L. Pearce Williams, Cambridge University Press, 1971

Preface

The existing number and variety of semiconductor circuits have created the need for an up-to-date handbook of practical transistor and integrated circuits. This book, a product of my own needs for reliable circuits, offers both experimenters and designers a graded series of selected and carefully designed transistor circuits. The circuits, shown with component values and readily available semiconductors, may be used either for design or for study to obtain a working knowledge of practical circuits without an encumbering theory and mathematics. Circuits of equipment that may be purchased in manufactured or in kit form are not included and not needed in a sourcebook.

I have tried to describe mainly those amplifier, diode, and switching circuits that are used by experienced designers. Each circuit is a complete package that may be used alone or combined with others to achieve known performance characteristics. To make the book useful as a design manual I have included charts and tabulated data to help a designer change a circuit in order that it may serve many different purposes. An annotated bibliography is included for persons needing supplementary information. The references are selected carefully to supply working circuits and to serve practical needs without requiring resources beyond the reach of a small home library.

Laurence G. Cowles

List of Symbols

C_I	Input capacitance
C_M	Miller effect capacitance
C_N	Neutralizing capacitance
C_{OB}	Collector-to-base capacitance
e_I	AC input voltage
e_O	AC output voltage
e_p	Peak voltage or peak-to-peak voltage
e_S	AC signal voltage or generator voltage
f_β	Beta cutoff frequency
f_c	Cutoff frequency (half power, or 3 db)
f_h	High frequency cutoff
f_l	Low frequency cutoff
f_T	Current gain-bandwidth product
G_i	Current gain
G_v	Voltage gain
G'_v	Voltage gain with feedback
i_b	AC base current
I_B	DC base current
i_c	AC collector current
I_C	DC collector current
I_{DSS}	Zero bias drain current
i_e	AC emitter current

I_E	DC emitter current
I_I	AC input current
I_L	AC load current
i_O	AC output current
P_O	AC output power
R_A	Bias resistor (usually adjustable)
R_B	Base resistor
R_C	Collector resistor
R_E	Emitter resistor
R_f	Feedback resistor
R_I	Input resistance
R_L	Load resistance
R_S	Generator or source resistor
S	Usually R_B/R_E or R_f/R_L; approximately the dc current gain
V_B	DC base voltage (to ground)
V_{BB}	DC base supply voltage
V_C	DC collector voltage (to ground)
V_{CC}	DC collector supply voltage
V_D	DC drain voltage
V_{DD}	DC drain supply voltage
V_E	DC emitter voltage (to ground)
V_{GS}	DC gate-to-source voltage
V_P	FET pinchoff voltage
V_R	DC regulated voltage
V_Z	DC zener diode voltage
α	CB short-circuit current gain, i.e.,—h_{fb}; approximately 1
β	CE short-circuit current gain, h_{fe}; approximately 50
ω	Frequency in radians per second ($2\pi f$)
Ω	Ohms

Abbreviations

A	Ampere
B	Base
C	Collector
CB	Common base
CC	Common collector
CE	Common emitter
D	Drain
dB	Decibel (see Appendix)
dBm	Decibel referred to 1 mW
E	Emitter
G	Gate
GHz	Gigahertz
Hz	Hertz
IC	Integrated circuit
kHz	Kilohertz
kΩ	Kilohm

mA	Milliampere
mH	Millihenry
mV	Millivolt
pF	Picofarad
p-p	Peak-to-peak
Q	Factor of merit
Q-point	Quiescent point
S	Source (FET)
V	Volts
μA	Microampere
μF	Microfarad
μH	Microhenry
Ω	Ohms

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