



Display Performance Touch, Appearance, Lighting and Color

1 Introduction

Note: Nothing in this standard supersedes applicable laws and regulations.

Note: In the event of conflict between the English and domestic language, the English language shall take precedence.

1.1 Scope. The purpose of this procedure is to validate the illuminated display appearance and performance component of Touch, Appearance, Lighting and Color (TALC) to the TALC Specifications for Production Part Approval Process (PPAP).

1.2 Mission/Theme. This procedure should be applied to all GM vehicle programs. Partial assessments may also be conducted on competitive vehicles using this procedure.

1.3 Classification. Not applicable.

2 References

Note: Only the latest approved standards are applicable unless otherwise specified.

2.1 External Standards/Specifications.

DIN EN 617 47-1	SAE ARP4256
ISO 15008	SAE J1757-1
ISO 7724-1	

2.2 GM Standards/Specifications.

GM9603P	GMW15118
GME 60292-1	GMW15246
GMW14298	

2.3 Additional References.

- Alliance 3.0 industry requirement no: 1.5
- Reference Material - Lean Closure Code found on the PRTS+ website:
http://quality.gm.com/quality_function_support/cpip_prts/index.html.
- TALC Log
- Issues Log
- Problem Resolution Tracking System (PRTS+)

3 Test Preparation and Evaluation

3.1 Documentation Samples of components or material released to this specification shall be tested for conformity with the requirements of this specification and approved by the responsible GM Department prior to the start of delivery of production level components or materials.

Any change to the component or material, e.g., design, function, properties, manufacturing process and/or location of manufacture requires a new release of the product. It is the sole responsibility of the supplier to provide the customer, unsolicited, with documentation of any change or modification to the product/process, and to apply for a new release.

If not otherwise agreed to the entire verification test shall be repeated and documented by the supplier prior to start of delivery of the modified or changed product. In some cases a shorter test can be agreed to between the responsible GM Department and the supplier.

3.1.1 Calibration. The test facilities and equipment shall be in good working order and shall have a valid calibration label.

3.1.2 Alternatives. Alternative test facilities and equipment may also be used. However, all measuring variables as specified in this specification shall be determined correctly with respect to its physical definition.

3.2 Preparation. Not applicable.

3.3 Conditions. Not applicable.

3.4 Instructions. Not applicable.

3.5 Data.

3.5.1 Calculations. Not applicable.

3.5.2 Interpretation of Results. All emitted lighting requirements in the GMW15118 specification are provided as targets to achieve a reasonable starting point for the matching process. Final approval is based solely on the visual appearance match.

3.5.3 Test Documentation. Subjective observations and illumination measurements should be summarized on data sheets. Performance deficiencies should be captured on a separate spreadsheet (called "Issues Log") noting

date of observation, owner of issue, action plans, and next action date. Issues log must be maintained throughout the program to record actions and final resolution. Review performance deficiencies along with actions taken with the Vehicle Performance Manager (VPM) to determine which issues should be entered into the PRTS+.

After each review a TALC Review Report will be generated and sent to the Director of Electrical Controls and Software.

Use issue description criteria under *Issue Resolution Process for Performance Integration* and closure code description wording under *Reference Material - Lean Closure Code* found on the PRTS+ website http://quality.gm.com/quality_function_support/cpip_prts/index.html. An Evaluation Report should be created prior to 100% PPAP including the data sheet and Issues Log. Distribute Evaluation Report to Vehicle Chief Engineer (VCE), Program Engineering Manager (PEM), Vehicle Performance Manager (VPM), and Vehicle Systems Engineers (VSE).

3.5.3.1 Master Lighting Samples.

3.6 Safety. This standard may involve hazardous materials, operations, and equipment. This standard does not propose to address all the safety problems associated with its use. It is the responsibility of the user of the standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

3.7 Documentation. Samples of components or material released to this standard shall be tested for conformity with the requirements of this standard and approved by the responsible GM Department prior to the start of delivery of production level components or materials.

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If not otherwise agreed to the entire verification test shall be repeated and documented by the supplier prior to start of delivery of the modified or changed product. In some cases a shorter test can be agreed to between the responsible GM Department and the supplier.

3.7.1 Test Results. Suppliers provide test results of the electrooptical performance on the forms in Appendix A, the measured displays should be

distributed to GM for an optional cross measurement of the results.

3.7.2 Deviations from Test Procedure. Deviations from the requirements of this standard shall have been agreed upon. Such requirements shall be specified on component drawings, test certificates, reports, etc.

4 Requirements and Procedure

4.1 General: The definitions below are reflected in the international norms: DIN EN 617 47-1, ISO 15008, SAE ARP4256, SAE J1757-1.

