

# Teaching Optical Communications Concepts in Embedded Systems Courses

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# Topics to be covered..

- n Introduction to the paper.
- n Communication using Optical fiber.
- n Communication using Infrared.
- n Lab exercise for Optical communication.

# PART 1

Introduction to the paper

# Aim of the paper

- n "To Introduce Optical engineering concepts to embedded system engineering students."
- n "This paper establishes the requirements of knowledge that an embedded optics engineer must possess."
- n "To create an embedded system that could be used to teach optical communications hardware interfacing and control ."

# Why????

- n Optical communications is a fast growing field.
- n Demand for engineers knowing embedded systems and optical communication.
- n Very few or no development environments available right now for classroom use to teach optical engineering concepts to embedded system students.

# Teaching optical engineering concepts to embedded system engineers.....

- n Involves basic concepts about the working of optical fiber, Optical transmitters and receivers.
- n Concepts about infra red communication.

# Lab Exercises used ....

- n Optical communication between two microcontroller boards using Optical Fiber, and optical transmitter and receiver.
- n Infra red communication between two Microcontroller Boards using Infrared transmitter and receiver.

# PART 2

## Communication using optical fiber



# What is Optical Fiber ?

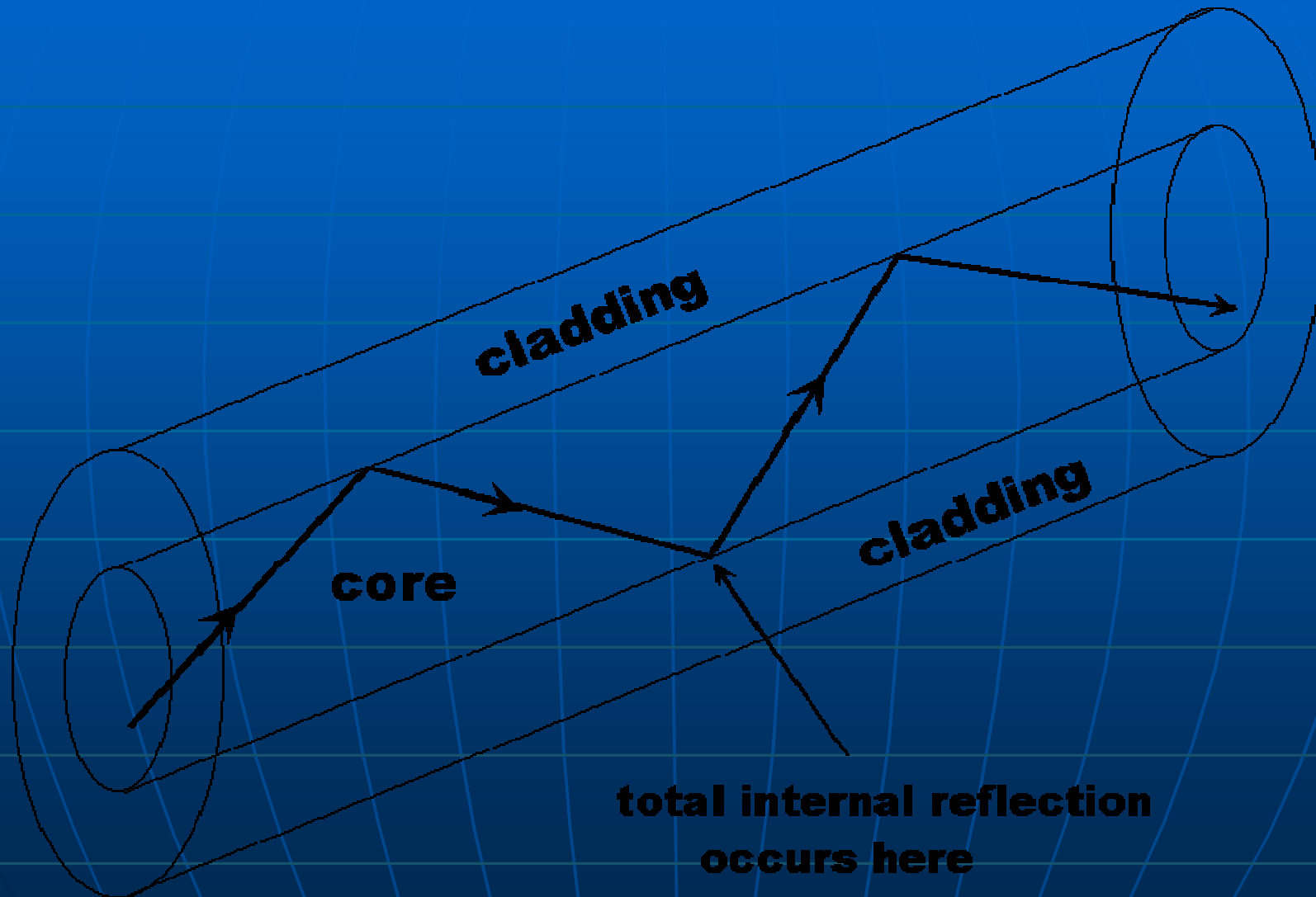
- n Optical fibers are thin, transparent strands almost the size of a human hair made from a dielectric cylinder surrounded by another transparent dielectric cylinder .

