

Lecture 02 - **BASIC COMPONENTS**

How to select components

Outline

- **R's, L's, and C's**
- **Component Speedthrough**
- **Examples**

R's, L's, and C's

- Most basic passive components are resistors, capacitors and inductors
- We know lumped constitutive equations
- Importantly, we can model non-ideal parameters of components as circuits consisting of ideal lumped components (RLCs)

R's, L's, and C's

Resistors



Unit: Ohm

Constitutive Relation:

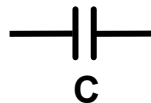
$$V = IR$$

Impedance:

$$Z = R$$

Typical values: 1 Ohm to 1
MOhm

Capacitors



Unit: Farad

Constitutive Relation:

$$I = C \frac{dV}{dt}$$

Impedance:

$$Z = \frac{1}{j\omega C}$$

Typical values: 10 pF to
100 uF

Inductors



Unit: Henry

Constitutive Relation:

$$V = L \frac{dI}{dt}$$

Impedance:

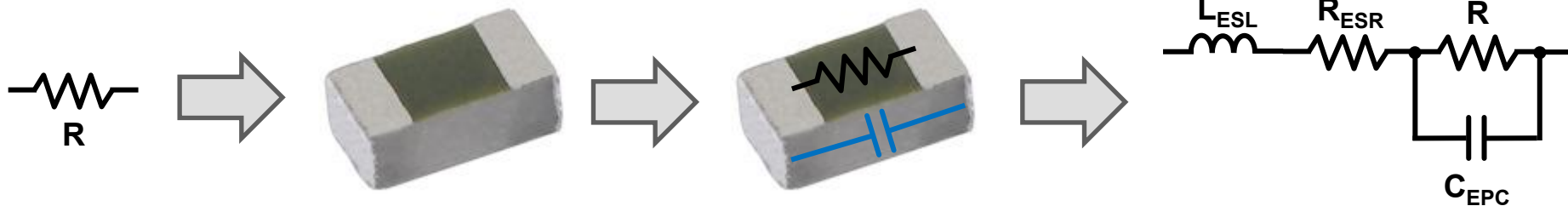
$$Z = j\omega L$$

Typical values: 10 nH to
1mH

R's, L's, and C's

Equivalent Circuits

We could get even more detailed...



Circuit components in a schematic are ideal

Parasitic and nonideal characteristics can be lumped into “equivalent circuit elements”

Parasitic parameters are typically determined by the construction of the physical component

- Retains circuit-analysis abstraction
- Important for high-frequency/power/sensitivity

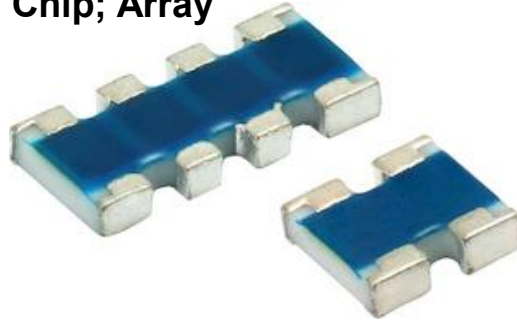
R's, L's, and C's

Resistors

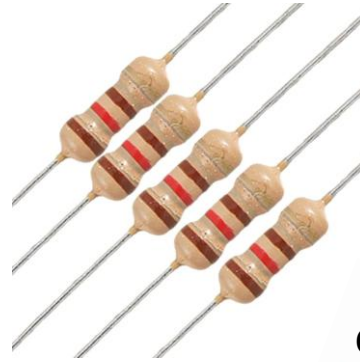
Critical Parameters:

- Resistance
- Tolerance
- Power Handling

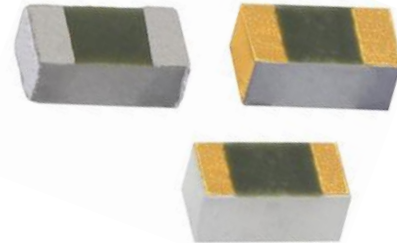
Chip; Array



Leaded



Chip; Thin Film



Flanged



Heatsinked



Chip; Thick Film



R's, L's, and C's

Inductors

Critical parameters:

- Inductance
- Tolerance
- DCR
- Q
- Resonant Frequency
- DC current max
- Saturation Current

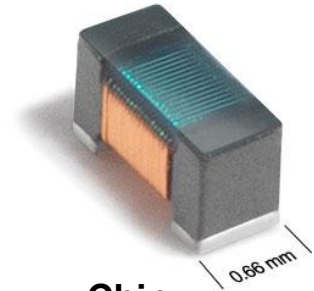
Shielded; SMT



Air Core; SMT



Chip;
Ferrite Core



Air Core; THT



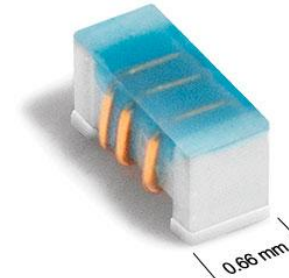
Chip;
Multilayer



Conical; SMT



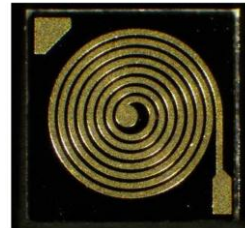
Chip;
Ceramic Core



Toroid; THT



Thin Film; Spiral



R's, L's, and C's

Inductors

Inductor Impedance

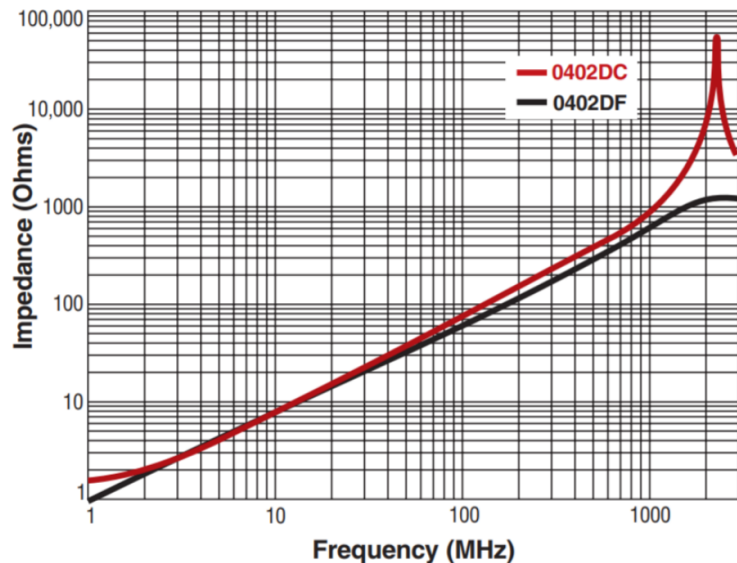
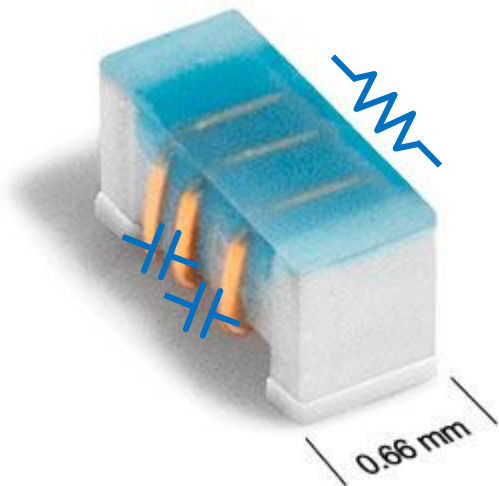
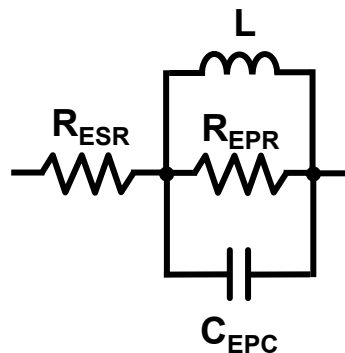


Figure 1. Coilcraft 0402DC & 0402DF 120 nH
Impedance



Ideal Impedance:

$$Z = j\omega L$$

Capacitance between windings

- Looks like a capacitor past self-resonance

Resistance of copper; emphasized by skin effect

- Flattens impedance peak at self-resonance

R's, L's, and C's

Inductors

Ferromagnetic materials have nonlinear permeabilities at high magnetic field strengths

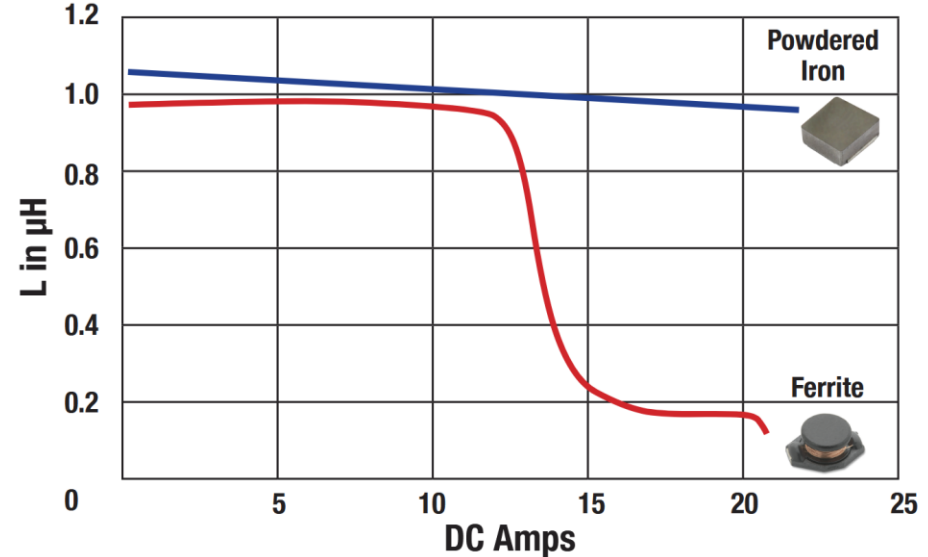
- Inductor has a saturation current
- At saturation, more current does not linearly produce more magnetic field $\rightarrow$ inductance decreases
- Must operate inductor below saturation current

When non-saturated:

$$Li = \Phi(i) \rightarrow \Phi(i) \text{ linear}$$

$$\vec{B} \equiv \mu_0 \vec{H} + \mu_0 \vec{M} \rightarrow \vec{B} = \mu_r \mu_0 \vec{H}$$

SATURATION COMPARISON



Vishay

R's, L's, and C's

Capacitors

Critical Parameters:

