

AN12969

铜排设计应用笔记

第2版 — 2023年5月15日

应用笔记

文档信息

信息	内容
关键词	MC33771x、铜排
摘要	本应用笔记介绍了如何将铜排连接到恩智浦电芯控制器。



修订历史

版本号	日期	说明
第2版	2023年5月15日	将安全状态更改为公开
第1版	2021年1月8日	初始版本

1 介绍

1.1 母线的定义

在电动出行工具的电池组中，铜排是用来连接电池电芯或模块的。在汽车电池组中，铜排是用来连接电池模块的。铜排由铜制成。在原理图中，铜排用很小的电阻来表示。铜排的阻抗通常非常低。

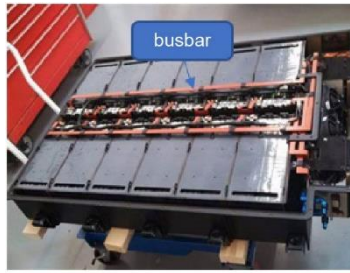


图1. 母线示例

2 铜排位置的确定

2.1 传统设计要求

如果一个电池组的电芯数量少于最大电芯数量，电芯端子引脚CT_x和电芯平衡引脚CB_x的使用必须满足一些约束条件。[表1](#)列出了堆叠电芯（7到14个电芯）的排列方式。

表1. MC33771B/C电池组的电芯数少于最大电芯数时的排列方式

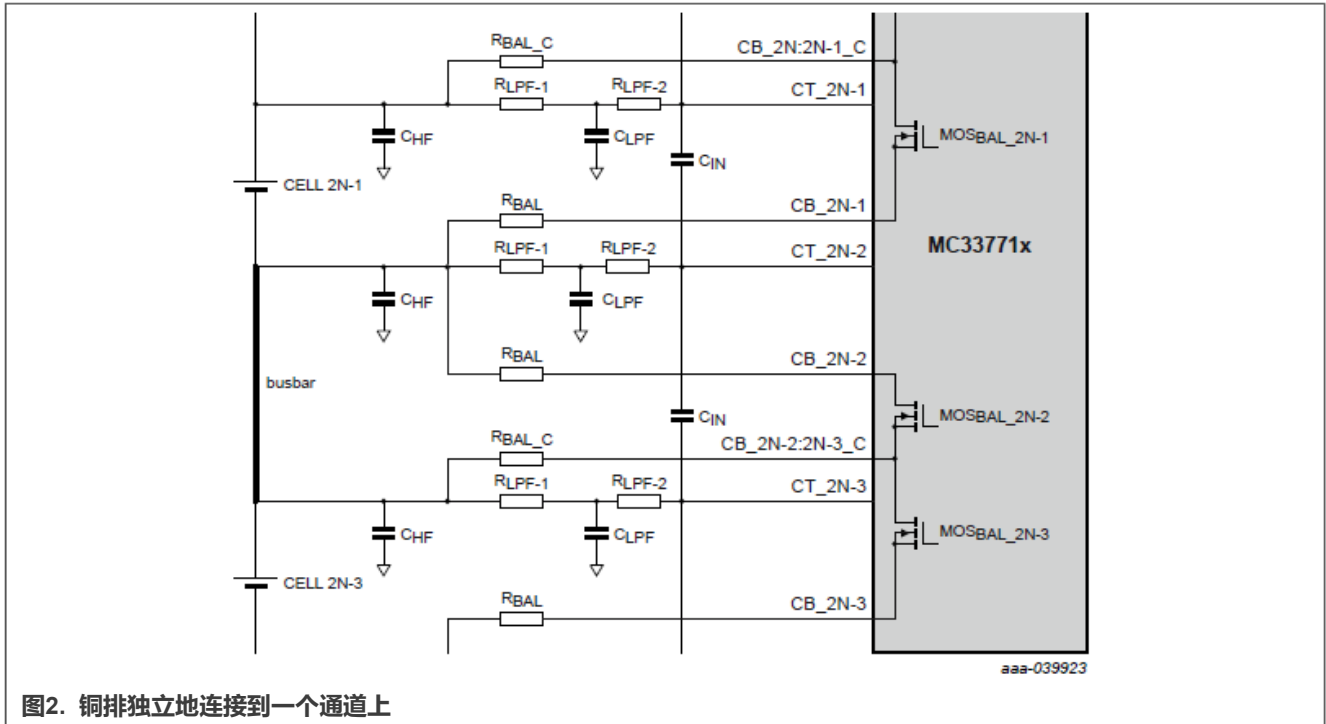
电芯	堆叠电芯							
	14	13	12	11	10	9	8	7
1	CT_REF/CT_1	CT_REF/CT_1	CT_REF/CT_1	CT_REF/CT_1	CT_REF/CT_1	CT_REF/CT_1	CT_REF/CT_1	CT_REF/CT_1
2	CT_1/CT_2	CT_1/CT_2	CT_1/CT_2	CT_1/CT_2	CT_1/CT_2	CT_1/CT_2	CT_1/CT_2	CT_1/CT_2
3	CT_2/CT_3	CT_2/CT_3	CT_2/CT_3	CT_2/CT_3	CT_2/CT_3	CT_2/CT_3	CT_2/CT_3	CT_2/CT_3
4	CT_3/CT_4	CT_3/CT_4	CT_3/CT_4	CT_3/CT_4	CT_3/CT_4	CT_3/CT_4	CT_3/CT_4	CT_3/CT_4
5	CT_4/CT_5	CT_5/CT_6	CT_6/CT_7	CT_7/CT_8	CT_8/CT_9	CT_9/CT_10	CT_10/CT_11	CT_11/CT_12
6	CT_5/CT_6	CT_6/CT_7	CT_7/CT_8	CT_8/CT_9	CT_9/CT_10	CT_10/CT_11	CT_11/CT_12	CT_12/CT_13
7	CT_6/CT_7	CT_7/CT_8	CT_8/CT_9	CT_9/CT_10	CT_10/CT_11	CT_11/CT_12	CT_12/CT_13	CT_13/CT_14
8	CT_7/CT_8	CT_8/CT_9	CT_9/CT_10	CT_10/CT_11	CT_11/CT_12	CT_12/CT_13	CT_13/CT_14	
9	CT_8/CT_9	CT_9/CT_10	CT_10/CT_11	CT_11/CT_12	CT_12/CT_13	CT_13/CT_14		
10	CT_9/CT_10	CT_10/CT_11	CT_11/CT_12	CT_12/CT_13	CT_13/CT_14			
11	CT_10/CT_11	CT_11/CT_12	CT_12/CT_13	CT_13/CT_14				
12	CT_11/CT_12	CT_12/CT_13	CT_13/CT_14					
13	CT_12/CT_13	CT_13/CT_14						
14	CT_13/CT_14							