# How does it work ?

The light in a fiber-optic cable travels through the core by constantly bouncing from the mirror-lined walls, .....**total internal reflection.**

The reflections inside the walls are possible because of high refractive index material of the inner cylinder and the low refractive index of the outer cylinder

# Optical fiber.... Inside it.



# Optical communication system

- n **Transmitter.**

Converts electrical signal into light signal.

- n **Optical fiber.**

Conducts the light signal over the distance.

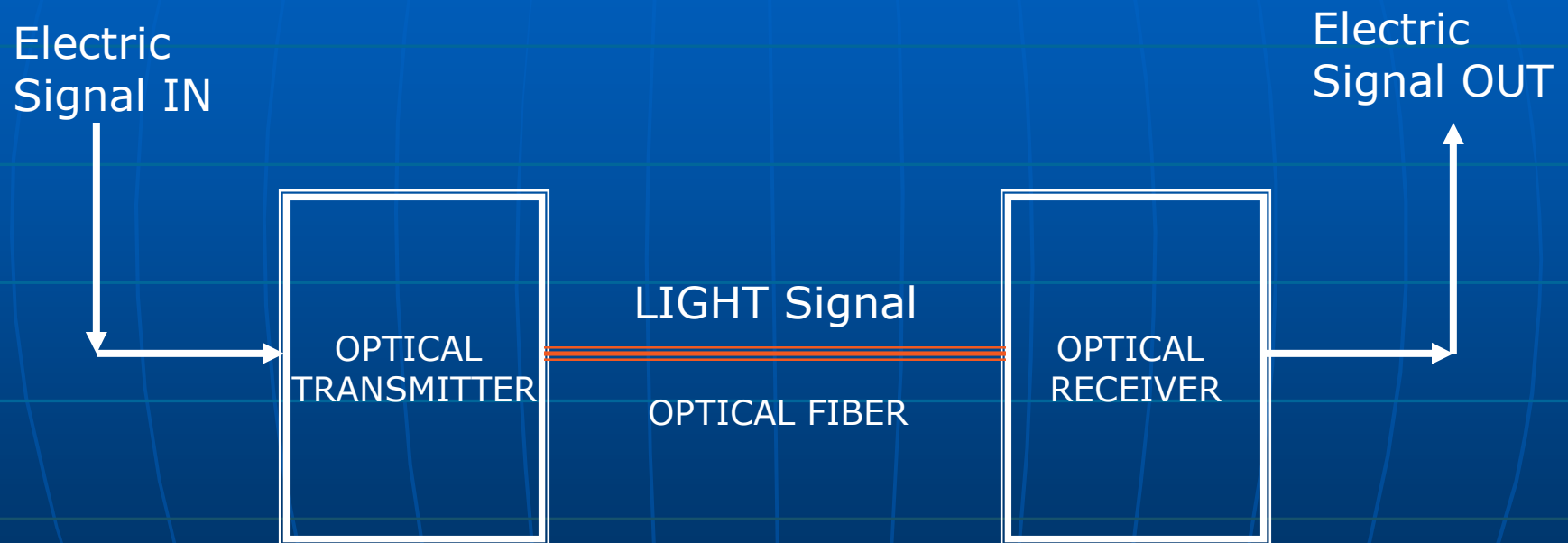
- n **Optical regenerator.**

May be required to boost the light signal for longer distances.

- n **Optical receiver.**

Converts light signals back to electrical signal.

# Typical Optical communication system.



# Advantages of using optical fiber

- n Less expensive.
- n Less volume (thinner than copper wires).
- n Higher capacity.
- n Less signal degradation.
- n No interference between two signals.
- n Low power.
- n Lightweight.
- n Flexible.

