# ENG128

### **INTRODUCTION TO ENGINEERING SYSTEMS**

# Lecture 2: Abstraction and Interfaces

# "Understand Your Technical World"

PUMA

### **Block Diagrams**

Helicopter power block diagram:



### **Modularity**

Helicopter power block diagrams:



### Abstraction

### What does "abstract" mean, anyway?



Van Gogh: "Starry Night"



Picasso: Portrait of Daniel-Henry Kahnweiler



Matisse: The Snail

Don't show me the details!

- Reduce the device/component/system to the simplest possible form
- Hide complexity and implementation details
- Focus on the inputs and outputs

### **Feedback Control Loop:**

- 1. I sense the position of the helicopter by watching it
- 2. I compute an appropriate reaction
- 3. I move the sticks on my remote
  - Which magically moves the motors on the helicopter (It won't be magic in about 8 weeks. It will just be homework)
- 4. This moves the helicopter in the world, and we repeat

### I am providing control:

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### The basic controller block diagram

This is one of the most common system diagrams

We will be using it extensively in this course

This is a **feedback** system. The output "feeds back" to the input.

This is also a **control loop**. (Because it controls and it loops)



### Feedback and control loops are everywhere:

	Sensor	Computer	Actuator
Building thermostat			
Automobile cruise control			
R/C helicopter heading lock			

[switch to white board]

### Interface

The *interface* to a component is a specification describing what goes in and what comes out

• It does not specify what happens inside (it's abstract, remember?)

Good interface design is the key to drawing block diagrams

• It can take several tries to get it right

What can go in and out?

• Power, information, data, motion, force, water, electricity...



### Interface

Consider our thermostat example

• What are the most abstract way to represent what is on these links?



We don't care about the details.

- Electrical signals? Hydraulic actuators? Smoke signals?
- The interface to each component defines it's input and output:



# **Block Diagramapalooza!**

# A Complex Block Diagram: The r-one robot:

aen source hardware

ing a IR3

4 . R23

7.2

GND

v12.

1824

10

GEIOA GEIOB OPUMOA

RO

5

BL

ST2

### **Measuring distance on the r-one robot:**

Measure distance in three easy steps:

1. Each robot has two sensors that tell the computer how many turns the motor makes (Problem Set 3)

2. The motor is connected to the wheels, so the computer can also figure out how many turns the wheel makes (Problem Set 6)

3. With information about wheel rotations, the computer can compute the distance the robot has traveled (Problem Set 8)

### **Measuring distance on the r-one robot:**

This sensor is called an *encoder*. Its block diagram is:



This is a simple block and a simple interface. How much complexity does this conceal?

### r-one Robot Block Diagram (v11)





### **Motor Circuit Board**

Start with commercial motors

• Pololu micro-gearmotors with extended shafts

Very inexpensive quadrature encoders

- Composed of a plastic wheel and a photointerupter
- 0.0625 mm/tick resolution
- Cost around \$5 each







### **Encoder Wheel**



### **Full Schematics:**



### **Motors and Encoders Schematic Page**



### **Encoder Circuit**



### **Encoder Chip**



## Photomicrosensor (Transmissive)

### Dimensions

Note: All units are in millimeters unless otherwise indicated.





E1

E2

Collector

Emitter 1

Emitter 2

	Recommended	Soldering Pattern
C		
E1		
E2	2 3	2 88
lame		
e		
onnected.		

Unless otherwise specified, the
tolerances are ±0.15 mm.

### Features

- Ultra-compact with a 5-mm-wide sensor and a 2-mm-wide slot.
- PCB surface mounting type.
- High resolution with a 0.3-mm-wide aperture.
- Dual-channel output.
- RoHS Compliant.

### ■ Absolute Maximum Ratings (Ta = 25° C)

	ltem	Symbol	Rated value
Emitter	Forward current	I <sub>F</sub>	25 mA (see note 1)
	Pulse forward current	I <sub>FP</sub>	100 mA (see note 2)
	Reverse voltage	V <sub>R</sub>	5 V
Detector	Collector–Emitter voltage	V <sub>CEO</sub>	20 V
	Emitter–Collector voltage	V <sub>ECO</sub>	5 V
	Collector current	I <sub>C</sub>	20 mA
	Collector dissipation	Pc	75 mW (see note 1)
Ambient	Operating	Topr	–30° C to 85° C
temperature	Storage	Tstg	–40° C to 90° C
	Reflow soldering	Tsol	240° C (see note 3)
	Manual soldering	Tsol	300° C (see note 3)

Note: 1. Refer to the temperature rating chart if the ambient temperature exceeds 25° C.

- 2. Duty: 1/100; Pulse width: 0.1 ms
- Complete soldering within 10 seconds for reflow soldering and within 3 seconds for manual soldering.