4.2. Performance Requirements.

4.2.1 Display.

4.2.1.1 Viewing Angles. The viewing angles for the driver and passenger shall be determined on the basis of an installation test. The specified viewing angles shall be documented in the parts drawing and in the specification.

The validation of the display shall be performed from the driver and passenger viewpoint. It shall be ensured that an optimal contrast distribution is always available to the driver.

4.2.1.2 Contrast. The contrast with respect to the specified viewing angle shall be documented in an ISO- contrast diagram (see ISO 7724-1), in which the viewing angle for driver and passenger are documented.

The optimum contrast should be reached under the viewing and azimuth angles $\theta_{opt.}$, $\varphi_{opt.}$, defined between the centroid of the mid - eye ellipses, the center of the display viewing area and the normal on the display surface. (See Figure 2).

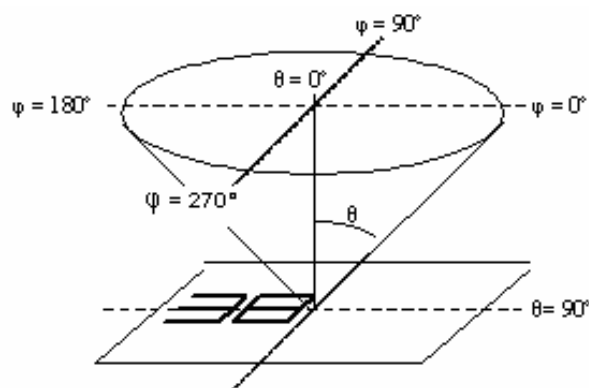


Figure 1: Definition of Viewing Angle θ and of Azimuth Angle φ

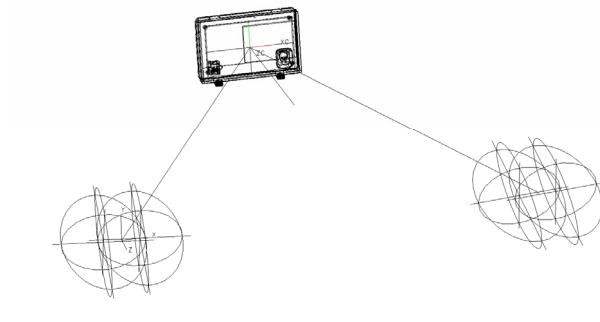


Figure 2: Position of Optimum Contrast Area

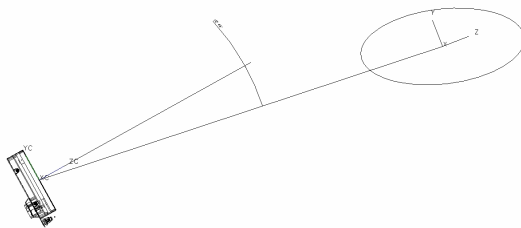


Figure 3: Position of Optimum Contrast Area: (Side View)

4.2.1.2.1 Passive LCD Display in Positive Mode of Presentation. The optimum contrast ratio should not be less than 15:1, for the angles θ_{opt} , ϕ_{opt} , defined between the centroid of the mid-eye ellipses, the center of the display viewing area and the normal on the display surface.

In a viewing cone of ± 30 degrees around θ_{opt} , a minimum contrast of 5:1 should be reached.

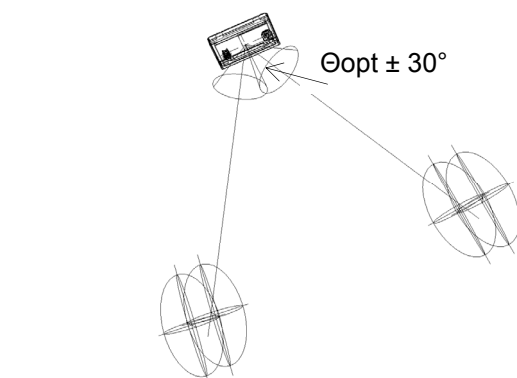


Figure 4: Definition of Minimum Contrast Area

4.2.1.2.2 Passive LCD Display in Negative Mode of Presentation. The optimum contrast ratio should not be less than 40:1 for the angles θ_{opt} , ϕ_{opt} , defined between the centroid of the mid-eye

ellipses, the center of the display viewing area and the normal on the display surface. In a viewing cone of ± 30 degrees around θ_{opt} , a minimum contrast of 10:1 should be reached.

4.2.1.2.3 High Ambient Illumination Contrast Ratio (Passive Displays). The measurement of high ambient illumination requires the measurement according to 4.2.1.2.3.1 and 4.2.1.2.3.2. Both measuring results have to be provided by the supplier.

