The designs of microscopic toroidal-core inductors in integrated circuits of DC-to-DC voltage converters would be modified, according to a proposal, by filling the gaps in the cores with permanent magnets that would apply bias fluxes (see figure). The magnitudes and polarities of the bias fluxes would be tailored to counteract the DC fluxes generated by the DC components of the currents in the inductor windings, such that it would be possible to either reduce the sizes of the cores or increase the AC components of the currents in the cores without incurring adverse effects. Reducing the sizes of the cores could save significant amounts of space on integrated circuits because relative to other integrated-circuit components, microinductors occupy large areas — of the order of a square millimeter each.

An important consideration in the design of such an inductor is preventing magnetic saturation of the core at current levels up to the maximum anticipated operating current. The requirement to prevent saturation, as well as other requirements and constraints upon the design of the core are ex-
pressed by several equations based on
the traditional magnetic-circuit approxi-
mation. The equations involve the core
and gap dimensions and the magnetic-
property parameters of the core and
magnet materials.

The equations show that, other things
remaining equal, as the maximum cur-
rent is increased, one must increase the
size of the core to prevent the flux den-
sity from rising to the saturation level. By
using a permanent bias flux to oppose
the flux generated by the DC compo-
nent of the current, one would reduce
the net DC component of flux in the
core, making it possible to reduce the

A proposed method of suppressing the
effect of background noise in an optical
communication system would exploit the
transmission and reception of correlated
photons at the receiver. The method would
not afford any advantage in a system in
which performance is limited by shot
noise. However, if the performance of the
system is limited by background noise
(e.g., sunlight in the case of a free-space
optical communication system or incoher-
ently scattered in-band photons in the case
of a fiber-optic communication system),
then the proposed method could offer an
advantage: the proposed method would make it possible to achieve a signal-to-
noise ratio (S/N) significantly greater
than that of an otherwise equivalent back-
ground-noise-limited optical communica-
tion system based on the classical trans-
mission and reception of uncorrelated
photons.

The figure schematically depicts a classi-
cal optical-communication system and a
system according to the proposed
method. In the classical system, a modu-
lated laser beam is transmitted along an
optical path to a receiver, the optics of
which include a narrow-band-pass filter
that suppresses some of the background
noise. A photodetector in the receiver de-
tects the laser-beam and background pho-
tons, most or all of which are uncorre-
lated.

In the proposed system, correlated
photons would be generated at the trans-
mitter by making a modulated laser beam pass through a nonlinear paramet-
ric down-conversion crystal. The sum of
frequencies of the correlated photons in
each pair would equal the frequency of
the incident photon from which they
were generated. As in the classical sys-
tem, the correlated photons would travel
along an optical path to a receiver, where
they would be band-pass filtered and de-
tected. Unlike in the classical system, the
photodetector in the receiver in this sys-
tem would be one that intrinsically favors
the detection of pairs of correlated pho-
tons over the detection of uncorrelated
photons. Even though there would be no
way of knowing the precise location and
time of creation of a given pair of corre-
lated signal photons in the nonlinear
down-conversion crystal, the fact that the
photons are necessarily created at the
same time and place makes it possible to
utilize conventional geometrical imaging
optics to reunite the photons in coinci-