IRMS5000
Microline, 115 Kb/s Data Transceiver

Appnote 81

Introduction

The IRMS5000 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 IRMS5000 functions.

Table 1. Input/Output Functional Description (IRMS5000)

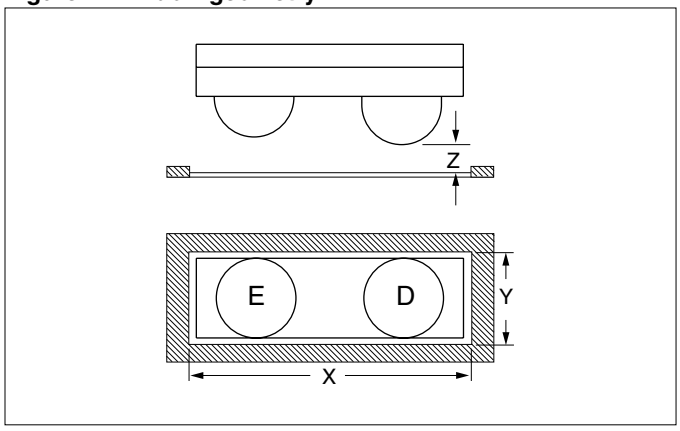
Pin #	Sym.	Type	Polarity	Function Description
1	IR LEDA	Input	AC	LED anode. It is required to connect it to the LED power supply (V_{LED}). An external resistor is required when V_{LED} is above 3.3 V.
2	TxD	Input/ TTL	Active high	LED driver. This input is capacitively coupled to limit transmit pulse width to no more than about 70 µs.
3	RxD	Output/ TTL	Active low	The output indicates received serial data. It is a CMOS driver providing rail to rail operation.
4	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 µA, and it will disable transmitter input and tri-state receiver output.
5	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 µF ceramic bypass capacitor as close as possible to this pin.
6	GND	Ground (power)	—	Connect to power supply ground.

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>4.90+2(Z+D)tan15°
Y>2(Z+D)tan15°

Figure 1. Window geometry



Here X is the width of the window, and Y is the height of the window, and Z is the distance from IRMS5000 to the back of the window. 4.90 mm is twice the distance between LED lens and module center line, and D is depth of LED image inside the module (4.2 mm). The result is shown below, in Table 2.

Table 2. Minimum Window Size

Depth Z (mm)	Min. X (mm)	Min. Y (mm)
0	7.15	2.25
1	7.69	2.79
2	8.22	3.32
3	8.76	3.86
4	9.29	4.39
5	9.83	4.93
6	10.37	5.47
7	10.90	6.00
8	11.40	6.54
9	11.97	7.07
10	12.51	7.61

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 Electrics' 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 2711at 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.

www.infineon.com/opto • 1-888-Infineon (1-888-463-4636)
OSRAM Opto Semiconductors GmbH & Co. OHG • Regensburg, Germany
www.osram-os.com • +49-941-202-7178

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 **(Note 1)**
2157	6214	red	translucent	2	5 **(Note 2)**
2404	5109	bronze	transparent	56	75 **(Note 3)**
2423	612	red	transparent	90	100 **(Note 1)**
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

IRMS5000 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:

a. Mounted with 72 hours at factory conditions of <=30°C/60°C RH, or
b. Stored at <=20% RH

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

1. 192 hours at 40 to 45°C and, 5% RH for low temperature device containers, or
2. 2. 24 hours at 125°C(+/-5C) for high temperature device containers.

Receiver

Since the receiver has good power supply rejection and the receiver output is slew rate limited, receiver supply decoupling is not critical. When driving a typical load of 15 pF, as little as 0.05 µF of receiver power supply decoupling is necessary and only needs to be within a few centimeters of the device. Typically, existing board V_{CC} decoupling will be adequate. Because of the excellent supply 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_{p-p} ripple or unregulated supplies with less than 1.0 V_{p-p} of 120 Hz ripple.

The IRMS5000 will handle most DC infrared ambients except direct sunlight. Due to the increasing shot noise of the photodiode at high DC ambients the receiver decreases it's input sensitivity by up to 10X to prevent spurious noise hits. This will have the effect of reducing receive range to 30% at maximum DC ambients (typically a rare event).

The AGC attack response of the IRMS5000 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 shutdown

cycling; that is, shutting down the IrDT for at least 1.0 us and powering it back up again. The Infineon IRMS5000 is designed to reset the AGC on shutdown and includes circuits which allow for fast power up DC ambient stabilization without pumping up the AGC.

The IRMS5000 is designed to have rapid transmit recovery (typically called Receiver Latency) which restores the device to full sensitivity within 100 us of the end of transmission. This allows rapid transmit/receive turn around, important for voice applications.

Transmitter

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 reduces some design constraints associated with battery operated hand held devices. When not transmitting, the maximum voltage on the LED anode should not exceed 9.0 V. When transmitting and for several microseconds after transmitting the voltage on the LED anode should not exceed V_{CC} + 4.0 V. This is because during transmit and for several microseconds afterwards, an inductive overshoot clamp circuit is active which begins conducting at 4.0 V above V_{CC}. Consequently, voltages above V_{CC} + 4.0 V but less than 9.0 V may cause transmit pulse stretching.

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 infrared 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. When operating above 3.3 V in high power current limiting mode, unless the duty cycle is less than 10%, it is recommended to use a series resistor in order to reduce package thermal dissipation during transmitting. For non-saturated operation with a 5.0 V LED anode supply, a 5.1 ohm series resistor is recommended.

Transmitter LED anode decoupling is more important than receiver decoupling due to the fast rise and fall times and large amplitudes of the LED currents. Transmitter current di/dt is around 15 mA/ns and total charge delivered during a 1.6 us transmit pulse may be up to 640 nano-coulombs. Consequently, it is recommended that the LED anode supply be decoupled locally within 1.0 cm with a 0.1 µF ceramic capacitor and that the total decoupling be at least 22 µF (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_{DD}, inductive noise can be significant between V_{dd} and ground during transmit pulses. Although the part is designed to have high V_{dd} noise immunity in transmit mode other devices sharing the same V_{dd} 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.

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