Extractor fan timer - project **Aug-Oct 2019**

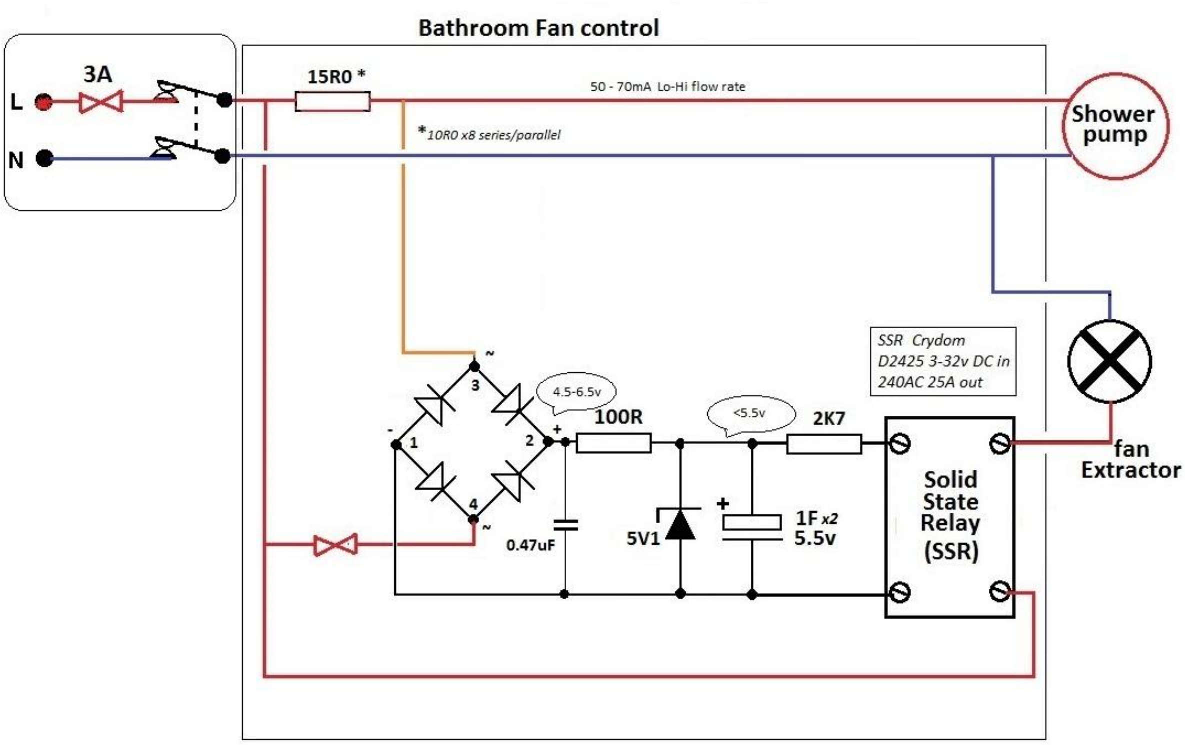
It sounds like a straightforward task. Construct a timer to operate a bathroom extractor fan. The fan should run for 15 - 20mins from the starting of the power shower unit.

The first problem is that the shower unit is completely divorced from the extractor fan. Only the power supply to each was in the attic, so there was no direct means to link the two.

The initial solution (circa 2005) was to detect current flow in the live feed to the shower unit, and arrange a method of switching the supply to the fan. Additionally, the fan supply needed to be maintained for 15-20mins from shower switch on (from the fan specification & the cubic capacity of the bathroom, it was calculated to take about 15mins to move the whole room's volume of air once!).

The initial solution worked adequately for about fourteen years. However, a new shower unit and the effects of ambient temperature resulted in erratic behaviour.

This is the initial solution:



The voltage (AC) across the 15R0 resistor was rectified and applied across a very large capacitor. In fact, two 1Farad capacitors, designed for memory backup, were used. Charging relatively quickly to about 5v and discharging relatively slowly (approx 15mins) via a 2K7 resistor (value determined over a period of time) and the input resistance of a solid state relay.