总之，当系统需要的电芯较少时，通道5至通道11可能较短。因此，铜排可将这些通道组装起来。

2.2 铜排排列方式

添加铜排有两种可能的方式。

- 铜排独立地组装在一个通道上。



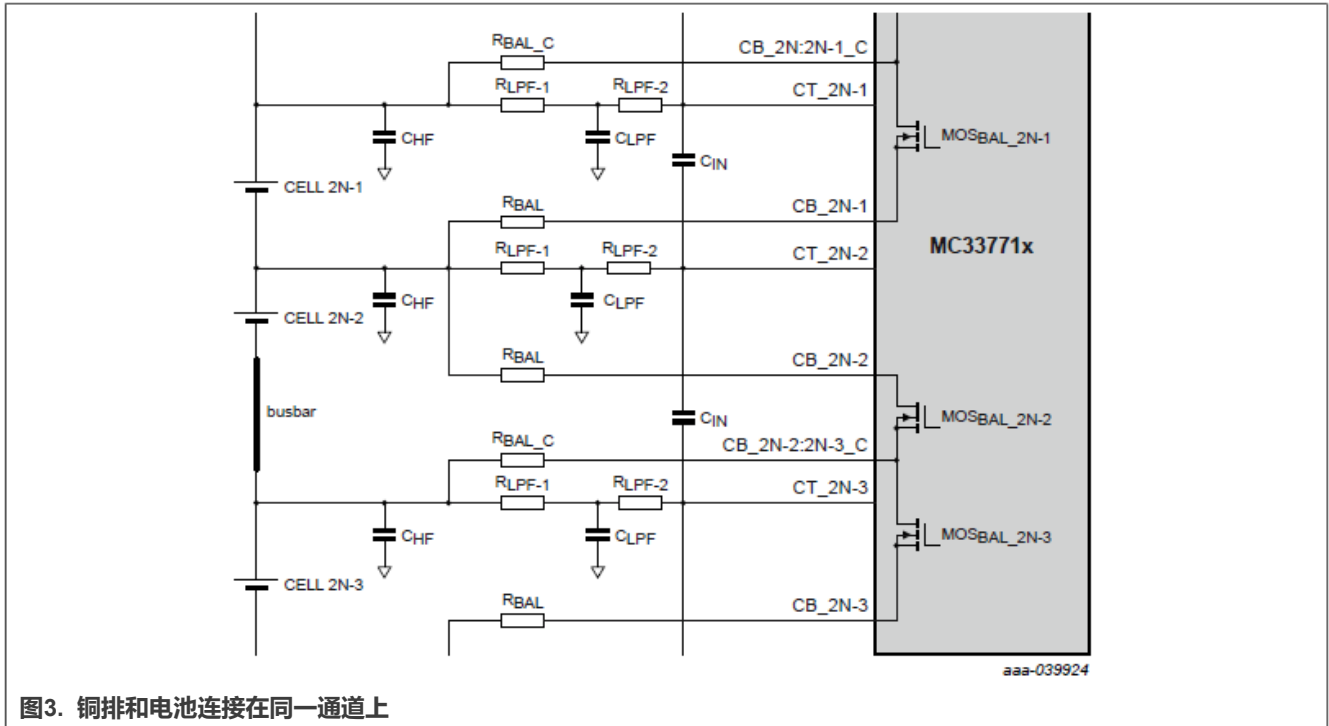
优点：铜排只连接到一个通道上，不会影响相邻电芯的精度。

缺点：铜排占用一个通道。

注意：电池放电时可能会产生负电压。每个通道的负电压限制为-0.3V。如果超过这个电压，相邻通道的测量精度将受到影响。最坏的情况是可能损坏设备。用户必须控制铜排电阻，确保电流条件最差时，压降不高于0.3V。如果无法实现，则不能使用这个选项。

