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J. DeGrego COMPILED / CHECKED 12/4/63	TITLE: CHECKING ELECTRONIC DRAWINGS	
APPROVED		

CHECKING ELECTRONIC DRAWINGS

Scope:

This standard has been developed to establish uniform checking procedures depending upon the nature of the drawings and are described in detail to serve as a guide. These are governed by the type of drawing ie; whether it is a mechanical drawing of a chassis, schematic or wiring diagram, or a harness assembly.

Purpose:

After a drawing has been completed it must be check d for accuracy, whether it is of the Mechanical or Circuit type. Mistakes such as a slight dimensional error or two wires inadvertently joined together on a circuit diagram add to manufacturing expense and possible extensive delays.

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CHECKING OF MECHANICAL DRAWINGS

Because mechanical drawings generally are more complex, the correct procedure to follow in their checking will be outlined first.

1. Obtain a set of prints of the drawings to be checked. These prints should not be used for any other purpose. Upon completion of checking, they should be saved for future reference.

2. If there are several drawings, begin by carefully checking each detail. The dimensional check of each drawing must be complete. A yellow pencil is to be used for changing, deleting or errors, and a red pencil for adding and corrections.

   Begin checking the less important items and dimensions first, then dimensions that tie into other detail drawings, and finally the notes, hole sizes and locations, etc.

3. Learn to recognize dimensions that appear to be out of scale. Normally, drawings are supposed to be drawn to the scale indicated. Thus, obvious errors can be caught almost by examination of the drawing.

   However, there are occasions when drawings are not drawn to scale. Dimensions may then be underlined by a short wavy line.

4. Determine important dimensions by calculation rather than by scaling. Prints cannot be scaled more accurately than about 1/32 in. because a print used for checking might have stretched or shrunk during printing.

5. Check that all necessary views and any cross-sectional views that might be needed for shop use are shown on each drawing.

6. Check that all drawings and views are completely dimensioned to obviate any calculations, such as subtraction or addition, on the part of the shop personnel to arrive at any required dimension.

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7. Check tolerances because unduly close toleranc s add to the cost of the finished product, so they should be submitted to critical examination.

8. Check that drawings bear all necessary information on surface finishes. See that all material sp ci-fications are correct, are given in detail, and are referred to material standards.

9. Carefully check clearances between parts to eliminate the possibility of interference be-tween adjacent parts when assembled.

10. Check that all mechanical components are accu-rately laid out to scale, or several times siz if needed, in order to check for clearance throughout the complete motion and for proper operation of such movements.

11. After the details have been varified, carefully check the assembly of these parts. See that fastening devices, such as screws, bolts, and nuts are specified, are of stock size, and the correct nomenclature.

12. Check the buildup (on assembly drawings) to see that it agrees with each drawing detail in respect to size, material specifications, etc.

13. Check any calculations that have been furnished with the set of drawings.

14. Check for maximum use of standard parts, mate-rials, and processes whether of government, industry, or company origin.

15. Check drawing title for compliance with H6-1 handbook (Federal Item Identification Guide).

16. Check TMC drawing number prefix.

17. Check TMC coding (Ref.: TMC S-567)

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CHECKING CIRCUIT DIAGRAMS

The checking procedure differs in many respects from mechanical-drawing checking. Any errors overlooked in schematic-diagram checking will be compounded because th wiring diagram and harness drawings are based on the schematic diagram.

A print, preferably black-on-white, must be used for checking because the checking method precludes the use of the original.

Checking Schematic Diagrams

The procedure for checking a schematic diagram is somewhat different from that used for checking a wiring diagram because the electronic draftsman has to check his work against the original circuit. Otherwise, there are many similarities between the two methods.

The following points should be covered in checking:

1. Make sure the drawing is in complete agreement with the original circuit sketch furnished by the engineer. Any questionable point should be reviewed with him to eliminate possible chances of error.

   There is only one bona fide method of circuit checking, and that is a line-by-line method. It eliminates the possibilities of errors.

   Begin by selecting a line in one corner of a print of the original sketch, and draw over it from one point to another with a colored pencil, trace the same part of the circuit on a print made from the newly completed drawing, extending it only between the same identical points that were selected on the original sketch. Use a colored pencil of contrasing color so there is no possibility of error. If necessary, loop around connection points on the print that do not tie in with the connections on the original sketch. This is very important.

   This proc ss of tracing ach corresponding l ad from th original ngin ring sk tch to th print is r peat d, taking only a limit d part of th circuit at a time to avoid possible errors. Do not attempt to memoriz any information that is to be add d to th sk tch or print later.

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It must be marked on both immediately. As checking progresses, larger areas of the circuit are eliminated on both the original and the print, until not a line or a connection point is left unmarked on either. If there are dotted connections between connection wires, be sure they agree on both the sketch and the print.

