Transit Signage Manual

Hardware Specifications

Volume

2

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Reference Volumes

Vol. 1
Graphic Standards

Vol. 2
Hardware Specifications
(Controlled Copy)

Vol. 3
Submittals
(Controlled Copy)

Software Requirements

Vector Graphics Editors

Adobe Illustrator Creative Suite 6
Adobe Illustrator Creative Cloud
Affinity Designer

Document Colour Modes

Printed Signs - CMYK
Digital Signs - RGB

File Formats

Adobe Illustrator Document (Ai)
Portable Document Format (PDF)
Scalable Vector Graphics (SVG)

Contents

Part A

Performance Requirements

Part A Performance Requirements

General 1

The contractor shall ensure that design development of the Signage Hardware shall include but are not limited to the following:

- Durability
- Ergonomic features
- Operation and maintenance strategy
- Consistency
- Safe to maintenance and use
- Corrosion-resistant
- Water-tightness
- Modular elements/parts
- Fast to maintain and use
- Non-proprietary

1.1 Modular System

Signs hardware shall be in modular design in every aspect, indicating its associated components. All parts shall be easy to remove and replace.

Where possible, the modular design shall be used and applied to all sign types.

Sub-components shall be assembled in modular composite components where possible to aid efficient production and maintenance. Templates shall be used for fabrication and installation where possible.

1.2 Site Environmental Conditions

The Contractor shall ensure that the hardware and system shall be fully capable of resisting the atmospheric conditions likely to occur at the work site, which, may be uncontrolled and in some areas, the temperature and/or relative humidity may exceed external conditions.

The Contractor shall provide all protective measures to protect all goods and materials supplied at all stages to completion of works. The contractor shall carefully remove all protection immediately before hand-over and leave the Works perfectly clean and fit for immediate use.

1.3 Illumination

All signs shall be illuminated with Light-Emitting Diode (LED) luminaire. Refer to section 1.6 for details. Verification of luminance uniformity and brightness shall be verified using a light meter. Illuminated sign boxes shall be designed and fabricated with no light leaks.

1.4 IP-rating/Water-tightness

All parts that are subject to the ingress of dust and water shall be totally enclosed in dust-proof and water-resistant housings. All sign hardware and system shall have a rating of IP55. Verification of IP-rating compliance is required. Final mock-ups shall be sent for testing with certification/report, by recognised laboratories or institutions.

1.5 Heat Dissipation/Ventilation

Where necessary, provision of a ventilation hole(s) shall be provided as to dissipate heat generated by electrical components within the hardware. A fine stainless steel insect filter shall be fitted to prevent infestation.

1.6 Structure for Cluster of Sign

Sign panels that are floor-mounted and grouped together shall have structural members connected to one another.

1.7 Rigidity and Robustness

Supports and fixtures of all signs shall be sufficiently rigid to prevent movement and generate noise that may be caused by the train or air flow.

1.8 Electromagnetic Compatibility

The Contractor shall ensure that all components and subsystems within the systems are electromagnetically compatible with its environment. This shall be achieved by the selection and coordinated application of current applicable EMC standards, systematic design to ensure compliance with these standards, and testing to demonstrate it.

1.9 Static and Dynamic Loads

The Contractor shall be responsible for the structural integrity of the sign. It shall comply with prevailing statutory requirements including the design of the fixing and supports within Civil Defence (CD) Shelter, entrances and corridor leading to CD shelters to comply with the Design Criteria for Civil Defence. The Contractor shall submit professionally endorsed calculations /drawings /schemes /specifications to show compliance.

The Sign System shall be designed to provide satisfactory operation and integrity under each specified loading condition throughout the design life of the installation. The Contractor shall engage a PE to submit structural calculations to the Engineer for reviews and such review shall not relieve the Contractor of his obligations in respect of the final works.

1.10 Product Labelling

No brand names, logos or identification of manufacture visible outside of the Signs shall be allowed unless prior agreement is obtained from the Engineer.

1.11 Tolerances

The Contractor shall ensure that the Shop Drawings allow for sufficient design, manufacture and installation tolerances of all interfacing conditions, and any differences between actual site dimensions and dimensions shown on the Design Drawings within the specified tolerances.

1.12 Trackside & Tunnel Signs / Tunnel Structural Gauge

Signs in the tunnels or trackside, they shall be designed with no parts fixed or movable, infringing into the Tunnel Structural Gauge Kinematics Envelope.

1.13 Cover Plates for Ceiling Hangers

All ceiling escutcheon cover plates for ceiling-mounted signs shall match the colour of the ceiling panel unless otherwise approved by the Engineer.

1.14 Information Fasteners for Posters

Information posters shall be secured onto the backing panel by means of stainless steel clips or fasteners. The fastening device shall be but are not limited to the following:

- Secured the poster firmly in place without slipping off, warping or distorted.
- Enabled replacement of poster in a quick and hassle-free way.
- Hidden from external visibility.

1.15 Sign Plates with double-sided Graphics

Ceiling-mount, Projected-mount and Floor-mounted signs shall have graphics on both sides, unless specified otherwise.

1.16 Acts and Regulations

The manufacture, supply, installation, testing, and commissioning of the signage system including the design of all construction and fixing shall comply with the latest prevailing relevant standards and regulations

Materials and Workmanship 2

2.1 Source of Materials

All materials and components to be used shall comply with the requirements.

Materials shall be new and of a single source. Multiple and alternative sources of equivalent or higher specifications can be submitted for the Engineer's approval.

All components shall be deemed to be purpose-made unless otherwise indicated to be proprietary or readily identifiable as common parts. Ready-made components may be supplied if they conform to the specification.

2.2 Fire Safety

Materials used in the Sign element shall compose of but are not limited to the following:

- They shall not introduce a significant fire load into the station and tunnels;
- They shall not in themselves be a cause of flame spread; and,
- They shall be constructed of materials which in case of fire, minimize smoke and heat emission and shall be free from toxic gasses.
- Materials that are required to be fire-rated shall be certified by the manufacturers be in compliance with the requirements of specified reference standards (SIS, BS, FSSD, SFSRTS, CP3, etc.).
- Compliance with the Standard for Fire Safety in Rapid Transit Systems (SFSRTS).
- All advertisement materials shall be approved by the FSSD (SCDF) and comply with CP3.
- All the major structural elements of the signage elements shall be of non-combustible material.
- Any surface finishes applied to the sign elements shall achieve a Class 1 low flame spread rating.
- All cables used shall be a minimum of fire-retardant.

2.3 Vinyl Film

The vinyl film shall be 0.05mm (maximum for base vinyl) thick cast vinyl with a permanent high-bond acrylic adhesive backing, to be applied on various background surfaces. The total thickness of vinyl and adhesive shall not exceed 0.08mm thick. All film shall be cast vinyl unless otherwise specified.

With an exception, only information signs which are printed posters mounted within the protection of covered sign boxes can be up to a maximum of 0.25mm (base vinyl) thick polymeric calendered vinyl.

Masking vinyl stickers that are meant to be peeled off at a later date shall have an adhesive that facilitates removal within 1 year unless otherwise stated. Manufacturer's specification shall be verified for this performance.

All graphics (texts and images) on vinyl are:

- computer cut; or
- silk-screen printed; or
- very high resolution digitally printed,
- as specified accordingly in the Design Drawings.

All films shall be applied in accordance with the manufacturer's recommendation.

Background surfaces shall be properly cleaned before application.

All printed vinyl graphics shall be over-laminated for protection.

Overlaminates shall be UV-resistant matt cold pressure-sensitive with liner compatible with the print media as recommended by the manufacturer.

With an exception, only information signs which are printed graphics posters mounted within the protection of covered sign boxes can be up to a maximum of 0.1mm (base vinyl) thick calendered vinyl. Prints shall be over-laminated for protection.

The adhesive for self-adhesive vinyl shall be permanent or removable depending on the short (1 to 3 years) or long-term (permanent) use.

Fire-resistant qualities as specified under the clause 'Fire Safety'.

2.4 Retro-Reflective Vinyl

The micro-prismatic retro-reflective sheeting used shall be suitable for the manufacturing of traffic signs, directional street marker signs and miscellaneous signs for guidance, warning, and working purposes. The sheeting must be applied as a system of materials and application as recommended by the manufacturer; it shall comply with specifications from the manufacturer.

Fire-resistant qualities as specified under the clause 'Fire Safety'.

2.5 Polyester Film/Translucent Vinyl

Polyester film (PET - PolyEthylene Terephthalate) shall be used for backlit signage poster prints.

The polyester film shall be 0.25mm thick (base film), anti-static, with a matte, single side coating, rendering good colour brilliance and image definition.
The print shall be viewed from the matt side.

The prints shall be over-laminated for protection. They shall be matt cold pressure-sensitive over-laminates with polyester liner compatible with the print media as recommended by the manufacturer.

Sign material and print finish shall be UV and water-resistant.

A translucent vinyl film shall be used in lieu of polyester, where performance and durability of polyester cannot be compiled, e.g. heat resistance, flammability.

Translucent film range is used across all continents for its outstanding quality, colour uniformity, adhesion properties, and flexible service.

2.6 LED Light Diffusing Polycarbonate

This is for illuminated sign-boxes using edge-lit technology.

A dot matrix shall be printed or laser cut onto the internal leaf of a double-leaf construction of polycarbonate sheet to evenly distribute light from a LED positioned at the ends of the casing for double-sided signs. Single leaf construction may be used for single-sided signs.

Use colourless polycarbonate as manufactured by an approved manufacturer. The quality of the raw material shall equal or exceed CIBSE standards as tested by an independent testing laboratory approved and licensed by BSI.

The diffuser shall be properly cast, moulded or extruded as specified, and shall remain free of any dimensional instability, discoloration or loss of light transmittance and shall not become brittle with age or exposure to ultra-violet light and sunlight. The diffuser shall be installed clean and free of scratches and fingerprints.

Alternative material or technology based on similar edge-lit diffusion principle may be proposed, to the acceptance of the Engineer. However, brightness levels and other general specifications and performance stipulated above must be compiled.

There shall be no deterioration or staining due to the atmospheric conditions in Singapore other than normal weathering.

2.7 Light Enhancement Film

They are manufactured specifically to enhance light in illuminated sign-boxes. They help to increase sign luminance and reduce hotspots. It shall have the characteristics of a matt white diffusing reflective surface and low light absorption. Usage shall comply with the manufacturer's specifications.

Fire-resistant qualities as specified under the clause 'Fire Safety'.

2.8 Digital Prints

All digital prints shall be in very high resolution (720dpi minimum). The print system shall be Pantone profile matched, waterproof, ultra-violet resistant, and for long-term outdoor use.

For information posters, the high resolution of the print shall be such that the smallest and finest detail on the print is in high definition, crisp and clearly legible from a distance of 600mm.

A matt overlaminate film shall further protect the print. This overlaminate shall be UV and water resistant.

Colour matching with a test print of colour ranges shall be conducted before producing sample prints.

For durability, colour-fastness, and UV-resistance, digital printing shall be UV cured process of the highest quality.

The print system shall also form part of the warranty for durability and colourfastness. The type of digital print system shall match the print media as recommended by the manufacturer of the print media.

The Contractor shall submit the specifications of his printing system – printer and ink, for verification that it can produce prints that are compliant with the high standards required.

Fire-resistant qualities as specified under the clause ‘Fire Safety’.

2.9 Screen Printing

Silkscreen inks must be of an appropriate quality for the material and finish on which they are applied.

Clear-coat silkscreen inks shall be used for face-screened surfaces.

The finish for inks on face-screened surfaces must be semi-matt (eggshell).

HUE-TRANSLUCENT INKS: where a specified hue is applied for translucent illumination, the ink must match that hue when lit.

HUE-FACE ILLUMINATION: where a specified hue is applied for face illumination, the ink must match that hue for daylight and colour-corrected ambient lighting conditions.

Inks hues must not be affected adversely by the presence or lack of ultraviolet radiation or of other rays in the spectrum.

Where inks are screened onto polycarbonate to an exact match in hue and finish with other surface coatings, the resistance to weathering of both coatings must be consistent in order to retain the match of hue and finish.

Inks must be UV-stabilized and able to withstand detergent cleaning, rain humidity, heat, and other ambient conditions.

All Signs shall be such that colours appear the same from one sign type to another. The colour references can be referred to in TSM Volume 1 or in the Authority's drawings.

Colour references are assigned in the Pantone colour system (Pantone Management System – PMS). The colour referred to for coatings, paint and print systems using other references (RAL, CMYK etc.) shall match the one assigned in PMS.

Fire-resistant qualities as specified under the clause 'Fire Safety'.

2.10 Polycarbonate

Transparent and matt polycarbonate shall be used for reversed silkscreen printed signs and front-paste die-cuts a backing for digitally-printed vinyl sticker signs.

They shall be UV-stabilised with an ultraviolet-protective.

Polycarbonate signs which are 3mm or more in thickness shall have all edges bevelled and polished smooth.

All polycarbonate shall be provided from a single supplier unless agreed otherwise by the Engineer.

Exposed edges of polycarbonate shall be finished so that no raw marks are visible.

All sheets shall be of the qualities specified to and of approved manufacture, free from bubbles, smoke waves, air holes, scratches, and other defects.

They shall be UV-stabilised with an ultraviolet-protective, surface impregnation treatment to prevent yellowing.

Impact resistance.

Fire-resistant qualities as specified under the clause ‘Fire Safety’.

2.11 Acrylic

Opal white translucent (white-light transmissive) acrylic sheet shall be provided where direct light-transmissive diffusion (back-lit) is required or when it is used as a backing panel in non-illuminated signs with cut-out vinyl.

Where direct light-transmissive diffusion is required, the acrylic sheets shall be opal white (white-light transmissive) translucent type.

The acrylic sheets shall be with impact performance to requirements.

Acrylic sheets shall be resistant to Ultra-violet exposure and to conditions of the local environment.

Acrylic signs 3mm or more in thickness shall have all edges bevelled and finished smooth.

Notwithstanding acrylic being specified for any sign component, polycarbonate shall be used in lieu of acrylic, where the fire-load is significant.