- Capacitance
- Tolerance
- Voltage
- Dielectric/temperature rating

Multilayer Chip Capacitor (MLCC)



Single Layer Capacitor (SLC)



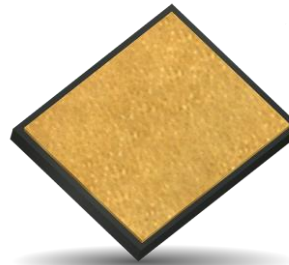
Hybrid (MLCC + SLC)



Electrolytic; Radial



Metal Oxide Semiconductor (MOS); SLC



Electrolytic; Axial

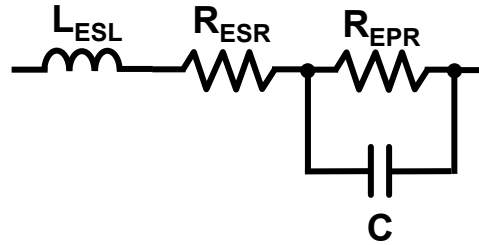


Ceramic; Radial



R's, L's, and C's

Capacitors



Ideal Impedance:

$$Z = \frac{1}{j\omega C}$$

THE ART AND
SCIENCE of
PCB DESIGN
IAP 2026

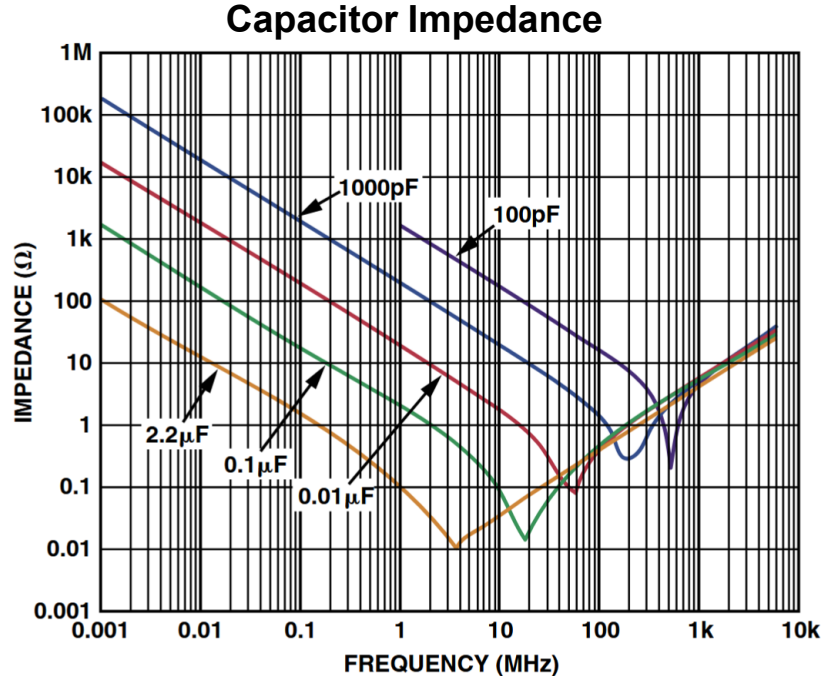
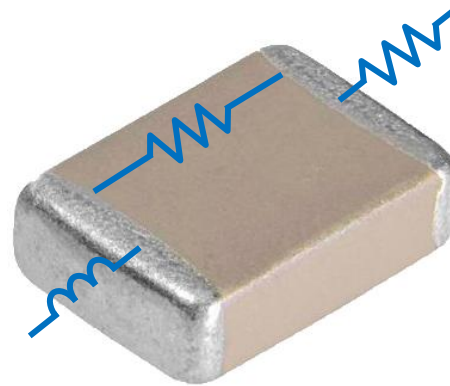


Figure 1. Capacitor impedance vs. frequency.



Inductance from contacts

- Looks like an inductor past self-resonance

Resistance from contacts

- Flattens impedance peak at self-resonance

R's, L's, and C's

Capacitors

Capacitors include a temperature rating code

- C0G/NP0 > X7R > X5R > Y5V

1206J1K04P70CCT



Image shown is a representation only. Exact specifications should be obtained from the product data sheet.

DigiKey Part Number

1608-1394-2-ND - Tape & Reel (TR)
1608-1394-1-ND - Cut Tape (CT)
1608-1394-6-ND - Digi-Reel®

Manufacturer

Knowles Syfer

Manufacturer Product Number

1206J1K04P70CCT

Description

CAP CER 4.7PF 1KV C0G/NP0 1206

Manufacturer Standard Lead Time

11 Weeks

Customer Reference

Detailed Description

4.7 pF ± 0.25 pF 1000V (1kV) Ceramic Capacitor C0G, NP0 (1B) 1206 (3216 Metric)

Datasheet

 [Datasheet](#)

EDA/CAD Models

[1206J1K04P70CCT Models](#)

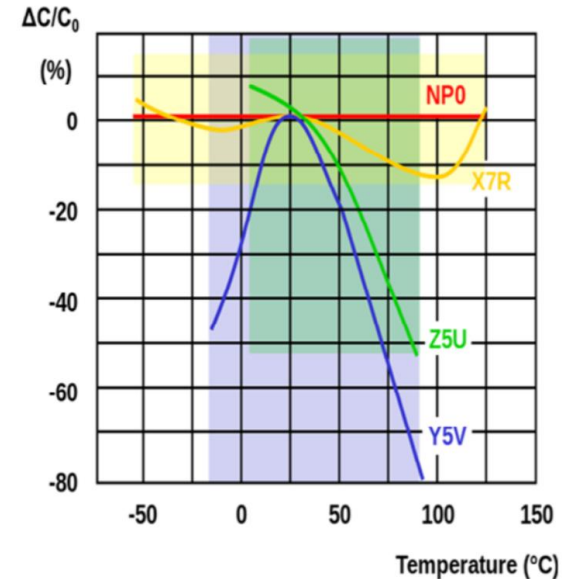
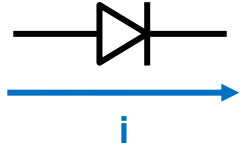


Figure 3: Temperature coefficient of capacitance (TCC)

Kyocera-AVX

Component Speedthrough

Diodes



- Schottky
- TVS
- PIN
- Zener

Zener-Dioden von ON SEMICONDUCTOR



This product is RoHS compliant.

ON Semiconductor®

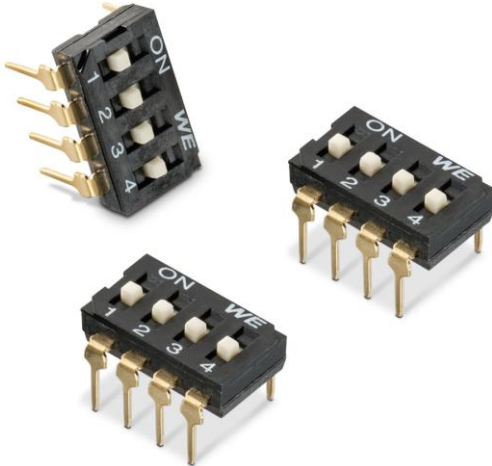


 Surmetric 30	 Surmetric 40	 SOD-323	 SMA	 SOT-23
 SOT-353	 SOD-923	 SOT-363	 SOD-123	 SMB

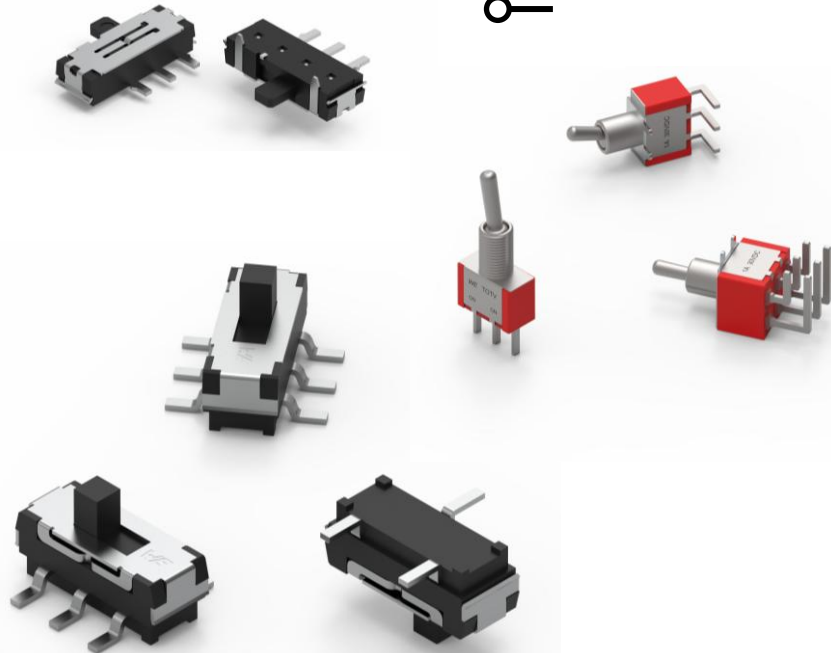
Switches

Toggle Switches

Single-Pole Single-Throw (SPST)



Single-Pole Double-Throw (SPDT)



Switches

Buttons

Basically, a temporary SPST switch



Normally Open (NO)



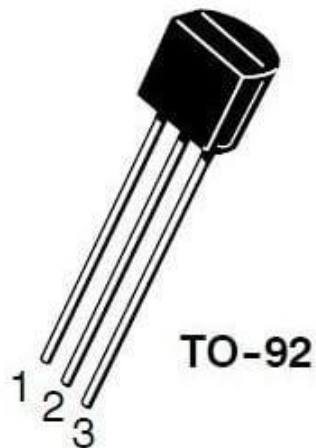
Normally Closed (NC)



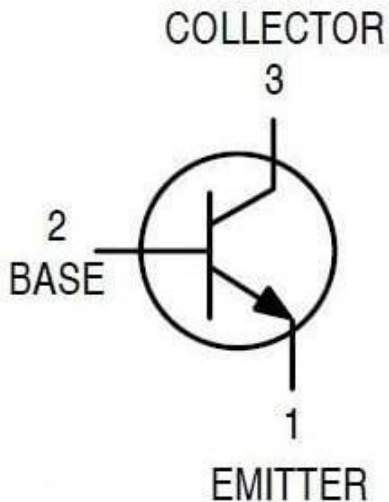
Transistors

Bipolar Junction Transistor (BJT)

