



# PCB设计及应用

主讲人:





# 任务4.1 直流稳压电源的 单层PCB设计







**2** 能力目标

3 相关知识

4 任务实施

5 解惑启智

6 思考与练习















任务目标



02

04

# 绘制直流稳压电源的PCB图



















2 能力目标

1. 知识能力: 熟悉原理图的设计流程; 熟悉 Altium Designer原理图编辑器界面、工具栏、 工作窗口和工作面板等相关基础知识。 2. 技能能力: 掌握原理图绘制中项目和文件的 建立; 掌握加载和卸载原理图元器件库的方法 ; 掌握元器件的放置、移动、翻转、镜像、选 取、拖动、属性重设、复制、粘贴、剪切对象 的操作方法:掌握导线的绘制技巧和方法。 3. 素质能力: 培养学生分析问题、解决问题的 能力: 培养学生建立工程意识和良好的劳动纪 律观念。树立学生创新意识,培养学生创新能 力。









# 3 相关知识

#### 4.1.1 PCB编辑器界面简介

PCB编辑器界面主要包括菜单栏、工具栏和工作面板3个部分。在PCB设计过程中,各项操作都可以使 用菜单栏中相应的命令来完成,PCB界面的菜单栏如图4-1所示,菜单栏中的各菜单命令功能与原理图 基本相同,这里不再赘述。

<u>File Edit View Project Place Design Tools Route Reports Window Help</u>

图4-1 菜单栏

工具栏(图4-2)中以图标按钮的形式列出了常用菜单命令的快捷方式,用户可根据需要对工具栏中包含的命令进行选择,对摆放位置进行调整。

# 3 相关知识

## 4.1.1 PCB编辑器界面简介

右击菜单栏或工具栏的空白区域即可弹出工具栏的命令菜单,它包含6个命令,带有√标志的命令表示 被选中而出现在工作窗口上方的工具栏中。每一个命令代表一系列工具选项。

- 1) "PCB Standard" (PCB标准)命令:用于控制PCB标准工具栏的打开与关闭。
- 2) "Filter" (过滤) 命令: 用于控制过滤工具栏的打开与关闭,可以快速定位各种对象。
- 4) "Wiring"命令:用于控制连线工具栏 ℤァ≈ァァァ。 □□A □ 的打开与关闭。
- 5) "Navigation" (导航) 命令: 用于控制导航工具栏的打开与关闭。通过这些按钮,可以实现在不同界面之间的快速跳转。

6) "Customize" (用户定义) 命令: 用于用户自定义设置。

通过PCB工作面板可以观察电路板上所有对象的信息,并可对元器件、网络等对象的属性进行编辑。 通过单击PCB编辑器右下角的PCB标签,选择其中的PCB选项即可打开PCB工作面板,进而实现对象 选择、命令选择、对象浏览等功能。



# 4.1.2 利用菜单命令创建PCB文件

用户可以使用菜单命令直接创建一个PCB文件,之后再为该文件设置各种参数。创建一个空白PCB文件可以采用以下几种方式。

- ◆ 1)选择"工程"菜单的"Add New to Project"-"PCB"(PCB文件)
   选项。
- ◆ 2) 选择菜单栏中的"File|New|PCB"命令。
- ◆ 3) 在"Projects" 面板内的工程名称上单击鼠标右键,使用弹出菜 单的"Add New to Project"-"PCB"(PCB文件)选项。

视频演示二维码





# 4.1.3 电路板物理边框的设置

# 1.边框线的设置 2.边框线属性的设置

	Com	ponent	s (and 12 r	nore) 🔽
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	Delay	N/A	Delay	Ops
4 Locatio	n			
	(X/Y)	4780	mil 230	00mil a
4 Propert	ies			
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	Layer	Me	chanical 1	•
	Width	10mi	í.	
	Width Start (X/Y)	10mi 4780	mil 2	:300mil
	Width Start (X/Y) End (X/Y)	10mi 4780 4780	mil 2 mil 5	:300mil :000mil

3.板形的修改

视频演示二维码





#### 4.1.4 电路板图纸的设置

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		Add T Place T	-
Other			
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		-1005	
Polygon Naming Scheme	NET NAME_LXX_PXXX		•
Designator Display	Physical		•
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Width	10000mil		
Height	8000mil		
Get Size From Sheet Layer	0		
othing calacted			
ouning selected			