Fire-resistant qualities as specified under the clause ‘Fire Safety’.

2.12 Workmanship

Workmanship and general finishes shall be of the highest quality and consistent throughout the Works.

Workmanship shall be in accordance with the standards of the trade and shall comply with the requirements of agencies having jurisdiction, codes of practice and the manufacturer’s instructions.

The Contractor shall ensure that, within the necessary tolerances, all cutting of materials is straight and free from burrs, and that all joints are horizontal or vertical, flush without gaps or imperfections and all edges square unless otherwise indicated on the Design Drawings.

2.13 Tropicalisation and Deterioration

All items of plant covered by this Specification shall be tropicalised to suit the prevailing conditions in Singapore and within the station buildings in particular. No materials shall discolour, crack or otherwise be damaged by the worst possible combination of environmental conditions identified herein.

2.14 Corrosion Protection

The Contractor shall ensure that protective measures are taken to avoid any corrosion or any deleterious effects caused by manufacturing, finishing, transportation, storage and installation of materials.

2.15 Compatibility

The Contractor shall use materials which are compatible with each other in their chosen applications, avoid degradation and comply with the prevailing relevant requirements.

2.16 Sign Fascia and Posters

The vinyl film with silk-screened artwork or vinyl cut-out text/graphics or high-resolution digitally printed graphics shall be laminated onto a minimum 3mm thick polycarbonate or finished powder-coated aluminium, as specified.

Reversed-silkscreen print on clear matt polycarbonate as specified. The reversed print shall be sealed with an opaque spray paint.

Front silk-screen print direct onto finished powder-coated aluminium plate as specified.

Where required for protection, vinyl cut-out type graphics and digitally printed graphics shall be protected with a compatible, durable, external-use type, transparent, matt, over-laminate film, selected and applied to manufacturer's specifications, to Engineer's acceptance.

All such signs to be fixed onto a smooth substrate by means of double-sided tape, or as specified, to Engineer's acceptance.

All such signs to be fixed onto a smooth substrate by means of double-sided tape, or as specified, to Engineer's acceptance.

2.17 Masking

Upon installation, some signs may not be ready for view by the public. The Contractor shall mask such signs completely as directed by the Engineer.

The protection works shall include the masking of signs from public view in a neat and secure manner during construction and after completion of installation, until the removal of all protective materials at a time agreed with the Engineer.

The method of masking shall be firm and secure while facilitating easy removal. The material and method of masking shall be approved by the Engineer.

The Contractor shall maintain the masking within the Defects Liability Period.

Metals and Components 3

3.1 Aluminium and Alloys

Any aluminium used for electrical purposes shall be of the highest purity commercially available, and the Contractor shall substantiate by submitting certificates of analysis stating the percentages and nature of any impurities.

Use appropriate grades, strengths, and thickness of aluminium to ensure that all structural and finishing requirements are met. The thickness of aluminium extrusions shall be sufficient to ensure their rigidity in the lengths required in the final installation.

Manufacture all aluminium fixing brackets and cleats from the most appropriate grade of the alloy. They shall be finished to match the metal panels and framing members.

All extruded framing members shall be fabricated from the appropriate grade of aluminium alloy unless otherwise specified. Aluminium sheeting shall be minimum 3mm thick

Where aluminium is to be anodised, aluminium sheeting and flat panels shall be manufactured using alloy grade and aluminium extrusions shall be manufactured using alloy grade.

Aluminium panels shall be manufactured such that the grain on each runs in the same direction.

Aluminium support post shall be extruded with corners rounded or chamfered.

All exposed surfaces of aluminium extruded section shall present a straight, clean and sharply defined line.

3.2 Steel

All mild steel components to be galvanised before receiving the specified finished-coating – PVF2 coating, powder coating or paint.

3.3 Finishing

All finishes shall be applied in the factory and shall be stable, fade resistant, and not affected by the effects of ultra-violet or natural daylight and sunlight.

All finishes shall be durable, of uniform texture and colour, and be resilient to all environmental and pollution effects.

All finished surfaces shall be smooth, free from blemishes pinholes, tears, orange peel effect and other coating defects when evenly illuminated by diffuse light and viewed using normal corrected vision from a distance of 100mm.

Unless otherwise specified, welds, rivets, screws, and stiffeners, etc., shall be treated so that there is no discontinuity of the finished surface appearance.

Samples of all finishes shall be submitted to the Engineer for inspection prior to the commencement of production. Colour and finish uniformity shall be established on the basis of reference samples.

The Contractor shall submit a list of finishes of all types of Signs for review by the Engineer.

3.4 Anodising

Aluminium and aluminium trims shall be finished with an anodized coating of not less than 50g/m2, of a colour and surface finish detailed on the Drawings.

Where aluminium is to be used for Signs and the final finish is dependent upon the base metal, then it shall be provided from a single batch to ensure identical chemical composition.

3.5 Thermoset Powder Coating

Powder coating shall be painted on a fully automatic continuous paint line by a single applicator to a minimum thickness of 80 microns and maximum thickness to match the hard coating process. Colour shall be reviewed by the Engineer and samples shall be submitted to the Engineer for review. One applicator and one powder coating supplier shall be used for the Works.

The powder coating thickness between adjacent metal panels shall not vary by more than 10 microns.

All powder-coated panels shall receive a clear protective top coat sealant, 70 microns thick.

Glazing 4

4.1 Performance

4.1.1 General

a. Selection of glass shall be in accordance with AS 1288.

b. The glazing works shall:

i. remain intact under the ambient in-service and climatic conditions;

ii. withstand the anticipated loads without damage or impairment of performance;

iii. provide adequate means of dealing with thermal and differential movement. No glass shall suffer from thermal fracture;

iv. be designed to minimise fragmentation and panel separation;

v. allow for effective maintenance and replacement to be carried out without damaging adjacent components.

vi. be installed to minimize visual impact of roller wave distortion or 'pillowing' effect. Direction of ripples shall be consistent.

4.1.2 External Glazing

a. All thickness of glass for external application shall meet with the required design wind pressure or suction and shall be watertight.

b. limit solar heat gain and UV penetration where enclosing or providing covered shelter;

c. be self-cleaning low iron glass or and solar control glass where exposed to the weather.

4.1.3 General Loading

The design of the structure shall incorporate good engineering practice and principles as per AS 1288. The design and loading requirements shall be as follows:

a. The loads specified and effects for the most severe combination of forces on every component /member.

b. The method and sequence of construction shall be specified and taken into account in the design.

c. Possible imperfections in fabrication and erection shall be considered in the design. The structurally acceptable margins of tolerance shall be clearly specified for critical members and installation/ operations.

d. All laminated glass shall be designed for one ply failure.
   The remaining unbroken/un-shattered glass ply shall be designed to carry self-weight of the whole panel and wind load. Tests shall be carried out to demonstrate that should one ply of any laminated glass break, the remaining unbroken plies held within the actual fixings, shall have sufficient strength to carry the weight of the broken ply, together with all anticipated loads with the broken glass being required to remain in position for a minimum of 72 hours.
e. Structural fixings shall be designed to resist all anticipated loads such as dead loads, live loads, wind loads, etc. including all structural movements individually and in combinations. All fixings shall accommodate the worst combination and the overall articulation of the glazing.
f. The breakage or removal of any panel of glass or any component shall not lead to a collapse or failure of adjacent elements or the system as a whole.
g. The design shall incorporate the clearances, dimensions, configurations and withstand the loads created by the selected façade / glazing washing system. Loads induced by the system shall be considered to act simultaneously with the design wind pressures.
h. The glazing system shall be capable of withstanding dynamic effect, including vibrations if appropriate. When the glazing is adjacent to a carriageway, viaduct or trackway, it shall be designed to withstand a vibration of 10mm/sec without breakage of the glass or separation of the glass from the supports.
i. The glazing system shall be designed to provide for maintenance personnel and equipment loads. The engineering computations submitted by the Contractor shall clearly identify these loads.

4.1.4 Temperature Loads

a. Glazing shall be designed to provide for expansion and contraction over the following temperature ranges without buckling, sealed joint failure, glass breakage, stone breakage, undue stress on members or anchors, and other detrimental effects:
b. External environment: Ambient temperature range from 15°C to 45°C.
c. Internal environment: Ambient temperature range from 20°C to 35°C.
   In addition, if the premise is air conditioned, ambient temperature range from 15°C to 27°C shall be considered.
d. Surface temperature allowance shall be +33°C (i.e. 60°C).

4.1.5 Maximum Deflection

a. For glass to be considered as four-edge fully supported, the deflection of edge of the glass shall be limited to glass span/175. This requirement shall also be applied to the one ply failure condition. Only self-weight and wind load (if applicable) need to be considered under such a condition.
b. Permanent deformation: Weld or fastener failure, component dislodgement or breakage shall not occur under loading equal to 1.5 times the design load pressures. Permanent deformation is defined as deflection without recovery exceeding length/1000.

4.2 Materials and Components

4.2.1 General

a. All glass and glazing materials shall be free from defects which detract from appearance or interfere with performance under normal conditions of use.
b. Glazing materials (including glazing compounds, sealants, gaskets, glazing tapes, spacing strips, spacing tapes, spacers, setting blocks and compression wedges) shall be appropriate for the conditions of application and the required performance.
c. All glazing materials used shall comply with the requirements of SS 341 Grade A unless otherwise stated.
d. Unless otherwise stated, glass used shall be clear with minimal visible green colour when viewing glass edge.

4.2.2

Flat glass quality shall at a be minimum meet Quality Q3 to ASTM C1036.
Unacceptable blemishes in heat-treated flat glass (including tinted and coated glass)
Standard: To ASTM C1048.

4.2.3

All toughened glass shall be heat soak tested to BS EN 14179 and subject to other quality control measures, to minimum the occurrence of nickel sulphide inclusions. This Specification defines nickel sulphide inclusions as a glass/material defect. Installed toughened glass which breaks due to nickel sulphide inclusions shall be considered a material defect and shall be replaced under the warranty provisions.

4.2.4

Roller wave shall not exceed requirements for toughened glass as per ASTM 1048 or EN 12150-1.

4.2.5

All laminated glass shall have clean-cut edges, or polished edges and protected to prevent de-lamination, contamination or other defects, caused by moisture, sealant contact or other external/internal source. Materials used shall not cause deterioration or discolouration of the interlayer.

4.2.6

Polyvinyl Butyral (PVB) interlayer of laminated glass shall be of appropriate thickness as recommended by manufacturer, but not less 1.52mm, to provide a Class A impact resistance.

4.2.7

Maximum allowable laminating process blemishes shall not greater than those listed in ASTM C1172.

4.2.8

Glazing accessories, including spacers, setting blocks, wedges and the like, shall comply with AS 1288, and the recommendations of the glass manufacturer or glazing system. Framed glass shall be smooth, of uniform dimensions, and free from components likely to bleed, stain or detrimentally affect performance of the glazing.

4.2.9

All jointing materials shall be compatible with each other and with the contact surfaces and non-staining to finished surfaces.
Do not use bituminous materials on absorbent surfaces.

4.2.10

Any reduction in quality beyond the requirements listed above shall be defined as a defect during the warranty period requiring the replacement of the glass panel.

4.2.10

Fastenings, including bolts, anchors, lugs and the like, shall be of a type appropriate to the work, capable of transmitting the loads and stresses imposed, and sufficient to ensure the rigidity of the assembly. All fixings and brackets shall be non-corrosive. Mild steel or cadmium plated steel fixings will not be acceptable.

4.3 Verification and Submission

The Contractor shall submit calculations for all the elements:-

- Structural calculations for frames, connections and glass panels including calculations for one ply failure condition to show that the total maximum stresses and deflections do not exceed specified performance requirements under full design loading. Building movements including loading deflections, shrinkage, creep, temperature variation and vibration, etc. are to be taken into account.

- Thermal stress calculations for each type, size and thickness of exterior glass.

- Calculations on expected expansion and contraction shall be compared against the allowable values in the design.

- Structural calculations for the anchorage of the glazing washing systems.

- Calculations for all the anchors, inserts and fasteners, demonstrating that they will sustain all imposed design loads.

- Design and construction of structural sealant glazing shall comply with BCA's requirements.

Accessories

5

5.1 Adhesive Tapes

Double-sided tape shall be of industrial and high-bond strength to be selected and used in accordance with the manufacturer's specifications and instructions.

The manufacturer and/or a professional engineer shall verify suitability in accordance with the required adhesion strength. The tape shall be supplied by a reputable, established manufacturer acceptable to the Engineer.

The Contractor shall submit all test certificates/reports of the proposed brand of double-sided tape.

The tape shall be able to transmit imposed loads sufficient to ensure the rigidity of the assembly, and which will not cause discolouration of finished surfaces or have any detrimental effect on materials with which it comes into contact

5.2 Sealants

The application of sealant shall be in accordance with the supplier's / manufacturer's written preparatory and application procedures.

5.3 Gaskets

All gaskets to be manufactured from neoprene profiles in accordance with the Design Drawings.

The Contractor shall provide written confirmation from the gasket manufacturer that the gasket material and designs are wholly suitable for their specific use and are compatible with all other materials and sealants used within the installation and interface with other materials/components.

The colour of all gaskets shall be black.

5.4 Springs, Pivots, and Hinges

They shall be corrosion-resistant. Stainless steel shall be used where the component is available in the industry/market.

5.5 Fasteners – Screws / Bolts / Studs / Nuts / Washers / Clips

All such fasteners and associated brackets/accessories shall be corrosion resistant; stainless steel 316 is preferred where it is available in the industry/market.

For Civil Defence shelters stations, all fixings shall comply to the Civil Defence Design Criteria issued by Building and Construction Authority (BCA).

Where screws or bolts are required to secure the hardware components e.g. aluminium sign panels or frames, lock-nuts or concealed blank rivet nuts shall be incorporated to receive screws and bolts in sign-boxes. The metal sectional components or metal extrusions of the sign-boxes shall not be threaded to directly receive screws or bolts.

5.6 Steel Conduits and Fittings

Steel conduits shall be heavy gauge, screwed and longitudinally welded.