2N2222



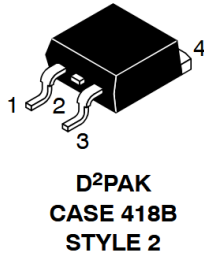
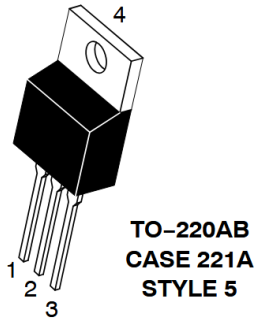
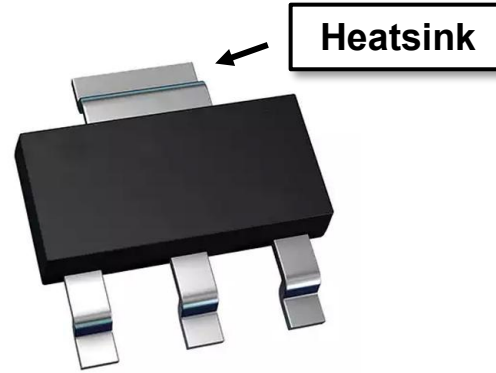
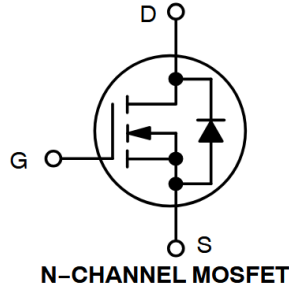
TO-92



- Amplifiers
- Building blocks for op-amps

Transistors

Metal Oxide Semiconductor Field Effect Transistors (MOSFET)



- Amplifiers
- Power regulation
- Logic gates (CMOS)

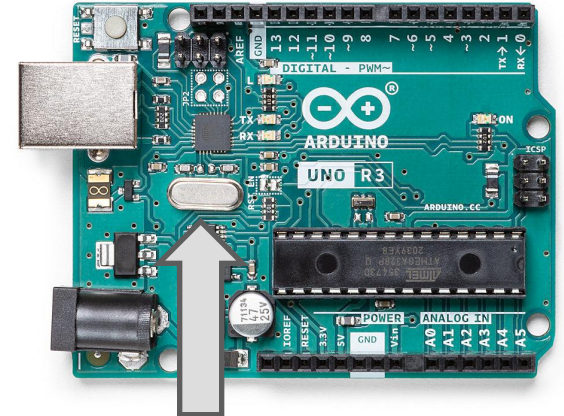
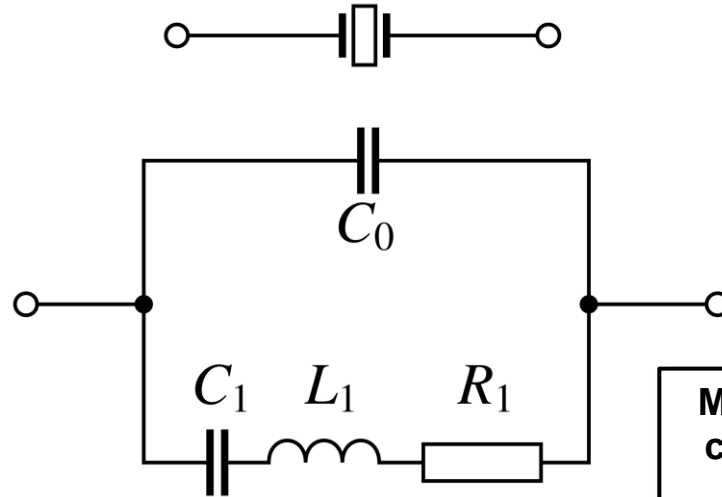
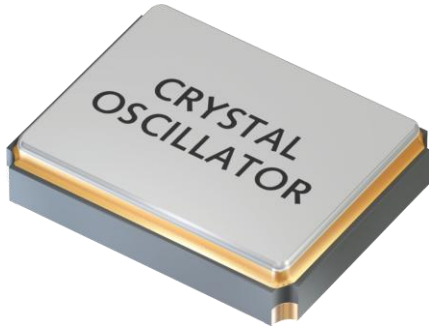
Take 6.208....

Oscillators

Crystals

Quartz crystals used to make highly accurate RLC resonant circuits

- They don't oscillate on their own → resonate to an externally provided oscillation source

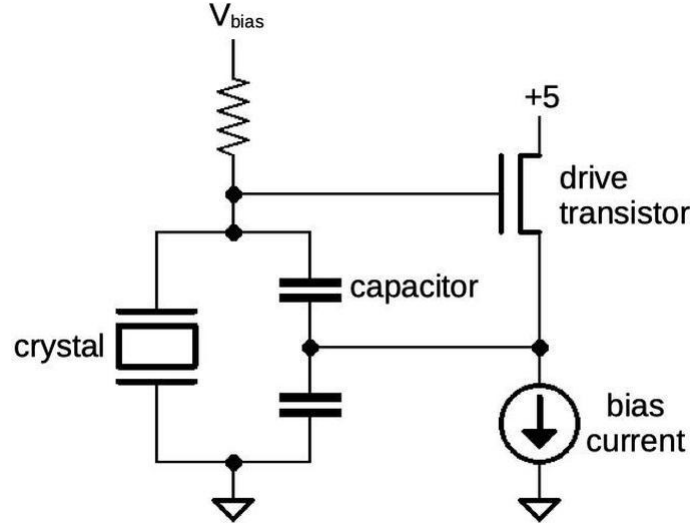
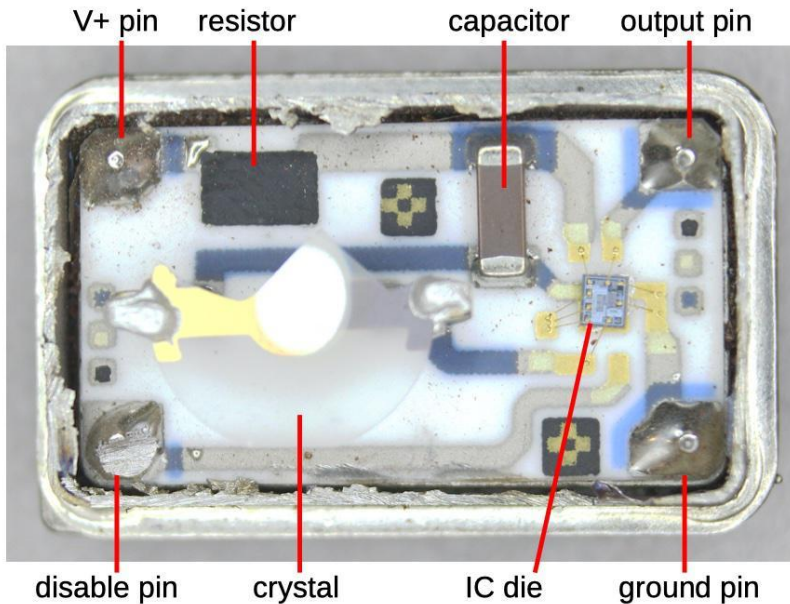


Microcontroller will utilize crystals to accurately set their clock frequencies

Oscillators

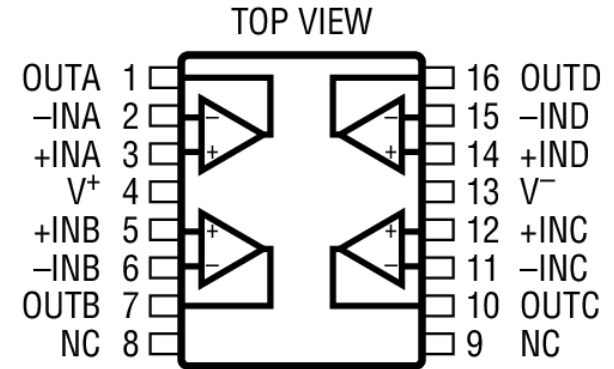
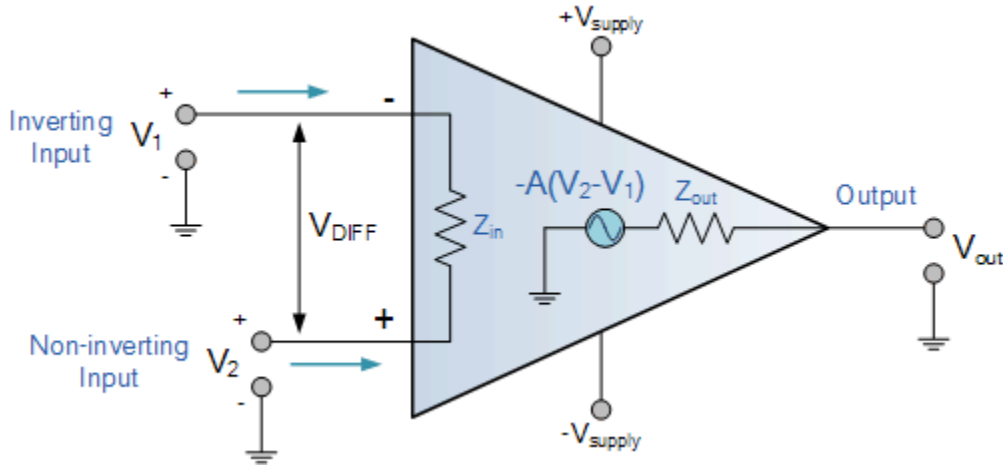
Crystal Oscillators (XO)

Feedback circuitry combined with a crystal creates an oscillator



Ken Shirriff's blog

Operational Amplifier



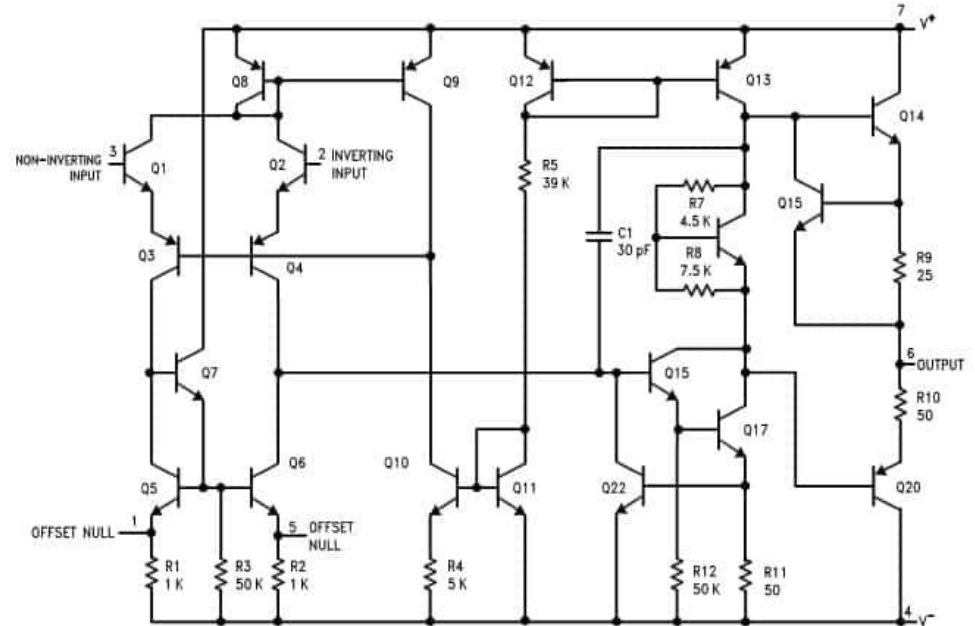
MS PACKAGE
16-LEAD PLASTIC MSOP

$T_{JMAX} = 150^{\circ}\text{C}$, $\theta_{JA} = 125^{\circ}\text{C/W}$ (NOTE 6)

