Design Considerations for Windows in IrDA-Enabled Devices

TABLE OF CONTENTS

Size

In order to be in compliance with IrDA specifications, the window used in the design must be larger than the outline of the transceiver to ensure that the device operates within a +/- 15 degree light cone. This minimum window size can be calculated as follows (see Figure 1).

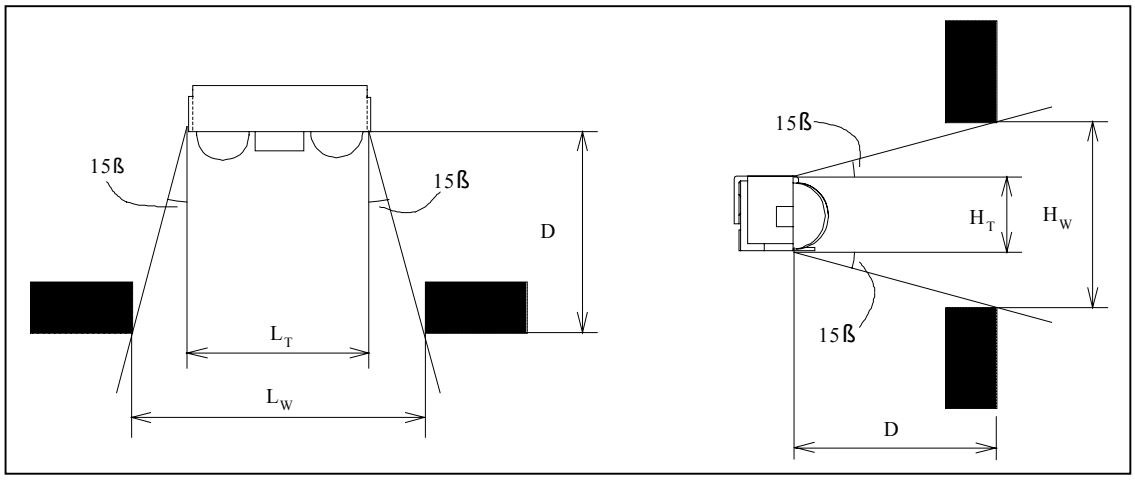

Figure 1. Minimum Window Size

Length of window: $L_W=L_T+D\times0.54$ [mm]
Height of window: $H_W=H_T+D\times0.54$ [mm]

L_W	Length of window
L_T	Length of transceiver
H_W	Height of window
H_T	Height of transceiver
D	Distance from transceiver (between lenses) to front of window
0.54	2 × tan 15 º

Table 1. Formulae for Various ZiLOG IrDA Transceivers

ZHX1000/1010	$L_W = 9.9 + D \times 0.54$ $H_W = 4 + D \times 0.54$
ZHX1201	$L_W = 8 + D \times 0.54$ $H_W = 2.5 + D \times 0.54$
ZHX1810	$L_W = 9.1 + D \times 0.54$ $H_W = 2.75 + D \times 0.54$
ZHX2010	$L_W = 9.8 + D \times 0.54$ $H_W = 4 + D \times 0.54$
ZHX1203/1403/3403	$L_W = 7.3 + D \times 0.54$ $H_W = 1.9 + D \times 0.54$

Other ideas to enhance your design:

- Don't make the window any larger than is needed. Too large of a window unnecessarily increases the amount of ambient (sun) light, a potential interference.
- Try not to locate the transceiver directly against the window. The larger the distance D, the better the shielding against the ambient light.
- The outer window surface can be recessed against the surrounding case material to protect the window

Plastics for Windows

Windows for IrDA-enabled devices are usually made in two ways:

1. Sheet stock—The most cost effective and quickest method to make a window is to use sheet stock. Sheet stock provide a flat window with minimum refraction effect. Specific sizes can be cut out of a large sheet of plastic that is approximately 1/16 inch or 1/8 inch thick. The windows are mounted in the device case by means of glue, tabs, detents, or other means.

2. Injection molding – In order to obtain a window of any shape, one that matches the curvature of the case into which it is fitted, as injection molding process is used. While this is more costly and time consuming, the window is usually more aesthetically pleasing. Although the molding can incorporate a lens, either conventional or Fresnel, great care must be used to ensure that IrDA specifications concerning +/- 15º cone of operability continue to be met. This style of window can also have integral mounting tabs that allow assemblers to snap it into place.

