

# DCC Dual Power Breaker – Design Fault Fixed

## Introduction

During the recent spell of very hot weather in some places, a design fault revealed itself in the Dual Power Breaker (DPB), as published in the [June](#) and [July](#) 2025 issues of MRH Magazine. When an overload was detected in either DPB district, both districts shut down and then either proceeded to rapidly reconnect and disconnect continuously, or refused to reset at all.

Although I initially suspected a fault in the Arduino code, I discovered (almost by accident) that simply connecting the Arduino USB port to the computer fixed the problem. Suspicion then turned to the Arduino's onboard voltage regulator which I use to power some additional DPB circuitry. However, a more thorough investigation revealed that the Arduino voltage regulator was blameless, and the real fault lies in my design of the 9V voltage regulator used to power both the Arduino module and the current-measuring sections of the DPB.

The DPB's 9V voltage regulator (VR1) is powered from the track DCC supply via bridge rectifier BR1 (see my A-Train Systems website at <https://www.a-train-systems.co.uk/dpb-download> for technical details). When a track short circuit occurs, the DCC supply drops to zero, leaving the DPB circuitry dependent for its operation on the residual charge stored in the voltage regulator reservoir capacitor C2. When there is a high ambient temperature not only does the voltage regulator output tend to drop, but this charge leaks away faster, leaving the DPB circuitry without adequate power and so triggering the faulty operation observed.

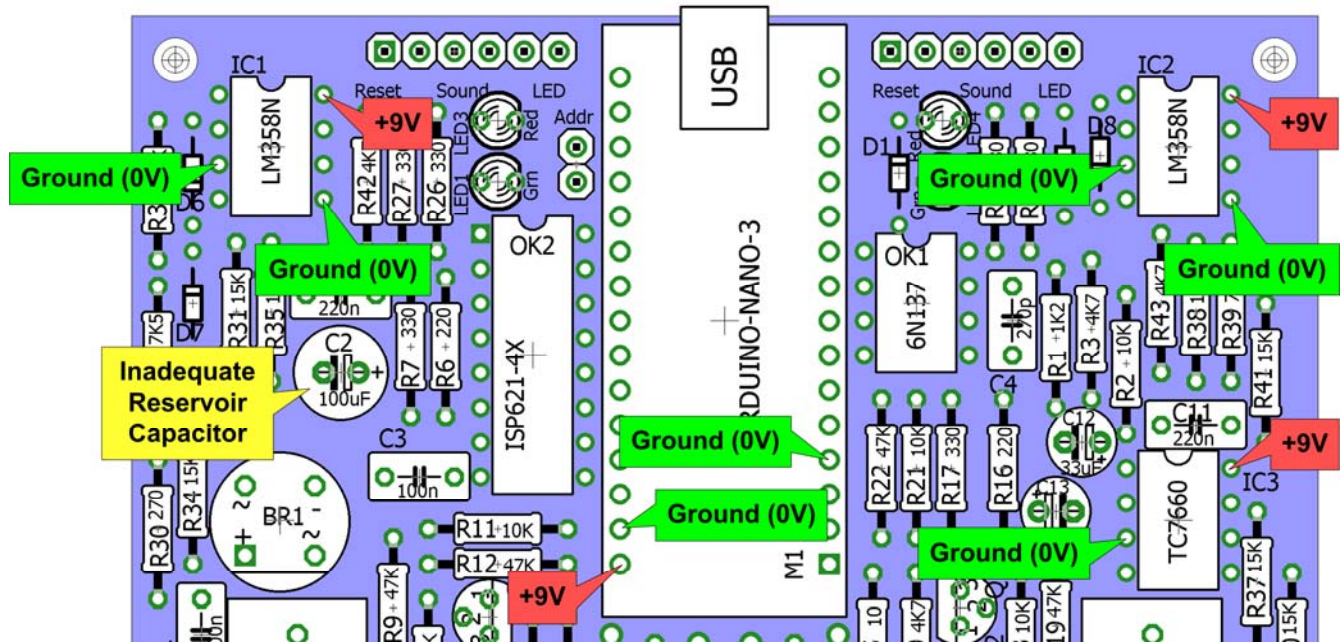
My design error was setting the value of capacitor C2 at only 100uF. This is insufficient to hold up the DPB onboard supply for the default overload delay time of 25msec at higher temperatures – and the DPB fails. During testing, I now realise that I had a connection to the Arduino USB port for almost all of the time, so that I could monitor the behaviour of the DPB – but without appreciating that this was completely masking the design flaw.