5.6 Lockset

Use tamper proof locksets/fixing where they will be accessible to the general public.

Locking device where specified as stainless steel screw shall be as follows:

- Stainless steel button-head M6 screws with 4mm hex-profile with threaded blind rivet (concealed) nuts.
- Self-tapping screws through sign panel frame are not acceptable.

Electrical Works 6

6.1 Contractor's Responsibilities

The Contractor shall be responsible for the electrical system of the illuminated signs.

The Contractor shall propose an energy efficient lighting system for the illuminated signs to the acceptance of the Engineer.

All equipment and installations supplied under this Contract shall comply with the requirements taken to be generally applicable in accordance with good practice, and they shall not relieve the Contractor of his responsibility of ensuring that all equipment and installations incorporated in the Works are suitable for their intended purposes and environment. The Contractor shall coordinate with the Electrical Contractor to ensure compatibility of equipment.

Where the illuminated sign has to be interfaced with other contracts or existing systems, it shall be designed to be compatible with their system.

All materials and workmanship for electrical works shall comply with the latest Singapore Standards and Codes of Practice.

6.2 Professional Endorsement/Supervision/Compliance

The Contractor shall submit professionally endorsed calculations /drawings /schemes / specifications to show compliance.

All electrical works shall be designed, endorsed and supervised by a Professional Engineer or Licensed Electrical Worker (LEW) as stipulated in current statutory regulations.

Electrical works shall be carried out in compliance with the latest edition of CP5 and EMA regulations and codes that are current.

6.3 Power Supply and Power Points

For works at new MRT/LRT stations, the Contractor shall connect the signs to the electrical connection provided for by Electrical System-Wide Contractor.

For signage works at existing MRT/LRT stations, the Contractor shall design and install the electrical supply for connection to signs from the electrical distribution board. All modification of the existing distribution boards and provide power to the illuminated sign shall be deemed to be part of the Contractor's scope of works.

6.4 Lightning-Protection System

The Contractor shall be responsible for the lightning-protection system of the signs, especially those at a high level. The lightning protection system shall comply with current statutory regulations.

6.5 Lighting and Electrical Components

The Contractor shall provide signs complete with the specific LEDs, subjected to Engineer's approval. The illuminated signs shall be factory wired and ready for installation upon delivery to the site.

All LEDs shall be supplied by a reputable, long established manufacturer acceptable to the Engineer. LEDs shall be supplied from the same production run with batch numbers clearly identified.

6.6 Light Emitting Diode (LED) Luminaire

The LED luminaire, including the LED, its associated electronic control gears (Driver) and all accessories, shall be designed to fully withstand the current-voltage surges of lightning strikes and the frequent switching operation of the power supplies.

Each luminaire shall consist of 2 main components consisting of an independent LED Module and Electronic Control Gear (driver).

The driver and LED module shall be integrated into the luminaire. The driver shall be designed to be replaceable with a standard compatible driver.

The luminaire shall be of robust constructions which combine excellent functional and visual design. The luminaire shall be of dustproof and jet proof to IP65, vandal proof and shall be completed powder coated finishing.

6.7 LED Performance Requirement

Operation of LED Life Span – The rated LED life should be more than 50,000 hours at an ambient temperature of 40 degree Celsius or higher.

The luminaire shall comply with the requirements of safety extra-low voltage (SELV) system.

The luminaire design shall be tested to relevant local or international standards.

The LED module shall be corrosion resistant and diffuser UV coated.

The LED luminaire shall be provided with an adequate thermal performance for the long-term operation of the LED's at an ambient operating temperature of not less than 35 C in accordance with relevant local or international standards

The LED junction temperature shall be maintained at 5000K for Information, Direction and Amenities Signs and 3000K-4000K for Identity Mega Sign or below manufacturer's recommendation.

The selected Electronic Control Gear (driver) shall comply with the requirements of safety extra-low voltage (SELV) systems.

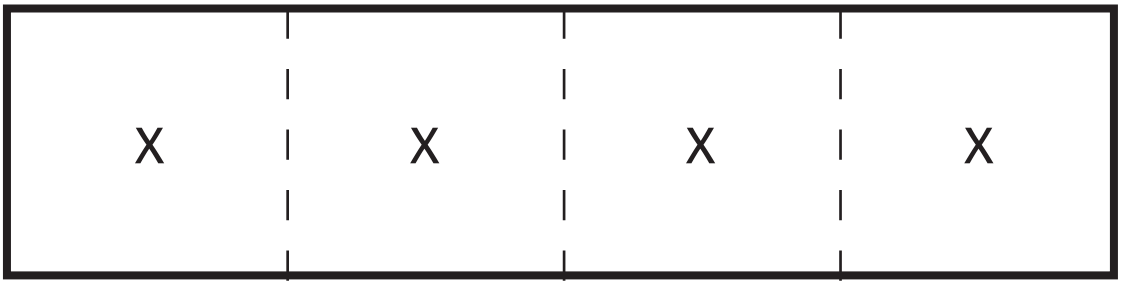
The electronic control gears shall power the LED such that the LED is flicker-free and it shall be suitable for Class 1 luminaires.

The LED lighting and drives shall have a minimum IP rating of 67.

6.8 Verification with Light Meter

Grids at approximately 450mm x 450mm. Luminance is spot-measured at the centre of squares formed by the grids. The light meter use shall be specifically made for the measurement of luminance; not to be confused with illuminance in 'lux'.

Luminance candela per square-metre (cd/m2), and Illuminance (lux), shall be verified with the appropriate light meter. An average is computed from the readings.



Performance	Description	Requirement	Units
*Uniformity	Ratio of min. to max. illumination	Max. 1:3	Ratio
*Brightness/ Luminance (backlit)	Average brightness of white foreground (Advertising)	min. 500	cd/m²
*Brightness/ Luminance (backlit)	Average brightness of white foreground (Information Signs)	min. 400	cd/m²
*Brightness/ Luminance (backlit)	Average brightness of background	max. 20	cd/m²
*Brightness/ Luminance (backlit)	Average brightness of hidden message	min. 150 (Not to be exceeded by any other illuminated colour.) To be 0 when 'hidden'	cd/m²
Brightness	Relative output expressed as a percentage of light emitted with reference LED and driver	min. 95	%
Specular reflectance	Reflector output	min. 23	%
Reflector	Total reflectance	min. 86	%
Reflector	Diffuse reflectance	min. 78	%
Illuminance (external light source)	Average brightness (illuminance) of light falling on the surface of the sign face	min. 200	lux

Internally Backlit Signs

Verification of Luminance: Uniformity and brightness shall be verified using a light meter.

Reference points of measurement shall be at the centre of squares formed by grids of approximately 300mm x 300mm.

Illumination shall be uniform, with no hotspots (of the lamps) visible.

Externally Lit Signs

Illuminance (lux) shall also be verified using an appropriate light meter.
An average of a few points of measurement shall be used.

Illumination levels on the sign surface shall be uniform over the sign surface. The illumination level on the surface of the sign shall not significantly be exceeded by the ambient light or visible bright lighting source behind or in front of the sign.

There shall be no shadows or dark areas cast on the sign.

6.9 Electrical Bonding

The Contractor shall ensure that all extraneous conductive parts of the Sign System are effectively bonded to earth. An extraneous conductive part is defined as being any part that is liable to transmit a potential, generally earth potential, and not forming part of the electrical installation. Each component shall constitute an extraneous conductive part.

The Sign System shall be electrically continuous as required by the latest edition of CP5.

The Contractor shall provide equipotential bonding in a manner that ensures that the various exposed conductive parts and extraneous conductive parts, as defined by the applicable regulations, are at a substantially equal potential.

Equipotential bonding requirements (EPB) comply with the requirements of CP5.

6.10 Isolation and Insulation

The illuminated signs shall be provided with a means of local isolation within the signs for maintenance purposes. A multi-way plug and socket shall be provided linking the incoming terminals to the control gear and lamps. Disconnection of the plug shall completely isolate the sign from all sources of external electricity supply.

6.11 Control Switch

All illuminated signs shall be switched to the control logic.

The on/off control to be linked to the central timer, usually at the distribution box, as required. In addition, the signs shall be controlled by their associated equipment.

6.12 Life Expectancy

The life expectancy of the sign hardware and system as a whole shall be at least twenty (20) years. The performance criteria shall be satisfied for the full lifespan.

All components and parts shall be easily accessible without obstructing the station operations and shall be capable of being maintained or completely replaced within or less three (3) hours during non-peak hours.

Warranty 7

7.1 Period of Warranty

The Contractor shall warrant each element of the Signage System (except lamps) for a minimum of five (5) years commencing from the date of completion of the whole of the Works certified by the Engineer.

With an exception, the period of warranty for building/architectural components & finishes used in the Signage System shall comply as follow:

Warranty	Period (years)	Warranty by whom	Against
Metal components, bars, rods, hollow sections, cables, etc.	15	The contractor, Contractor's designer and supplier	All defects in design, material and workmanship
Sealants	15	The contractor, Contractor's designer and supplier	All defects in design, material and workmanship
Pre-finishes	15	The contractor, Contractor's designer and supplier	All defects in design, material and workmanship
Polyester powder coating / z	10	The contractor, Contractor's supplier	All defects in design, material and workmanship
Proprietary & fabricated metalwork items and components, generally	15	The contractor, Contractor's designer and supplier	All defects in design, material and workmanship
Vinyl Film	5	The contractor, Contractor's supplier	All defects in design, material and workmanship
Proprietary paint systems and components	5	The contractor, Contractor's supplier	All defects in design, material and workmanship
LED lightings and drivers	5	The contractor, Contractor's supplier	All defects in design, material and workmanship

7.2 Manufacturer's Warranties

Provide manufacturer's warranties where applicable, especially for signage vinyl and overlaminate material and print media used for posters and sign panels.

7.3 Specific Scope of Warranties

Provide warranties for the materials and workmanship for each signage item or component in the following terms:

"The Warrantor agrees to rectify, without cost to the Authority:

- Inadequate and erroneous design, in the case of the designer (design development) of the works required by the Contract,
- Faulty materials and components, in the case of the manufacturer, and
- Faulty workmanship, in the case of the fabricator & installer, where:
- There is a structural failure;
- Discolouration or fading of prints, materials, components or fixings has occured;
- The systems fail to achieve the performance criteria specified."

7.4 Other Specific Scopes of Warranty

The warranty shall also expressly confirm that there shall be no change in colour, "yellowing" or other detrimental effects be caused to the sign panel, vinyl, and prints due to heat or ultra-violet radiation either emanating externally or internally from the light source. There shall also be no peeling, cracking, de-lamination or smudging.

7.5 Signage Building Materials and Applied Finishes

The warranty for the following that is used for signage shall be consistent with the warranties of building/architectural components & finishes against all defects in design, material, and workmanship: (see 7.1)

- Factory applied finishes/coatings on signage, such as pre-finished (e.g. galvanizing), powder-coating, fluorocarbon-coating, paint systems; and

- Building/architectural components and materials that are used for signage, such as stainless steel, bars, rods, hollow sections, cables, metalwork items, glazing, sealants, etc.

7.6 Light-Emitting Diode (LED)

The Contractor shall provide a warranty jointly and severally with the manufacturer against all defective materials and workmanship of the LED light fixture up to 5 years after the date of Completion of the whole of the Works certified by the Engineer.

To ensure immediate replacement, the Contractor shall maintain a stock of 5 units of LED Light fixtures in his store at all times during the warranty period. The Contractor shall permit inspection of the stock by the Engineer who shall have the right to procure the LED light to make up any shortfall and recover from the Contractor all costs incurred by the Engineer plus 15% administration charges.

Defects Liability 8

8.1 General

General: During the defects liability period, carry out periodic inspections and maintenance work as recommended by manufacturers of supplied equipment, and promptly rectify faults.

Emergencies: Attend emergency calls promptly. (Similarly extended to the warranty period).

8.2 Maintenance Program

Submit details of maintenance procedures and program, relating to the installed plant and equipment, 4 weeks before the date for practical completion. State contact telephone numbers of service operators and describe arrangements for emergency calls.

8.3 Maintenance Records

Record and maintain a maintenance/rectification attendance log, stating details of attendance.

During the defects liability period, carry out periodic inspections and maintenance work as recommended by manufacturers of supplied equipment, and promptly rectify faults.

Operation and Maintenance 9

9.1 Strategy

The Contractor shall provide both a proposed maintenance plan and a major component replacement programme for review and issue of notice of no objection by the Engineer.

9.2 Safety

Passenger and LTA/Operators personnel safety shall be a prime consideration in all aspects of the design and construction of the Sign System. Design of the signs and the proposed maintenance procedure shall comply with safety practices regulated by Singapore Standards or Code of Practice.