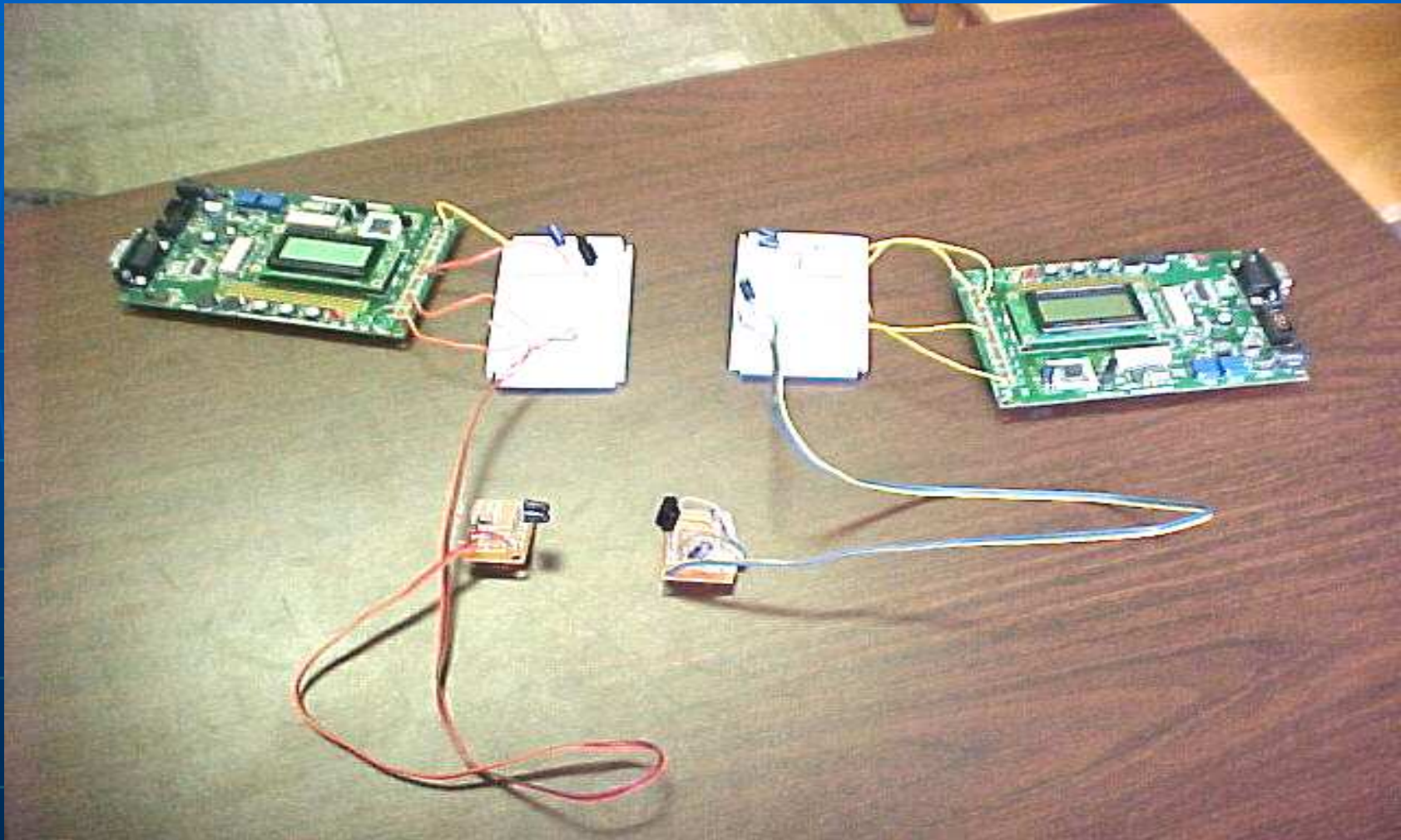


# PART 3

## Communication using Infrared



# IR communication using two SKP-30262 boards





# Wireless infrared (IR) communication

Using Infrared emitters and detectors capable of high-speed transitions

Transmitter: High-powered IR  
(TSAL6100) LED.