## The Fix

The simplest fix is to power the Arduino module from an external 5V supply, either by connecting it to a USB port on your computer or to an independent 5V USB charger.

This is probably inconvenient for most users so, fortunately, there is an alternative straightforward fix which involves adding an additional capacitor to the DPB board. This extra component supplements the inadequate 100uF reservoir capacitor, holding up the DPB internal power supply until the shorted power district is disconnected and the DCC track voltage returns to normal. The principle is exactly the same as when you add a keep-alive unit to one of your DCC decoders.

To meet most operational needs, my recommendation is to fit a 1000uf 25V capacitor to the DPB, leaving the existing 100uF capacitor (C2) in place. Note that I have chosen a voltage rating of 25V to reduce the physical size (rather than my normal selection of 35V). For long term reliability do not use a capacitor with a lower voltage rating. The extra capacitor is connected between the +9V output from voltage regulator and ground (0V), and suitable connection points on the PCB are labelled in diagram [1].

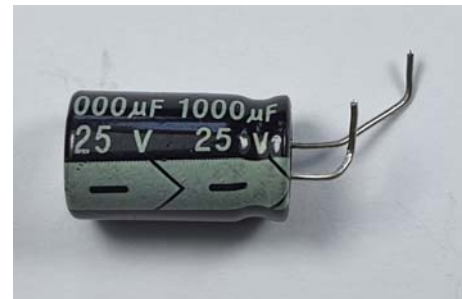


*All photographs and diagrams by the author*

## 1. Additional capacitor connection points

The easiest place to fit the capacitor, given its relatively large size (10mm diameter x 17mm), is beside C2, between BR1 and IC1, with the positive lead going to IC1 pin 8 (+9V) and the negative lead (indicated by a stripe on the side of the capacitor) going to IC1 pin 3 (Ground).

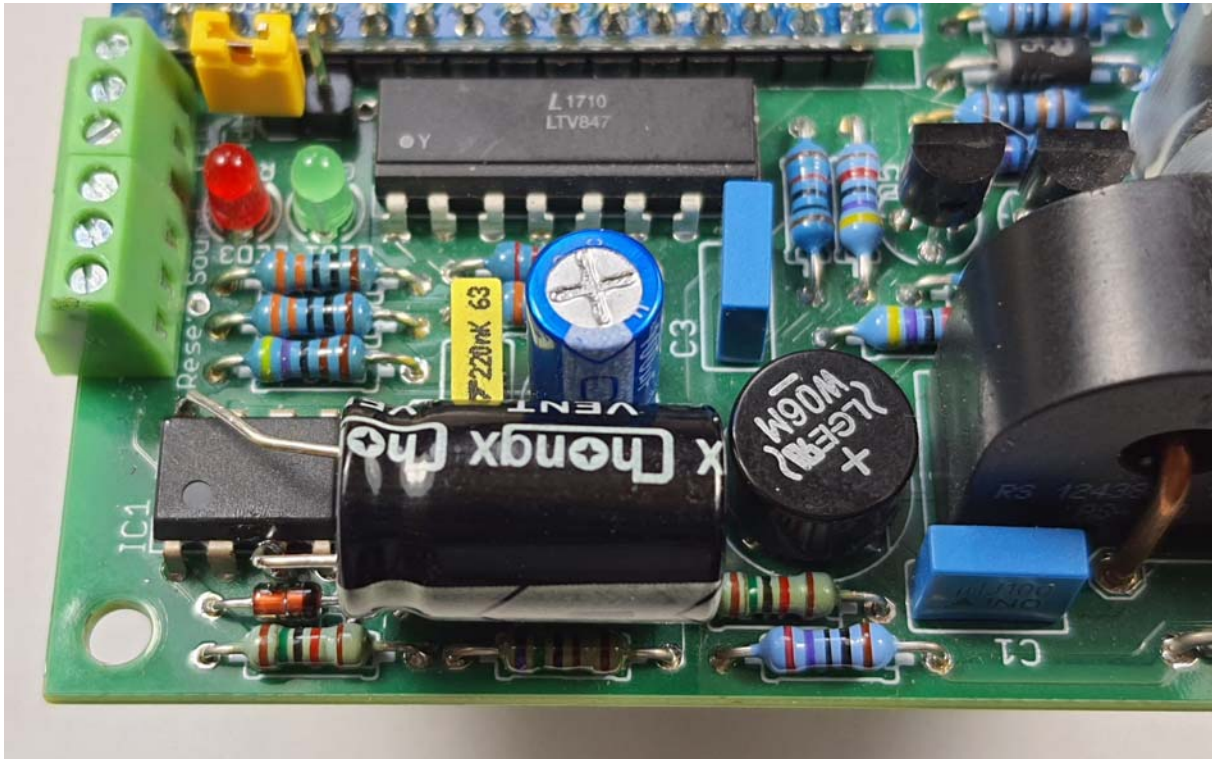
Bend and trim the capacitor leads as shown in [2] below so that they match the positions of IC1 pins 3 and 8 when the capacitor is held in place.