2. While line-by-line is in progress, check all terminal numbers, symbols, tube identifications, etc., for agreement with the original sketch. and MIL STD-15 (symbols for electronic diagrams)

3. Check all numbered electron-tube-socket connections for accuracy.

4. Check circuit symbols for numbering and values (if indicated).

5. Check for overcrowding of letter symbols or possible ambiguity as to their reference points.

6. Check punctuation and spelling.

7. Check labels of all terminal blocks, large units, etc.

8. Check the drawing title for completeness and proper identification.

9. Double check all the tie points for correctness because this is where errors are most apt to occur.

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CHECKING WIRING DIAGRAMS

As mentioned previously, the wiring diagram of a giv n electronic equipment is based on the schematic diagram, and any inaccuracy in the latter will automatically be repeat d in the wiring diagram. Such an error is extremely difficult to detect later.

As for checking the wiring diagram itself, the checked schematic diagram is considered the equivalent of the original circuit sketch. It now becomes the master against which the wiring diagram must be checked. As before, a print, pref rably black-on-white, should be made of the schematic and wiring diagrams.

Several points should be covered in checking:

1. Accuracy is just as important here as in checking the schematic diagram. Check that the circuit agrees exactly with the schematic diagram. No deviation should be allowed in any respect. As the wiring diagram is the basis for the preparation of harness drawings, accuracy cannot be ov r-emphasized.

   Here again, the one method of checking is line-by-line, point-by-point. It eliminates all possible errors.

   Begin by selecting a line on the wiring diagram print, extending from one point to another, and draw over it with a colored pencil. Locate the same point-to-point connection on the schematic-diagram print, and trace on this diagram with the colored pencil. If necessary, loop around connection points on the schematic print, so that only the points tied on the wiring diagram are similarly connected on the schematic. Use a colored pencil with enough contrast in color so there is no possibility of error.

   This process of tracing each lead appearing on the wiring diagram and locating and marking it on the schematic-diagram print is repeated, taking only one lead on the wiring diagram at a time to avoid error. Again, do not attempt to carry over circuit information by memory. It must be immediately mark d on both prints. Larg r ar as

on both diagrams will be eliminated as the checking progress until there is not a line left on either of the two prints.

2. Check the same points that were mentioned on items 2 to 8 in the check list for schematic diagrams.

3. If harness wiring is used, ascertain that all leads that are a part of a harness or harnesses are shown tied together on the wiring diagram, rather than separated throughout the wiring diagram. This is especially important later in the preparation of harness drawings.

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CHECKING HARNESS DRAWINGS

No attempt should be made to draw a wiring diagram from the schematic diagram unless the schematic has been previously checked. This also applies to wiring diagrams; they should be checked before any harness drawings are prepared from them.

As in checking schematic and wiring diagrams, a print of the wiring diagram and each harness-assembly drawing should be obtained. Black-on-white prints are preferred. The wiring-diagram print becomes the master against which the harness drawing is checked. The reference to harness-drawing assemblies is, of course, to the harness assemblies used within a given piece of equipment and not to the external cables used for interconnecting various pieces of equipm nt.

Accuracy cannot be overstressed, remembering that th harness assemblies cannot be changed easily once they are made. Again, point-by-point checking is used to eliminat errors.

Begin by selecting a lead on the harness-assembly print and determine its termination points from the print. Ch ck off the two ends of this lead with a colored pencil, then trace the same lead in the harness with a colored pencil. Continue to do this until every lead in the harness assembly has been accounted for and its counterpart has been carefully marked on the wiring-diagram print.

Check the wiring-diagram circuit carefully, and determine if every lead in the harness assembly has been shown tied together and not independently somewhere els on the diagram.

During this process, every lead on the wiring diagram and the harness assembly should be checked for exact agreement of color specified. All additional information on the assembly drawing should also agree with that of the wiring diagram, e.g., size of the conductors and shielding.

The connection points of the harness conductors, indicated on the assembly drawing, should be checked for agr ement with the connections on the wiring diagram.

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CHECKING PRINTED-CIRCUIT MASTER DRAWINGS

To properly check the master drawing, it is necessary to refer to the original schematic diagram of the unit which th printed circuit is a part. The part of the circuit includ d on the printed-circuit board is actually a wiring diagram and therefore should be treated as such, following the procedure outlined for checking wiring diagrams.

If the master drawing is made on Bristol board or other stiff material, a duplicate can be secured for checking purposes by having a photostat copy made or by tracing over the original to obtain a rough duplicate. Prints of master drawings made on polyester film such as Mylar can be obtained in the normal manner.

On double-sided boards with interconnections through the board, caution should be exercised that all the circuit is copied. It may be advisable to indicate these interconn ctions by dotted lines to differentiate them from the wiring pattern on each side of the board.

Items 1 and 2 in the check list for wiring diagrams should be followed to obtain a complete circuit check. In addition, it is important to check all connection information from th printed-circuit board to the remainder of the circuit.

The printed-circuit master drawing should also be checked for the following information:

1. Drawing number of the master drawing within the limits of the board.
2. Scale to which the master drawing is drawn.
3. Location of all holes outside the wiring pattern, indicated by round black spots.
4. FACE or BACK designation of views of double-sided boards.
5. Dimension between register marks.
6. Trim marks at each corner of the board.
7. TMC Part Number.
8. Scale used
9. Designation of which sid to be up when printing.

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