Part B

Schematic Details

Part B Schematic Details

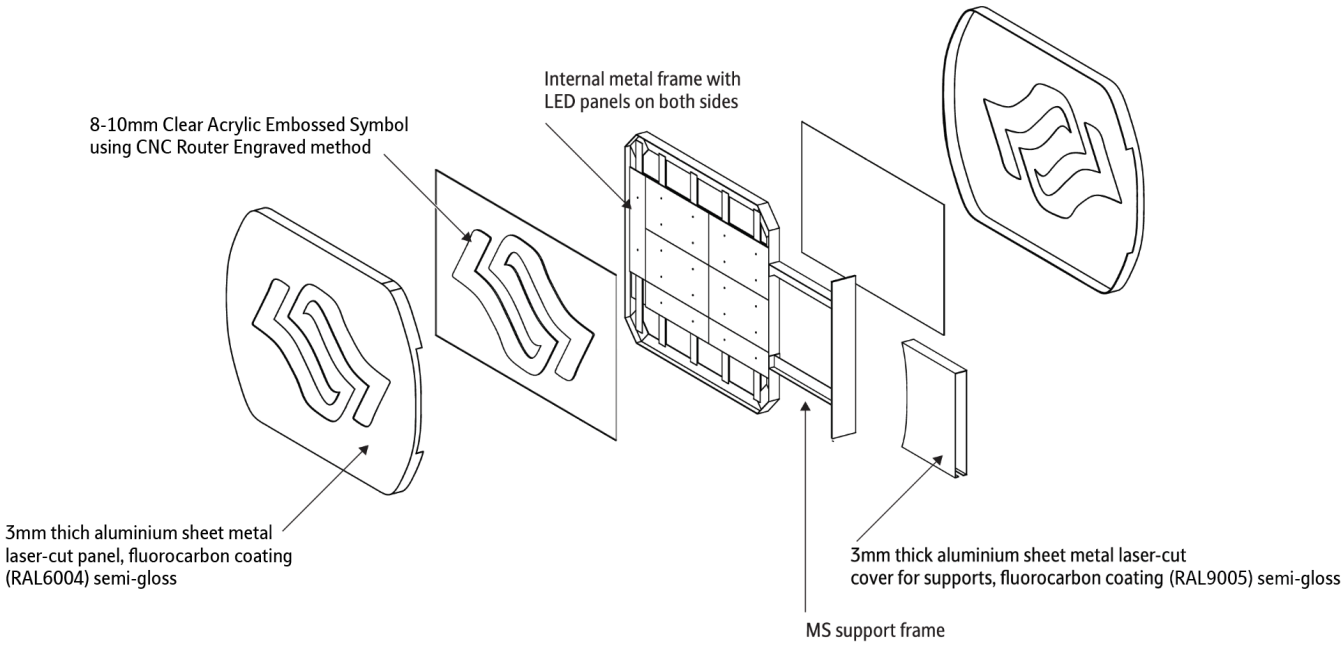
Identification Signs 10

MRT Logo Caplet M-Sign 10.1

Refer to Volume 1: Graphic Standards for
graphic. colours and sizes of respective M-signs

Sizes

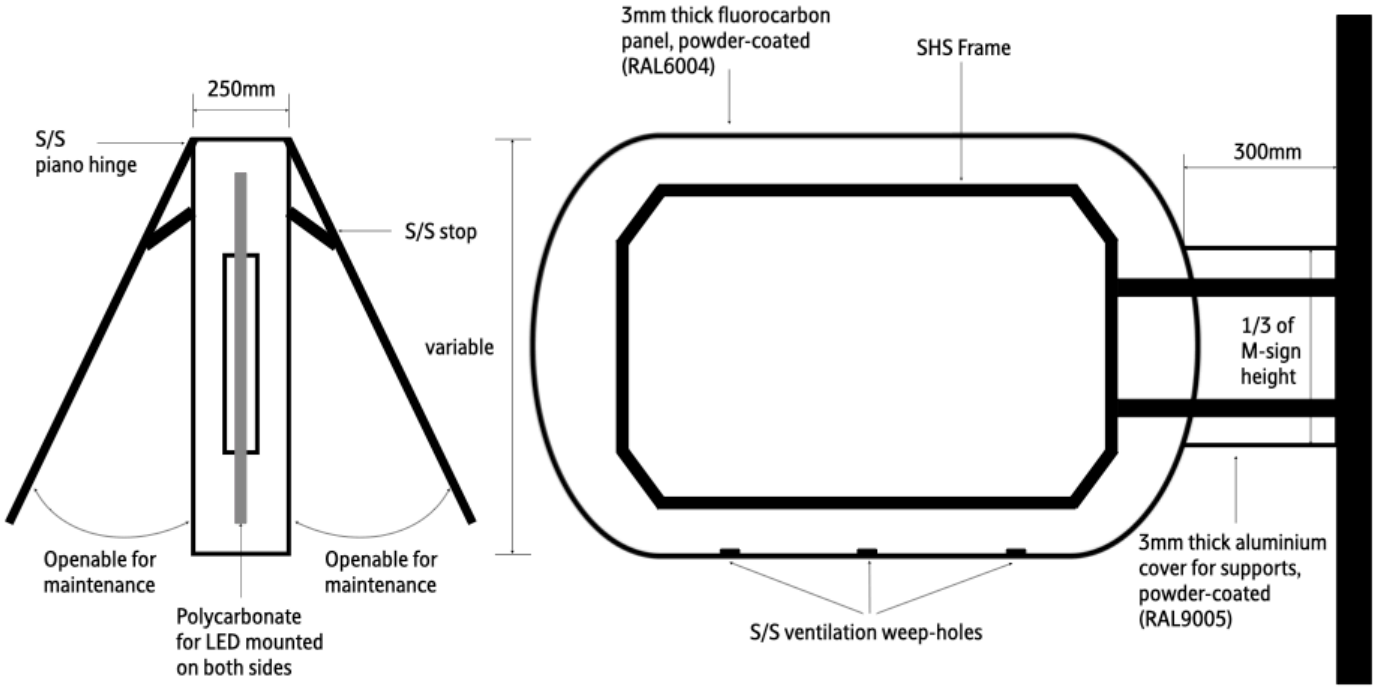
M1 : 1800mm x 1140mm x 250mm
M2 : 2250mm x 1425mm x 250mm
M3 : 3000mm x 1910mm x 250mm