Materials

Because the material can attenuate the IR signal, care must be taken when choosing the material and color. The window thickness is important as it can negatively affect the signal. The following provides information about manufacturers and window materials and their known properties. For more information, the designer should contact these companies directly. See Table 7.

The two most commonly used plastics for windows are acrylics and polycarbonates. The best known trade names are Plexiglas (acrylics) and Lexan (polycarbonates). These two plastics are similar in most respects, with the exception that polycarbonates are tougher and, therefore, provide greater strength.

Most manufacturers produce sheet stock only in metric thickness but often refer to them by the closest English ("inch") thickness. See Table 2.

Table 2. Sheet Stock

Thickness (mm)	Thickness (inches)	Common Callout
0.5	0.030	1/32
1.0	0.040	---
1.5	0.060	1/16
2.0	0.080	---
2.5	0.100	---
3.0	0.118	1/8

Sheet stock in 1/16” thickness and less is easily cut to size by shearing. Thicker sheets must be sawed or routed to avoid cracking. Commonly available sheet sizes are 4’ by 8’.

Acrylics

Colored acrylics are identified by name and number. The numbering system used by the majority of companies for colors has become a de facto standard. These four-digit numbers are shown in Table 3, which lists eight of the most popular colors available and their relative transmittance expressed as a percentage.

Table 3. Typical Acrylics and Characteristics

Color #	Color	Description	IR Transmittance % (typical)
2025	Black	Semi-opaque	0
2050	Blue	Translucent	4
2064	Gray	Transparent	48
2157	Red	Translucent	2
2404	Bronze	Transparent	56
2423	Red	Transparent	90
2711	Dark Red	Semi-opaque	85-90
----	Clear	Transparent	92

Note: Table 3 transmittance values are for 3 mm (0.118 inch) thickness. Transmittance varies inversely (logarithmically) in proportion to the thickness of the window. Thinner plastics have a slightly greater transmittance while thicker plastic is slightly less. Please contact plastic manufacturer for more details.

It is unfortunate that most acrylic colors tend to attenuate IR so much that they cannot be used in IR windows. Numbers 2423 (red) and 2711 (dark red) possess a high transmittance value (85-90%) of IR and are most suitable for use. As can be seen, clear plastic affords the highest IR transmittance and is typically used where cosmetics is not a consideration. Number 2711 is a very dark red that appears black to the eye. It is manufactured specifically for use in IR windows (and is often called an IR transmitting filter). This material is also available from Cyro Industries under their number 1146-0. AtoFina (formerly Rohm and Haas) offers acrylic injection molding pellets, in addition to sheet stock, under their number is 58015. (Companies mentioned here are listed in Table 7.)

In addition to their own color numbering system, manufacturers use “brand” names for their acrylic products. The colors of the plastic are generally identical to those of the industry “standard.” Some manufacturers produce both sheet stock and injection molding pellets, others sheet stock only. Please see Table 4.

Table 4. Common Acrylic Brand Names and Manufacturers

Brand name	Manufacturer
Acrycast	Calsak Corp.
Acylite	Cyro Industries
Plexiglas	AtoFina
Polycast	Polycast Technology Corp.

Polycarbonates

Polycarbonates are usually available in the same colors as acrylics; however, most manufacturers use their own color number system rather than the 2xxx-series often used for acrylics. Like acrylics, most colors have low IR transmittance with the exception of those specifically designed as IR transmitting filters.

Bayer, Dow, and General Electric are three well known manufacturers of polycarbonates.

Bayer

Bayer’s (formerly known as Miles, Inc.) Makrolon 2405O is a family of polycarbonates that is suitable for IR windows. It is available most standard colors but only in pellet form. Bayer # 7881 appears black to the eye and has an IR transmittance of approximately 90%.

Dow

Dow offers Calibre 301 or 303 series of polycarbonate for IR windows. Various colors, including clear, blue, black, and ivory are available. Dow sells these only in pellet form. Third-party companies such as Manchester Products and Spartec Plastics have sheet stock using Dow pellets available. These can be obtained from distributors such as Cadillac and Regal.