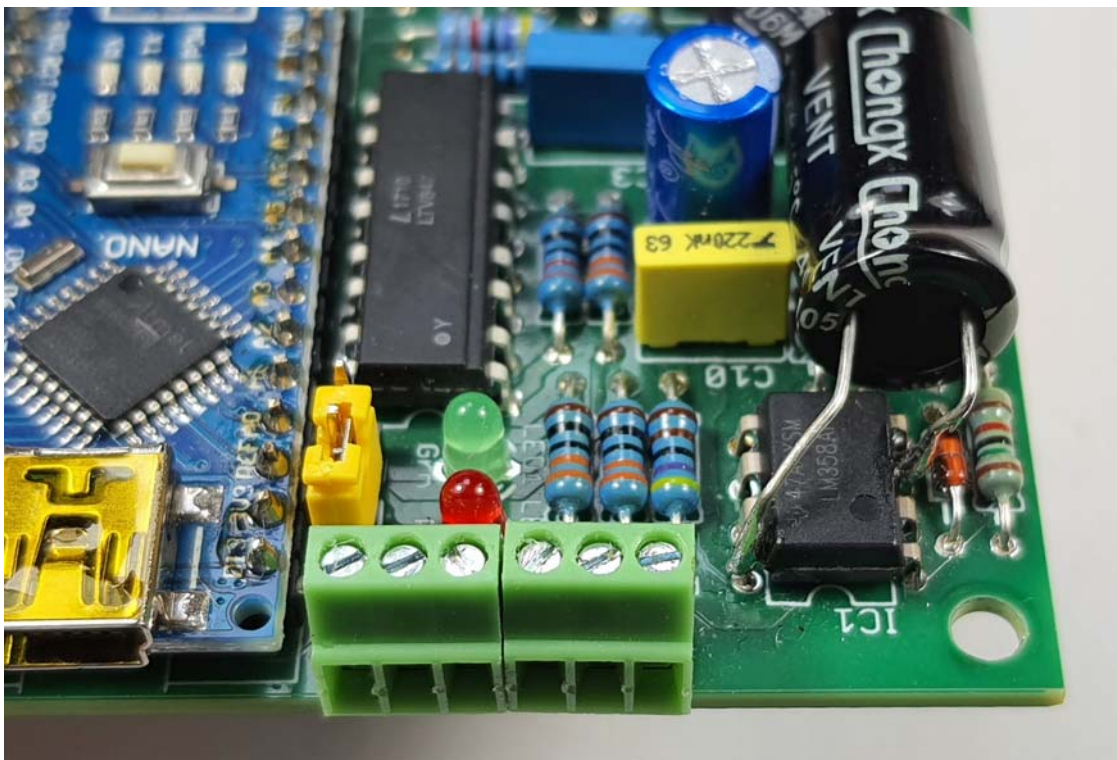
## 2. Preparing the capacitor leads

With a fine-tipped soldering iron, and thin, resin-cored solder wire, carefully tin pins 3 and 8 of IC1 and the ends of the capacitor leads ie. coat them with a small amount of solder. Get a small amount of solder on the tip of the iron, offer the capacitor leads up to the IC1 pins one at a time, then touch the iron to both pin and lead together to complete a sound solder joint. This method avoids having to attempt to manoeuvre component, solder wire and iron into the correct position simultaneously.