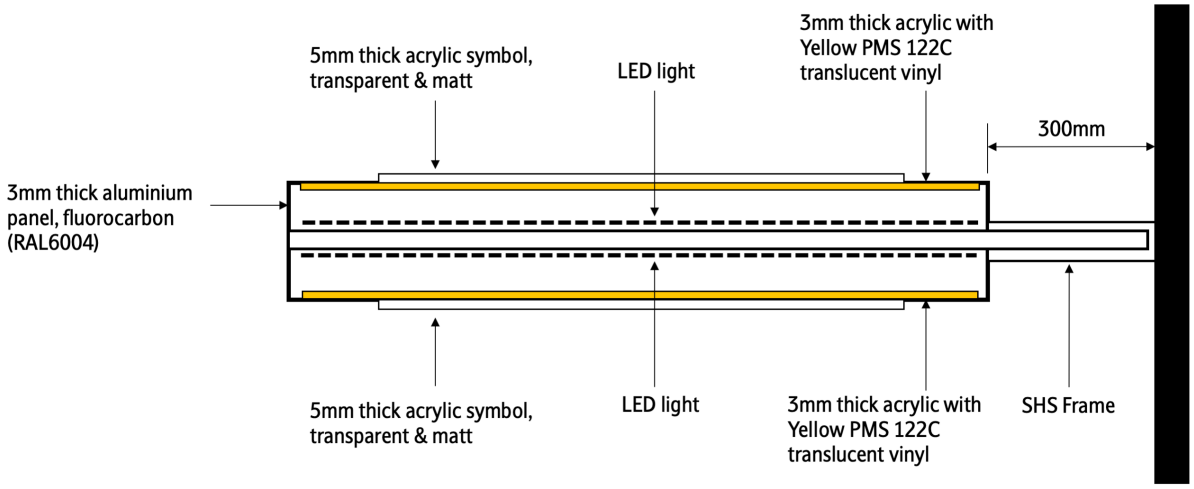
Cantilivered M-Sign

Side View

Front View

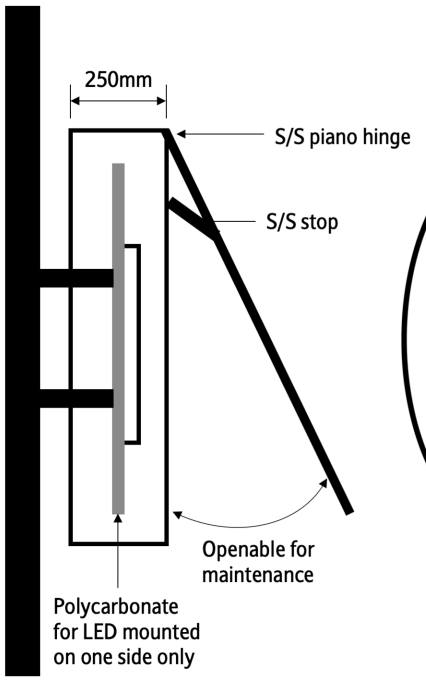


Top View

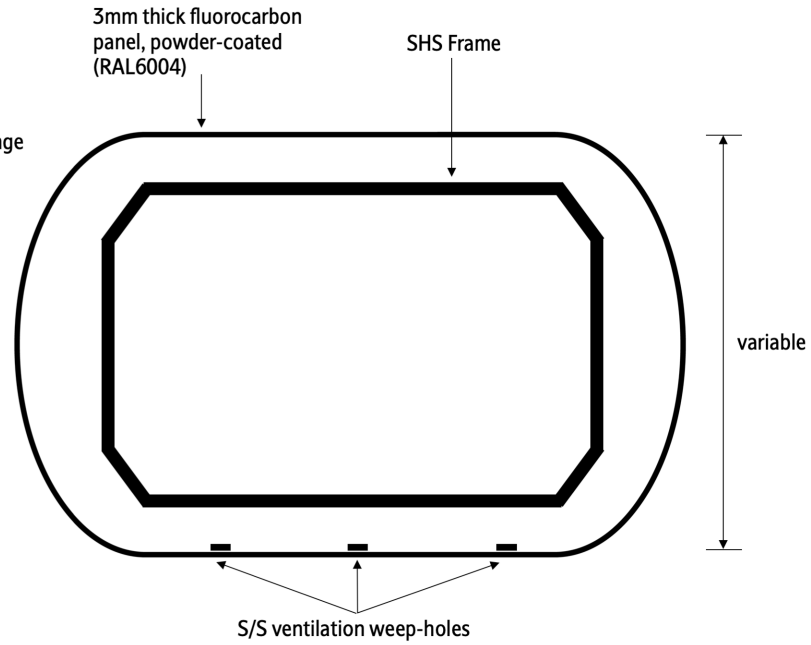


Surface Mounted M-Sign

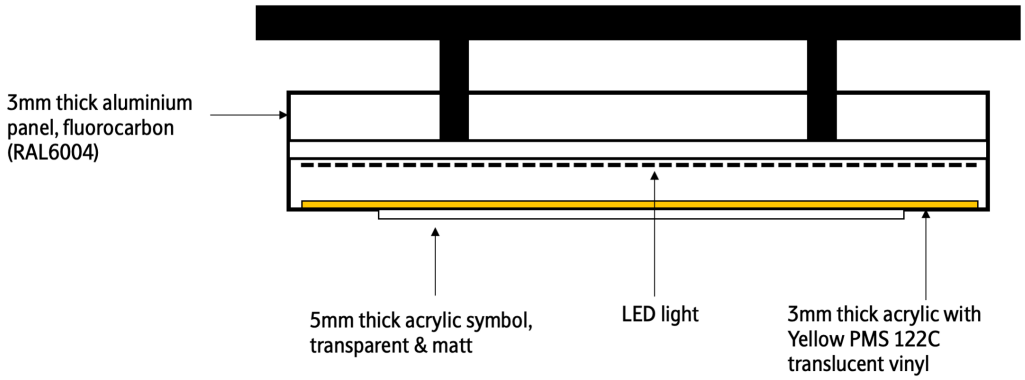
Side View



Front View

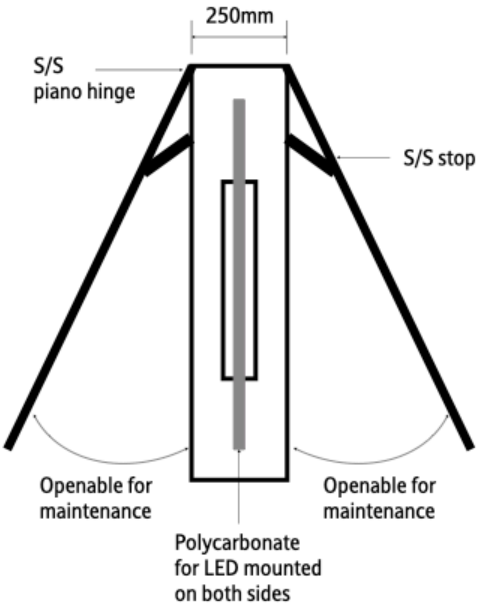


Top View

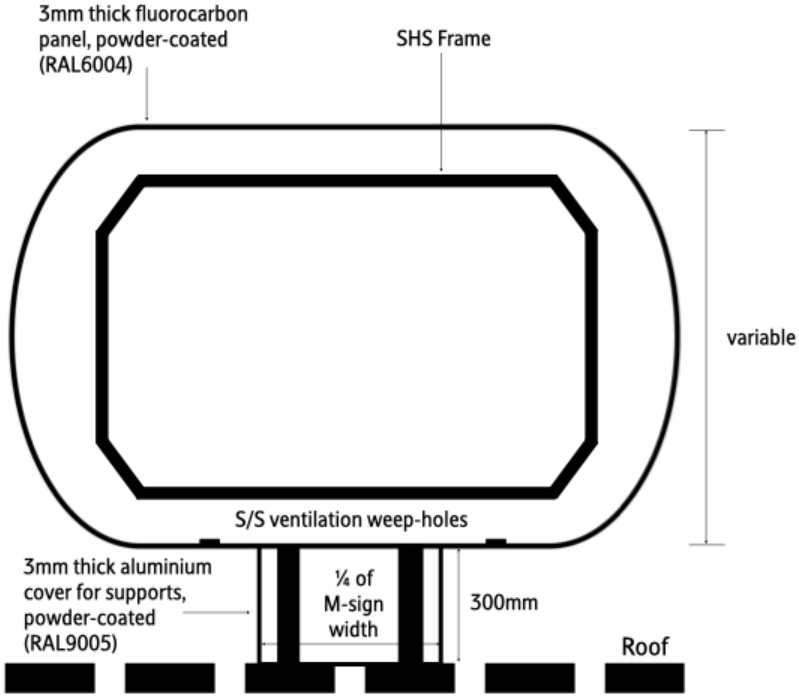


Above/Under Roof Mounted M-Sign

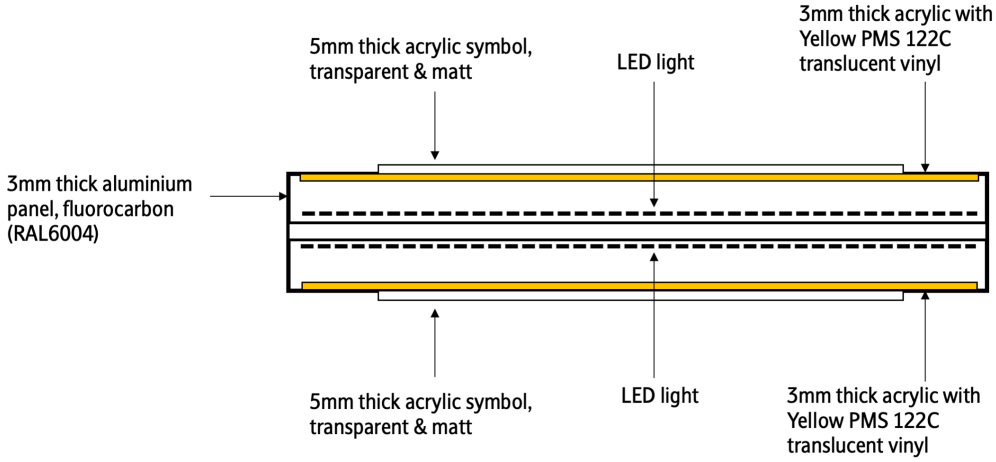
Side View



Front View



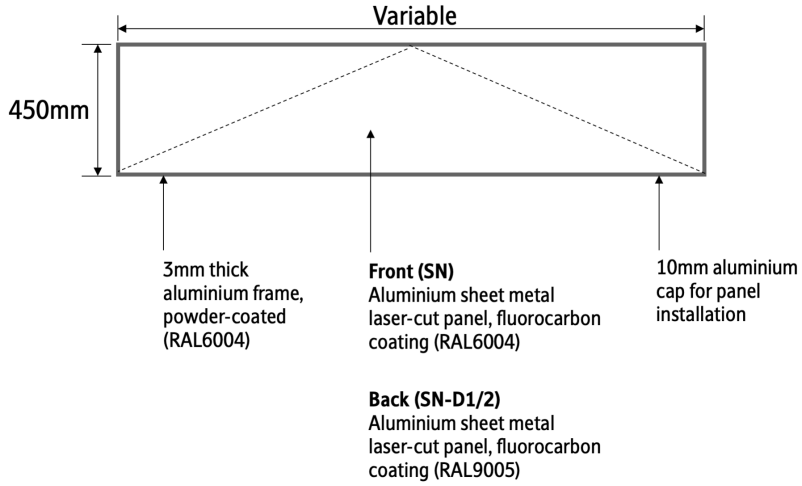
Top View



Station Name Sign 10.2

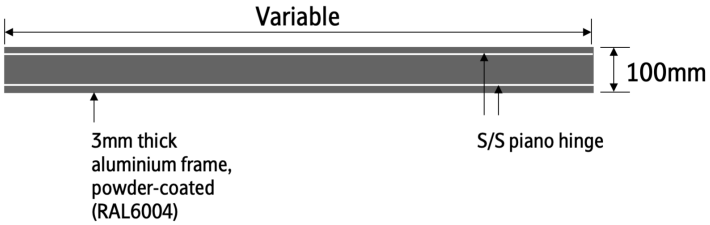
Refer to Volume 1: Graphic Standards for graphic. colours and sizes of SN-Signs

Front View

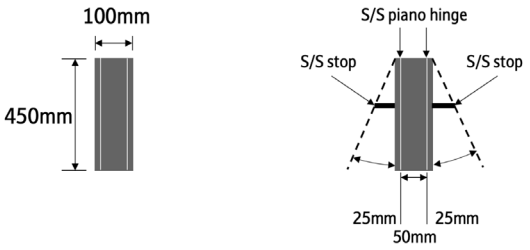


Internal

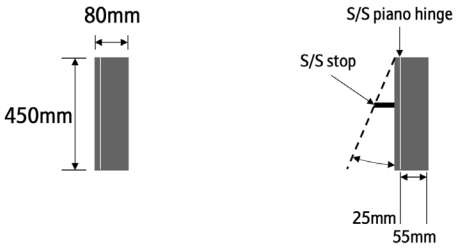
Top View



Side View (Double)

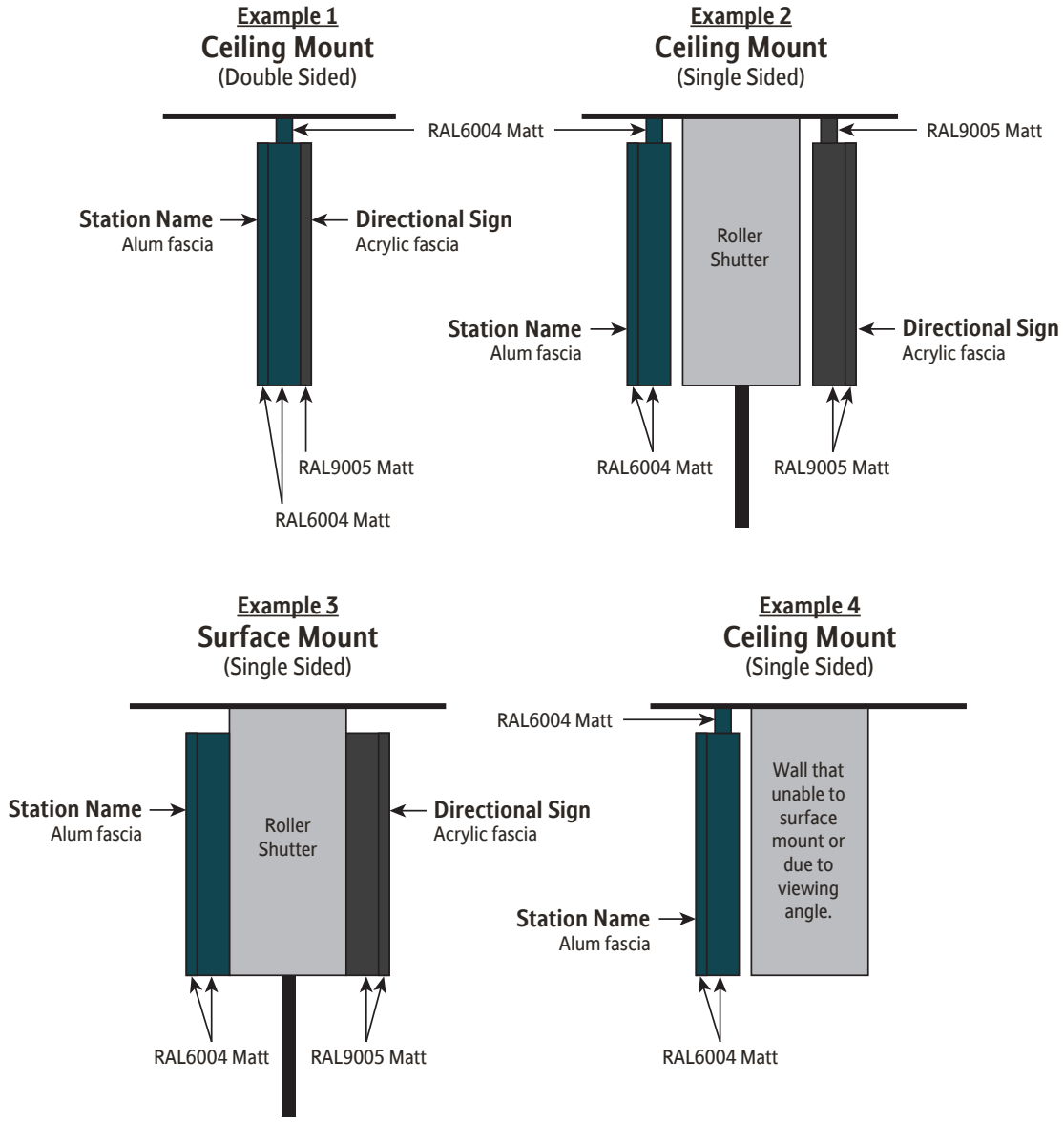


Side View (Single)



Station Name Sign 10.3

Applying colour on SN/SN-D signbox (Side view)



Note: Proposed mounting shall be indicated on elevation drawings or superimpose on site photos for review and approval.
Ensure no visual blockage or conflict with all SWCs and archi finish e.g. Covered shelter, columns, rain louvers, roller shutterbox & etc.

Information Panels 11

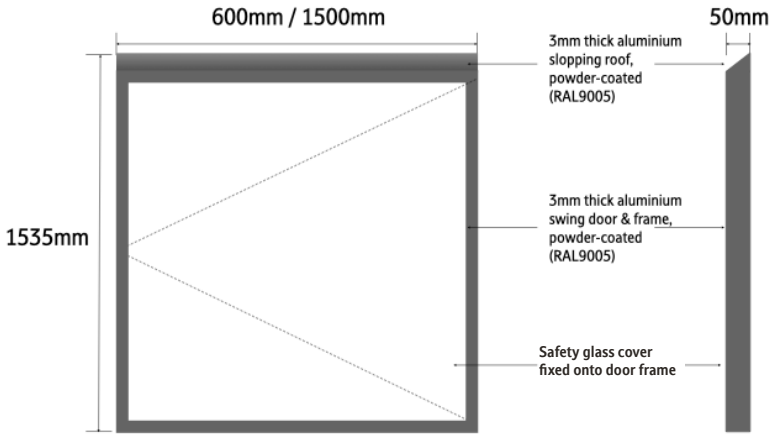
Refer to Volume 1: Graphic Standards for Information posters for IN-Signs