The 15R0 comprised of eight 1W 10R0 in parallel, not ideal but acceptable. The max dissipation would be about 7W to less than 4W on low shower rate. On the plus side, the design was very straightforward and there was no need for an additional DC power source to operate a timing device.

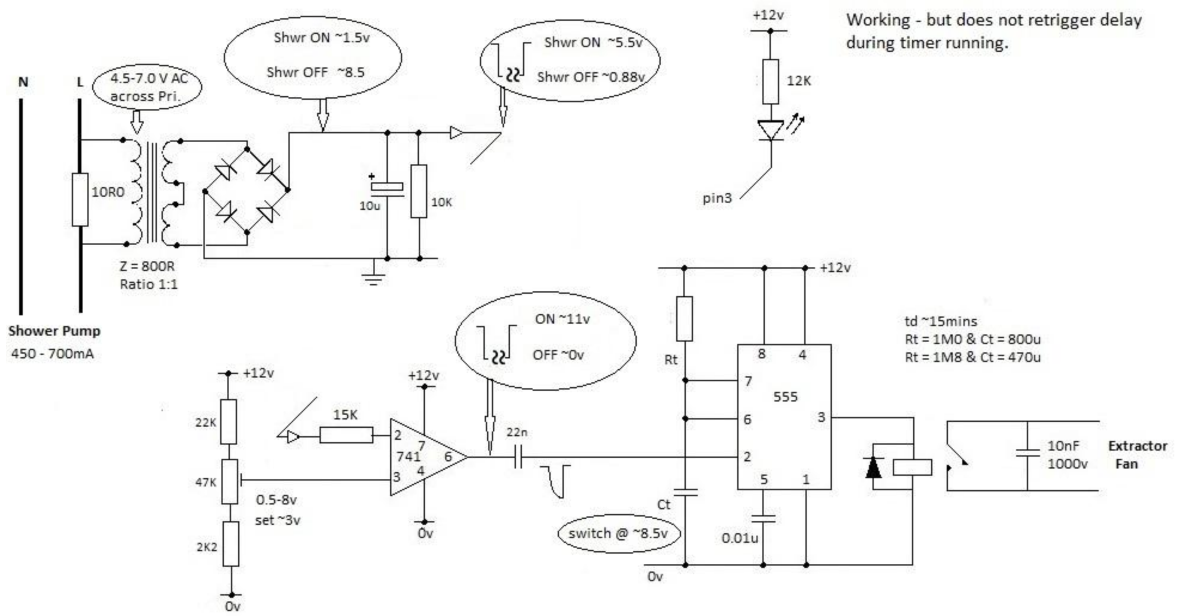
The biggest drawback was due to the fan not starting, or at least starting and stopping at erratically, sometimes not at all when the ambient temperature has high (ie summer months). This factor could be ignored as there was far less condensation being produced in the summer!

Replacement of the shower unit made things worse. It appeared that the newer shower pump was more efficient and so the current drawn was less.

A new approach was required.

To begin with, using raw mains to derive DC voltage as an indication that the pump was running, was not an acceptable (safe?) solution. I did not want to increase the series resistor value and could not derive more that about 9v AC. Adding a 1:1 transformer provided some isolation and little loss. As before this was applied to a bridge rectifier. A low value capacitor helped to remove most of the residual AC component, lightly loaded (10K) to maintain the DC level.

Now, I had hoped that the new design would just require an timer IC and thus an additional DC supply had to be used. The recovered DC was applied to the input of an op-amp (the good old '741'). This provided a clean transition when the shower pump was started which produced a useful trigger for a NE555 timer IC. At first I used a relay to switch the fan mains supply rather than the solid state switch (NB later changed back to the SSW).



With a 12v DC supply and using a 470uF in conjunction with about 1M8 for the timing elements, the arrangement worked satisfactorily at first. But then another problem was noticed. The fan was to run while the shower unit was in use and was to continue for a period after it was stopped. Bearing in mind that the time period for the fan to run was 15-20mins, if one person used the shower there was no problem. But if a second person used the shower before the timing period ended, the fan was likely to stop midway through their showering or at least soon after the showering had ceased. The requirement was for the fan to continue for some time (10-15mins) after the shower pump was turned off.