The result should be as shown in [3] and [4] –



3. Capacitor fitted – side view



4. Capacitor fitted – end view

### Revised operation

With the larger capacitor fitted, the DPB will now operate correctly with overload delay periods of up to 90msec, which should be adequate for the majority of layout situations, but bear in mind that the nominal value of electrolytic capacitors is generally subject to a  $\pm 20\%$  tolerance.

Since this DPB fault came to light, I have done a bit more research into the operation of commercial power breakers and DCC boosters. Most power breakers, such as the NCE EB1 and AR1, are set to react in around 16msec although they can be adjusted to delay for longer. No delay time is specified for the PSX series, since they automatically adjust their shutdown period depending on the nature of the overload, but they generally appear to react in less than 16msec.

The shutdown delay for DCC boosters varies considerably between manufacturers. Digitrax have the shortest delay at 24msec, although it can be adjusted to around 60msec. NCE quote a shutdown delay of 500msec for all their systems but, in practice, some appear to switch off much more quickly. My older Power Pro system actually shuts down after an overload in 190msec, whereas my PH5 and PB5 boosters shut down in around 75msec, although in this case the switch off may be a function of the switchmode power supplies which they employ (in comparison to the large 15VAC transformer powering the Power Pro). My NCE Power Cab shutdown delay is longer than the maximum 255msec delay which can be set for the DPB (operating with power via the Arduino USB port).

It seems sensible, therefore, to reduce the default DPB overload delay time to 15msec, rather than the previous 25msec, and the revised version of the Arduino software (Version 3.9) allows you to reduce the delay time to as short as 3msec if you wish. A copy of the revised Arduino code is available from my A-Train Systems website at <https://www.a-train-systems.co.uk/dpb-download>.

Note that simply uploading the revised version of the Arduino software to a built DPB with the original software installed will not alter any of the previously set DPB parameters (such as trip current or delay). After uploading the Version 3.9 code, you either need to execute command 'F', via the Arduino IDE Serial Monitor, to set all parameters to the revised default values, or to execute one or more of the available commands to alter specific operational settings.

The Version 3.9 code now includes an additional instruction 'H' which you can use, via the Arduino IDE Serial Monitor, to display a list of all available DPB setup commands with their allowed parameters, as shown in [5] –