Operational Amplifier

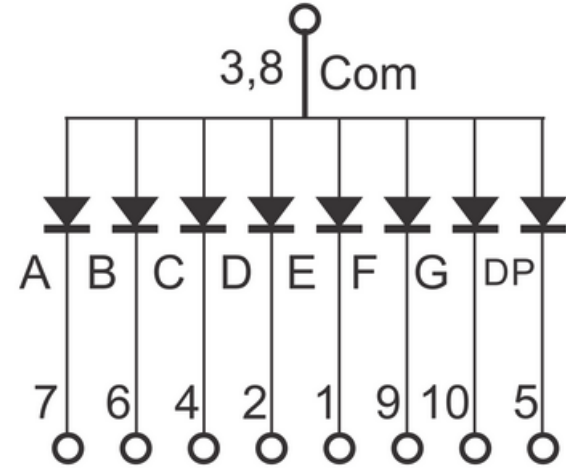
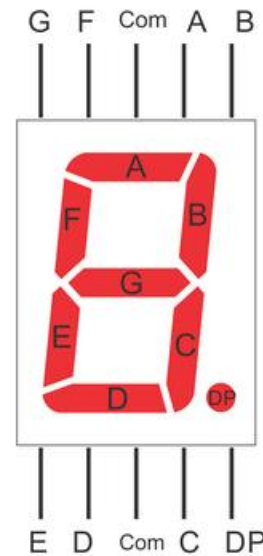
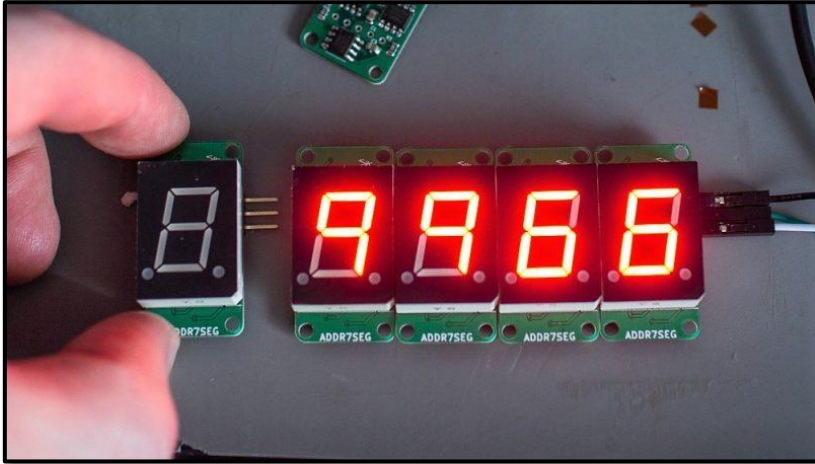
Schematic

Op-amp schematic (take 6.209...)

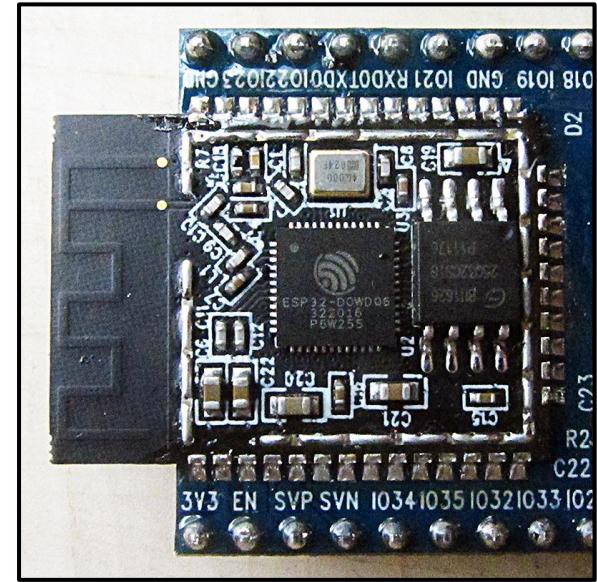
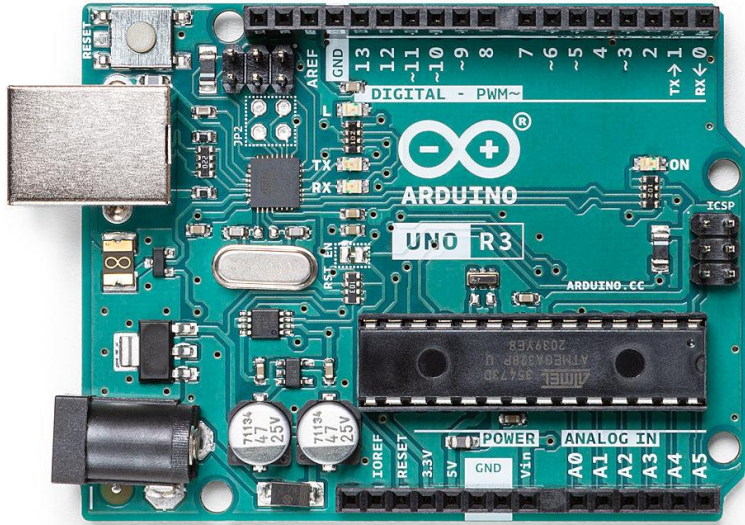


Displays

Seven-Segment Display



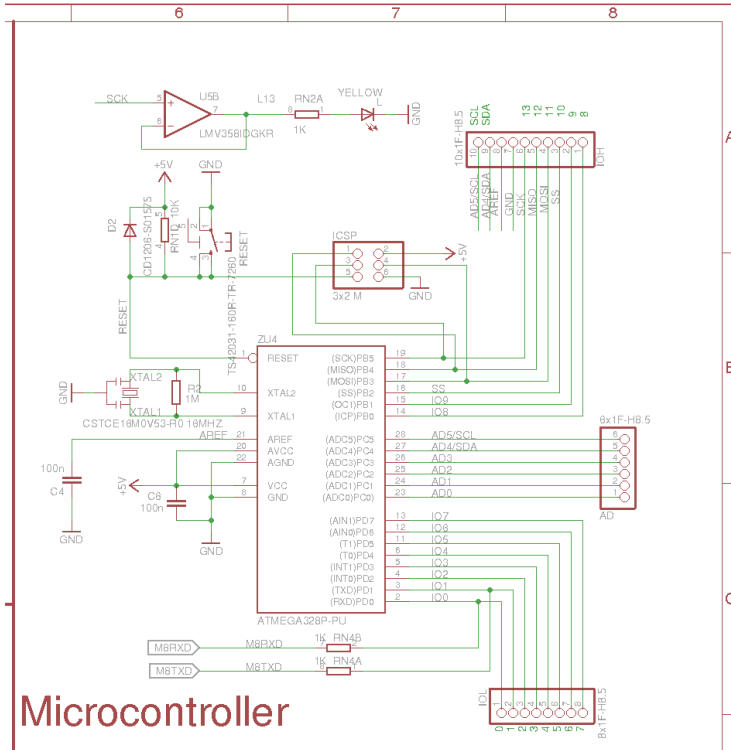
Microcontrollers



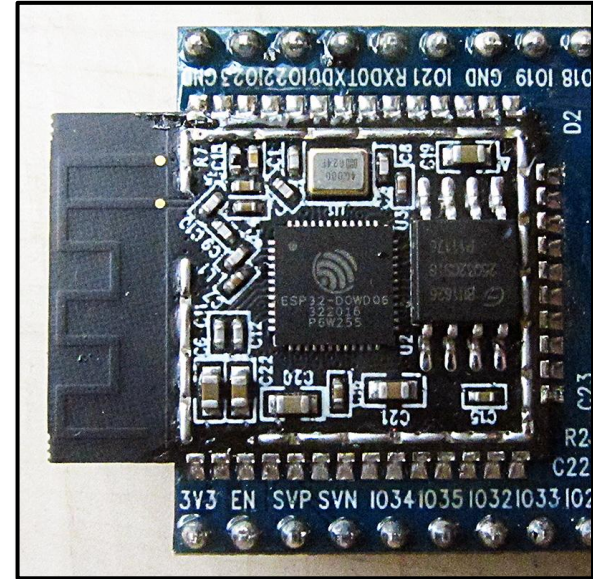
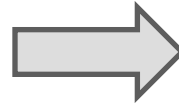
Microcontrollers

ESP32

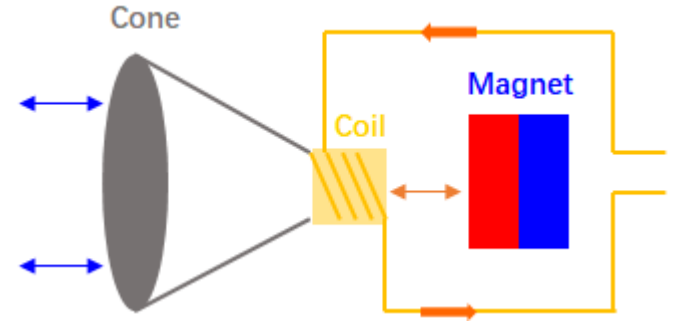
Arduino Uno



ESP32 is great since all support components are integrated into a shielded system-on-a-module