图4-4 设置PCB图纸







#### 4.1.4 电路板图纸的设置

图4-5

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General	Paramete	rs Healt	h Check	~			
jects for	r snapping	l					*
On/Off	Objects						
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	Track/Arc	s Lines					
	Arc Cente	ers					
	Intersecti						
	Pad Cent	ers					
	Pad Verti	ces					111
	Pad Edge	s					
	Via Cente	ers					
	Regions/R	olygons/l	Fills				
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$\checkmark$	3D Body	Snap Poin	its				v
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Axis Sna	ap Range	1000mi	1				
oard Info	ormation ager						
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Unit	Imperial 🔹		Coarse	Lines -	Lighter Darker
<u>R</u> otation	0.000		Multiplier	5x Grid Step	•
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Step <u>Y</u>	15mil 🔻	Set Step Y in PCB View	Height	300mil	Set Height in PCB View
	Set Step X from Delta Set Step Y from Delta Set Both Steps from 1	і Х I Y Delta		Set Width And Heig	ht in PCB View
Drigin			Quadrants		
Show Origin				2	<u>.</u>
Origin X	Omil	Set Origin in PCB View	Valid	<u>3</u>	L
Origin Y	Omil				

"Grid Manager"选项 图4-6 "Cartesian Grid Editor"对话框PCB设计及应用



### 4.1.5 电路板的分层

#### ◆ 1)"Signal Layers"(信号层)

信号层即铜箔层,用于完成电气连接。Altium Designer允许电路板设计32个信号层,分别为Top Layer、Mid Layer I、Mid Layer 2、...、Mid Layer 30和Bottom Layer,各层以不同的颜色显示。

#### ◆ 2) "Internal Planes Layer" (中间层,也称内部电源层与地线层)

中间层也属于铜箔层,用于建立电源和地线网络。系统允许电路板设计16个中间层,分别为Internal Planes 1、Internal Planes 2、...、Internal Planes 16,各层以不同的颜色显示。

#### ◆ 3) "Mechanical Layers" (机械层)

用于描述电路板机械结构、标注及加工等生产和组装信息所使用的层面,不能完成电气连接特性,但 其名称可以由用户自定义。系统允许PCB板设计包含16个机械层,分别为Mechanical Layer I、 Mechanical Layer 2、...、Mechanical Layer 16,各层以不同的颜色显示。





### 4.1.5 电路板的分层

#### ◆ 4)"Mask Layers"(阻焊层)

用于保护铜线,也可以防止焊接错误。系统允许PCB设计包含4个阻焊层,即"Top Paste"(顶层锡膏防护层)、"Bottom Paste"(底层锡膏防护层)、"Top Solder"(顶层阻焊层)和"Bottom Solder"(底层阻焊层),分别以不同的颜色显示。

#### ◆ 5) "Silkscreen Layers" (丝印层)

丝印层也称为图例(legend),通常该层用于放置元器件标号、文字与符号,以标示出各零件在电路 板上的位置。系统提供有两层丝印层,即"Top Overlay"和"Bottom Overlay"(底层丝印层)。

#### ◆ 6) "Other Layers" (其他层)

"Drill Guides"(钻孔)和"Drill Drawing"(钻孔图)用于描述钻孔图和钻孔位置;"Keep-Out Layer"用于定义布线区域,基本规则是元器件不能放置于该层上或进行布线。只有在这里设置了闭合的布线范围,才能启动元器件自动布局和自动布线功能;"Multi-Layer"用于放置穿越多层的PCB元器件,也用于显示穿越多层的机械加工指示信息。

# 3 相关知识

## 4.1.6 参数设置

选择菜单栏中的"Tools|Preferen ces..."命令,系统将弹出如图4-7 所示的"Preferences"对话框。 在该对话框中PCB Editor可以设 置的有General、Display、PCB L egacy 3D (PCB的3D图)和Defa ults (默认)等15个选项卡。