Receiver : TSOP12 (IR receiver  
module)

# Infrared transmitter and receiver

- n Transmitter: The Vishay TSAL6100 is a high efficiency infrared emitting diode in GaAlAs on GaAs technology.
- n Receiver : TSOP12-series are miniaturized receivers for infrared remote control systems

# PART 4

## LAB EXERCISE lab 5

### Advanced embedded systems

# Communication between two microcontroller boards using optical fiber

# Purpose of the lab..

The purpose of this lab is to create a cost-efficient exercise that helps students to learn the basics and benefits of optical communication

The optical fiber allows very high-speed ( $>100\text{kbps}$ ) data transfer between two microcontroller development boards.

# Hardware used.....

- n The HFBR-1412 standard transmitter is capable of speeds in excess of 10Mbps.
- n The HFBR-2412 TTL receiver is capable of speeds up to 5Mbps .
- n Length of optical fiber cable.

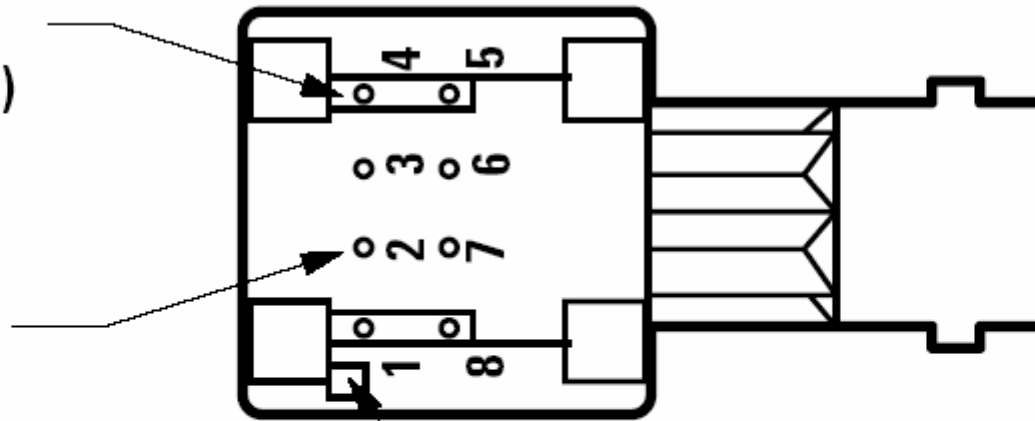
# Optical fiber cable ,transmitter and receiver.



# HFBR transmitter and receiver.

**PINS 1,4,5,8**  
**0.51 X 0.38**  
**(0.020 X 0.015)**

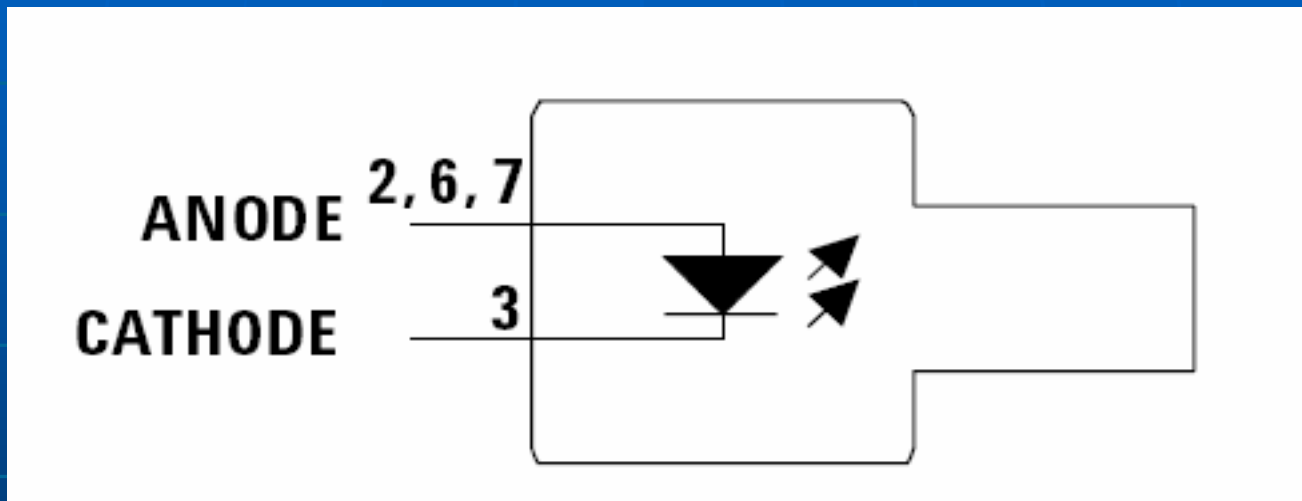
**PINS 2,3,6,7**  
**0.46**  
**(0.018) DIA.**