Speakers



Digital Logic

Logic Gates

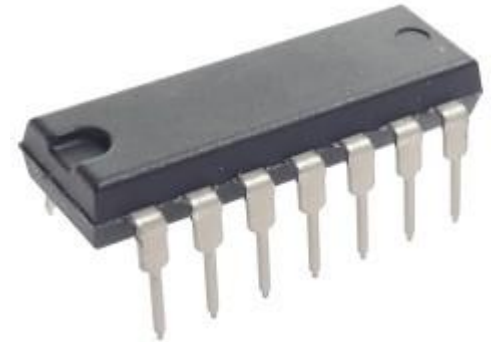
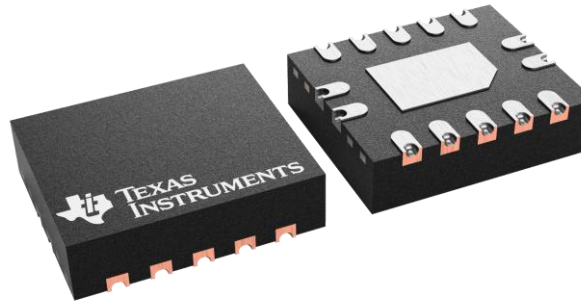
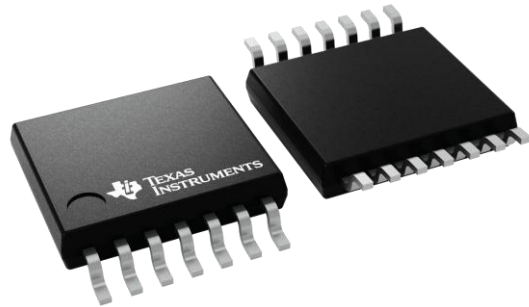
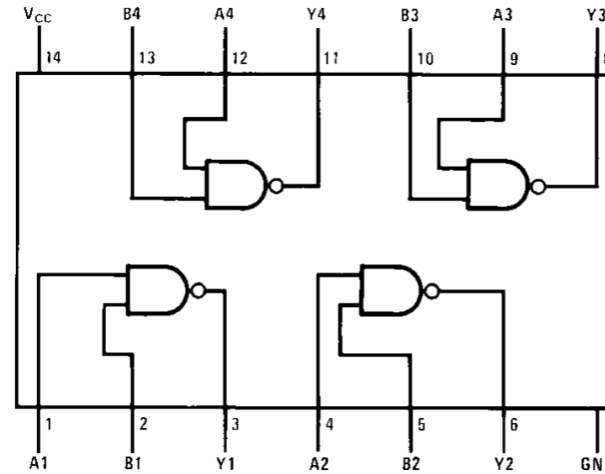


A	B	Z
0	0	0
0	1	0
1	0	0
1	1	1



A	B	Z
0	0	0
0	1	1
1	0	1
1	1	1

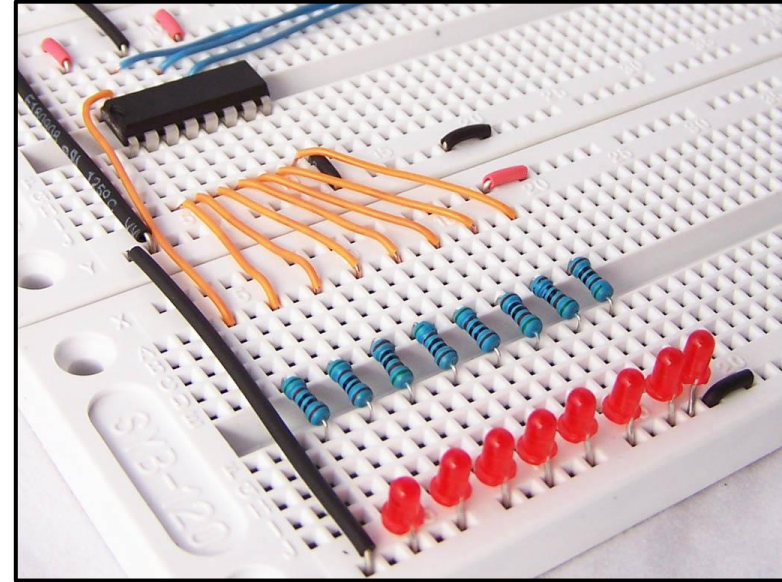
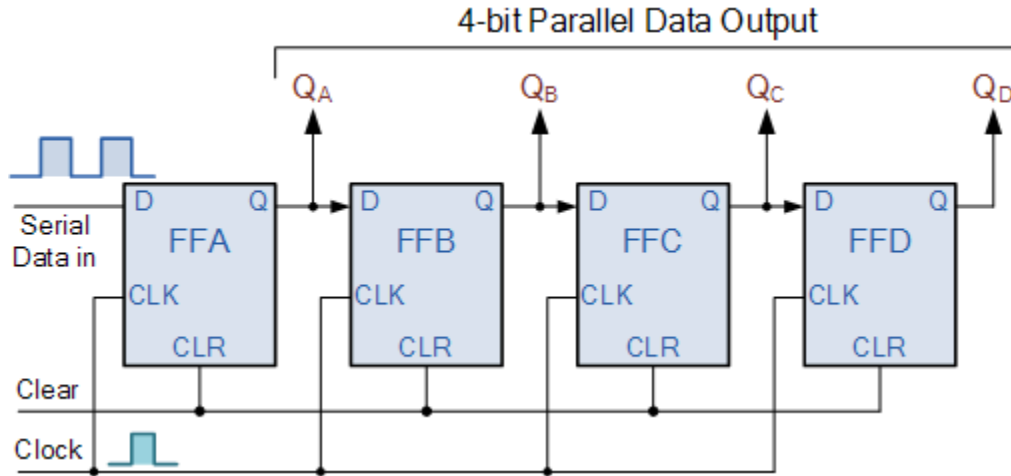
Connection Diagram



Digital Logic

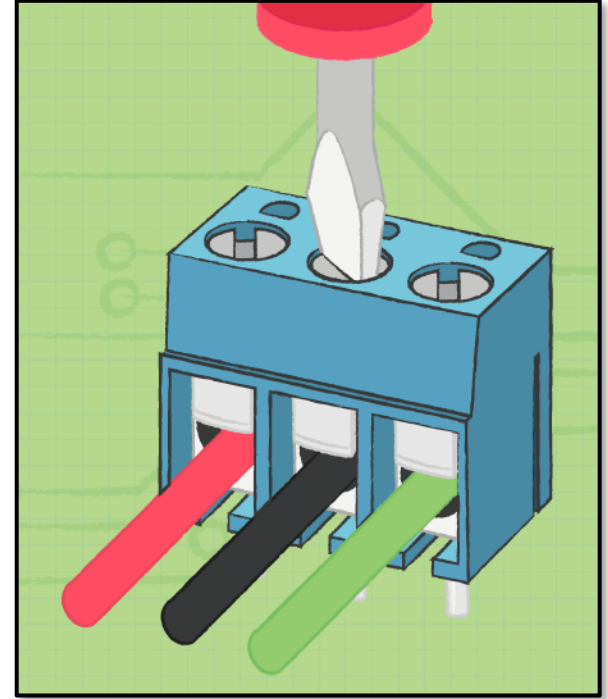
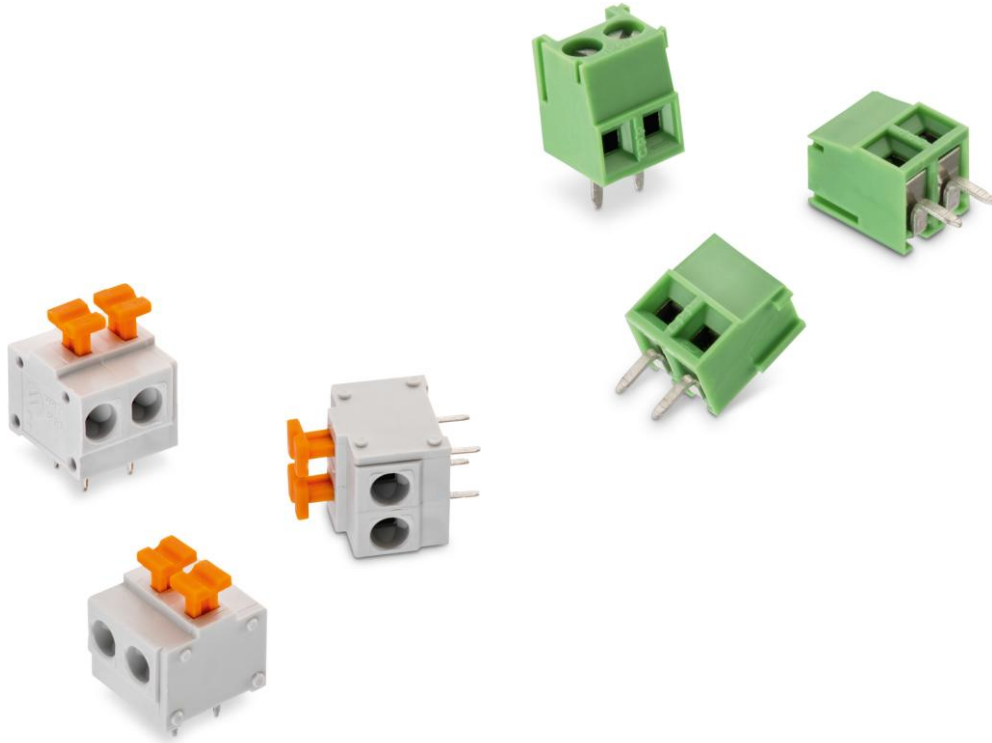
Shift Registers

Same packages...