Surface Mounted (IN1/2) 11.1

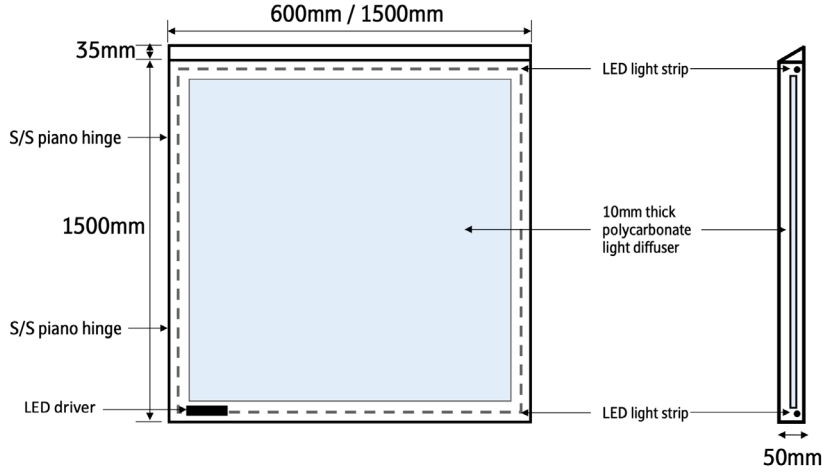
Sizes

IN1 : 600mm x 1500mm x 50mm
IN2 : 1500mm x 1500mm x 50mm

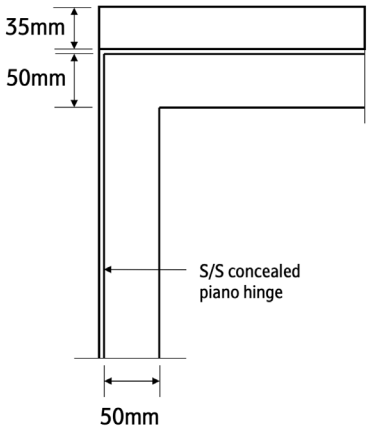
Front View

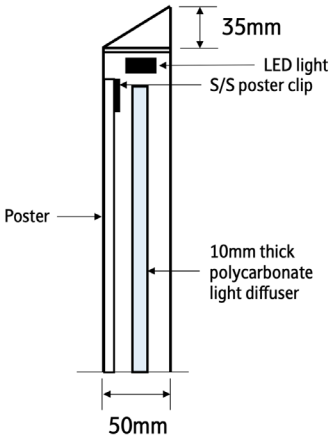


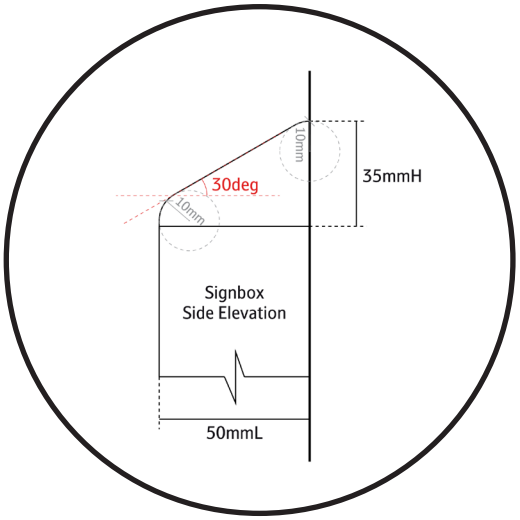
Internal



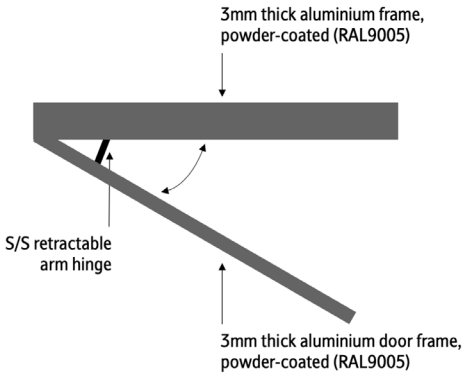
Section







Top View

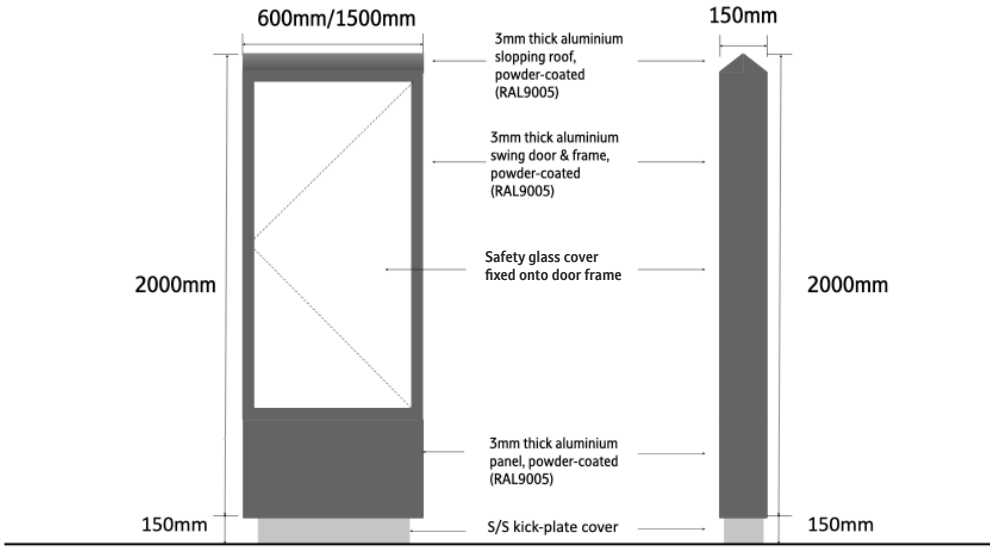


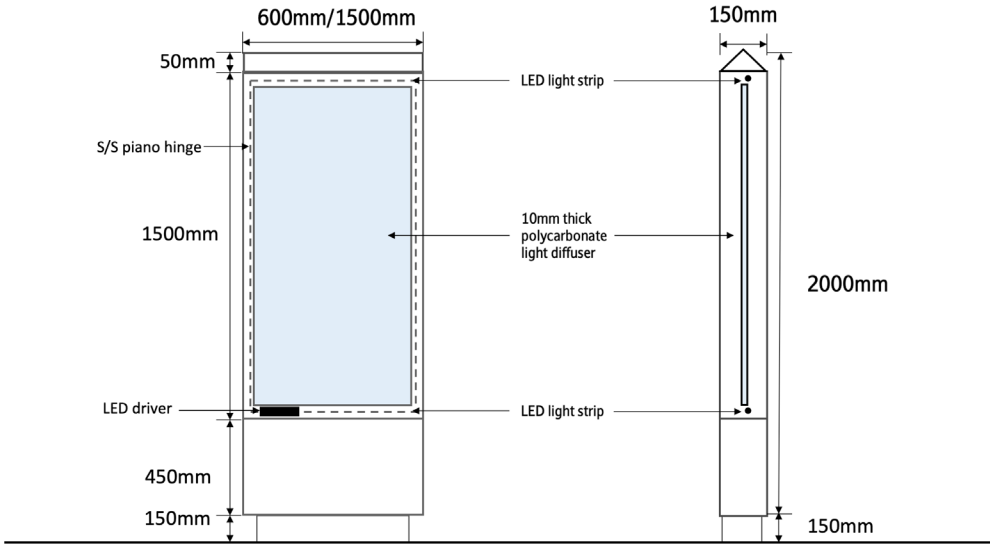
Floor Mounted (IN1/2) 11.2

Sizes

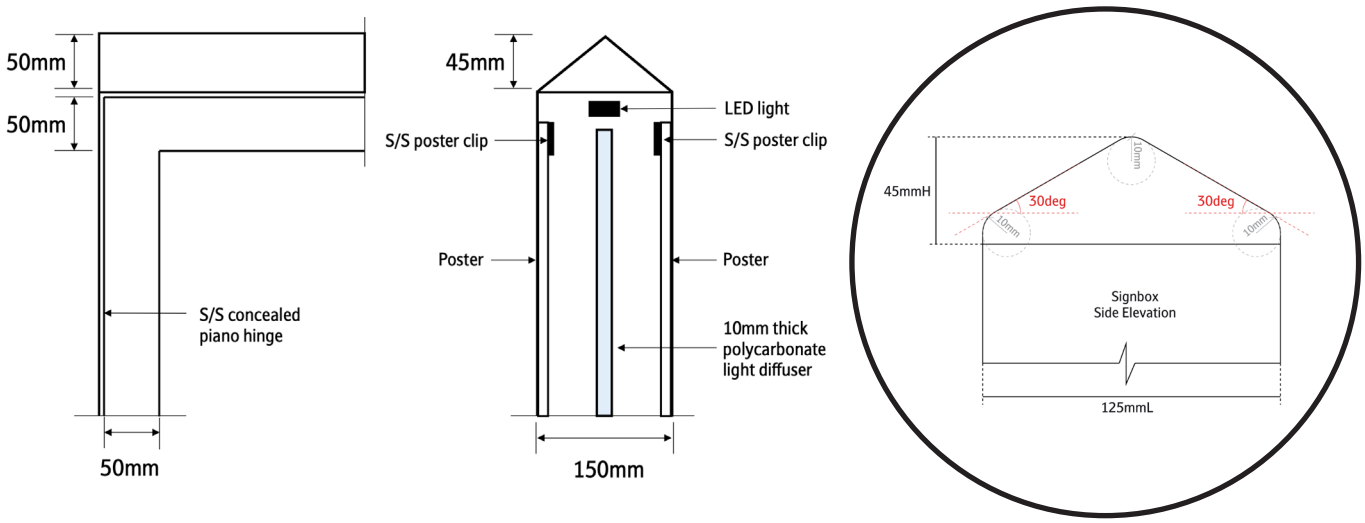
IN1 : 600mm x 2150mm x 150mm

INC : 1500mm x 2150mm x 150mm

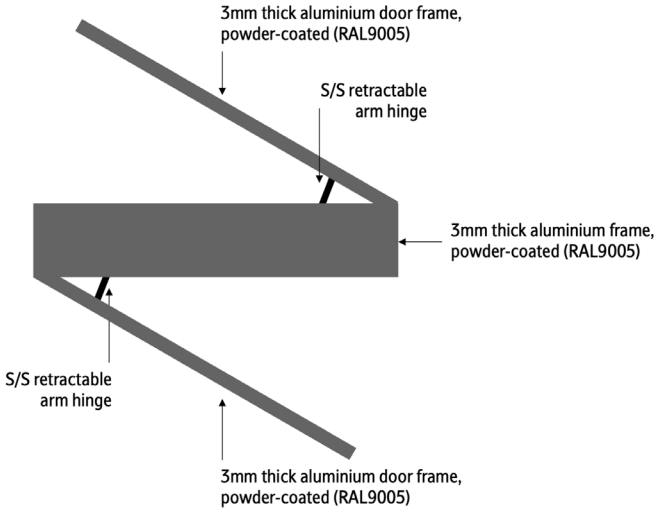




Section

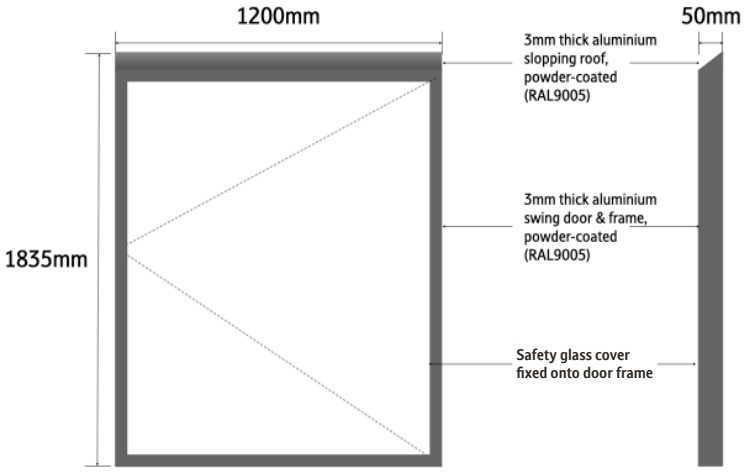


Top View

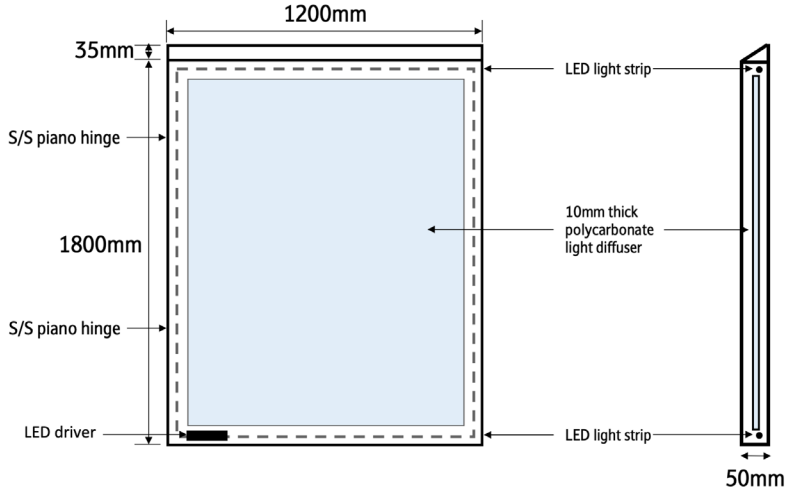


Advertising Panels (INMC) 11.3

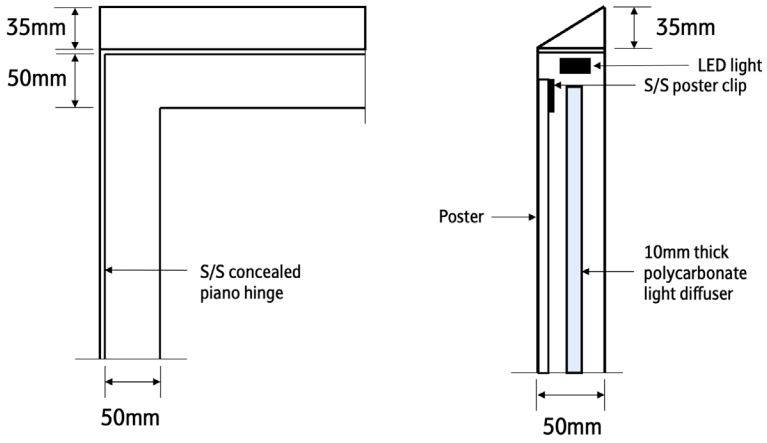
Front View



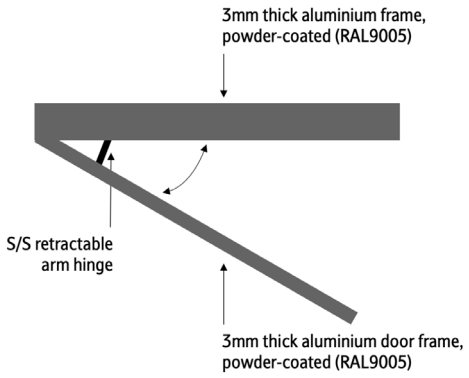
Internal



Section



Top View

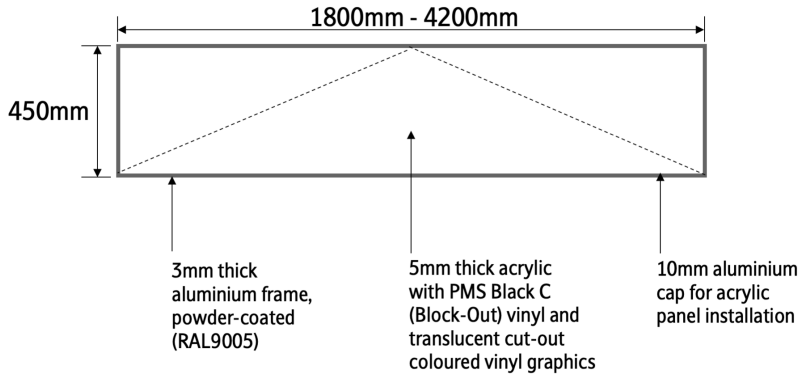


Directional Signs 12

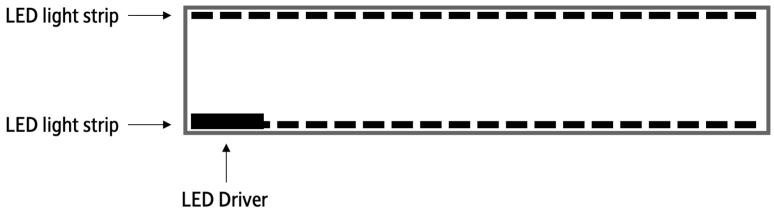
Refer to Volume 1: Graphic Standards for graphic. colours and sizes of respective D-signs

