Voltage doublers power microprocessor PROMs

by Andrew Longacre Jr.
University of New Orleans, New Orleans, La.

When a single-voltage microprocessor system is augmented with some extra components that operate at different voltages, the power-supply requirements can be conveniently met by adding doubler circuits to a full-wave bridge rectifier. These extra supplies are enough to power memory or peripheral elements that do not operate at the standard single-supply system voltage.

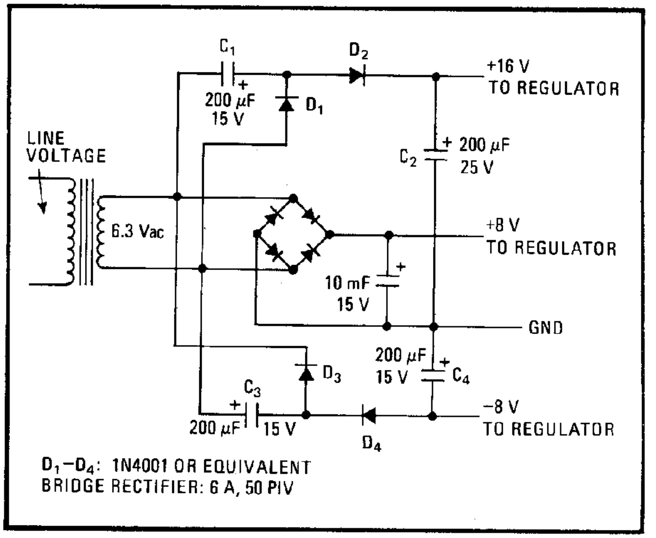
For example, Motorola's M6800 microprocessor family is designed to run from a single supply of +5 volts, the same voltage required by the transistor-transistor logic that is often used in peripheral and support functions. The M6800 family lacks, however, any sort of programable read-only memory or that designer's friend, the erasable PROM, and unfortunately, the familiar versions of these memory devices require additional supply voltages at +12 V and/or −5 V. A terminal interface conforming to the RS-232C standard, if desired, also requires a supply at −5 V.

A typical M6800 development system therefore may involve implementation of unbalanced power supply requirements like:

+5 V at 2.5 A
+12V at 50 mA
−5 V at 50 mA

These requirements can all be met from a single 6.3-V/3-A filament transformer by amending the conventional full-wave bridge configuration with two voltage-doubling circuits, as shown in the figure. A low-voltage prepackaged diode bridge carries the bulk of the rectified current in charging a 10,000-microfarad capacitor to about 8 V (9 V peak) for regulation down to +5 V. Two capacitors and two diodes form each of two voltage-doubling circuits—a positive one that generates about +16 V (18 V under no load) for regulation to +12 V, and a negative one that generates just about −8 V for regulation to −5V.

Capacitors C_1 and C_2, plus diodes D_1 and D_2, make up the doubler that provides +16 V across C_2. They are connected in a diode-pump arrangement; C_1 charges through D_1 to 8 V when the bottom of the transformer secondary is positive, and C_2 adds this voltage to that of the secondary during the next half cycle as C_2 charges through D_2 and one bridge rectifier.



Add-on sources. Voltage-doubler circuits, added to full-wave bridge rectifier, provide extra positive and negative voltage supplies. Bridge provides over 2.5 A at +8 V to drive a regulator IC for +5-V output. Upper doubler delivers 50 mA at +16 V for regulation to +12 V, and lower doubler delivers 50 mA at −8 V for regulation to −5 V. The extra sources meet the voltage and current requirements of microprocessor peripherals that cannot use the +5-V source.

Similarly, capacitors C_3 and C_4, together with diodes D_3 and D_4, constitute the extra elements that provide −8 V relative to ground. Capacitor C_3 charges to 8 V through diode D_3 when the bottom of the secondary is positive. When the top of the secondary is positive, C_3 charges capacitor C_4 through D_4 and one of the bridge rectifiers.

Necessary regulation is added to the circuit by use of three-terminal integrated-circuit regulators (not shown in the circuit diagram). An LM342H-12 driven by +16 V provides the regulated +12-V output. An LM323K (or three LM309Ks driving separate parts of the load circuit), connected to the +8 V, provides the regulated +5 V, and an LM320H-5.0 connected to the −8 V provides the regulated −5-V output.

With the components shown in the figure, each of the required voltages is provided at the desired current level. Where requirements vary, either of the voltage doublers can be modified to provide more current simply by scaling upward both of its capacitors; however, one would not retain this fundamentally unbalanced configuration where the current requirements at the three voltages approach equality. □

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