



## IRMS6118/IRMT6118 115 Kb/s Infrared Data Transceiver

### Appnote 84

#### Introduction

The IRMS6118/IRMT6118 is a fully integrated 115 Kb/s optical transceiver module designed to meet the IrDA physical layer specification. The following application note describes specific attributes of how the IRMS6118/IRMT6118 functions.

**Table 1. Input/Output Functional Description (IRMS6118/IRMT6118)**

Pin #	Sym.	Type	Polarity	Function Description
1	IR LEDA	Input	AC	LED anode. It is required to connect it to the LED power supply ( $V_{LED}$ ). An external resistor is required when $V_{LED}$ is above 3.3 V.
2	IR LEDC	Input	Switching DC	Internally connected to LED cathode. No external connection needed unless used to drive additional LED.
3	TxD	Input/TTL	Active high	LED driver. This input is capacitively coupled to limit transmit pulse width to no more than about 70 $\mu$ s.
4	RxD	Output/TTL	Active low	The output indicates received serial data. It is a CMOS driver providing rail to rail operation.
5	SD	Input	Active high	Inserting this pin to $V_{CC}$ causes the device to shutdown with a maximum current drain of less than 1.0 $\mu$ A, and it will disable transmitter input and tri-state receiver output.
6	$V_{CC}$	Receiver power supply	Positive power supply	Receiver power supply 2.4 V to 5.5 V. Place a typical value of 0.1 $\mu$ F ceramic bypass capacitor as close as possible to this pin.
7	GND	Ground (power)	—	Internally grounded.
8	GND	Ground (power)	—	Connect to power supply ground.

#### Receiver Power Supply

Since the receiver has good power supply rejection and the receiver output is internally slew rate limited, receiver supply decoupling is not critical. When driving a typical load of 15 pF, as little as 0.05  $\mu$ F of receiver power supply decoupling is necessary and only needs to be within a few centimeters of the device. Typically, existing board power supply decoupling will be adequate. Because of the excellent ripple rejection, the device can be operated from most type of standard power supplies. For example, it will work with 100 kHz switching supplies of less than 50 mV<sub>P-P</sub> ripple or unregulated supplies with less than 1.0 V<sub>P-P</sub> of 120 Hz ripple.

#### DC Ambient Light Rejection

The IRMS6118/IRMT6118 will handle most DC infrared ambients except direct sunlight. If the ambient light DC current surrounding the module is exceeding the capability of ambient light rejection, the RxD output will go low for more than 100  $\mu$ s. This information may be used to warn the user that the ambient light is excessive. Due to the increasing shot noise of the photodiode at high DC ambients the receiver sensitivity decreases by up to 4X to prevent spurious noise hits. This equates to halving the receive range at maximum DC ambients (typically a rare event).

#### Automatic Gain Control (AGC)

The AGC attack response of the IRMS6118/IRMT6118 is designed to give good first pulse response after complete AGC decay. The AGC decay response is sufficiently slow to provide adequate AGC noise immunity at 9.6 Kb/s during typical worse case data (no pulses for 9 bit intervals). Typically AGC recovery from a strong signal (Near-Far Latency) takes about 2.5 ms, but if necessary, faster AGC recovery can be obtained by Shut Down cycling; that is, shutting down the IrDT for at least 1.0  $\mu$ s and powering it back up again. The IRMS6118/IRMT6118 is designed to reset the AGC on shutdown and includes circuits which allow for fast power up DC ambient stabilization.

## Receiver Latency

The IRMS6118/IRMT6118 is designed to have rapid transmit recovery (typically called Receiver Latency) which restores the device to full sensitivity within 100  $\mu$ s of the end of transmission. This allows rapid transmit/receive turn around, important for voice applications. In addition, the receiver output is blanked (forced high) during transmit pulses and for about 50  $\mu$ s after the end of the last transmitting pulse.

## Increased Data Rates

Although primarily intended to operating at 9.6 Kb/s to 115 Kb/s, the IRMS6118/IRMT6118 transmitter and receiver is usable at IrDA data rates up to 576 Kb/s. At these increased speeds the sensitivity will decrease somewhat and the RxD output pulses will be widened slightly. Most IrDT controllers should be able to function with this pulse widening.