Ceiling/Surface Mounted 12.1

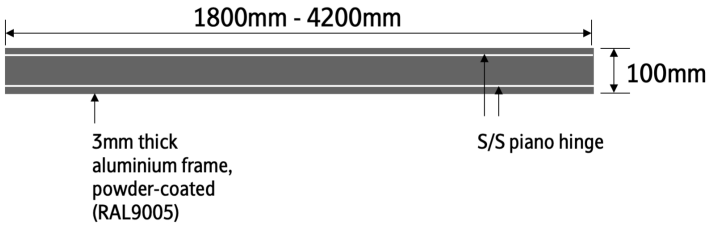
Front View



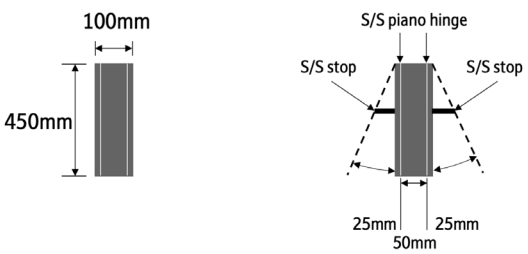
Internal



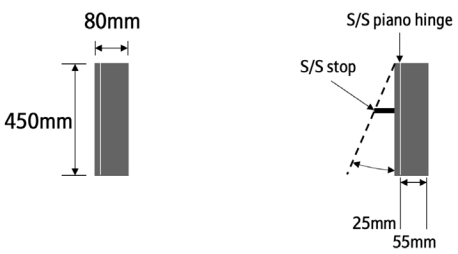
Top View



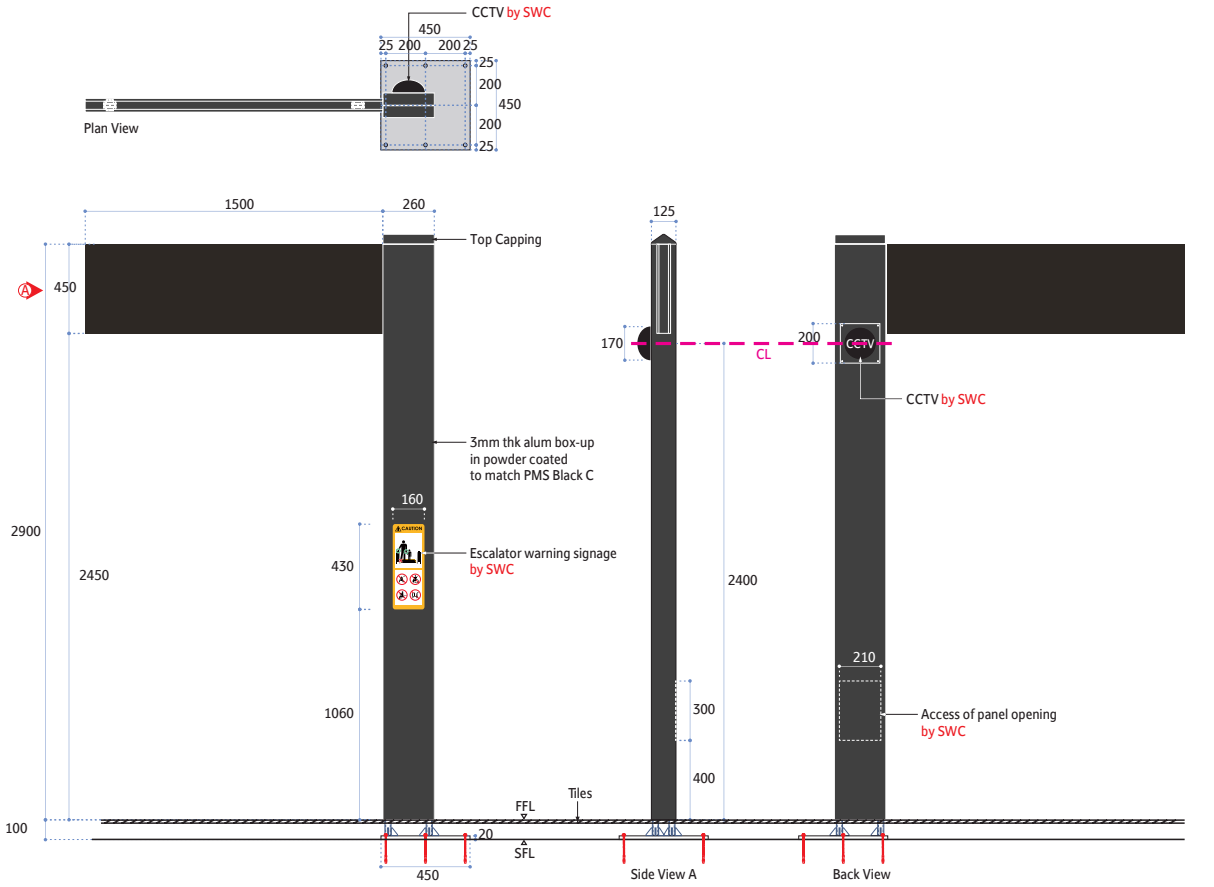
Side View (Double)



Side View (Single)

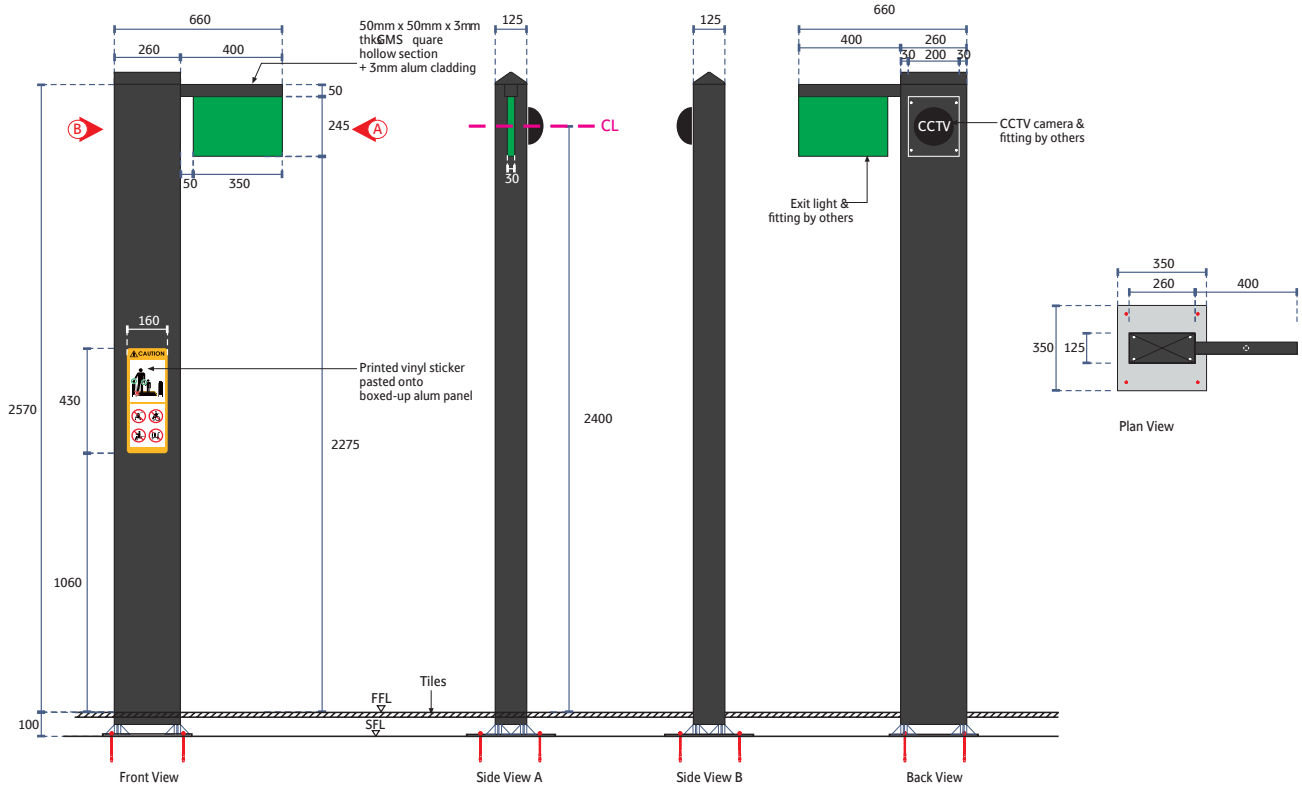


Floor Mounted D1 Sign 12.2



Integrated Service Pole (ISP) 12.3

Provision and location of ISP shall be proposed by consultants / contractors.

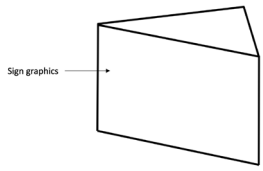


Amenities Header Signs 13

Refer to Volume 1: Graphic Standards for Amenities Header Signs

Non-Lit Headers 13.1

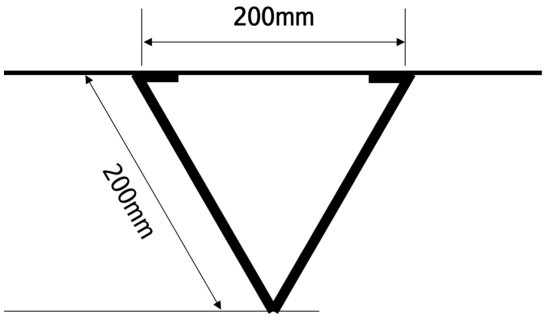
FS-Headers



3mm thick aluminium panel, powder coated with retro-reflective engineering grade cut-out vinyl graphics.

Top View

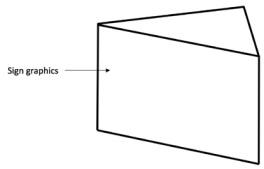
200 x 200 x 200



Lit Headers

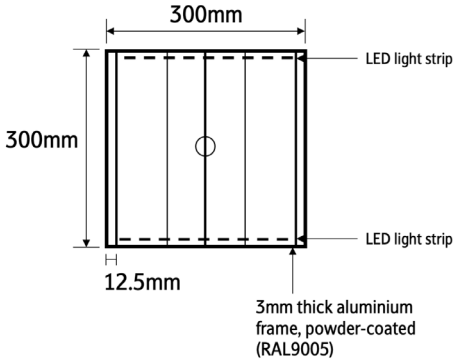
13.2

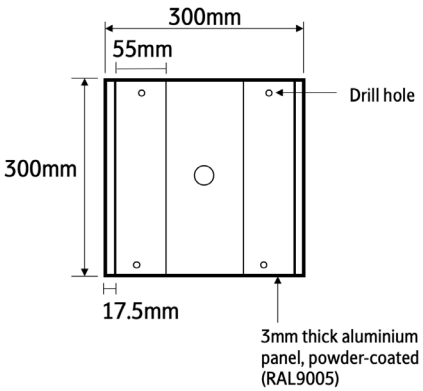
Amenities and Information Point Headers



3mm thick aluminium panel,
with laser-cut graphics and acrylic backing with vinyl

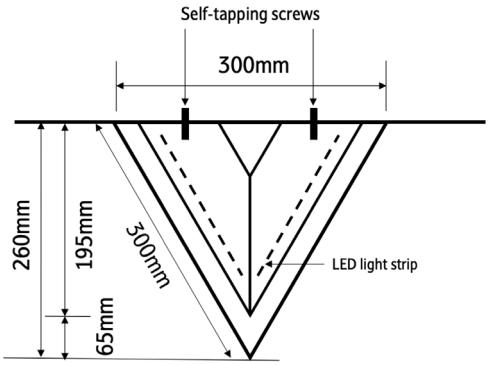
Front Internal View





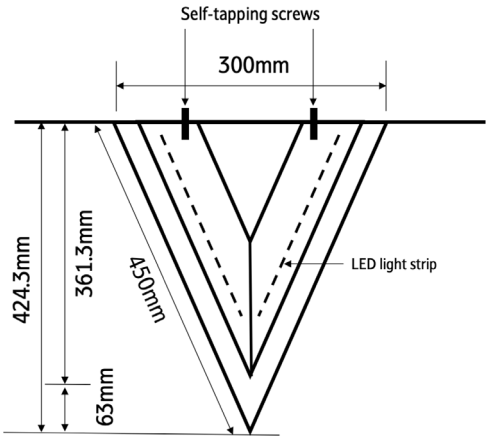
Top View

300 x 300 x 300



Top View

450 x 300 x 300



Mounting Methods (Lit) 14

Ceiling Mounted Signs

- Powder-coated 2mm thick aluminium sign-box with LEDs
- Ceiling galvanized mild steel threaded rod and nut for mounting
- 25mm diameter powder-coated RAL9005 aluminium CHS pipe
- 100mm diameter x 2mm thick aluminium capping with internal diameter 20mm hole

Surface Mounted Signs

- Powder-coated 2mm thick aluminium sign-box with LEDs
- Wall galvanized steel support SHS frame for mounting
- Wall galvanized mild steel bracket plate

Projection Mounted Signs

- Powder-coated 2mm thick aluminium sign-box with LEDs
- Wall galvanized steel support SHS frame for mounting
- Wall galvanized mild steel bracket plate
- Powder-coated RAL9005 aluminium box-up cover

Floor Mounted Signs

- Powder-coated 2mm thick aluminium sign-box with LEDs
- Floor galvanized mild steel SHS frame for mounting
- Floor galvanized mild steel baseplate is concealed by floor finish
- Powder-coated RAL9005 aluminium box-up cover
- Stainless steel kick-plate box-up cover

Floor Mounted-Cantilever Signs

- Powder-coated 2mm thick aluminium sign-box with LEDs
- Floor galvanized mild steel SHS vertical frame for mounting
- Floor galvanized mild steel baseplate is concealed by floor finish
- Powder-coated RAL9005 aluminium box-up vertical cover
- SWCs EXIT, CCTV and Escalator Safety Messages may be incorporated into the vertical frame

Non-Lit Sign Panels 15

Refer to Volume 1: Graphic Standards for Non-Lit Signs

Vinyl Graphics 15.1

Outdoor Sign Panels

Opaque vinyl wrapping with retro-reflective vinyl cut-out graphics

- Diamond grade for MRT Caplet Logo
- Engineering grade for graphics
- Opaque vinyl sticker must wrap around vertical edge of sign-flag and base plate, to prevent peeling/fraying

Indoor Sign Panels

UV-resistant digitally printed graphics on vinyl sticker with compatible matt overlaminate

- Use 'Non-Lit' Line Colours & CMYK working files (see Volume 1)
- Printed vinyl sticker must wrap around vertical edge of sign-flag and base plate, to prevent peeling/fraying

Non-lit Vinyl Sticker Signs

UV-resistant digitally printed graphics on vinyl sticker with compatible matt overlaminate

- Use 'Non-Lit' Line Colours & CMYK working files (see Volume 1)
- Sticker directly pasted onto cleaned, dried, and primed surface

Mounting Methods (Non-Lit) 15.2

Projected Signs

- **Light-weight sign, no drilling/cutting permitted on smooth surfaces (Metal, Vitreous Enamel (VE) Panel, Glass, Plastic, Stone, Ceramic)**
  - 3mm thick polycarbonate backing with light-weight aluminium bracket, or
  - 3mm thick polycarbonate backing with 5mm thick polycarbonate base and triangular polycarbonate beading; glued joints
  - **All surfaces:** Industrial high-strength closed-cell acrylic foam-based double-sided tape

- **Heavy-weight sign. requires drilling on rough surfaces (Concrete, Plaster, Metal Post)**
  - 3mm thick aluminium plate with cast aluminium bracket (powder coated RAL7012)
  - **Concrete Wall/Plaster & Paint:** S/S anchor bolt/screw with expansion plug
  - **Metal Post/Metal Frame:** S/S anchor bolt/screw with blind rivet nut and washer (Use self-tapping screws when rivet nut cannot be applied)
  - **Wall Partition & Wall Cladding:** S/S self-tapping screws