Connectors

Terminal Blocks



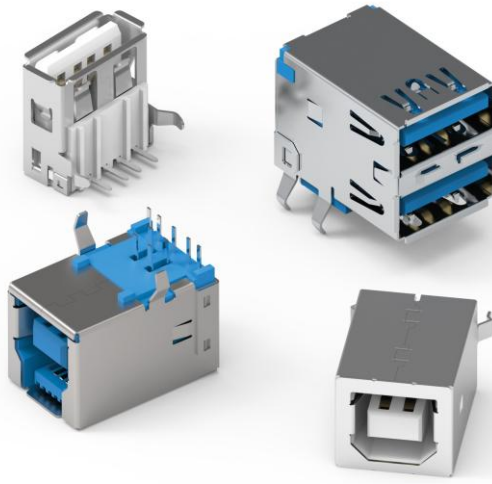
Connectors

USB

Type-C



Type-A



Mini



Micro (3.0)



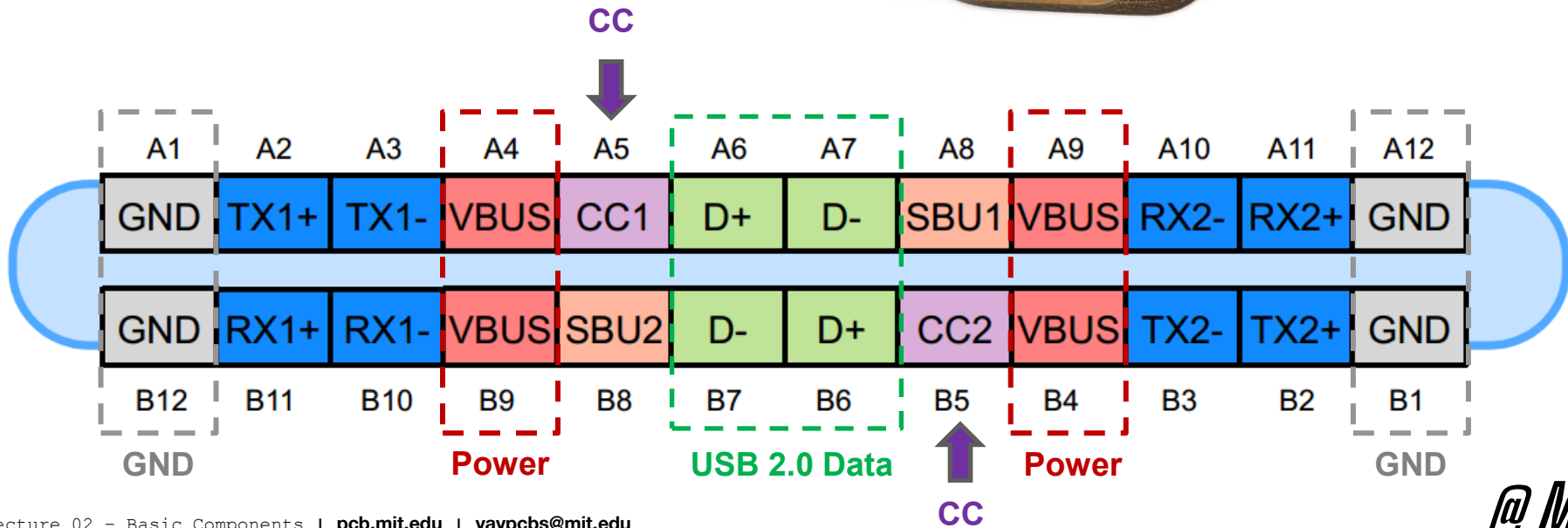
Micro



Connectors

USB Type-C

Top and bottom pins are identical, just rotated 180-degrees around center axis



Examples

Example

Radio State Switch

FM Radio Need:

- **SP3T switch to control between various radio states**

Product index > Switches > Slide Switches > Same Sky (Formerly CUI Devices) SLW-1277545-2A-RA-S-D

SLW-1277545-2A-RA-S-D

Display Part Number: 2229 SLW-1277545-2A-RA-S-D-ND
Manufacturer: Same Sky (Formerly CUI Devices)
Manufacturer Product Number: SLW-1277545-2A-RA-S-D
Description: 12.7 X 7.5 X 4.5 MM, 2 MM RAISED
Manufacturer Standard Lead Time: 12 Weeks
Customer Reference:
Detailed Description: Slide Switch SP3T Through Hole, Right Angle
Datasheet: [Datasheet](#)
EDA/CAD Models: [SLW-1277545-2A-RA-S-D Models](#)

Product Attributes

TYPE	DESCRIPTION	SELECT ALL
Category	Switches Slide Switches	☒
Manufacturer	Same Sky (Formerly CUI Devices)	☐
Series	SLW	☐
Packaging	Box	☐
Part Status	Active	☐
Circuit	SP3T	☐
Contact Timing	Shorting (MSB)	☐

In-Stock: 2,611

Check for Additional Incoming Stock

QUANTITY

All prices are in USD

Box

QUANTITY	UNIT PRICE	EXT PRICE
1	\$0.39000	\$0.39
10	\$0.33600	\$3.36
25	\$0.31400	\$7.85
100	\$0.28110	\$28.11
250	\$0.26048	\$65.12
500	\$0.24382	\$122.91
1,000	\$0.23217	\$232.17
3,000	\$0.21280	\$638.40
5,000	\$0.20479	\$1,023.95

☐ Manufacturers Standard Package

Tariff Status: Tariff may apply if shipping to the United States. Tariff costs are calculated and will be displayed in the shipping cart.

39 cents! 🤖

Additional Resources: [Product Page](#)

date 06/10/2024
page 1 of 3

CUI DEVICES

MODEL: SLW-1277545-2A-RA-S-D | **DESCRIPTION:** SLIDE SWITCH

FEATURES

- SP3T
- shorting
- through hole



RoHS

SPECIFICATIONS

parameter	conditions/description	min	typ	max	units
rated voltage				50	Vdc
rated current				300	mA
withstanding voltage	for 1 minute		500		Vac
contact resistance	measured at 1 kHz at 100 mA or less			100	mΩ
insulation resistance	at 500 Vdc for 1 minute	100			MΩ
operating force		150	250	350	gf
actuator travel		1.8	2	2.2	mm
operating temperature		-20		70	°C
storage temperature		-25		70	°C
life	at uniform rate of 15-18 cycles per minute, no load		10,000		cycles

Example

Button Volume Control

FM Radio Need:

- Buttons to digitally control volume

Product Index > Switches > Tactile Switches > TE Connectivity ALCO SWITCH Switches FSMSM

FSMSM

Image shown is a representation only. Exact specifications should be obtained from the product data sheet.

Manufacturer: [TE Connectivity ALCO SWITCH Switches](#)

Manufacturer Product Number: FSMSM

Description: SWITCH TACTILE SPST-NO 0.05A 24V

Manufacturer Standard Lead Time: 16 Weeks

Customer Reference:

Detailed Description: Tactile Switch SPST-NO Top Actuated Surface Mount

Datasheet: [Datasheet](#)

EDA/CAD Models: [FSMSM Models](#)

Product Attributes

TYPE	DESCRIPTION	SELECT ALL
Category	Switches Tactile Switches	☐
Mfr	TE Connectivity ALCO SWITCH Switches	☐
Series	FSMSM	☐
Packaging	Bulk ☒	☐
Part Status	Active	☐
Circuit	SPST-NO	☐
Switch Function	Off-Mom	☐

In-Stock: 51,319

[Check for Additional Incoming Stock](#)

QUANTITY

[Add to List](#) [Add to Cart](#)

All prices are in USD

Bulk

QUANTITY	UNIT PRICE	EXT PRICE
1	\$0.32000	\$0.32
10	\$0.27900	\$2.79
25	\$0.26120	\$6.53
100	\$0.23390	\$23.39
250	\$0.21672	\$54.18
500	\$0.20452	\$102.26
1,000	\$0.19311	\$193.11
3,000	\$0.17685	\$530.55
5,000	\$0.17010	\$850.50

☒ Manufacturers Standard Package

Tariff Status: Tariff may apply if shipping to the United States. Tariff costs are calculated and will be displayed in the shopping cart.

32 cents! 🎉

FSMSM ☒ ACTIVE

[Alcoswitch](#) | [Alcoswitch FSM](#)

TE Internal #: 1437566-3

Tactile Switches, Rectangular Actuator Style, Off (On), Brass, Silver,

Low Profile, 50mA Contact Current Rating, Alcoswitch FSM

[View on TE.com](#) >



Switches > Tactile Switches



Actuator Style: **Rectangular**

Operating Function: **Off (On)**

Contact Base Material: **Brass**

Switch Contact Plating Material: **Silver**

Low Profile: **With**

Features

Product Type Features

Switch Connection Type	Printed Circuit Board
Leg Style	Gull Wing
Illuminated	Without
Actuator Style	Rectangular

Configuration Features

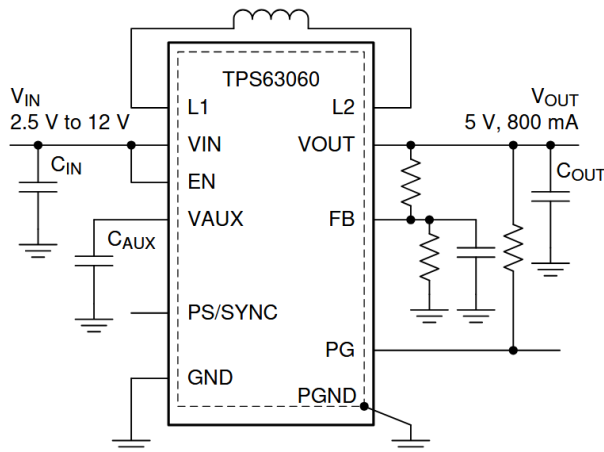
ESD Grounding Terminal	Without
Ganged	With
Switch Feedback Type	Tactile

Example

Battery Regulator

FM Radio Need:

- Buttons to digitally control volume



Simplified Application

TPS6306x High Input Voltage, Buck-Boost Converter With 2-A Switch Current

1 Features

- Input voltage range: 2.5 V to 12 V
- Efficiency: Up to 93%
- Output current at 5 V ($V_{IN} < 10$ V): 2 A in buck mode
- Output current at 5 V ($V_{IN} > 4$ V): 1.3 A in boost mode
- Automatic transition between step down and boost mode
- Typical device quiescent current: $< 30 \mu\text{A}$
- Fixed and adjustable output voltage options from 2.5 V to 8 V
- Power save mode for improved efficiency at low output power
- Forced fixed-frequency operation at 2.4 MHz and synchronization possible
- Power good output
- Buck-Boost Overlap Control™
- Load disconnect during shutdown
- Overtemperature protection
- Overvoltage protection

2 Applications

- Dual Li-ion application
- Digital still cameras (DSC) and camcorders
- Notebook computer
- Industrial metering equipment
- Ultra mobile PCs and mobile internet devices
- Personal medical products
- High-power LEDs

3 Description

The TPS6306x devices provide a power supply solution for products powered by either three-cell up to six-cell alkaline, NiCd or NiMH battery, or a one-cell or dual-cell Li-Ion or Li-polymer battery. Output currents can go as high as 2 A while using a dual-cell Li-Ion or Li-polymer battery, and discharge to 5 V or lower. The buck-boost converter is based on a fixed frequency, pulse width modulation (PWM) controller using synchronous rectification to obtain maximum efficiency. At low load currents, the converter enters power save mode to maintain high efficiency over a wide load current range. The power save mode can be disabled, forcing the converter to operate at a fixed switching frequency. The maximum average current in the switches is limited to a typical value of 2.25 A. The output voltage is programmable using an external resistor divider, or is fixed internally on the chip. The converter can be disabled to minimize battery drain. During shutdown, the load disconnects from the battery.

The devices are available in a 3 mm × 3 mm, 10-pin, WSON (DSC) package.

