

Notes on Analog (mostly Operational Amplifier) - Timeline Milestones

[Rough first draft largely based on Kent Lundberg's lecture notes on op-amp history]

1932 - Nyquist amplifier stability criterion

Harry Nyquist describes a stability criterion for feedback amplifiers in his paper, "Regeneration Theory," [1], solving the stability problems that Black was having with his amplifiers.

1934 – Black publishes AT&T work

Black publishes "Stabilized Feedback Amplifiers" [2], the first description of his work to appear in the open literature, almost three years after AT&T started widespread commercial use of his amplifiers.

1940 – Bode plot published

Hendrik Bode publishes "Relations Between Attenuation and Phase in Feedback Amplifier Design" [3], introducing the world to the Bode plot and ending Bell Labs' futile quest for an amplifier with high gain, sharp cutoff, and small phase shift.

1940s – Summing Amplifiers used in gun director

Bell Labs designs the T-10 gun director, which used "summing amplifiers" to help calculate firing angles [4].

1947 – "Operational Amplifier" term coined

John Ragazzini coins the term "operational amplifier" in his paper "Analysis of Problems in Dynamics by Electronic Circuits" [5]. The paper includes discussions and examples of op-amp amplifiers, integrators, differentiators, and summers.

1952 – Philbrick introduces the "Model T" of op amps

George A. Philbrick Researches (GAP/R) [6] introduces the K2-W. For about \$22, you could buy a two-tube, eight-pin, interchangeable, plug-and-play op amp. The K2-W was the Model T of operational amplifiers; the first one where you didn't have to design it to drive it.

1956 – Burr Brown starts op amp business

Burr-Brown Research is founded and starts selling op amps.

1958 – First transistorized op amps

The first solid-state op amps (using germanium transistors) are introduced.

1960 – First Silicon op amps

High-performance silicon transistor op amps are produced.

1962 – Op amp modules introduced

Nexus Research Laboratory starts selling op amps in module packages. Philbrick and Burr-Brown follow suit.

1962 – TI Introduces first Linear IC family

Series 52 linear IC family introduced

1963 – First Spacecraft to use ICs

NASA launches the IMP satellite, the first to contain integrated circuits.

<http://www.answers.com/topic/1963>

1964 – First Commercial Analog IC product application

Zenith develops a hearing aid equipped with an integrated circuit (the same chip used as an amplifier in NASA's IMP satellite). The hearing aid is the first commercial product incorporating such a device

<http://www.answers.com/topic/1964>

1965 – Analog Devices

Analog Devices, Inc. founded.

1964 – First IC op amp

Fairchild Semiconductor introduces the first integrated circuit op amp, Robert Widlar's μ A702 [7].

1965 – First High-Volume IC Op Amp

Widlar's μ A709, "the first IC op amp that works like an op amp," was introduced the following year [8].

1967 – National's improved 709

Widlar's LM101 is a vast improvement over the μ A709 [9].

1968 – Most Popular Op Amp of all time

Fairchild Semiconductor introduces the first internally compensated IC op amp, David Fullagar's μ A741 [10]. It does not require any external components for compensation, and it becomes the most popular operational amplifier of all time.

1968 – National begins leadership of IC op amp market

In January, National introduced the LH101, a hybrid, internally compensated version of the LM101. In December, they introduced the LM101A [11], an improved version of the LM101, and the LM107, a monolithic, internally compensated version of the LM101A.

1969 – Externally compensated 741

Fairchild μ A748, an externally compensated version of the μ A741.

1969 – Low Input Op Amp

Widlar's LM108 super-beta low-input-current op amp

1971 – High Speed Op Amp

Robert Dobkin's LM118 high-speed op amp

1974 – JFET Input Op Amp

Ronald Russell's LF156 JFET input op amp

1975 – Precision Op Amp

George Erdi's OP-07 precision op amp

References [From: Op Amp History, Lecture 12, Kent Lunberg]

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