**PIN NO. 1**  
**INDICATOR**

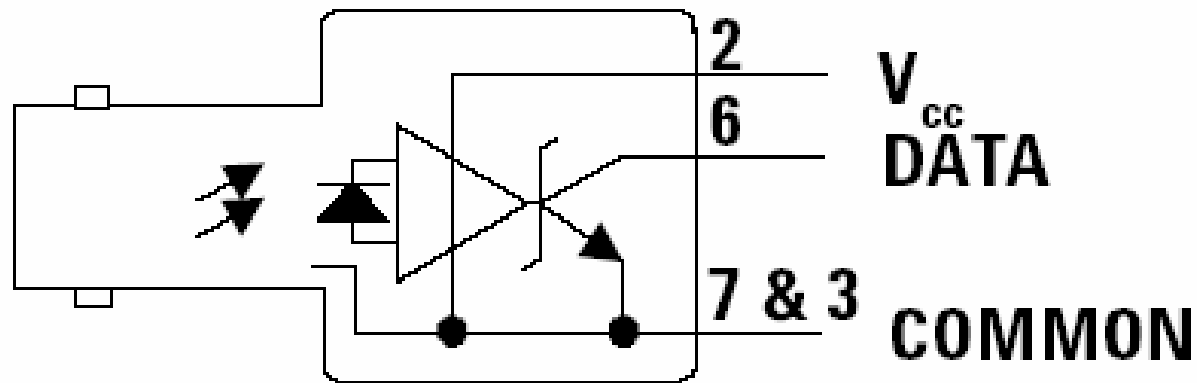


# HFBR-1412 Transmitter



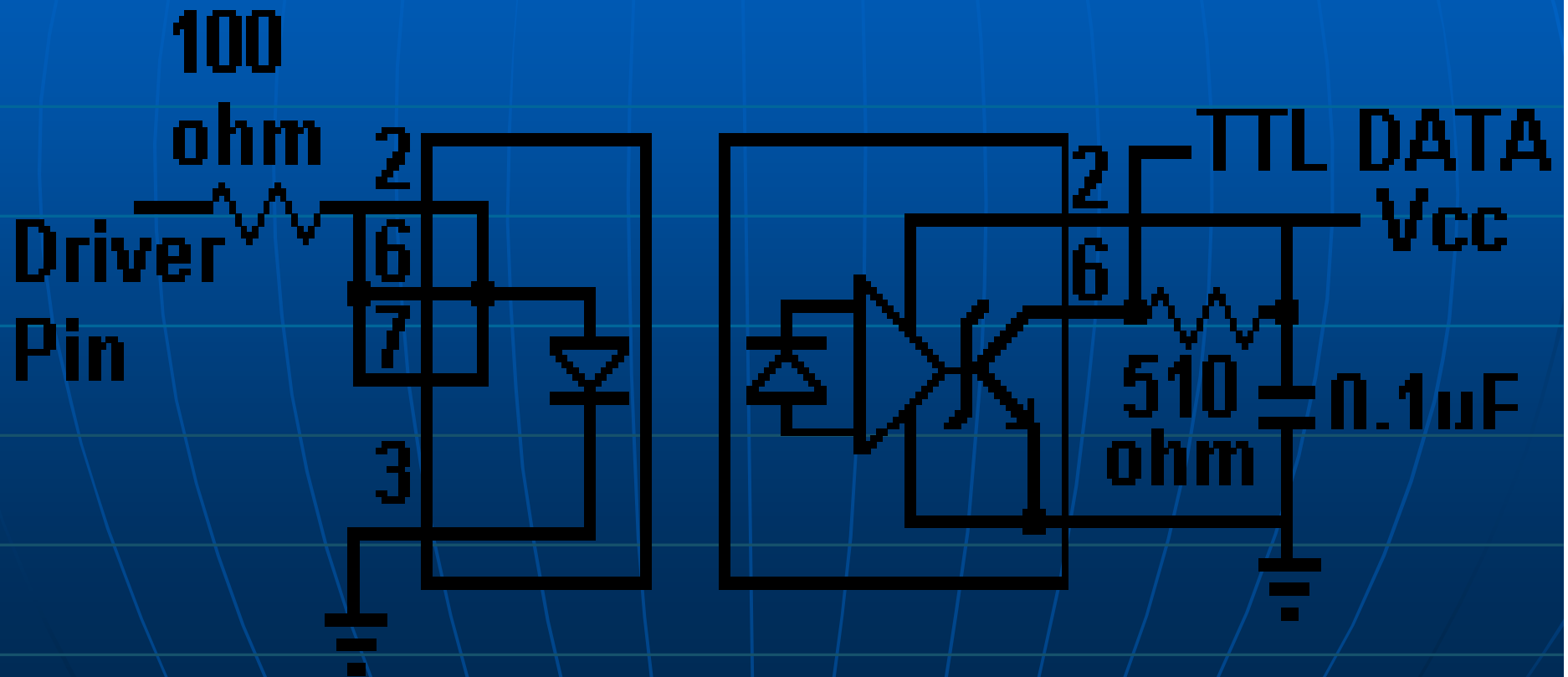
The HFBR-14xx fiber optic transmitter contains an 820 nm AlGaAs emitter