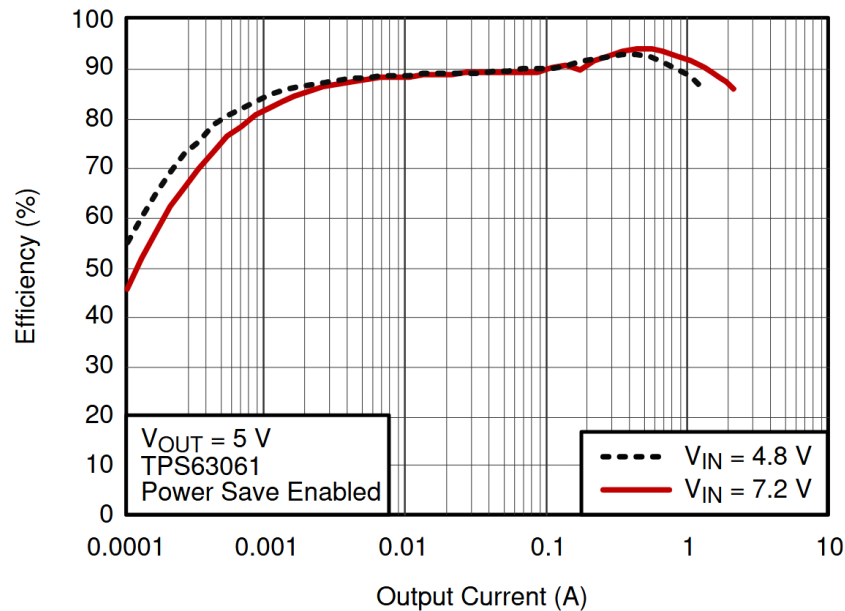
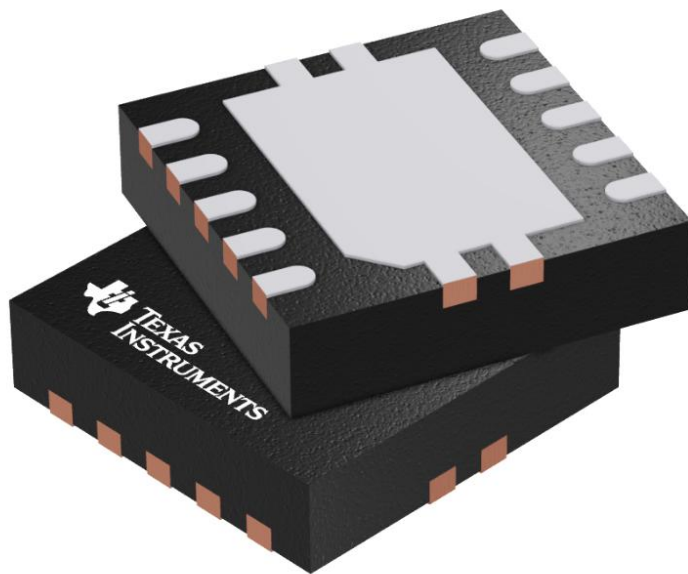
Device Information ⁽¹⁾

PART NUMBER	PACKAGE	BODY SIZE (NOM)
TPS63060	WSON (10)	3.00 mm × 3.00 mm
TPS63061		

(1) For all available packages, see the orderable addendum at the end of the data sheet.

Example

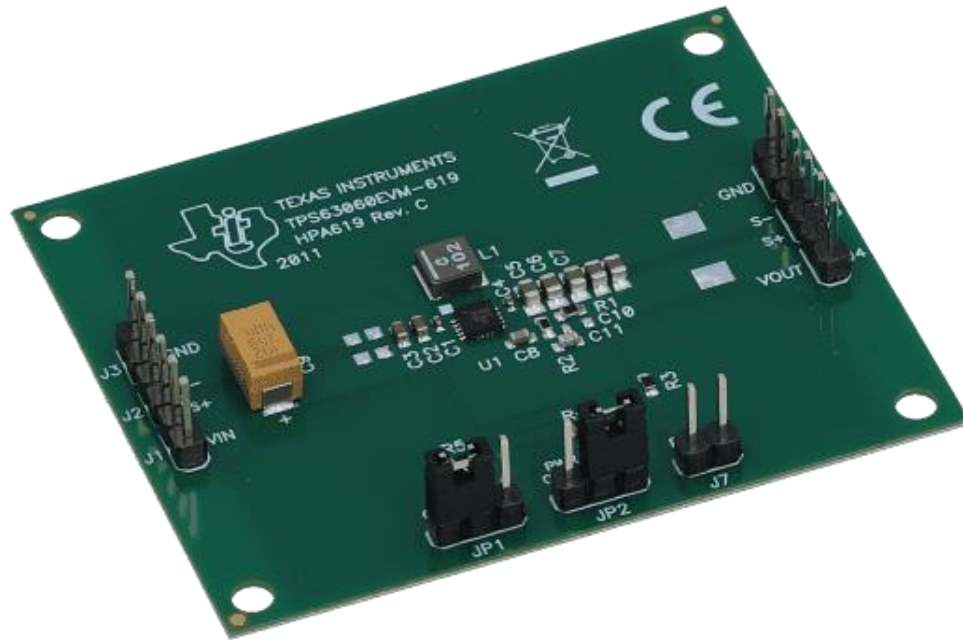
Battery Regulator



Efficiency vs Output Current

Example

Battery Regulator



11.2 Layout Example

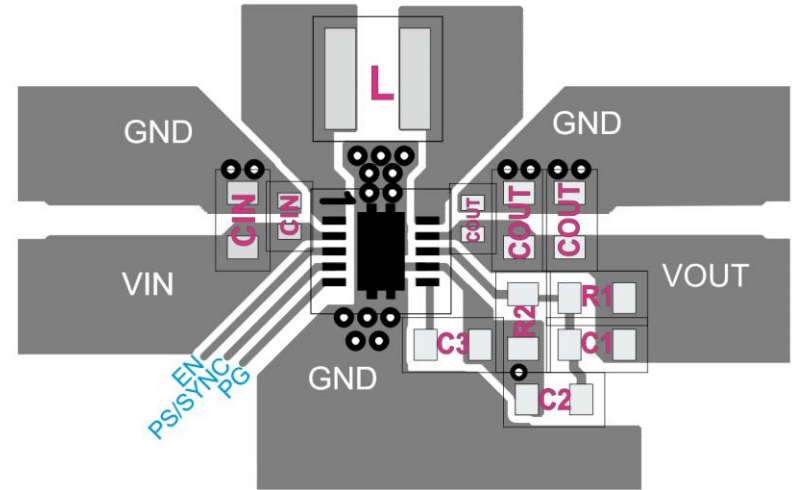


Figure 11-1. TPS6306x Layout

Example

Battery Regulator

7.3 Recommended Operating Conditions

	MIN	MAX	UNIT
Supply voltage at V_{IN}	2.5	12	V
Output current I_{OUT} ⁽¹⁾		1	A
Operating free air temperature range, T_A	-40	85	°C
Operating virtual junction temperature range, T_J	-40	125	°C

(1) $10 \leq V_{IN} \leq 12$ V

7.5 Electrical Characteristics

Over operating free-air temperature range (unless otherwise noted) $T_A = 25^\circ\text{C}$

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
DC/DC STAGE						
V_{IN}	Input voltage range		2.5		12	V
V_{IIN}	Minimum input voltage for startup				2.5	V
V_{OUT}	Output voltage	TPS63060	2.5		8	V
		$V_{PS}/\text{SYNC} = \text{GND}$ referenced to 5 V TPS63061	0.6%		5%	
D_{MIN}	Minimum duty-cycle in step down conversion			10%	20%	
I_{OUT}	Output current at 5V in buck mode	$V_{IN} < 10$ V		2		A
	Output current at 5V in boost mode	$V_{IN} > 4$ V		1.3		A

Example

Battery Regulator

Product Index > Integrated Circuits (ICs) > Power Management (PMIC) > Voltage Regulators - DC DC Switching Regulators > Texas Instruments TPS63060DSR

Dark Mode ☐ Share



Image shown is a representation only. Exact specifications should be obtained from the product data sheet.

TPS63060DSR

DigiKey Part Number 296-30204-2-ND - Tape & Reel (TR)
296-30204-1-ND - Cut Tape (CT)
296-30204-6-ND - Digi-Reel®

Manufacturer [Texas Instruments](#)

Manufacturer Product Number TPS63060DSR

Description IC REG BUCK BOOST ADJ 2A 10WSON

Manufacturer Standard Lead Time 12 Weeks

Customer Reference

Detailed Description Buck-Boost Switching Regulator; IC Positive Adjustable 2.5V 1 Output 2A (Switch) 10-WFDFN Exposed Pad

Datasheet [Datasheet](#)

EDA/CAD Models [TPS63060DSR Models](#)

Product Attributes

TYPE	DESCRIPTION	SELECT ALL
Category	Integrated Circuits (ICs) Power Management (PMIC) Voltage Regulators - DC DC Switching Regulators	☐ ☐ ☒
Mfr	Texas Instruments	☐
Series	-	☐
Packaging	Tape & Reel (TR) Cut Tape (CT) Digi-Reel®	☐ ☐ ☐
Part Status	Active	☐
Function	Step-Up/Step-Down	☐

In-Stock: 17,756

[Check for Additional Incoming Stock](#)

QUANTITY

All prices are in USD

Cut Tape (CT) & Digi-Reel®

QUANTITY	UNIT PRICE	EXT PRICE
1	\$2.94000	\$2.94
10	\$2.20000	\$22.00
25	\$2.01480	\$50.37
100	\$1.81070	\$181.07
250	\$1.71344	\$428.36
500	\$1.65480	\$827.40
1,000	\$1.60654	\$1,606.54

* All Digi-Reel orders will add a \$7.00 reeling fee.

Tape & Reel (TR)

QUANTITY	UNIT PRICE	EXT PRICE
3,000	\$1.54693	\$4,640.79
6,000	\$1.51777	\$9,106.62

Manufacturers' Standard Package

Acceptable given the features...

\$2.94!