General Electric

Lexan 9034, GE’s popular brand of polycarbonate sheet stock, is available in various thicknesses and colors. Table 5 shows several Lexan 9034 colors and their approximate acrylic equivalents.

Table 5. Selected Colors of Lexan 9034 Compared to Acrylics

Acrylic Color #	Approximate Equivalent Lexan #	Color	Description	Typical Transmittance (%)	
				Acrylics	Lexan
2025	701	Black	Semi-opaque	0	0
2050	*	Blue	Translucent	4	---
2064	7113	Gray	Transparent	48	70 [1)]
2157	6214	Red	Translucent	2	5 [2)]
2404	5109	Bronze	Transparent	56	75 [3)]
2423	612	Red	Transparent	90	100 [1)]
2711	*	Deep red	Semi-opaque	85-90	---
---	112	Clear	Transparent	92	92

* No equivalent color
1) Thickness 0.125”; color number 71023 for 0.060” thickness
2) Thickness 0.100”
3) Thickness 0.060” or 0.125”
4) Thickness 0.062”

One of General Electric’s polycarbonates particularly suitable for use as IR windows is Lexan 121. This product is available only in injection molding pellets. A selection of transmission filter colors are available for Lexan 121; all are in shades of green and blue-violet which appear black to the eye. All of these filters, which have cutoff wavelengths in the 600 to 700 nm region, are suitable for use as IR windows. Their product numbers are 21051, 21064, 21092, 21125, 21127, and 31142.

General Electric’s Lexan 92X, 94X, and 95X series are suitable filter material (Table 6). Please contact the manufacturer for information on transmittance characteristics and flame retardant specifications.

Table 6. Filter Material

Lexan Part #	Light transmission	Haze	Refractive Index
141L	88 %	1%	1.586
920A	85%	1%	1.586
940A	85%	1%	1.586

Note: 920A and 940A are more flame retardant than 141L.

Table 7. Plastic Window Sources

AtoFina Chemicals Inc. (mfg) (Formerly Rohm and Haas) Plastics Technology Center P.O. Box 219 Bristol, PA 19007 800-523-7500 www.atofinachemicals.com	Bayer Corporation (mfg) (Polymers – Plastics Div.) 100 Bayer Road Pittsburgh, PA 15205-9741 412-777-2000 www.plastics.bayer.de/bayer/index_ae.jsp	Cadillac Plastic and Chemical Co. (dist) 11515 Vanstory Drive Huntersville, NC 28078 1-800-333-0534 www.cadillacplastic.com
Calsak Corporation (dist) 200 W. Artesia Blvd. Compton, Calif. 90220 800-743-2595 www.calsak.com	Cyro Industries (mfg) 100 Enterprise Drive PO Box 5055 Rockaway, NJ 07866 (973) 442-6102 www.cyro.com	Dow Chemical Company (mfg) 2040 Dow Center Midland, Mich. 48674 800-441-4369 www.dow.com/plastics/
General Electric Company (mfg) One Plastics Ave. Pittsfield, MA 01201 413-448-5800 www.geplastics.com	PSI-Manchester Products (mfg) 10630 Marina Drive Olive Branch, MS 38654-3712 (866) 638-7926 (toll-free) www.psilighting.com	Plastic Sales Incorporated (dist) 849 W. 18th St. Costa Mesa, CA 92627 (714) 645-6860
Polycast Technology (Div of UTC) (mfg) 70 Carlisle Place Stamford, CT 06902 800-243-9002 www.polycast.com	Spartec Plastics (mfg) 120 South Central Avenue, Suite 1700, Clayton, Missouri 63105-1705 888-721-4242 www.spartech.com	Specialty Manufacturing Inc. 6790 Nancy Ridge Dr. San Diego, Calif. 92121 (858) 450-1591 www.smi-mfg.com

Shape of the Window

For optimal IrDA performance, only a flat window should be used. This ensures that the radiation pattern of the IRED or the receiver pattern of the photodiode is not affected by the window (Figure 2).

For those designs where aesthetics or mechanical necessity dictates that the window must be curved, it is important that the backside of the window that has a curve of the same radius as the front side to minimize the lens effect of the front curved surface. The amount of change in the radiation pattern is dependent upon the material chosen for the window, the radius of the front and back curves, and the distance from the back surface to the transceiver. Once these factors are known, a lens design can be made that eliminates the effect of the front surface curve.