# HFBR-2412 Receiver

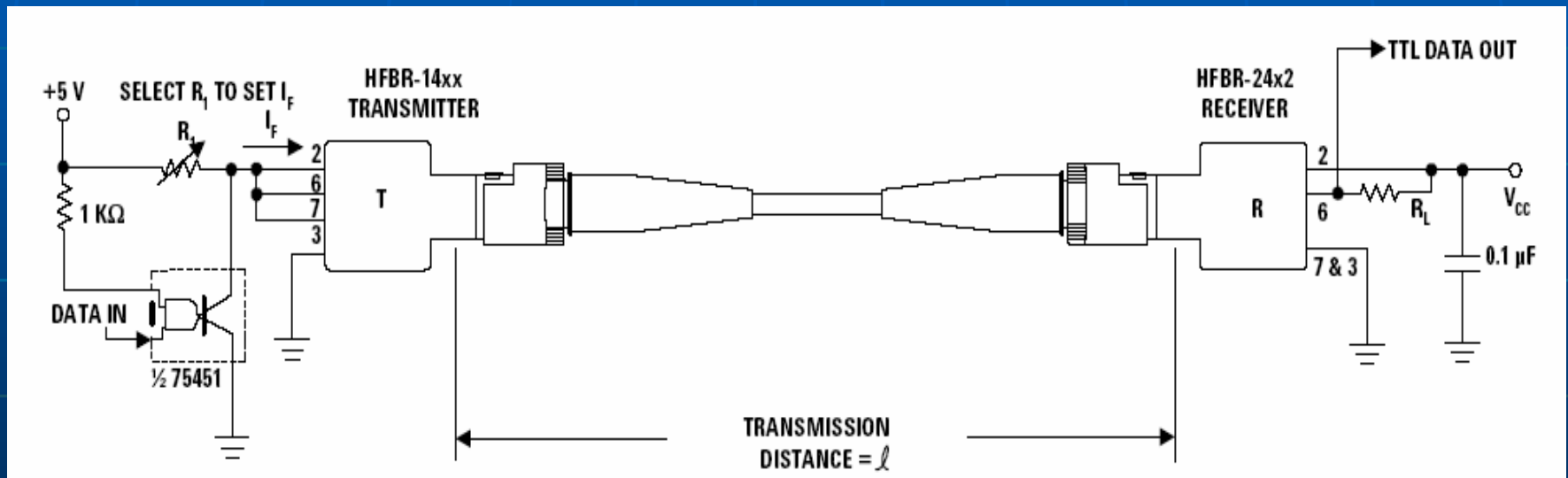


The HFBR-24x2 receiver incorporates an integrated photo IC containing a photo detector and dc amplifier driving an open collector Schottky output transistor.

# HFBR transmitter and receiver circuits..



# Optical communication circuit.



# Conclusion.

- n Engineers who have knowledge of embedded systems and optical communications will be in high demand.
- n Using these lab exercises or development environments ,students learn about these technologies.

# Future work..

- n Development of a microcontroller board which contains an optical fiber transceiver and an IR transmitter and receiver circuitry for use by any university in their embedded systems or communications courses.

# References

- n Teaching Optical Communications  
Concepts in Embedded Systems  
Courses

*James M. Conrad, Sami Lasassmeh, Ishfan Vakil, and Benjamin Levine.*

THANK YOU