Example

FM Radio Receiver Chip

FM Radio Need:

- FM radio receiver chip to do radio demodulation to audio



**BROADCAST ANALOG TUNING DIGITAL DISPLAY
AM/FM/SW RADIO RECEIVER**

Si4844-B20



Features

- Worldwide FM band support (64–109 MHz)
- Worldwide AM band support (504–1750 kHz)
- SW band support (2.3–28.5 MHz)
- Selectable support for all AM/FM regional bands
- Enhance FM/SW band coverage
- 2-wire control interface
- Mono/Stereo and valid station indicator
- Digital volume support
- Bass/Treble support
- Minimal BOM components with no manual alignment
- Excellent real-world performance
- China TV channels audio carrier reception in FM band
- EN55020 compliant
- Two AAA batteries with 2.0 to 3.6 V supply voltage
- Wide range of ferrite loop sticks and air loop antenna support
- 24-pin SSOP package
- RoHS compliant

Applications

- Table and portable radios
- Stereos
- Mini/micro systems
- Boom boxes
- Clock radios
- Modules for consumer electronics
- Entertainment systems
- Toys, lamps, and any application needing an AM/FM/SW radio
- Mini HiFi
- iPhone docking

Example

FM Radio Receiver Chip

Table 5. FM Receiver Characteristics^{1,2}

(V_{DD} = 2.7 to 3.6 V, T_A = -15 to 85 °C)

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
Input Frequency	f_{RF}		64	—	109	MHz
Sensitivity with Headphone Network ³		(S+N)/N = 26 dB	—	2.2	—	μ V EMF
Notes: 1. Additional testing information is available in “AN603: Si4822/26/27/40/44 DEMO Board Test Procedure.” Volume = maximum for all tests. Tested at RF = 98.1 MHz. 2. To ensure proper operation and receiver performance, follow the guidelines in “AN602: Si4822/26/27/40/44 Antenna, Schematic, Layout, and Design Guidelines.” Skyworks will evaluate schematics and layouts for qualified customers. 3. Frequency is 64~109 MHz. 4. Guaranteed by characterization. 5. V_{EMF} = 1 mV. 6. F_{MOD} = 1 kHz, MONO, and L = R unless noted otherwise. 7. Δf = 22.5 kHz. 8. $f_2 - f_1 > 2$ MHz, $f_0 = 2 \times f_1 - f_2$. 9. B_{AF} = 300 Hz to 15 kHz, A-weighted. 10. At L_{OUT} and R_{OUT} pins. 11. Δf = 75 kHz. 12. Tested in Digital Volume Mode.						

Example

FM Radio Receiver Chip

Table 6. AM/SW Receiver Characteristics^{1, 2}

($V_{DD} = 2.7$ to 3.6 V, $T_A = -15$ to 85 °C)

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
Input Frequency	f_{RF}	Medium Wave (AM)	504	—	1750	kHz
		Short Wave (SW)	2.3	—	28.5	MHz
Sensitivity ^{3,4,5}		(S+N)/N = 26 dB	—	30	—	μ V EMF
Large Signal Voltage Handling ⁵		THD < 8%	—	300	—	mV _{RMS}
Power Supply Rejection Ratio ⁵		$\Delta V_{DD} = 100$ mV _{RMS} , 100 Hz	—	40	—	dB
Audio Output Voltage ^{3,6,8}			—	60	—	mV _{RMS}
Audio S/N ^{3,4,6}			—	55	—	dB
Audio THD ^{3,6}			—	0.1	0.5	%
Antenna Inductance ^{5,7}			180	—	450	μ H

Notes:

1. Additional testing information is available in "AN603: Si4822/26/27/40/44 DEMO Board Test Procedure." Volume = maximum for all tests. Tested at RF = 520 kHz and RF = 6 MHz.
2. To ensure proper operation and receiver performance, follow the guidelines in "AN602: Si4822/26/27/40/44 Antenna, Schematic, Layout, and Design Guidelines." Skyworks will evaluate schematics and layouts for qualified customers.
3. FMOD = 1 kHz, 30% modulation, 2 kHz channel filter.
4. $B_{AF} = 300$ Hz to 15 kHz, A-weighted.
5. Guaranteed by characterization.
6. $V_{IN} = 5$ mV_{rms}.
7. Stray capacitance on antenna and board must be < 10 pF to achieve full tuning range at higher inductance levels.
8. Tested in Digital Volume Mode.

Example

FM Radio Receiver Chip

[Product Index](#) > [RF and Wireless](#) > [RF Receivers](#) > Skyworks Solutions Inc. SI4844-B20-GU



Image shown is a representation only. Exact specifications should be obtained from the product data sheet.

SI4844-B20-GU

DigiKey Part Number SI4844-B20-GU-ND

Manufacturer [Skyworks Solutions Inc.](#)

Manufacturer Product Number SI4844-B20-GU

Description RF RX AM/FM 504KHZ-1.75MHZ SSOP

Manufacturer Standard Lead Time 8 Weeks

Customer Reference

Detailed Description - RF Receiver AM, FM 504kHz ~ 1.75MHz, 64MHz ~ 109MHz PCB, Surface Mount 24-SSOP

Datasheet  [Datasheet](#)

In-Stock: 738

[Check for Additional Incoming Stock](#)

Once available stock of this product has been depleted, manufacturer standard package and lead time will apply. [View Alternative Package Types](#)

QUANTITY

[Add to List](#) [Add to Cart](#)

All prices are in USD

Tray

QUANTITY	UNIT PRICE	EXT PRICE
1	\$4.75000	\$4.75
10	\$4.11300	\$41.13
 56	\$3.70643	\$207.56
112	\$3.55893	\$398.60
280	\$3.37675	\$945.49
504	\$3.26720	\$1,646.67

 **Manufacturers Standard Package**

Note: Due to DigiKey value-add services the packaging type may change when product is purchased at quantities beneath the standard package.

We need it....

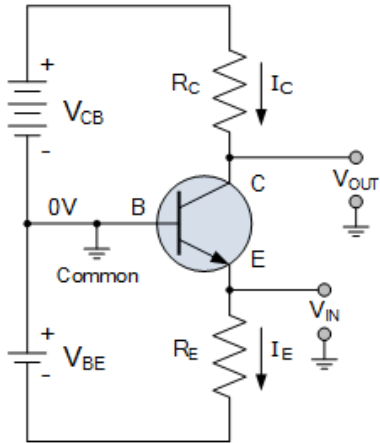
\$4.75! 🤖

Example

Low Noise Amplifier

FM Radio Need:

- A low noise amplifier to improve reception of weak radio signals



Can make a
common-emitter
amplifier, just
need good BJT

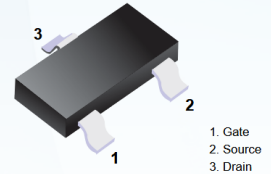
2SC3356

EVVOSEMI®
THINK CHANGE DO

■ NPN Transistors

■ Features

- Low noise and high gain.
NF = 1.1 dB Typ., Ga = 11 dB Typ. @V_{CE} = 10 V, I_C = 7 mA, f = 1.0 GHz
- High power gain.
MAG = 13 dB Typ. @V_{CE} = 10 V, I_C = 20 mA, f = 1.0 GHz



■ Simplified outline(SOT23)

■ Absolute Maximum Ratings Ta = 25°C

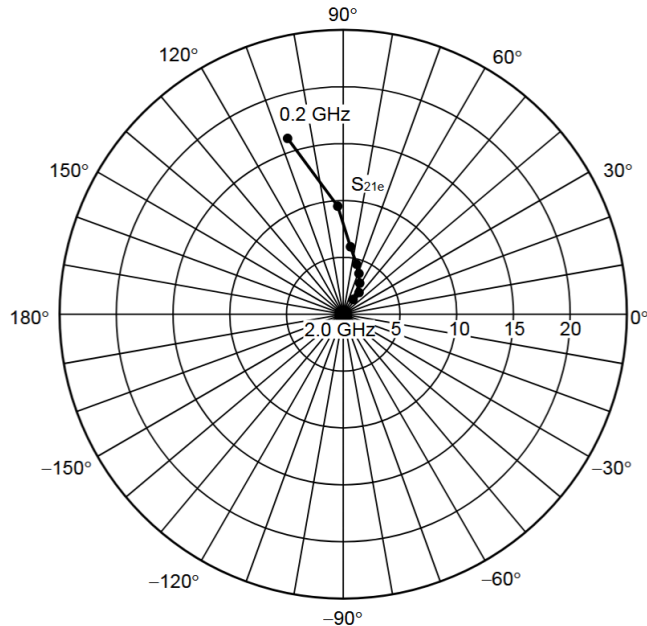
Parameter	Symbol	Rating	Unit
Collector to base voltage	V _{CB0}	20	V
Collector to emitter voltage	V _{CE0}	12	V
Emitter to base voltage	V _{EB0}	3.0	V
Collector current (DC)	I _C	100	mA
Total power dissipation	P _{tot}	200	mW
Junction temperature	T _J	150	°C
Storage temperature range	T _{stg}	-65 to +150	°C

Example

Low Noise Amplifier

S_{21e} -FREQUENCY

CONDITION $V_{CE} = 10\text{ V}$
 $I_C = 20\text{ mA}$



■ Electrical Characteristics $T_a = 25^\circ\text{C}$

Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
Collector- base breakdown voltage	V_{CBO}	$I_C = 100\text{ }\mu\text{A}$, $I_E = 0$	20			V
Collector- emitter breakdown voltage	V_{CEO}	$I_C = 1\text{ mA}$, $I_B = 0$	12			
Emitter - base breakdown voltage	V_{EBO}	$I_E = 100\text{ }\mu\text{A}$, $I_C = 0$	3			
Collector-base cut-off current	I_{CBO}	$V_{CB} = 10\text{ V}$, $I_E = 0$			1	μA
Emitter cut-off current	I_{EBO}	$V_{EB} = 3\text{ V}$, $I_C = 0$			1	
Collector-emitter saturation voltage *	$V_{CE(sat)}$	$I_C = 50\text{ mA}$, $I_B = 5\text{ mA}$			0.4	V
Base - emitter saturation voltage *	$V_{BE(sat)}$	$I_C = 50\text{ mA}$, $I_B = 5\text{ mA}$			1.2	
DC current gain *	h_{FE}	$V_{CE} = 10\text{ V}$, $I_C = 20\text{ mA}$	50		400	
Insertion power gain	$ S_{21e} ^2$	$V_{CE} = 10\text{ V}$, $I_C = 20\text{ mA}$, $f = 1\text{ GHz}$		11.5		dB
Noise figure	NF	$V_{CE} = 10\text{ V}$, $I_C = 7\text{ mA}$, $f = 1\text{ GHz}$		1.1	2	
Reverse transfer capacitance	C_{re}	$V_{CB} = 10\text{ V}$, $I_E = 0$, $f = 1\text{ MHz}$		0.55	1	pF
Transition frequency	f_T	$V_{CE} = 10\text{ V}$, $I_C = 20\text{ mA}$		7		GHz

*. Pulse measurement: $PW \leq 350\text{ }\mu\text{s}$, Duty Cycle $\leq 2\%$.