Pinpoint your relay needs by writing complete specifications

Don't risk excessive costs, poor performance, or delivery delays because of incomplete relay specs. Here's a checklist to remind you of the details.

BEFORE WRITING a relay specification, establish a checklist that is even more comprehensive than the final specification itself. This will insure that the relay is neither overspecified nor underspecified. And it will help you and the supplier to settle on the best relay for the job.

The suggestions that follow can help you draw up such a checklist. Remember that they are broad reminders, though. You may have to modify them to suit your needs. Moreover, the suggestions don't mention such commercial factors as quantities, delivery, etc. These depend on your particular needs. Once you have drawn up your checklist, refer to it and proceed to write your relay specification.

Here are prime factors to consider in drawing up any checklist:

1. Establish the broad class of application to identify what industrial, commercial and military standards apply, as well as the types of relays that meet the general requirements. A partial list of application categories for the checklist includes military, commercial, industrial, automotive, communication and home entertainment. Sub-categories such as ground, vehicular, shipboard, airborne, etc., might be helpful.

2. Describe the equipment in which the relay is to be used. Alert the supplier to the safety, operational and environmental requirements that generally apply.

3. Describe the specific function of the relay. For example: "The relay shall respond to a 120-volt ac ON-OFF signal. It will switch a 120-volt ac circuit from a 6-watt tungsten pilot light to a 1/2-hp, capacitor-start motor. The pilot light is connected to normally-closed (NC) contacts and the motor to normally-open (NO) contacts."

4. Refer to general specifications—such as MIL and NASA—but use only these sections that pertain to your particular application. General specifications often contain multiple choices which must be selected by a detail specification.

5. Consider the environmental conditions. Include high and low temperature, temperature cycling, humidity, salt spray, sand or dust, oil, sulfur fumes, road-conditioning chemicals, vibration, shock, etc. These can be further classified as operational, non-operational, static, dynamic, etc.

Although ambient air temperature and velocity are generally recognized as important, three other associated factors should be considered: (a) mounting surface temperature, mass and heat-sink characteristics; (b) temperature, size and distance of adjacent bodies that could radiate heat to or absorb heat from the relay; (c) temperature, proximity and orientation of adjacent bodies that could transfer heat by convection.

6. Specify the magnitude and duration of permissible contact chatter during a shock or vibration test.

Don't underestimate physical considerations. At times handling or manufacturing procedures in the relay user's plant call for protective mounting or a protective enclosure. In the soldering of components adjacent to the relay, for instance, solder flux or flux vapors may contaminate the relay. A relay enclosure can prevent this. Similarly, connected or adjacent wires, dangling into the open relay, may cause enough damage to warrant an enclosure. Watch out for oil,

This article represents a condensed version of material extracted from Section IV of the forthcoming NARM Engineers Relay Handbook.

Sample relay specifications

(1) Class of application
A. Military B. Commercial C. Industrial D. Electronic E. Communications F. Commercial airborne G. Other

(2) Description of equipment in which relay is used

(3) Relay function

(4) Applicable documents
A. Military specifications
(1) MIL-R-5757D (2) MIL-R-6106E (3) MIL-STD-202 (4) Other
B. Underwriters Laboratories (UL)
C. Canadian Standards Association (CSA)
D. National Electrical Manufacturers Association (NEMA)
E. Electronic Industries Association (EIA)
F. Quality assurance specifications
G. Reliability specifications

(5) Environmental tests
A. Non-operative
(1) Thermal shock (2) Sealing (3) Salt spray (4) Humidity
B. Operational
(1) RF noise (2) Vibration (3) Altitude (4) Shock (5) Random drop (6) High & low temperature operation
(7) Temperature cycling (8) Acceleration (9) Temperature range

(6) Contact specifications
A. Form designation
B. Loads (specify each pole separately if loads are different)
(1) Current (2) Voltage (3) Ac or dc (4) Frequency (5) Resistive (6) Inductive (7) Motor (8) Lamp
C. Transient conditions D. Circuit diagram E. Rate of operation F. Overload