## Independent LED Power Supply

The LED anode can be supplied from a power supply independent of  $V_{CC}$  (often unregulated) that does not require correct power up/down sequencing relative to  $V_{CC}$ . This along with the current limiting characteristics of the transmitter eases power supply design constraints commonly associated with battery operated hand held devices. For example, the LED anode can be supplied directly from two alkaline cells in series (without an LED current limiting resistor) and provide usable transmit output over the full voltage range of the two cells (1.8 V to 3.4 V). For a small battery powered PDA type device that uses either a switching regulator, powering the transmitter directly from the batteries may reduce the peak load requirement of the regulator by several fold. This power supply configuration is not possible with many other competitor's IrDT devices which either do not allow the LED anode supply to rise more than 2.0 volts above  $V_{CC}$  or require the use of a current limiting resistor which results in excessive variation in transmit output when operated from an unregulated supply.

At no time should the maximum voltage on the LED anode exceed 9.0 V. The LED anode should also not exceed  $V_{CC} + 4.0$  V while transmitting and for several microseconds after. Voltages above  $V_{CC} + 4.0$  V but less than 9.0 V may cause transmit pulse stretching.

## External Resistor

When the transmit driver is not saturated, the transmit current limit has a positive temperature coefficient of 0.47% per degree C, which corrects for most of the LED negative temperature coefficient of -0.5% per degree C, maintaining relative constant light output despite temperature variation. More commonly the transmitter is operated in the saturated mode where the resistor in series with the LED anode is used to limit LED current. However, even if the transmitter is not operated saturated, it is necessary to include a smaller series resistor in the LED anode supply when operating above 3.3 V in order to reduce thermal dissipation during transmitting. For non-saturated operation with a 5.0 V LED anode supply, a 6.8 ohm series resistor is recommended.

## External Capacitors

Transmitter LED anode decoupling is important due to the fast rise and fall time and large amplitudes of the LED currents, an issue common to all infrared data transmitters. Transmitter

current di/dt is 30 mA/ns and total charge delivered during a 1.6  $\mu$ s transmit pulse may be up to 800 nC. Consequently, it is recommended that the LED anode supply be decoupled locally within 1.0 cm with a 0.1  $\mu$ F ceramic capacitor and that the total decoupling be at least 22  $\mu$ F (electrolytic) within about 15 cm. If decoupling which meets this criteria is already present, then additional LED supply decoupling may not be necessary. If the transmitter is supplied from  $V_{CC}$ , inductive noise can be significant between  $V_{CC}$  and ground during transmit pulses. Although the part is designed to have high  $V_{CC}$  noise immunity in transmit mode, other devices sharing the same  $V_{CC}$  supply may be disrupted by these transients which can easily exceed 0.5 V. It is recommended that the user check this noise with a scope (this requires a good scope ground) when transmitting and provide sufficient low inductance capacitive decoupling to keep this noise below about 0.5 V for transients of longer than about 20 ns.

## LEDs in Parallel

The device allows several external LED configurations which may used to improve transmit coverage or range. The LED Cathode connects directly to the transmit driver and can be used to drive an external LED either in lieu of the internal LED or in parallel with it. If driving LEDs in parallel, ballasting resistors should be used to balance current. When operating from an LED supply of 5.0 V or more, typically a second LED can be placed in series with the internal LED to increase output without increasing LED transmit current.

## Board Layout Design

### A. Impedance Considerations

Because the transmitter switching results in extremely high di/dt, significant inductive voltage drops can occur on the short signal traces in the transmitter LED AC current path. This AC path is formed by the loop passing from the LED anode through the dropping resistor, the transmit supply decoupling capacitor, and the  $V_{SS}$ . The distance around this loop should be minimized (<0.5"), and wide traces (>0.050") with multiple vias should be used to minimize loop inductance. For example, 0.5" of 0.012" trace has about 10 nH of inductance, which will drop about 1.0 V with a 600 mA rise in 6.0 ns. For 5.0 V anode supplies, loop inductances above 10 nH but less than 100 nH (25 ns rise time) slow the rise and fall time of the transmit pulse but have little effect on its half current width. With a low voltage anode supply (3.0 V), loop inductance has a more pronounced effect on rise and fall times, and consequently should be held below 25 nH. The user should keep in mind that slowing transmit rise times beyond 25 ns has the effect of narrowing the pulse bandwidth, which contributes to receiver pulse demodulation distortion.

More importantly, excessive inductive peaks on either the LED anode supply or the transmit ground returns can cause problems on the transmit bias circuits. If transmit-induced transients between the IC ground and  $V_{CC}$  exceed 1.0 V peak, then significant transmit pulse distortion may occur. Although the IC has better transient immunity with a 5.0 V  $V_{CC}$  supply and will typically tolerate up to 2.0 V peak, it is also easier to generate larger inductive peaks with a 5.0 V anode supply. Since these transients can also cause problems on other nearby ICs, it is suggested that while the transmitter is run-

ning, the user measure the  $V_{CC}$ -to-ground transient noise with a good high-rate scope capable of seeing 10 ns pulses. Normally, with reasonable attention to board layout, the amplitude of these pulses can be held under a 0.5 V peak.