### Ordering Information

Description	Model	
Photomicrosensor (transmissive)	EE-SX1131	

### Electrical and Optical Characteristics (Ta = 25°C)

	Item	Symbol	Value	Condition
Emitter	Forward voltage	V <sub>F</sub>	1.1 V typ., 1.3 V max.	I <sub>F</sub> = 5 mA
	Reverse current	I <sub>R</sub>	10 μA max.	V <sub>R</sub> = 5 V
	Peak emission wavelength	λ <sub>p</sub>	940 nm typ.	I <sub>F</sub> = 20 mA
Detector	Light current	I <sub>L1</sub> /I <sub>L2</sub>	50 μA min., 150 μA typ., 500 μA max.	I <sub>F</sub> = 5 mA, V <sub>CE</sub> = 5 V
	Dark current	I <sub>D</sub>	100 nA max.	V <sub>CE</sub> = 10 V, 0 <i>l</i> x
	Leakage current	LEAK		
	Collector-Emitter saturated voltage	V <sub>CE</sub> (sat)	0.1 V typ., 0.4 V max.	I <sub>F</sub> = 20 mA, I <sub>L</sub> = 50 μA
	Peak spectral sensitivity wavelength	λ <sub>p</sub>	900 nm typ.	
Rising time		tr	10 μs typ.	$V_{CC} = 5 \text{ V}, \text{ R}_{L} = 1 \text{ k}\Omega$ $I_{L} = 100 \mu\text{A}$
Falling time		tf	10 μs typ.	$V_{CC} = 5 \text{ V}, \text{ R}_{L} = 1 \text{ k}\Omega$ $I_{L} = 100 \mu\text{A}$

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### OMRON

### **Encoder Chip, complete**

OMRON

Symbol Rated value

20 \

pr -30°C to 85°0

Model

100 mA (see note

### OMRON

OMRON





ature ecceeds 35° C. Duty: 1/100; Pulse width: 0.1 ms Complete soldering within 10 seconds for reflow soldering and within 3 seconds for manual soldering. Ordering Information Description

item

Pulse forward current

Collector-Emitter voltage Emitter-Collector voltage Collector current

ssive) EE-SX1131 Electrical and Optical Characteristics (Ta = 25°C)

ace mounting type. Aution with a 0.3-mm-wide aperture.

	liem	Symbol	Value	Condition
Emitter	Forward voltage	V,	1.1 V typ., 1.3 V max.	l <sub>e</sub> = 6 mA
	Reverse current	44	10 µA max.	V <sub>k</sub> = 5 V
	Peak emission wavelength	2.0	940 nm typ.	l <sub>r</sub> = 20 mA
Detector	Light current	C4a	50 μA min., 150 μA typ., 500 μA max.	Ip = 5 mA, V <sub>GR</sub> = 5 V
	Dark current	P.	100 nA max.	V <sub>ct</sub> = 10 V, 0 /x
	Leakage current	Law.		
	Collector-Emitter saturated voltage	V <sub>CE</sub> (saf)	0.1 V typ., 0.4 V max.	l <sub>2</sub> = 20 mA, l <sub>2</sub> = 50 μA
	Peak spectral sensitivity wavelength	24	900 nm typ.	***
Rising time		¥	10 µs typ.	V <sub>00</sub> = 5 V, R <sub>2</sub> = 1 kQ I <sub>2</sub> = 100 µA
Falling time		1	10 µs typ.	V <sub>00</sub> = 5 V, R <sub>1</sub> = 1 kQ I <sub>1</sub> = 100 µA

Photomicrosensor (Transmissive) EE-SX1131

### OMRON

### Precautions

### Soldering Information

### Reflow soldering

Notining solating public to recommended Mathing thermation: 24% to 220° C deposition (bit 3.4 get 76 due recommended hibboard of the multi aduation proteing is between 0.2 and 0.25 mm. The reformance of the multi-aduation profile shown in the following shall a cataland for the upper nurface of the product being solatere



Manual soldering • Use "to fit (KON's in and KON's lead) or solder with silver content. • Use a soldering ond Hass Tanz 25 W, and have the temperature of the iron tip at 300° C or below. • Solder each point for a maximum of three seconds. • Alter advancing, time the point of to short to room temperature before handling it.

### Storage

To protect the product from the effects of humidity until the package is opened, dry-box storage is ner product under the billowing conditions: Temperature: 10 to 30°C Humidity: 60% max.

The product is packed in a humistry-price fermilope. Refore solidering must be done within 44 hours after opening the envelope, during which time the product must be stored under 30° C at 60% maximum humidity. It is measures to store the product article opening the envelope, use dry-box storage or reseal the envelope.

### Baking

If a product has remained packed in a humidity-proof envelope for six months or more, or If more than 48 hours have lapsed since the envelope was opened, bake the product under the following conditions before use: Reet: 60° C for 24 hours or more Bulk: 80° C for 4 hours or more





Photomicrosensor (Transmissive) EE-SX1131 2

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### Photomicrosensor (Transmissive) EE-SX1131 5

Unit mm (inch Tape and Reel

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Photomicrosensor (Transmissive) EE-SX1131 3

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### Certain Precautions on Specifications and Use

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### **Encoder block diagram**



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