NOISE REDUCTION CHECK LIST

A. Suppressing Noise At Source

- ☐ Enclose noise sources in a shielded enclosure.
- ☐ Filter all leads leaving a noisy environment.
- ☐ Limit pulse rise times.
- ☐ Relay coils should be provided with some form of surge damping.
- ☐ Twist noisy leads together.*
- ☐ Shield and twist noisy leads.
- ☐ Ground both ends of shields used to suppress radiated interference (shield does not need to be insulated).*

B. Eliminating Noise Coupling

- ☐ Twist low-level signal leads.*
- ☐ Place low-level leads near chassis (especially if the circuit impedance is high).
- ☐ Twist and shield signal leads (coaxial cable may be used at high frequencies).
- ☐ Shielded cables used to protect low-frequency, low-level signal leads should be grounded at *one end only* (coaxial cable may be used at high frequencies with shield grounded at both ends).*
- ☐ Insulate shield on signal leads.
- ☐ When low-level signal leads and noisy leads are in the same connector, separate them and place the ground leads between them.*
- ☐ Carry shield on signal leads through connectors on a separate pin.
- ☐ Avoid common ground leads between high- and low-level equipment.*
- ☐ Keep hardware grounds separate from circuit grounds.*
- ☐ Keep ground leads as short as possible.*
- ☐ Use conductive coatings in place of nonconductive coatings for protection of metallic surfaces.
- ☐ Separate noisy and quiet leads.*
- ☐ Ground low-frequency, low-level circuits at one point only (high frequencies and digital logic are exceptions).*
- ☐ Avoid questionable or accidental grounds.
- ☐ For very sensitive applications, operate source and load balanced to ground.
- ☐ Place sensitive equipment in shielded enclosures.
- ☐ Filter or decouple any leads entering enclosures containing sensitive equipment.
- ☐ Keep the length of sensitive leads as short as possible.*
- ☐ Keep the length of leads extending beyond cable shields as short as possible.*
- ☐ Use low-impedance power distribution lines.
- ☐ Avoid ground loops in low-frequency, low-level circuits.*
- ☐ Consider using the following devices for breaking ground loops:
  - Isolation transformers
  - Common-mode chokes
  - Optical couplers
  - Differential amplifiers
  - Guarded amplifiers
  - Balanced circuits
  - Hybrid ground

C. Reducing Noise at Receiver

- ☐ Use only necessary bandwidth.
- ☐ Use frequency-selective filters when applicable.
- ☐ Provide proper power-supply decoupling.
- ☐ Bypass electrolytic capacitors with small high-frequency capacitors.
- ☐ Separate signal, noisy, and hardware grounds.*
- ☐ Use shielded enclosures.
- ☐ With tubular capacitors, connect outside foil end to ground.*

D. Guidelines for Controlling Emissions in Digital Systems

- ☐ Minimize ground inductance by using a ground plane or ground grid.
- ☐ Locate decoupling capacitors next to each IC in the system.
- ☐ Use the smallest value decoupling capacitor that will do the job.
- ☐ Use a bulk decoupling capacitor to recharge the individual IC decoupling capacitors.
- ☐ Clock signal loop areas should be kept as close to zero as possible.
- ☐ All cables should be treated to minimize their common-mode current.
- ☐ All unused inputs on logic gates should be connected to either power or ground.
- ☐ I/O drivers should be located near where the cables leave the system.
- ☐ Use the lowest-frequency clock, and slowest rise time that will do the job.
- ☐ Keep clock circuits and leads away from the I/O cables.

FROM H.W. OTT, 1988 (2nd Ed.)
"NOISE REDUCTION TECHNIQUES IN ELECTRONIC SYSTEMS"