注意：如图2所示，如果母线占用一个通道，则必须禁用CT_x OV/UV功能验证 (SM01)，否则会触发误报。

- 铜排和电芯组装在同一通道上。



优点：铜排不占用任何通道。

缺点：大电流通过铜排时，铜排上的压降影响通道的精度。

2.3 特殊设计要求

根据系统要求，一些用户可能会在通道5至通道11之外的通道上添加铜排。对于这种应用，应该详细列出添加铜排的条件。铜排位置最重要的限制是每个CT_x引脚的电压要求。如果电压不能满足要求，CT_x的精度可能受到影响。[表2](#)列出了电压要求。

表2. 每个MC33771x引脚的电压要求

MC33771x引脚	到AGND的最小电压(V)	到VPWR的最小绝对电压(V)
CT_REF	-	-
CT_1	-	-
CT_2	1.9	-
CT_3	1.9	-
CT_4	4.8	-
CT_5	-	-
CT_6	-	-
CT_7	-	-
CT_8	-	-
CT_9	-	-

表2. 每个MC33771x引脚的电压要求 (续)

MC33771x引脚	到AGND的最小电压(V)	到VPWR的最小绝对电压(V)
CT_10	-	-
CT_11	-	6
CT_12	-	4
CT_13	-	-
CT_14	-	-

用户应根据应用电芯的电压配置铜排，确保在任何情况下都符合表2中的条件。典型的电池工作电压范围如表3所示。

表3. 电池电压范围

技术	缩略语	额定电压(V)	满电电压(V)	放电结束电压(V)
LiNiMnCoO ₂	NMC	3.6 至 3.7	4.2	2.5 至 3.0
LiNiCoAlO ₂	NCA	3.6	4.2	2.7
LiFePO ₄	LFP	3.2	3.6	2.0
LiCoO ₂	LCO	3.7	4.2	2.4
Li ₂ TiO ₃	LTO	2.4	3 至 3.9	1.5
LiMn ₂ O ₄	LMO	3.0	3.5	2.0

3 电池组装配过程中的铜排安装

为了避免在安装过程中损坏电芯控制器 (BCC)，必须首先连接电池的所有铜排，然后再插入MC33771x。

表4. 母线配置示例

MC33771x	3 × 3个电芯	3 × 4个电芯	2 × 6个电芯	13个电芯
CT_14引脚和CT_13引脚之间的位置	3个模块X3个电芯	3个模块X4个电芯	2个模块X6个电芯	1个模块X13个电芯
CT_13引脚和CT_12引脚之间的位置	3个模块X2个电芯	3个模块X3个电芯	2个模块X5个电芯	1个模块X12个电芯
CT_12引脚和CT_11引脚之间的位置	3个模块X1个电芯	3个模块X2个电芯	2个模块X4个电芯	1个模块X11个电芯
CT_11引脚和CT_10引脚之间的位置	母线	3个模块X1个电芯	2个模块X3个电芯	1个模块X10个电芯
CT_10引脚和CT_9引脚之间的位置	2个模块X3个电芯	母线	2个模块X2个电芯	1个模块X9个电芯
CT_9引脚和CT_8引脚之间的位置	2个模块X2个电芯	2个模块X4个电芯	2个模块X1个电芯	1个模块X8个电芯
CT_8引脚和CT_7引脚之间的位置	2个模块X1个电芯	2个模块X3个电芯	母线	1个模块X7个电芯
CT_7引脚和CT_6引脚之间的位置	0 Ω	2个模块X2个电芯	1个模块X6个电芯	1个模块X6个电芯
CT_6引脚和CT_5引脚之间的位置	0 Ω	2个模块X1个电芯	1个模块X5个电芯	1个模块X5个电芯
CT_5引脚和CT_4引脚之间的位置	0 Ω	母线	0 Ω	0 Ω
CT_4引脚和CT_3引脚之间的位置	母线	1个模块X4个电芯	1个模块X4个电芯	1个模块X4个电芯
CT_3引脚和CT_2引脚之间的位置	1个模块X3个电芯	1个模块X3个电芯	1个模块X3个电芯	1个模块X3个电芯
CT_2引脚和CT_1引脚之间的位置	1个模块X2个电芯	1个模块X2个电芯	1个模块X2个电芯	1个模块X2个电芯
CT_1引脚和CT_REF引脚之间的位置	1个模块X1个电芯	1个模块X1个电芯	1个模块X1个电芯	1个模块X1个电芯

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