Figure 2 shows the effects of a curved window on the radiation pattern. In all cases, the center thickness of the window is 1.5 mm, the window is made of polycarbonate plastic, and the distance from the transceiver to the back surface of the window is 3 mm.

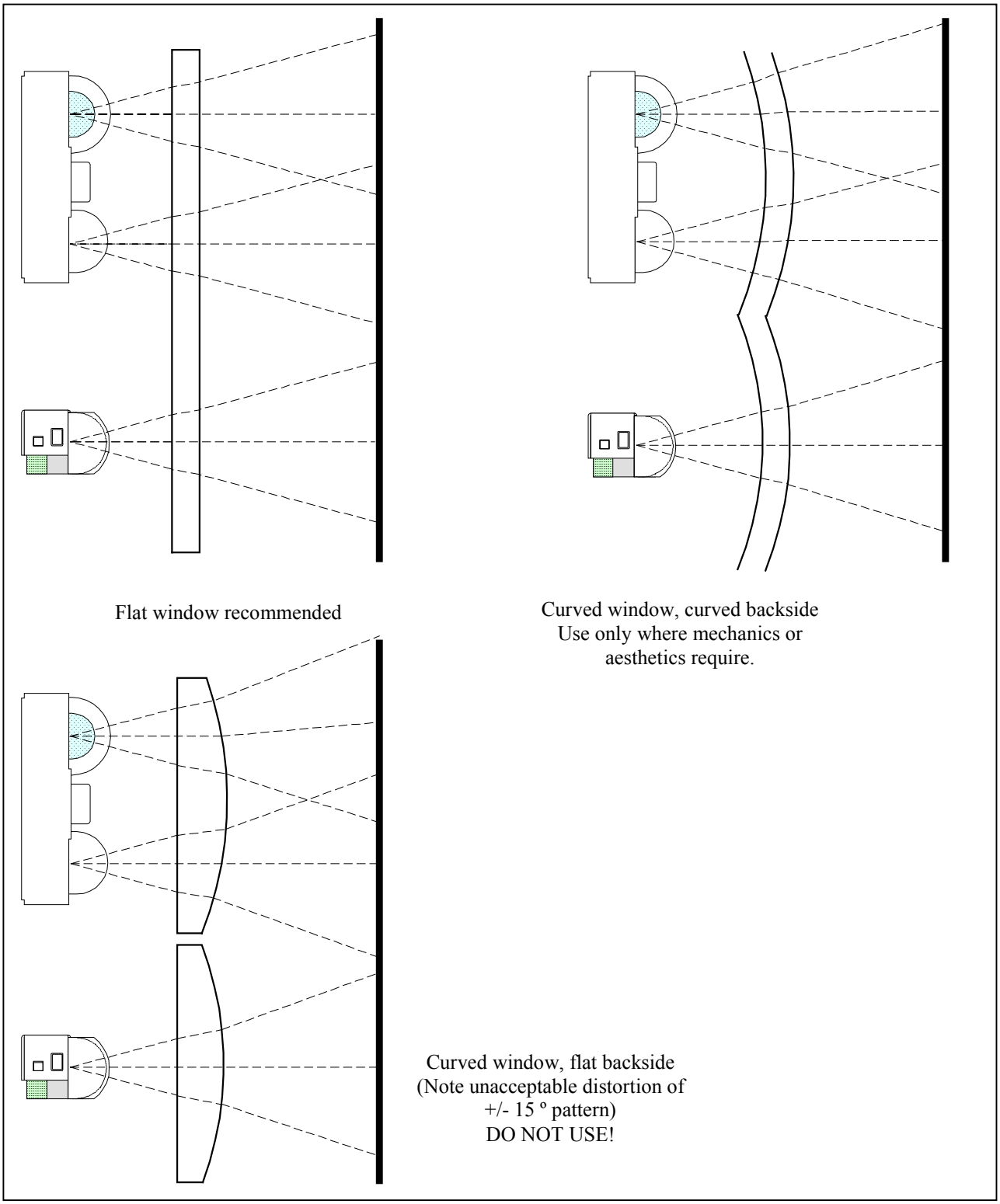

Figure 2. Shape of the Window

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