Surface Mounted Signs

- **No drilling/cutting necessary on smooth surfaces (Metal, Vitreous Enamel (VE) Panel, Glass, Plastic, Stone, Ceramic)**
  - Vinyl sticker directly pasted onto cleaned, dried, and primed smooth surface
  - 2mm thick polycarbonate backing with industrial high-strength closed-cell acrylic foam-based double-sided tape

- **Requires drilling on rough surfaces (Concrete, Plaster)**
  - Sign backing and screw/bolt/brackets used to be determined in specialist's detail

Non-Lit Sign Panels (Metal Post) 15.3

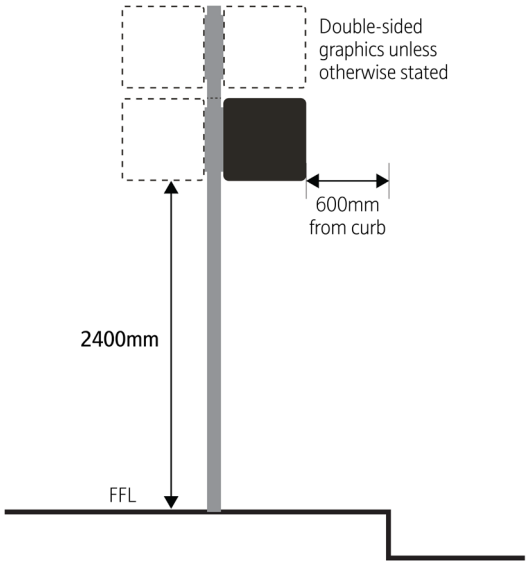
Refer to Volume 1: Graphic Standards for Non-Lit Signs

Metal Post

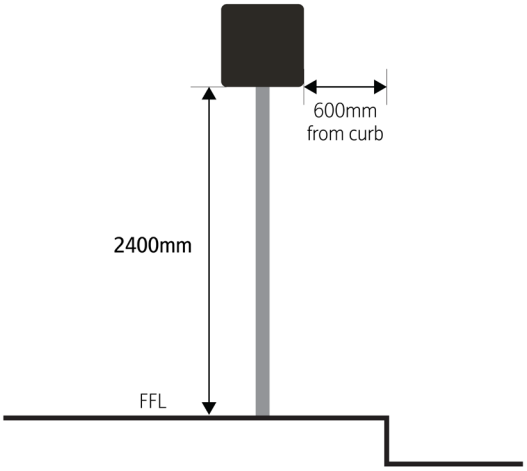
- SHS 75mm x 75mm powder-coated hot-dipped galvanised steel section metal pole with S/S bolts/nuts/washers
- 3mm thick aluminium plate with cast aluminium bracket (powder coated RAL7012)

Mounting on Ground

- Base Plate is concealed by floor finish, no base cover necessary
- Base Plate is exposed when mounted onto floor, base cover to conceal base plate.
- Absence of structural floor, pre-cast footing is required for post to be mounted on.



Multi-Flag



Single-Sign

Non-Lit Sign Panels (Lamp Post) 15.4

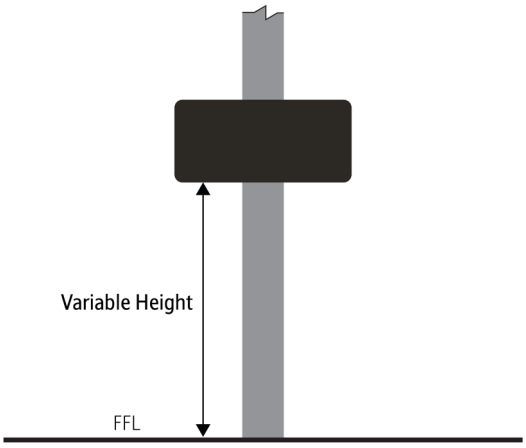
Refer to Volume 1: Graphic Standards for Non-Lit Signs

Single-sign (facing only footpath)

- Bracket: 250mm x 25mm x 6mm thick aluminium flat bar
- S/S tie-band with buckle secure (Note: Screw-tightening type is **not** acceptable.)

Double-signs (facing both footpath and road)

- Cantilever mounted arm, screw/bolt/brackets used to be determined in specialist's detail
- S/S tie-band with buckle secure (Note: Screw-tightening type is **not** acceptable.)



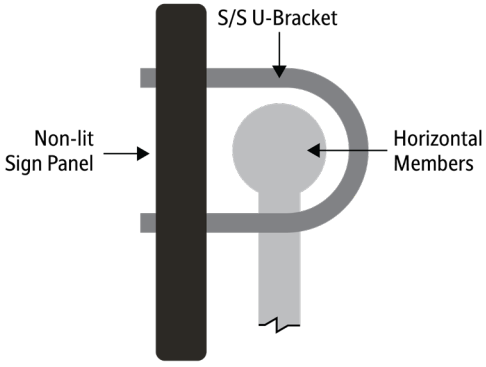
Lamp Post

Non-Lit Sign Panels (Railing) 15.5

Refer to Volume 1: Graphic Standards for Non-Lit Signs

All railings

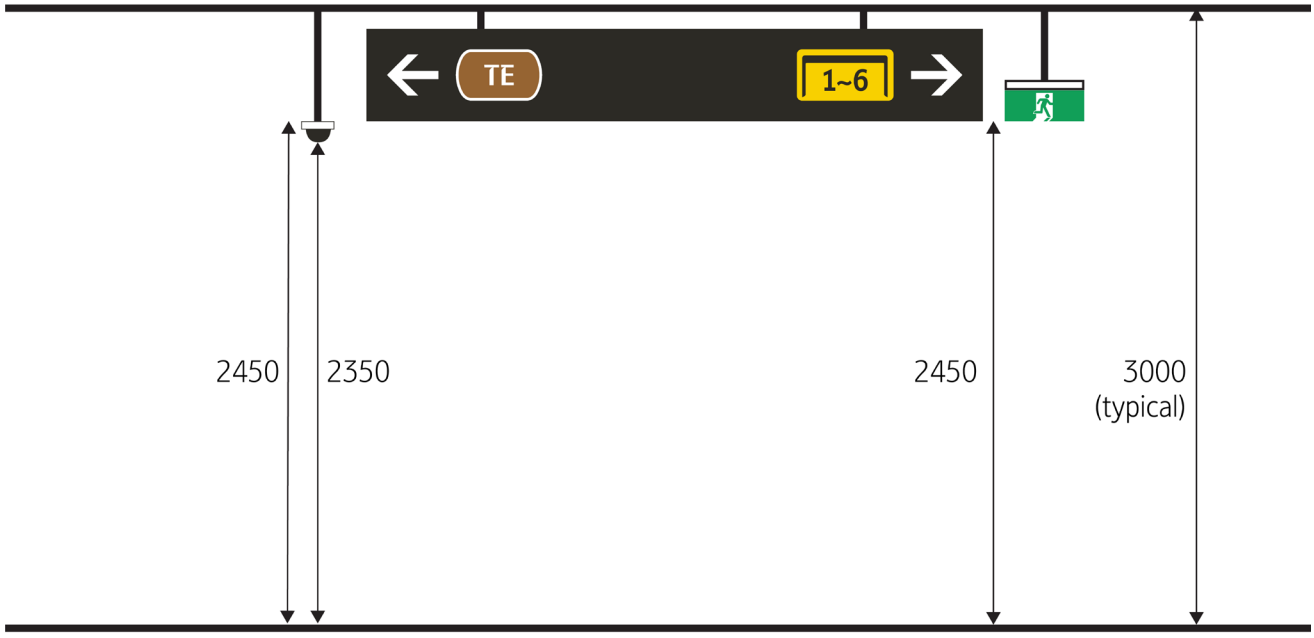
- S/S U-bracket with screws



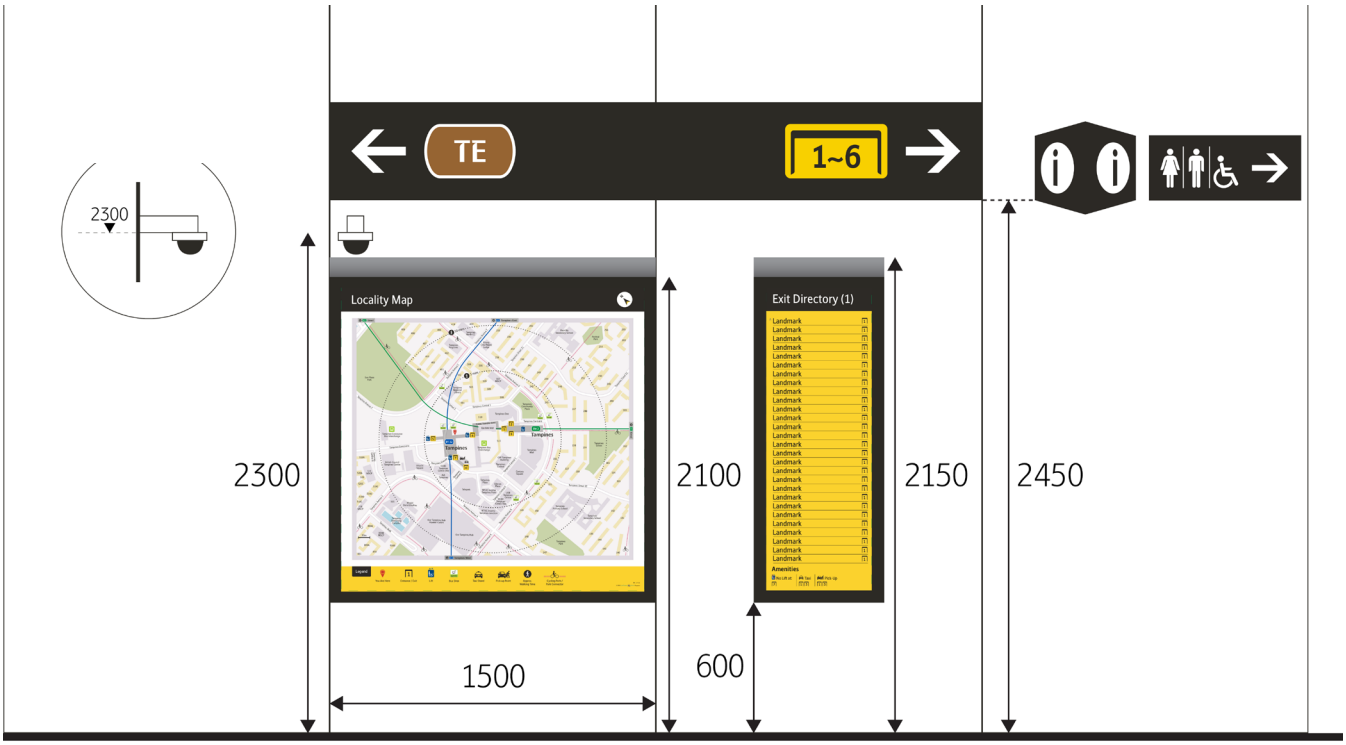
Datum Line 16

Refer to Volume 1: Graphic Standards for placement guides

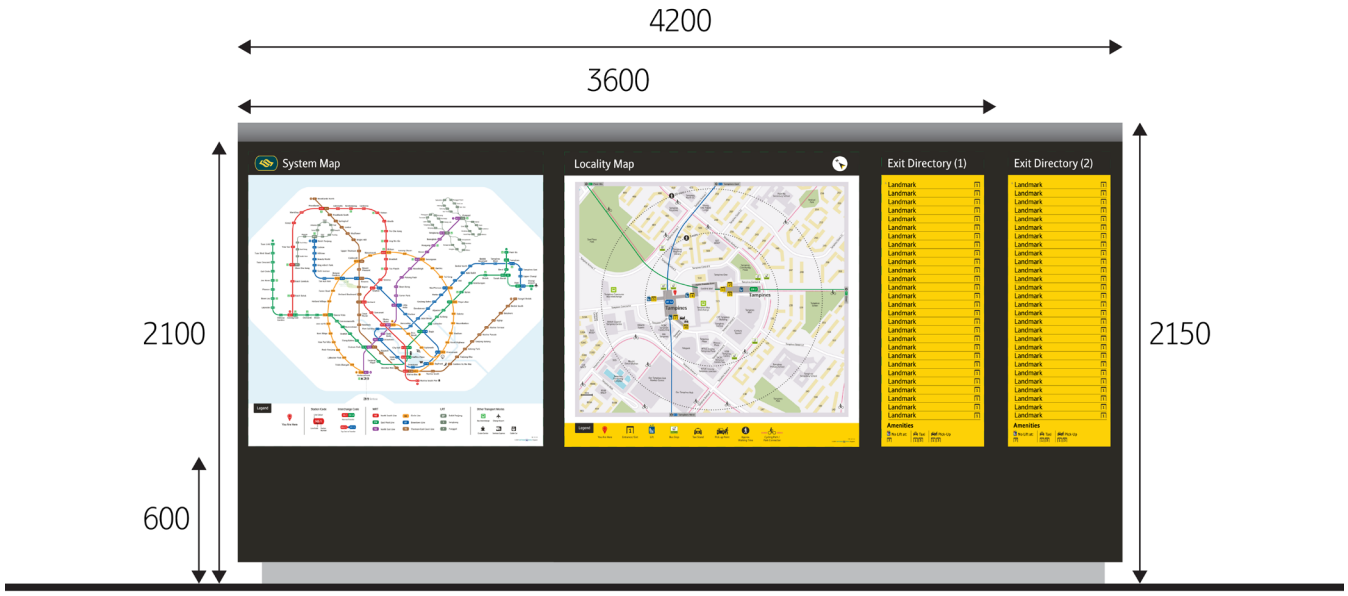
Ceiling Mounted



Surface Mounted



Floor Mounted



Reference Volumes

Vol. 1
Graphic Standards

Vol. 2
Hardware Specifications
(Controlled Copy)

Vol. 3
Submittals
(Controlled Copy)

Annex A
Revision Log
for revision histories and
implementation strategy

Land Transport Authority, Singapore