4.2.1.2.3.1 Diffuse ambient light. The optimum contrast measured with an illuminated sampling sphere should be not less than 20:1, with an illumination of 5 klx, measured inside the sphere. (See Figure 5).

For measuring the LCDs, it is recommended, to position the good viewing angle of the display in direction of the measuring port.

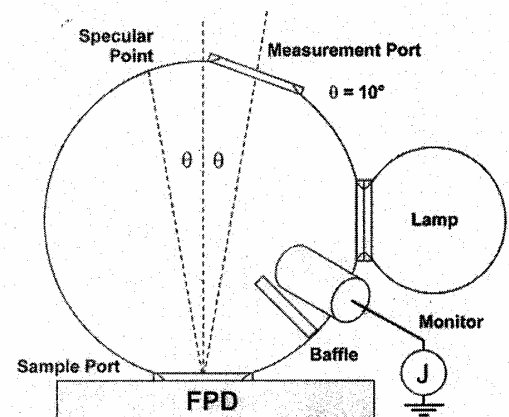


Figure 5: Setup for Contrast Measurement with Diffuse Ambient Light

4.2.1.2.3.2 Direct Sun - Light Exposure. The optimum contrast ratio should not be less than 5:1 for the angles θ_{opt} , ϕ_{opt} , defined between the centroid of the mid-eye ellipses, the center of the display viewing area and the normal on the display surface. (CSL, critical specular line).

The light source should be positioned symmetrical to CSL. The illuminance measured on the display surface covered for adjustment with a standard reflective diffuser should be 45 klx. (Normlight D65)

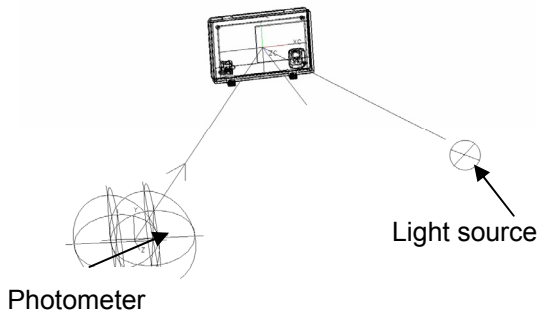
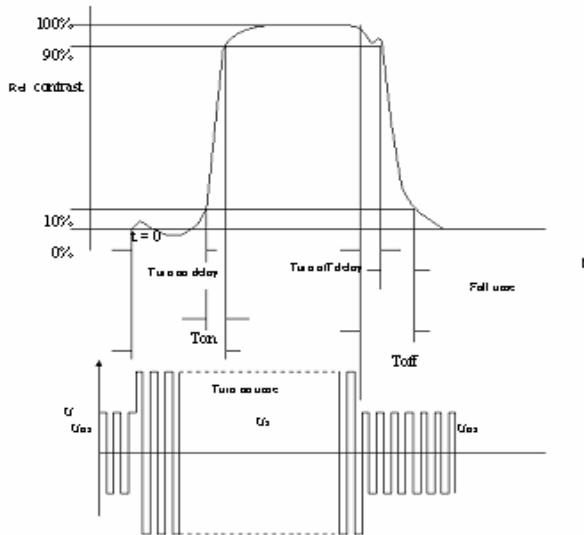


Figure 6: Setup for Contrast Measurement Simulating Direct Sunlight Exposure

4.2.1.3 Switching Times. The switching times $T_{\Sigma} = T_{on} + T_{off}$ should not exceed the following values in the temperature range:



Note Key: Switching Times:
 T_{on} = switching on delay + rise time
 T_{off} = switching off delay + fall time
 $T = T_{on} + T_{off}$

Figure 7: Definition of Switching Times

Table 1: Allowable Switching Times in Automotive Temperature Range (Passive Displays)

Temperature	Switching time T_{Σ}
-30°C	5 s
-20°C	2 s
0°C	0.5 s
20°C	0.2 s

4.2.1.3.1 Panel Heater. If, the display shall have a heater, the heater shall meet the following requirements:

(Heater performance at the driving voltage in DC current)

- Heat up time from -20°C to +15°C within maximum 2 minutes, measured on surface of active cell.
- Evenness of temperature on the heater surface: On each position on the glass surface of the active cell, the temperature difference between each point must be less than 15°C.
- Operation temperature range: of the heater is -40°C to + 20°C.

4.2.1.4 Readability with Polarized Sunglasses. When viewed with polarized glasses, there shall be no images, rainbows, or other defects caused by internal stresses in the lens or display, which can detract from readability of the display.

When a polarizer is used as part of the display, the polarizer shall be oriented to optimize readability when viewed with polarized glasses. Optimization of the polarizer shall be done for the driver position, assuming left hand drive vehicles.