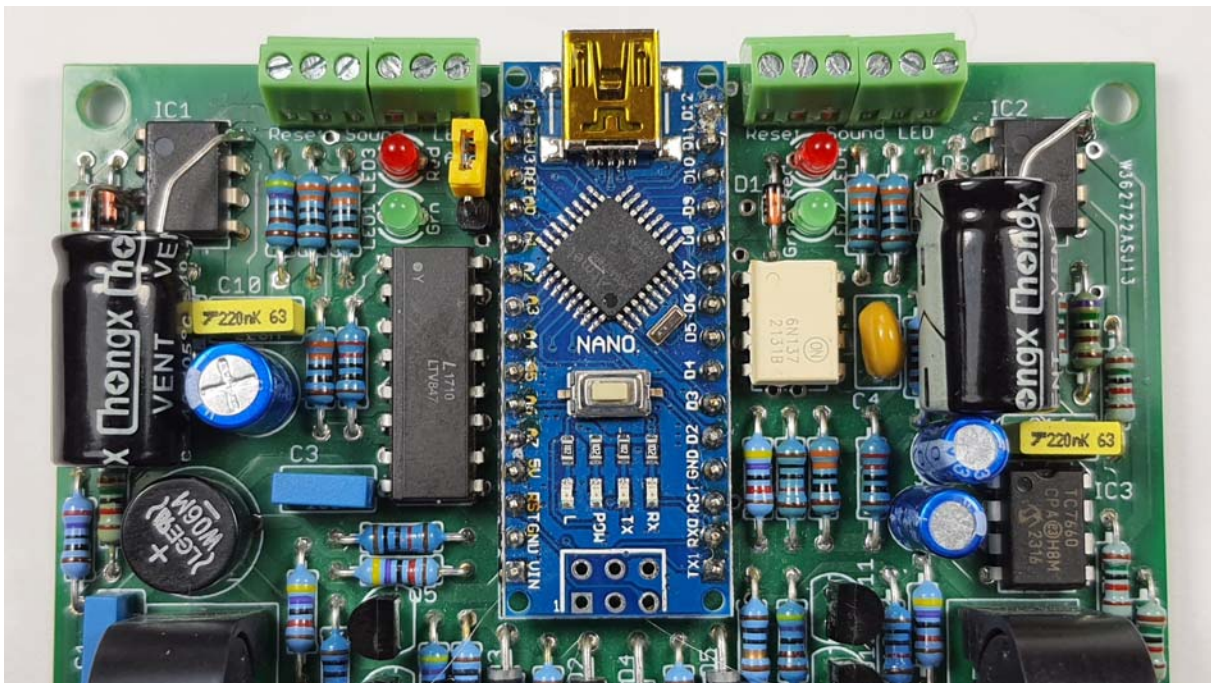
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Output  Serial Monitor X
Message (Enter to send message to 'ATmega328' on 'COM10') New Line 38400 baud
H >> Available Commands - Use upper or lower case
H - Help - Show this List of Commands
N - NOP - Set Normal Operation
S - Return Values of CV41-CV56
A - Return Set Accessory Address
V - Return Code Version Number
G - Enable Debug Messages
K - Enable Display of ADC Values
T - Set Accsy Address - Tnnnn [1 - 2043]
C - Set Trip Current - C1nn, C2nn [1 - 20]
D - Set Trip Delay - D1nnn, D2nnn [3 - 255]
R - Set Reconnect Delay - R1nnn, R2nnn [1 - 240]
M - Set Auto/Manual Reconnect - M1A, M1M, M2A, M2M
F - Set CV Values to Factory Default
B - Break Power District - B1, B2, BB
P - Resume Power District - P1, P2, PB
UE - AutoReverser Mode Enable
UD - AutoReverser Mode Disable
  
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Ln 1, Col 38 ATmega328 on COM10

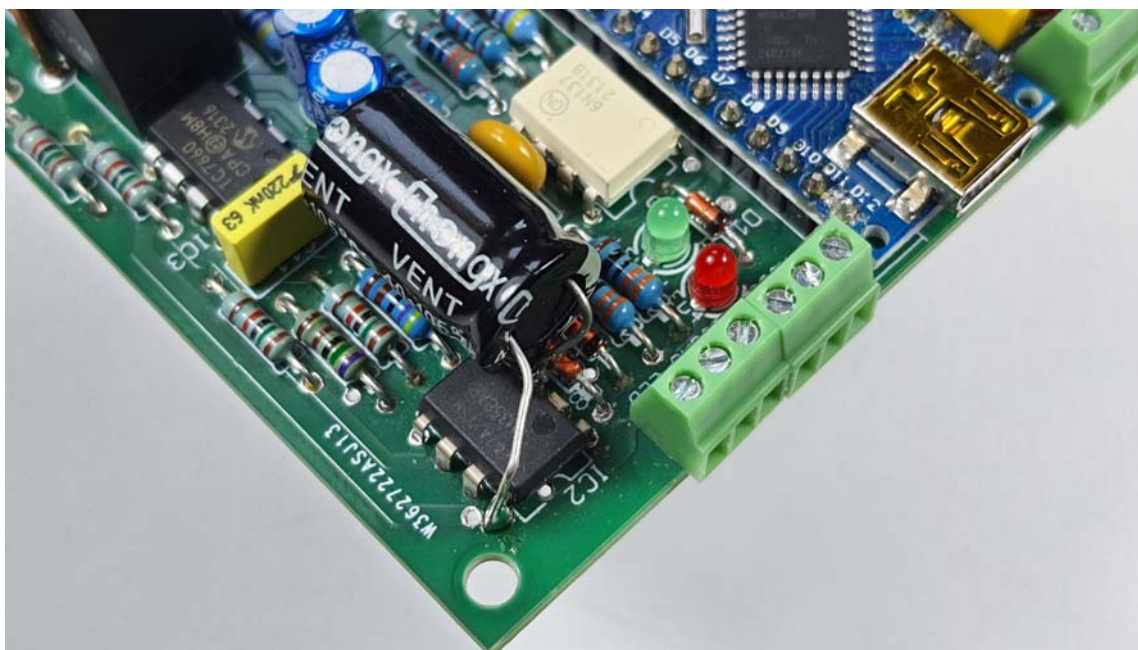
## 5. DPB setup commands – Arduino IDE Serial Monitor