(7) Coil specifications
A. Resistance
B. Current
(1) Nominal (2) Minimum (3) Maximum
C. Duty cycle
(1) ON-OFF ratio
(2) Magnitude of ON time
(a) Minimum (b) Maximum
D. Impedance
E. Ac or dc
F. Frequency
G. Voltage
(1) Nominal (2) Minimum (3) Maximum
H. Repetition rate
I. Circuit diagram

(8) Electrical characteristic specifications
A. Contact resistance B. Dielectric strength C. Insulation resistance

(9) Operational specifications
A. Pickup values C. Operate time E. Contact bounce G. Instrumentation
B. Dropout values D. Release time F. Contact chatter H. Temperature

(10) Enclosures
A. Open B. Dust cover C. Hermetically sealed D. Size limitations

(11) Mounting methods

(12) Termination
A. Terminal type B. Terminal strength

(13) Marking
A. Type designation B. Part number C. Date code D. Manufacturer's code

(14) Life expectancy
A. Mechanical B. Electrical

(15) Failure criteria
A. Minor B. Major C. Catastrophic

(16) Qualification tests

(17) Acceptance tests

(18) Procurement factors
A. Quantity required B. Delivery schedule C. Cost limitations

Checklist of detailed relay specifications

Note: Numerical identification preceding each item in this sample specification corresponds to numbered items on the Specification Checklist.

(1), (4) This equipment will be used on commercial airlines, and the following documents are applicable: MIL-R-5757D, MIL-STD-202A and MIL-R-6106E Specifications. Only those paragraphs specifically mentioned in this detail specification apply. In case of any discrepancy, the detail spec shall govern.

(2) Model 9999 airborne equipment.

(3) Relay is required to switch audio-frequency circuitry in radio receiver.

(5) The following environmental specifications apply:
- (A) Thermal shock per test condition B of method 107 of MIL-STD-202A
- (B) Sealing test 2 per paragraph 4.7.7.2. of MIL-R-5757D
- (C) 100-hour salt spray per paragraph 4.7.10. of MIL-R-5757D
- (D) Humidity per moisture resistance test method 106A of MIL-STD-202A, except eliminate paragraph 2.4.2
- (E) Vibration test 1 of paragraph 4.7.7.2..of MIL-R-5757D
- (F) Shock test of 30 g per MIL-R-5757D shock test 4 paragraph 4.7.12.2
- (G) High altitude performance at 70,000 ft.
- (H) Relay shall operate over ambient temperature range of –65°C to +125°C.
- (I) High and low temperature test per MIL-R-5757D, paragraph 4.7.16. shall apply

(6) This relay shall have a contact form C (spdt). Both A and B portions of the pole shall handle similar loads of audio-frequency levels of 30 ma min to 1 amp max at voltage of 100 mv to 8 volts. Load will be basically resistive with power factor exceeding 0.8. Normal rate of operation in equipment will be 4 cpm with equal ON and OFF times.

(7) The relay coil resistance shall be 250 ohms min at 25°C. The nominal dc coil voltage shall be 28 volts dc with a range of 24-32 volts dc. Coil shall be capable of continuous duty over temperature range of –65°C to +125°C.

(8) Contact resistance shall not exceed 0.02 ohms initially when checked by voltmeter-ammeter method with an open-circuit voltage of 1 volt dc and a closed-circuit current of 100 ma. Relay contact shall be closed before applying test circuit voltage. Dielectric strength at sea level shall be as required by paragraph 4.7.4.1.1. of MIL-R-5757D. Dielectric strength at 70,000 ft shall be in accordance with paragraph 4.7.4.2 of MIL-R-5757D. Insulation resistance of 1 Meg min shall be determined per paragraph 4.7.3. of MIL-R-5757D.

(9) Relay shall pick up at 20 volts dc max over the temperature range of –65°C to +125°C and shall drop out at 1 to 10 volts dc over the temperature range of –65°C to +125°C.

(10) Relay shall be hermetically sealed.

(10), (11), (12) Size, mounting and solder terminals to be per drawing 9999-1 (to be included as part of the specification).

(13) Relay shall be marked per paragraph 3.2.3.1. of MIL-R-5757D, item b, e, f and g only.

(14) Electrically loaded life expectancy shall be per paragraph 4.7.18. of MIL-R-5757D, except switching rate shall be 4 cpm.