So, turning the shower on & off & on momentarily to restart the timer was an idea - but unsatisfactory. Once under the shower it was not possible to tell if the fan was running or not!

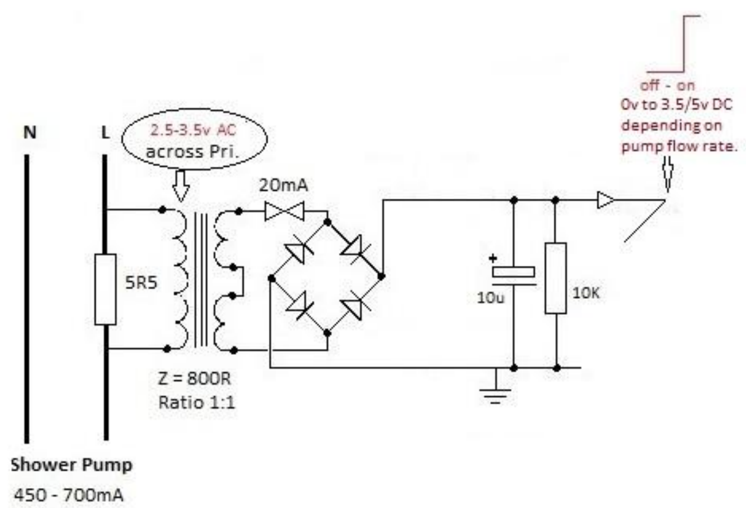
I could not find a reliable method for restarting the delay timer once it was running. The application notes do suggest a method to restart the NE555 but did not find it to be reliable in this context.

Yet another approach

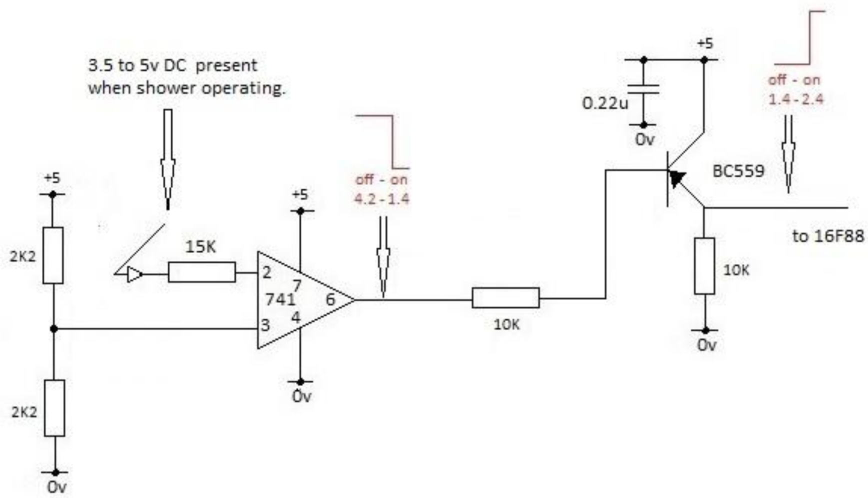
I decided that a more flexible timing solution had to be found. I began by selecting one of the mid-range Microchip PICs, the 16F88. This was more than adequate for the task. The hardest part was deciding which of its many features would be most suited to the job! [See 'assembly program code']

Using linear, tried & tested series of delays was chosen. Based upon a 2mS timing loop, the subsequent delay periods (100mS, 10S, 1min & 1min x n).

The shower pump current flow develops a low potential difference AC across an 5R5 ohm resistor. This lower value reduced the dissipation, still providing sufficient p.d. The exact value depends on the pump rate. The Mira Power Shower current flow was found to be 450 to 700mA ie Lo to Hi rate of flow selected.