Q <ul> <li>System</li> <li>Data Management</li> <li>Schematic</li> <li>PCB Editor - General</li> <li>Filting Options</li> <li>State major Room Page</li> <li>Speed</li> <li>Tool Options</li> <li>Speed</li> <li>Speed</li> <li>Tool Options</li> <li>Speed</li> <li>Tool Options</li> <li>Speed</li> <li>Speed</li> <li>Speed</li> <li>Speed</li> <li>Tool Options</li> <li>Speed Tool Options</li> <li>Speed Tool Options</li> <li>Speed Tool Options</li> <li>Option Obtail Edit</li> <li>Delable Roll</li> <li>Portect Locked Obtail State</li> <li>Speed Tool Options</li> <li>Speed Tooother applications</li></ul>			Preferences			×
<ul> <li>Data Management</li> <li>Schematic</li> <li>PCB Editor</li> <li>Connie DRC</li> <li>Objetsy</li> <li>Board Insight Diplay</li> <li>Board Insight Modes</li> <li>Protect Locked Objects</li> <li>Protect Locked Objects</li> <li>Protect Locked Objects</li> <li>Protect Locked Primitives In Component</li> <li>Confirm Global Edit</li> <li>Disable Opening the report from older versions</li> <li>Strift Clark To Select</li> <li>Primitives</li> <li>Stripting System</li> <li>Cutation Step 90.000</li> <li>Free From Charge Report</li> <li>Subable Opening the report from older versions</li> <li>Disable Opening the report from Netry Locked</li> <li>Attum Vault</li> <li>3D Sene Rotation 30.000</li> <li>Layers Sorting By Name</li> <li>Attum Vault</li> <li< td=""><td>Q • System</td><td>PCB Editor -</td><td>- General</td><td></td><td></td><td></td></li<></ul>	Q • System	PCB Editor -	- General			
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<ul> <li>Multi-board Assembly</li> <li>Rotation Step</li> <li>90.000</li> <li>Preferred Format</li> <li>Metafile</li> <li>Cursor Type</li> <li>Small 90</li> <li>Collaboration</li> <li>Shared file</li> <li>Comp Drag</li> <li>none</li> <li>Shared file</li> <li>Shared file</li> <li>Attium Vault</li> <li>3D Scene Panning</li> <li>S00mil</li> <li>Ask when moving rooms containing No Net/Locked</li> <li>Objects</li> <li>Save</li> <li>Load</li> <li>Import From</li> <li>OK</li> <li>Cancel</li> <li>Apply</li> </ul>	<ul> <li>Multi-board Schematic</li> </ul>	Other		Paste from other a	pplications	
Cursor Type       Small 90         Cursor Color       • Shared file         Comp Drag       • Shared file         3D Scene Panning       500mil         3D Scene Rotation       • Altium Vault         3D Scene Rotation       30.000         Layers Sorting       By Name         Move Rooms Options       • Ask when moving rooms containing No Net/Locked         Objects       • Mover Trom •	Multi-board Assembly	Rotation Step	90.000	Preferred Format	Metafile	
Cursor Color Cursor Color Comp Drag Domi Domi Domi Domi Domi Domi Domi Domi		Cursor Type	Small 90 👻			- 11
Comp Drag       none         3D Scene Panning       500mil         3D Scene Rotation       30.000         Layers Sorting       By Name         Move Rooms Options         Layers Sorting       By Name         Move Rooms Options         Comport From       OK         Cancel       Apply		Cursor Color		Collaboration		- 11
Set To Defaults V Save V Load V Import From V OK Cancel Apply		Come Dava		<ul> <li>Snared file</li> </ul>		
3D Scene Panning     500mil     Altium Vault       3D Scene Rotation     30.000     Move Rooms Options       Layers Sorting     By Name     Ask when moving rooms containing No Net/Locked       Objects     Objects		Comp Drag	Tione		67	
3D Scene Rotation     30.000     Move Rooms Options       Layers Sorting     By Name     Ask when moving rooms containing No Net/Locked       Objects     Objects		3D Scene Panning	500mil	Altium Vault		
Layers Sorting By Name  Ask when moving rooms containing No Net/Locked Objects  Set To Defaults  Save  Locad  More from  OK Cancel Apply		3D Scene Rotation	30.000	Move Rooms Optio	ons	
Set To Defaults V Save V Load V Import From V OK Cancel Apply		Layers Sorting	By Name 👻	Ask when movi	ng rooms containing No Net/Locked	
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	Set To Defaults 👻 Save 💌 I	Load Import Fro	m 💌		OK Cancel A	pply

#### 图4-7 Preferences对话框



# 4.1.7 在PCB文件中导入原理图网络表信息

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✓ Add	i D1	То	🔜 直流稳压电源.PcbDoc		
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✓ Add	d 🚺 D5	То	🔜 直流稳压电源.PcbDoc		
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✓ Add	1 🖡 P3	То	III 直流稳压电源.PcbDoc		
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Add	1 🔢 R2	То	🔜 直流稳压电源.PcbDoc		
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✓ Add	t 🗍 U1	То	III 直流稳压电源.PcbDoc		