### B. Noise Considerations

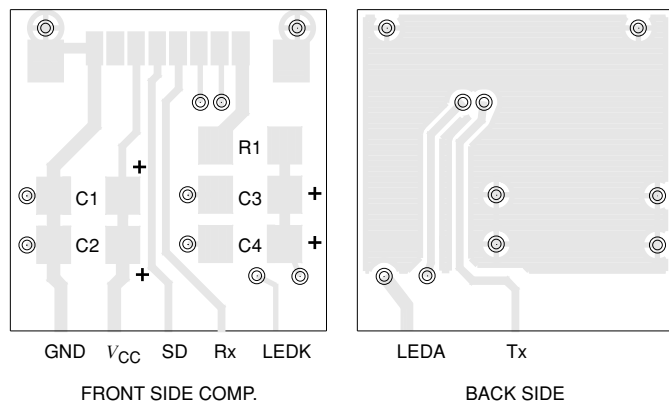
The IRMS6118/IRMT6118 photodiode input is extremely sensitive to low-level current transients. Except for the TxD or RxD, digital signal traces should not be run directly under the IrDA package. Ideally, the package should be mounted over a local ground plane to minimize noise and EMI pickup. If an internal printed circuit board ground plane is not available, then ground fill directly under and surrounding the package may be helpful. If necessary, an external grounded shield can be used.

A moderately clean  $V_{CC}$  supply should be used to power the IC, since peak noise above 10 to 50 mV (depending on frequency) can cause receiver disruption. Usually PC boards with ground planes and standard decoupling will provide a sufficiently clean  $V_{CC}$  supply, unless the supply is powered by a switching supply with a high-ripple levels on its output. A suitable ripple filter to remove this noise can be constructed by using a 10  $\mu$ H SMD choke to supply  $V_{CC}$  to the IC and then bypassing it with a 10  $\mu$ F capacitor. At 80 kHz, this filter will attenuate supply ripple by over 26 db, depending on the ESR of the capacitor. Do not connect the LED anode supply to this filtered supply.

### C. Recommended Board Design

Based on above discussion, we recommend users use the following PC board layout design or similar ones.

**Figure 1. Recommended Board Layout Design for IRMS6118/IRMT6118**



Users are also advised to place the IrDT module as far away as possible from other electromagnetic wave generating components, such as transformers, LCD drivers, and RF generating diodes. If such arrangement is not possible, an additional EMI shield for these components is recommended.

### RxD Echo During Transmit

During transmit, the receiver output will toggle due to transmit infrared signals being reflected back into the receive photodiode; however, the receiver output is not an accurate representation of the transmit signal and will have significant data errors. Receiver output is not suppressed during transmit so as to allow software to check on the transceiver. If no receiver output is detected during transmit, then the system firmware

may assume that the part is defective or not present. The latter may be important to allow software to automatically determine what IrDA I/O devices are present at system boot-up.

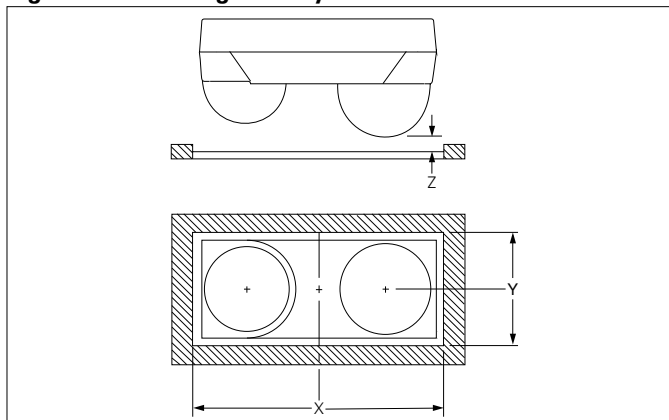
### Window design considerations

Some application of this product may need an IR optical window. To be compliant with IrDA specifications, the IR window must be larger than a minimum size to make sure the device will operate within a 30 degree light cone. This minimum window size can be calculated as follows (see figure 1):

$$X > 5.9 + 2(Z+D)\tan 15^\circ$$

$$Y > 2(Z+D)\tan 15^\circ$$

**Figure 2. Window geometry**



Here X is the width of the window, and Y is the height of the window, and Z is the distance from IRMS6118/IRMT6118 to the back of the window. 5.9 mm is twice the distance between LED lens and module center line, and D is depth of LED image inside the module (5.0 mm).