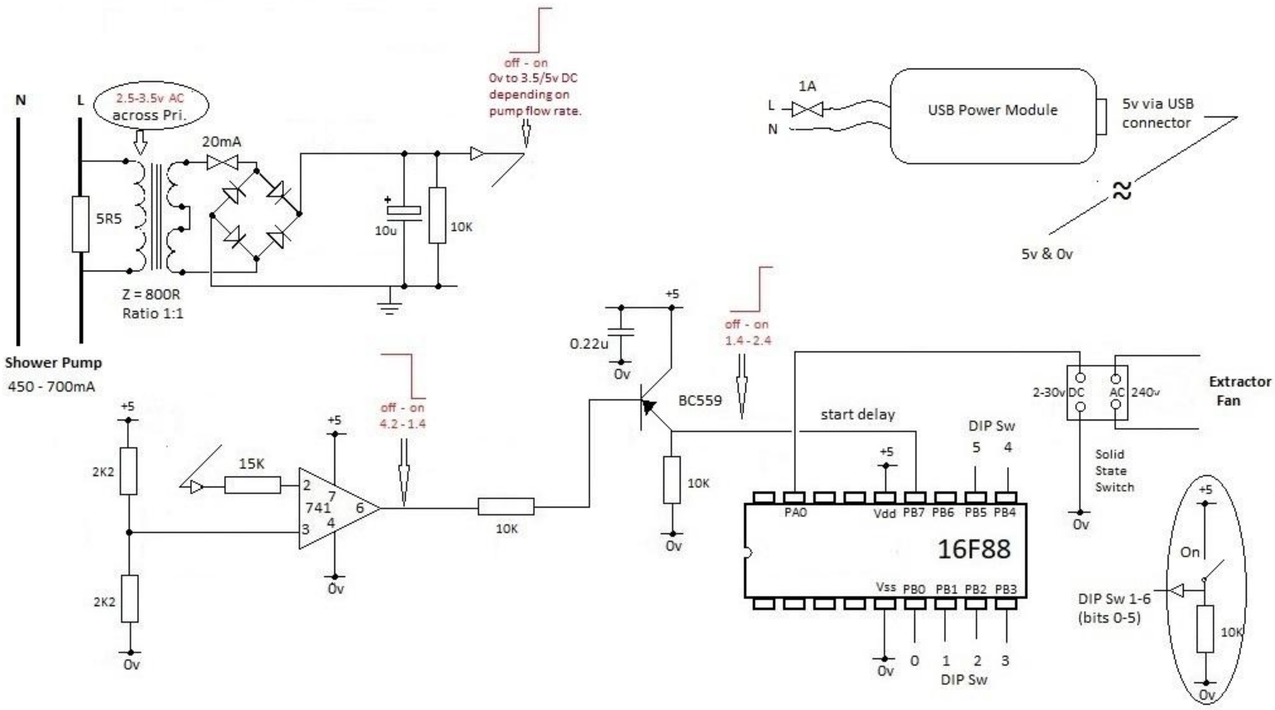
Approximately 2.5 to 3.5v AC is isolated from the remaining circuitry using a 1:1 (audio) transformer.



The secondary AC is full wave rectified and applied across a reservoir capacitor of 10uF with a 10k load in parallel.

Approximately 3.5 to 5v of the recovered DC was applied to a 741 comparator and an inverting amplifier. This provided an output of 4v when shower ON and 1.5v when shower is OFF.