图4-8 "Engineering Change Order"对话框

# 3 相关知识

# 4.1.8 元器件的手动布局

# 元器件的对齐操作



视频演示二维码



PCB设计及应用

# 图4-9 Align Objects对话框



### 4.1.8 元器件的手动布局

### 元器件说明文字的调整

选择菜单栏中的"Edit|Align|Position Component Text。(编辑|对齐|设置元器件文字位置)"命令,系统将弹出"Component Text Position"(元器件文字位置)对话框。在该对话框中,用户可以对元器件说明文字(标号和说明内容)的位置进行设置。

#### 元器件间距的调整

元器件间距的调整主要包括水平和垂直两个方向上间距的调整,包括"Distribute Horizontally"(水平分布)、"Increase Horizontal Spacing"(增大水平间距)、"Decrease Horizontal Spacing"(减小水平间距)等命令,可实现元器件间距的灵活调整。

#### 移动元器件到格点处

手动布局过程中移动的元器件往往并不是正好处在格点处,使用"Move All Components Origin To Grid"(移动所有元器件的原点与栅格对齐)命令,选择该命令时,元器件的原点将被移到与其最靠近的格点处。

# 3 相关知识

### 4.1.9 电路板的手动布线

注意: 手动布线模式主要有任意角 度、90°拐角、90°弧形拐角、 45°拐角和45°弧形拐角5种。在 布线过程中,按Shift+空格键即可 在5种模式间切换,按空格键可以 在每一种的开始和结束两种模式间 切换。多次单击确定多个不同的控 点,完成两个焊盘之间的布线。



# 图4-10 "Un-Route" 子菜单中的命令

# 视频演示二维码





#### 4.1.10 补泪滴





视频演示二维码











# 4 任务实施

# 1.打开工程及新建图纸

在进行本电路的设计前,首先需要打开任务4.1并建立PCB设计文件。

1) 启动Altium Designer 17。

2)在Altium Designer主界面的菜单栏中,选择"file|Open"命令打开位于"D:\第四部分\任务4.1 直流稳压电源电路PCB设计中的直流稳压电源电路设计工程文件。

3) 打开直流稳压电源电路设计的工程文件后,选择"file|New|PCB"命令,新建一个PCB设计 文件,并执行"file|save As",将新建的工程文件保存于任务4文件夹下的子任务4.1中,并命名为" 直流稳压电源"。在"Project"面板中,项目文件名变为"直流稳压电源.PcbDoc"。

#### 2.设置PCB参数和环境参数

1)单击菜单栏中的"Design(设计)|Board Options...(电路板选项)"命令,在弹出如图4-5所示的Board Options(电路板选项)对话框上设置Measurement Unit(度量单位)选项组的Metric(公制)改为Imperial(英制);

2) 在Cartesian Grid Editor对话框中将Step X和Step X均设为20Mil, Multiplier设置为5x Grid Step。



## 3.添加新图纸模板





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100	1000		a generation of the second			
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#### 图4-12 将模板文件导入工作窗口

#### 图4-13 将模板文件复制到工作窗口

#### 图4-14 视图配置对话框(局部)



# 4.板层设定

	[1] 直流稳压电源.Sch	Doc 💷 直流稳加	玉电》	源.PcbDoc * 📰 直	流稳压电源.PcbDoc	[Stackup] 🏠 Home	e Page	
	+ Add	🖌 Modify 🔵	ŵ	Delete				
#	Name	Material		Type	Weight	Thickness	Dk	Df
	Top Overlay							
	Top Solder	Solder Resist	-	Solder Mask		0.4mil	3.5	
1	Top Layer		-	Signal	loz	1.4mil		
	Dielectric 1	FR-4		Dielectric		12.6mil	4.8	
2	Bottom Layer			Signal	loz	1.4mil		
	Bottom Solder	Solder Resist	-	Solder Mask		0.4mil	3.5	
	Bottom Overlay			Overlay				