The result is shown below, in Table 2.

**Table 2. Minimum Window Size**

Depth Z (mm)	Min. X (mm)	Min. Y (mm)
0	8.58	2.68
1	9.12	3.22
2	9.65	3.75
3	10.19	4.29
4	10.72	4.82
5	11.26	5.36
6	11.79	5.89
7	12.33	6.43
8	12.87	6.97
9	13.40	7.50
10	13.94	8.04

It should be noted that the window material will affect the IrDT link distance. Depending on the window thickness and the material selected an IR signal attenuation of up to 15% could take place. General Electric's Lexan 92X, 94X, and 95X series are suitable filter material. Please contact the manufacturer for information on transmittance characteristics and flame retardance specifications.

## Plastics for IR Data Transmission Windows

The IR Data Transmission windows are made in two ways:

1. Sheet stock—For flat windows, the most cost effective and quickest method is to use sheet stock. Custom 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 secured in the equipment case by glue, tabs, or other means.

2. Injection molding - A window of any shape and curvature, that matches the curvature of the case into which it is fitted can be created by injection molding process. Though more costly and time consuming, the molding can incorporate a lens, either conventional or Fresnel. The window can also have integral mounting tabs to allow snapping into place.

The two commonly used plastics for windows are acrylics and polycarbonates. The well known trade names are Plexiglas in acrylics and Lexan in polycarbonates. The two kinds of plastics are similar in most respects, except that polycarbonates are tougher, i.e., will withstand greater abuse.

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

**Table 3.**

Thickness	Imperial equivalent	Called
0.5 mm	0.030"	1/32"
1.0 mm	0.040"	—
1.5 mm	0.060"	1/16"
2.0 mm	0.080"	—
2.5 mm	0.100"	—
3.0 mm	0.118"	1/8"

Sheet stock in 1/16" thickness and less can be cut to size by shearing, which is quick and easy. Greater thickness often must be sawed or routed to avoid cracking.

Commonly available sheet sizes are 4' by 8'.

### Acrylics

Colored Acrylics are identified by number as well as name. The color number system which many companies use and which has become a defacto standard consists of four digits beginning with the number 2. The following table presents eight of the many "standard" colors available, along with selected characteristics:

**Table 4. Typical Acrylics and Selected Characteristics**

Color Number	Color Name	Appearance	Typical IR Transmittance (%)
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	deep red	semi opaque	85-90
None	colorless	transparent	92

Note: Table 4 transmittance values are for 0.118 inch thickness, equal to 3 mm. Transmittance varies inversely (logarithmically) proportional to thickness, therefore transmittance of thinner plastic is slightly greater, that of thicker plastic slightly less.

Most acrylic colors attenuate IR to such an extent as to render them unsuitable for use as IR windows. Color numbers 2423 and 2711 transmit 85-90% of IR light and are the ones commonly used for this purpose (see transmittance curve for 2711 at the back of this paper). If cosmetics is not a consideration, colorless plastic affords the highest IR transmittance. Color 2711 is a deep red that in reflected light appears black to the eye. It is produced specifically for use as IR windows and is often called an IR transmitting filter. The same material produced by Cyro Industries is called color 1146-0. In addition to sheet stock, AtoHaas (formerly Rohm and Haas) produces acrylic injection molding pellets for use as IR transmission filters; the color number is 58015. (Companies mentioned in this Application Note are listed at the end of the text, with addresses and phone numbers.)

Some manufacturers have their own color numbering system but the colors of the plastic itself are generally identical to those of the industry "standard", and the numbers can be translated.

**Table 5. Common Acrylic trade names and manufacturers**

Acrylic Trade name	Manufacturer
Acrycast	Calsak Corporation
Acrylite	Cyro Industries
Plexiglas	AtoHaas
Polycast	Polycast Technology Corporation

Some acrylics manufacturers produce both sheet stock and injection molding pellets, others sheet stock only.

### Polycarbonates

Polycarbonates are available in same colors as Acrylics, but most manufacturers use their own color number system rather than the 2000-series commonly used for acrylics. As with acrylics, most colors have low IR transmittance except for 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 suitable for IR windows. It is available from Bayer in many colors but only in pellet form (no sheet stock). Color 7881 appears black in reflected light and has an IR transmittance of approximately 90%.