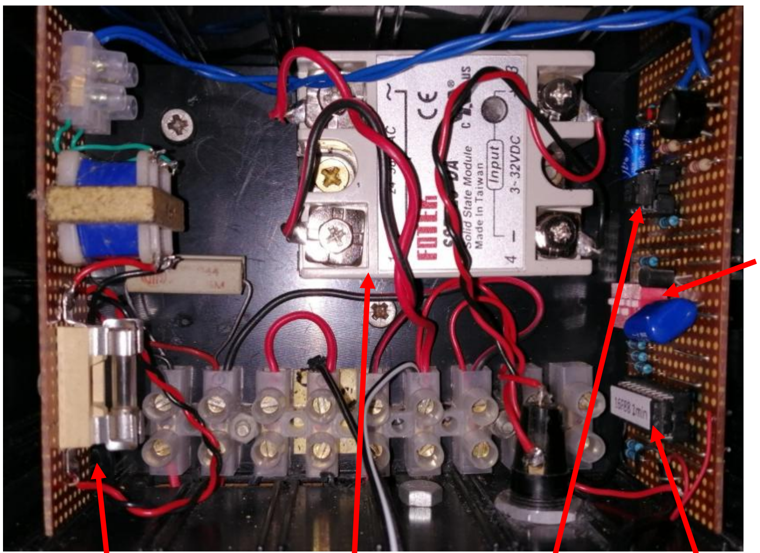
Note: while perfectly functional, the 741 is not ideal for single rail 5v operation - a better choice would be an LM358 or similar.



Overall schematic diagram

The Microchip device was programmed to detect an input (lo-Hi) accept on pin13 (PB7) and to generate an immediate output on pin 17 (PA0). This remains present (Hi) for the preset delay period (DIP switch setting - ie 6bit binary sets minutes multiplier). The DIP switches are held Lo until selected ON.

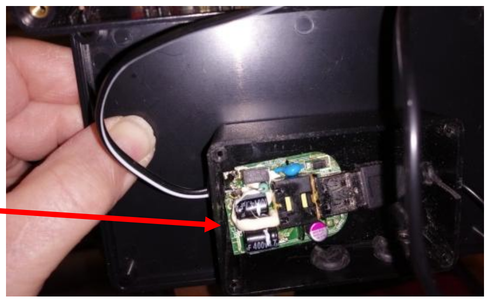
The time delay runs from shower ON to time-out. If the shower 'ON' demand is applied before the time-out period, the delay will restart.



The 16F88 output is connected directly to a Solid State Switch. A 3-30v DC input closes the AC output. In this case it is in the switch line of the extractor fan.

6bit DIP switch

AC board *Solid State Switch* *Comparator & 16F88*



The 741 comparator & microchip are powered by a separate 5v PSU. This is a mains to USB PCB module.

October 2019 modification

In October 2019, it was evident that a modification to operate the extractor fan remotely would be a useful feature.

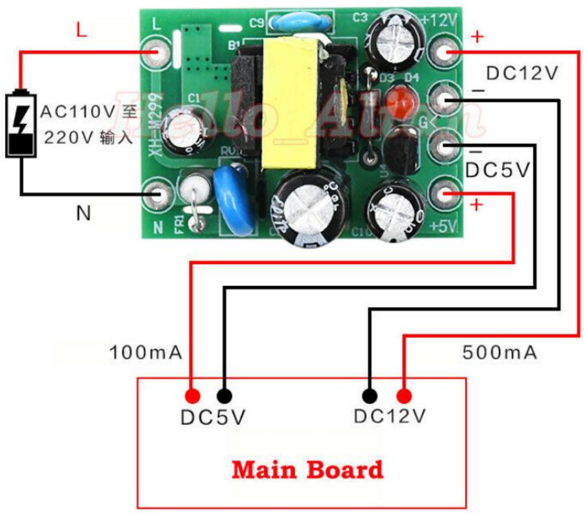
An RF transmitter & receiver with non-latching relay contacts was ideal. The design would allow the extractor fan to run for a fixed period (3mins) rather than the DIP switch selection used for the main function.

PortB bit 6 was already configured as an input, all that was required was additional code and a connection to PB6.

One slight difficulty was the relay board's need for a 12v DC supply. So far only 5V had been needed, so a module that accepts 240AC input and provides both 12v & 5v was sourced. This would replace the existing 240vAC to 5V DC USB module.

Some thought was given to option of a 'pull-up' or 'pull-down' switching configuration. In the end a 'pull-up' arrangement was chosen - so that the same code structure as the PB7 input would be used.

A small PSU switching regulator module was chosen to power both the PIC +5v and the relay board +12v. It was small enough to attach to the inside of the ABS case, replacing the +5v USB PSU.



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