(15) Failure criteria are categorized as follows:
- (A) Minor
  - (a) marking dimensions in error
  - (b) 0.1-volt deviation beyond allowable limits of pickup and dropout.
- (B) Major
  - (a) contact resistance exceeds 0.02 ohms but is less than 0.5 ohms.
- (C) Catastrophic
  - (a) failure of normally open contacts to make contact when coil is energized at 28 volts
  - (b) open coil circuit.

(18) 5,000 relays required, with delivery to begin 60 days after receipt of order at a rate of 100 relays per week.

paint-spray or particle contamination, too.

Various terminations—such as solder, screw, plug-in and others—should be considered. Terminal spacing, pullout or deflection forces, voltage drop and current limitation must also be evaluated.

In the relay drawing, include only those dimensions necessary for proper factory installation of field application. Allow options, wherever possible, to give the supplier the widest latitude. This may allow several relay manufacturers to qualify, and may cut costs. If the application dictates limitations on coil resistance or impedance, these should be noted. Maximum allowable power to operate a relay affects its cost and performance. Do not specify it unless absolutely necessary.

7. State whether the coil voltage or current is ac or dc. Also tell its frequency, waveshape, details of pulse shape, nominal, minimum, and maximum values. In the specification of duty cycle, an ON-OFF ratio alone is inadequate; absolute magnitudes of ON and OFF times are essential. Specify the range of rate of operation. Indicate the voltage or current at which the temperature rise is specified and explain the method of determining this rise.

With regard to the field requirements, be sure to specify the position of the relay with respect to gravity. Power-source impedance, regulation, ripple and waveshape are also important. If the relay's resistance varies with temperature, as it does in most types, some correlation problems may be circumvented by specifying current instead of voltage values (for the coil).

When relay coils are operated ON-OFF in the field, do not specify slowly rising or falling voltages to test the relays. You may thus avoid relay noise due to improper test procedures.

Timing specifications should clearly differentiate operate and release times from bridge or transfer time and contact-bounce time. Power supply impedance, instrumentation and the means of switching have significant effects on timing, and these should be considered, too. In specifying the sequence of operation of multiple contacts, be aware of the short time differences. Allow enough time for all of the contacts to complete their operation in the circuit. Note that the time differentials (which are of the order of microseconds) may not be large enough for sequential operation.

8. Bear in mind the functions that the relay must perform when specifying such characteristics as contact resistance, insulation resistance and dielectric strength. Consider the voltages and times usually involved in insulation resistance or dielectric strength test specifications. Although one minute exposure of the specimen to dielectric stress is frequently specified, shorter periods of one to five seconds at higher voltage are occasionally substituted for economic reasons. Failure criteria should be established at some level of leakage current. Avoid excessive transient voltages in the test set resulting from switching the high-voltage.

List the equipment to be used in a "miss" test (usually associated with low-level switching). Specify open and closed-circuit voltage and current, maximum allowable contact resistance and its time duration, number of permissible misses, rate of operation, total operations and ambient temperature.

9. Specify the load for each contact circuit. "Standard" load specifications do not help to attain field reliability. There is no such thing as a single ampere rating for a specific contact. Varied results will be obtained on different types of relays, and even on the same relay, with different voltages, types of loads, temperatures and rate of operation.

Fully describe the nature of load (motor, lamp, L/R ratio, power factor, etc.) and indicate the magnitude and the duration of transient voltages and currents, as well as the nominal, or steady-state, values. An oscillogram may be helpful to "fingerprint" inductive, motor, lamp or capacitive loads. Describe the type of contact protection that can be used, if any.

Include a complete circuit diagram. Note conductor types and sizes to be connected to the relay. Indicate the polarities to be switched. If possible, connect only one polarity to all transfer contacts of a given relay to avoid short-circuits during service. In selecting polarity, consider electrolytic corrosion of the devices being switched. Mechanical or elecrically loaded life expectancy should be defined, with indication of whether loads are to be switched, made or carried only, broken, or a combination thereof.

Failure criteria should be established with field functions in mind. In each area, define the minor, major and catastrophic categories.

Qualification and acceptance tests procedures are intimately associated with relay specifications and should also be included. ■ ■