The maximum trip delay which you can set has been left at 255msec although, with the additional capacitor fitted but without a direct USB connection, reliable operation is only available up to 90msec delay. If you really need to set a trip delay beyond 90msec or so then you have the option of fitting a second 1000uF 25V capacitor to pins 3 and 8 of IC2, as shown in [6] –



6. Two capacitors fitted

Space for the second capacitor between existing components is a little more limited, so you need to bend the wires closer to the capacitor body to get it to fit in tidily, as shown in [7] –



7. Second capacitor – connections

With the second capacitor fitted, you can safely set trip delays of up to around 175msec for either or both districts should your layout power connections demand it.

### Ordering components

Although 1000uF 25V electrolytic capacitors are readily available from all the major component suppliers, the suppliers' delivery charges have increased markedly in the past year and will likely exceed the cost of the actual components by a large margin.

I suggest, therefore, that you go to Amazon, where suitable capacitors can be found in the USA at <https://a.co/d/02YvW8qK> or in the UK at <https://amzn.eu/d/0h3BpHrA>. You do have to buy a pack of 10, but at a reasonable cost.

### Revised PCB design

For anyone who is planning to build a Dual Power Breaker from scratch, based on the original article published in the [June](#) and [July](#) 2025 issues of MRH Magazine, I have revised the printed-circuit board design to have more space for C2, to accommodate the larger 1000uF 25V capacitor. If the need arises you would be able to fit even larger values of capacitor in this position, provided that their voltage rating is no lower than 25V and, physically, that they have a diameter of 10mm with 5mm lead spacing.

You can download a copy of the Gerber files for the revised printed-circuit board (DualPowerBreaker-4) from the special download section of my A-Train Systems website at <https://www.a-train-systems.co.uk/dpb-download> .

As part of the design revision, I revisited the calculations for the current-carrying capacity of the PCB tracks and, although I previously concluded that the board must be manufactured using 2oz

(70 micron) copper, I am now confident that a PCB manufactured with standard 1oz (35 micron) copper will be able to handle the high currents involved – which should make the PCB considerably cheaper to procure.

This still assumes that the normal maximum DCC current through DPB (the total of both districts) will 5 amps. The PCB will handle up to a total of 8 amps, but the tracks around the DCC terminal blocks and MOSFETs will get noticeably warm.

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### Dr Terry Chamberlain

Terry Chamberlain got into model railroading almost by accident in the 1990s when he responded to a request from some modellers in California to build a DCC system based around an Atari personal computer – and he had to build a simple layout to prove that it all worked. Eventually the project evolved into A-Track, a Windows application to provide full computer support for the complete range of NCE DCC systems, with facilities similar to JMRI's Decoder Pro and Panel Pro.



Terry is a professional electronics engineer and spent most of his career in the UK defence industry designing, and managing the development of, large real-time computer systems for the Royal Navy. Now that he is fully retired he is beginning to make progress building the small logging and mining layout he has been planning for many years (after several visits to Colorado) – but keeps getting distracted by new computer and electronics projects for model railroading.