4.2.1.5 Display Uniformity Requirement. The display shall have luminance non-uniformity across the display not to exceed 10%.

The measuring points are defined in the graphic (See Figure 8).

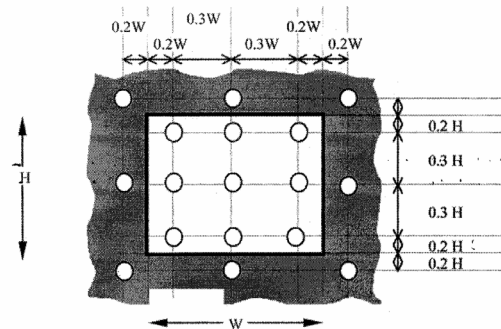


Figure 8: Definition of Measuring Points

4.2.1.6 Color Coordinates and Intensity and Uniformity. The supplier needs to take lighting measurements per GM9603P, GMW15118 and GMW15246 and submit this data to the TALC performance engineer during the TALC approval process see GMW14298.

The values for the luminous density of the display are defined through the tangents from the upper and lower, left and right points from the eye ellipses to the center of the display.

Within these viewing angles the following luminance must be realized:

4.2.1.6.1 LCD Displays in Negative Mode of Presentation: On Segment Brightness under daylight conditions: (See Table 2).

Table 2: Minimum Brightness at Daylight Conditions

Minimum Brightness	Temperature Range
Minimum 150 cd/m ²	between 10°C and 60°C
Minimum 100 cd/m ²	between -30°C and 0°C
Minimum 100 cd/m ²	between 60°C and 85°C

- The minimum brightness is required from all directions of the envelope of the eye ellipse to the center of the display.
- Maximum variation of luminous density over the surface: 10%.

4.2.1.6.2 Displays in Positive Mode of Presentation: (see Table 3)

- Maximum Background Brightness under night conditions: 4 cd/m².
- Maximum variation of luminous density over the surface: 10%.

4.2.1.7 Color and Brightness Over Temperature Range. The display shall meet all color and brightness requirements specified herein over the entire operating temperature range according GMW15118.

The specified display color coordinates including the allowable tolerances should be measured for the angles θ_{opt} , ϕ_{opt} , defined between the centroid of the driver mid- eye ellipse, the center of the display viewing area and the normal on the display surface.

For displays in negative mode of presentation the coordinates should be measured on the segment surface, for displays in positive mode of presentation on the background surface of the display.

4.2.2 Appearance and Quality Requirements.

4.2.2.1 LCD Passive Technology.

4.2.2.1.1 Surface Treatment. To prevent scratches on the surface of the LCD, hard coated material shall be used for the front polarizer.

The display surface shall be hard coated to a hardness of H3 or harder.

4.2.2.1.2 General Specific Requirements for LCD Applications:

4.2.2.1.2.1 Humidity Test. During the normal humidity testing conducted during environmental testing, the displays shall be tested for contrast

ratio degradation. After 500 hrs of humidity testing, the display's contrast ratio shall not have degraded more than 30% from its original value.

4.2.2.1.2.2 Resistance to UV Radiation. After the testing according GME 60292-1 the displays shall be tested for contrast ratio degradation. The display contrast ratio shall not have degraded more than 30% from its original value after the UV test

4.2.2.1.3 Optical Appearance/Defects. Inside the viewing area of the display, the following defects must not disturb the optical appearance:

4.2.2.1.3.1 Optical Defects:

- Scratches on glass, **polarizers** or printings
- Visible anti reflection treatment
- Uneven colouring of the segment or background colour of **the** display. (Limit sample)
- Incorrect colour placement in case of a print. (**not** allowed)
- Spots, wipe marks, stains bubbles, or inclusions
- **Beneath** the polarizers. (**max. extend** < 0.1 mm)
- Irregular dark transmissions Limit samples)
- **Disclinations** (Visible error in liquid crystal orientation) (**not** allowed)
- Etch faults (**max. extend** < 0.1 mm)

The optical defects are inspected in a distance of 60 cm in a time of maximum 10 seconds. The maximum tolerable extension of an optical defect is < 0.1 mm.

The nominal size of an extension is defined (See Figure 9).

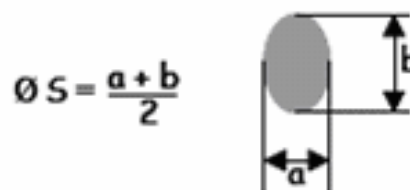


Figure 9: Definition of Nominal Size of Defects

For the accumulation of small optical defects, limit samples should be provided.

4.2.2.1.3.2 Functional Defects:

- Incomplete segment zones
- Segment shorts (dark or bright segments/dots)
- Wrong position of the good viewing area
- Irregular contrast