图4-15 "直流稳压电源.PcbDoc[Stackup]" 文件

### 5.手动规划电路板的物理边界

任务实施

- 在"直流稳压电源电路.PcbDoc"的PCB文件界面,单击工作窗口下方的"Mechanical 1"标签,使该 层面处于当前工作窗口中。
- 选择菜单栏中的"Place|Line"命令,此时鼠标指针变成"十"字形状,将鼠标指针移到工作窗口的合适位置,单击即可进行线的放置操作,每单击一次就确定一个固定点。通常将板的形状定义为矩形,但在特殊的情况下,为了满足电路的某种特殊要求,也可以将板形定义为圆形、椭圆形或者不规则的多边形。这些都可以通过"Place"菜单来完成。这里绘制不大于6500mil×3000mil的矩形框。
- 当放置的线组成了一个封闭的边框时,就可结束边框的绘制。右击或者按Esc键退出该操作,双 击任一边框线即可弹出该边框线的设置对话框设置边框线的属性。



# 6.导入网络报表

选择菜单栏中的"Design|Update PCB Document 直流稳压电源电路 .PcbDoc"命令,系统将对原理图 和PCB图网络报表进行比较并弹出 一个"Engineering Change Order"对话框,如图4-16所示。

任务实施

difications				Status	
Ena 🗸 Action	Affected Object	8	Affected Document	Ch Done Message	
Add Components	(24)				
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Add	II G	То	III 直流稳压电源.PcbDoc		
Add	🚺 C4	То	IIII 直流稳压电源.PcbDoc		
✓ Add	📑 C5	То	🔜 直流稳压电源.PcbDoc		
Add	🕕 C6	То	IIII 直流稳压电源.PcbDoc		
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Add	D1	То	🔜 直流稳压电源.PcbDoc		
Add	1 D2	То	🔜 直流稳压电源.PcbDoc		
Add	D3	То	🔜 直流稳压电源.PcbDoc		
Add	10 D4	То	🔜 直流稳压电源.PcbDoc		
Add	1 D5	То	🔜 直流稳压电源.PcbDoc		
Add	<b>□</b> D6	То	🔜 直流稳压电源.PcbDoc		
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Add	1 F2	То	🔜 直流稳压电源.PcbDoc		
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	-102	-			

图4-16 "Engineering Change Order"对话框





### 6.导入网络报表



#### 图4-17 导入所有元器件的PCB图





# 7.手动布局元器件



#### 图4-18 手动调整后的PCB板布局





# 8.手动布线



图4-20 导线绘制完成的PCB图





#### 9.补泪滴

选择菜单栏中的"Tools|Teardrops"命令,进行补泪滴操作。

#### 10.保存

选择菜单栏中的"File|Save All"命令,保存PCB文件和项目文件。



1) PCB文件中的格点设置比原理图文件中的格点设置选项要多,因为PCB文件中格点的设置要求更精确。原理图中的可视栅格总是正方形的,而在PCB文件中,格点的X值与Y值可以不同。在PCB编辑器中,将图纸格点和元器件格点设置成不同的值,有利于PCB中元器件的放置操作。通常将PCB格点设置成元器件封装的引脚长度或引脚长度的一半。例如,在放置一个引脚长度为100mi1的元器件时,可以将元器件格点设置为50mi1或100mi1,在该元器件引脚间布线时可以将"Snap Grids"(捕获栅格)设置为25mi1。格点设置合适不仅可以精确地放置元器件,还可以提高布通率。

2)采用按住Ctrl键+单击的方式完成的自动连线,连线的起点和终止的元器件引脚必须在同一层上,并且两个连线上没有其他元器件。

3)本任务手动布线规则设置采用的是默认值,其规则的设置与自动布线基本相同,后续任务将详细介绍。

































- 1. 本任务设计前的准备工作具体有哪些?
- 2. 简述Altium Designer设计PCB图的流程。需要注意什么问题?
- 3. PCB图设计中元器件的封装如何选择?
- 4. PCB图的系统环境和图纸参数如何设定? 在本任务中主要提供了哪些参数的设置?
- 5. 单面PCB图有哪些特点? 如何设置?
- 6. PCB图中元器件布局有哪些注意事项? 应遵守哪些标准或规则?
- 7. PCB图中手动布线有哪些注意事项? 应遵守哪些标准或规则?
- 8. PCB图中的泪滴有何作用?如何设置?
- 9. 本任务实施过程中如何提升效率? 提出你的建议。
- 10. 对整个任务的完成进行记录。
- 11. 按照本任务的学习内容,请绘制图4-21和图4-22所示电路原理图相对应的PCB图。





图4-21 计算机传声器的电路原理图





#### 图4-22 RS232接口电路原理图



# THANK YOU