#### Dow

Dow recommends their Calibre 301 or 303 polycarbonate for IR windows. Various colors, including clear, blue, black, and ivory are available. Dow sells it only in pellet form, but several companies including Manchester Products and Spartec Plastics produce sheet stock using Dow pellets. These are available from distributors such as Cadillac and Regal.

## General Electric

Lexan 9034, GE's polycarbonate sheet stock, is available in several thickness and many colors. The following chart presents several Lexan 9034 colors and their approximate acrylic equivalents. It is noteworthy that acrylic colors Lexan 9034 have similar kind of transmittance qualities.

**Table 6. Selected Colors of Lexan9034 Compared to Acrylics**

Acrylic Color	Approximate Equivalent	Lexan Color	Description	Typical IR Transmittance (%)	
				Acrylics	Lexan
2025	701	black	semi opaque	0	0
2050	*	blue	translucent	4	—
2064	7113	gray	transparent	48	70 <b>(Note 1)</b>
2157	6214	red	translucent	2	5 <b>(Note 2)</b>
2404	5109	bronze	transparent	56	75 <b>(Note 3)</b>
2423	612	red	transparent	90	100 <b>(Note 1)</b>
2711	*	deep red	semi opaque	85-90	—
No number	112	colorless	transparent	92	92

\* No equivalent color.

**Note 1.** Thickness 0.125". Color number 71023 for 0.060" thickness.

**Note 2.** Thickness 0.100".

**Note 3.** Thickness 0.060" or 0.125".

**Note 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. Several IR transmission filter colors are available for Lexan 121; all are in shades of green and blue-violet which appear black in reflected light. All have cutoff wavelengths in the 600 to 700nm region and all are suitable for use as IR windows. The color numbers are 21051, 21064, 21092, 21125, 21127, and 31142. The transmittance curve for 21051 is included at the back of this Application Note.

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

**Table 7.**

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

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

## Resources for Plastic Materials

AtoHaas Americas Inc. (manufacturer)  
(Formerly Rohm and Haas)  
Plastics Technology Center  
P.O. Box 219  
Bristol, PA 19007  
800-217-3258

Bayer Corporation (manufacturer)  
Polymers Division)  
9 Corporate Park Drive Suite 240  
Irvine, Calif. 92714-5113  
(714) 833-2351

Cadillac Plastic and Chemical Co. (distributor)  
10801 Norwalk Blvd.  
Santa Fe Springs, CA 90670-5107  
(310) 903-0197

Calsak Corporation (distributor)  
200 W. Artesia Blvd.  
Compton, Calif. 90220  
800-743-2595

Cyro Industries (manufacturer)  
25 Executive Blvd.  
Orange, Conn. 06477  
(203) 799-4066

The Dow Chemical Company (manufacturer)  
2040 Dow Center  
Midland, Mich. 48674  
800-441-4369

General Electric Company (manufacturer)  
One Plastics Ave.  
Pittsfield, MA 01201  
800-845-0600

Manchester Products (manufacturer)  
20401 Prairie St.  
Chatsworth, CA 91311  
(818) 886-9816

Plastic Sales Incorporated (distributor)  
849 W. 18th St.  
Costa Mesa, CA 92627  
(714) 645-6860

Polycast Technology Corporation (manufacturer)  
Acrylic Division  
70 Carlisle Place  
Stamford, CT 06902  
800-243-9002

Regal Plastics (distributor)  
14709 Spring Ave.  
Santa Fe Springs, CA 90670-5107  
(310) 404-4014

Spartec Plastics (manufacturer)  
14263 Gannet St.  
La Mirada, Calif. 90638  
800-557-4338

Specialty Manufacturing Inc.  
Paul Kennedy  
6790 Nancy Ridge Dr.  
San Diego, Calif. 92121  
(619) 450-1591  
800-491-1652

Has several sheets of Lexan IR transmitting filter for sale as surplus material.

## Handling moisture-sensitive devices

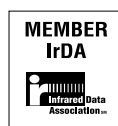
IRMS6118/IRMT6118 IrDT modules are moisture sensitive devices that require proper storage and handling before mounting on the final products.

After the bag is opened devices that will be subject to infrared reflow, vapor reflow, or equivalent processing must be:

- Mounted with 72 hours at factory conditions of  $\leq 30^{\circ}\text{C}/60\% \text{RH}$ , or
- Stored at  $\leq 20\% \text{RH}$

Devices require baking, before mounting if a or b is not met. If baking is required, we recommend:

- 192 hours at 40 to 45°C and, 5% RH for low temperature device containers, or
- 24 hours at 125°C(+/-5C) for high temperature device containers.



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