Electric Druid Digital Delay DIGIDELAY

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Introduction

The Electric Druid Digital Delay chip is designed to make building longer, high quality delay effects much simpler. Most DIY digital delays use the Princeton PT2399, which limits the maximum delay time to around half a second, and which has a serious effect on audio quality, especially at longer delay times. These were the limitations that the DIGIDELAY was designed to overcome.

The DIGIDELAY uses a 12-bit, 32KHz ADC for input, and 16-bit, 32KHz for processing and output. Since it uses a fixed sample rate, quality is exactly the same for the longest delays as the shortest. It uses two 128KB SRAMs to give a maximum of 4 seconds of delay.

Features

Up to 4 seconds of delay

The chip expects to work with two 128KByte SRAM chips, which give it a maximum delay time of around four seconds.

Tap tempo with Tempo LED to indicate echo rate

Provision is made for a Tap Tempo button if you want that feature. There is also a flashing Tempo LED which indicates the tempo, whether set by the Delay Time knob, or by the Tap Tempo.

Momentary/latching feature on bypass switch for "echo splashes"

Pressing the bypass switch turns the effect on or off as normal. A longer press of the switch, however, switches the pedal on only while you hold the switch down. This allows you to selectively add echos to single phrases or passages, and works really well with the Delay Trails feature.

Clickless Effect In/Out switching

Obviously the DIGIDELAY chip can be integrated into a "true bypass" pedal if that's what you want. However, it offers on-chip clickless In/Out switching which is extremely easy to use and effective. This is done by fading the delay signal in or out over a few milliseconds, which eliminates any pops or bumps.

Delay trails (tails) on/off

If you're using the on-chip In/Out switching, you can select whether echos should be allowed to die away naturally when the pedal is bypassed (known as "Delay Trails" or "Delay Tails"), or whether they should disappear instantly (like happens with true bypass delay pedals). The choice is yours.

Dry audio path is entirely analog

No need to worry about your tone getting mangled - the dry signal is unaffected by the chip. The DIGIDELAY *only* produces a delayed, "wet" signal, so this is the only part which is digital.

Delay Time, Repeats, and Delay Level controls

All the standard Delay controls are present and correct.

Highpass and Lowpass tone filter controls

Highpass and Lowpass shelving tone filters are provided that affect the recirculated echos. This allows you to shape the tonality of the delays enormously, from dark and cave-like, to crispy and light.

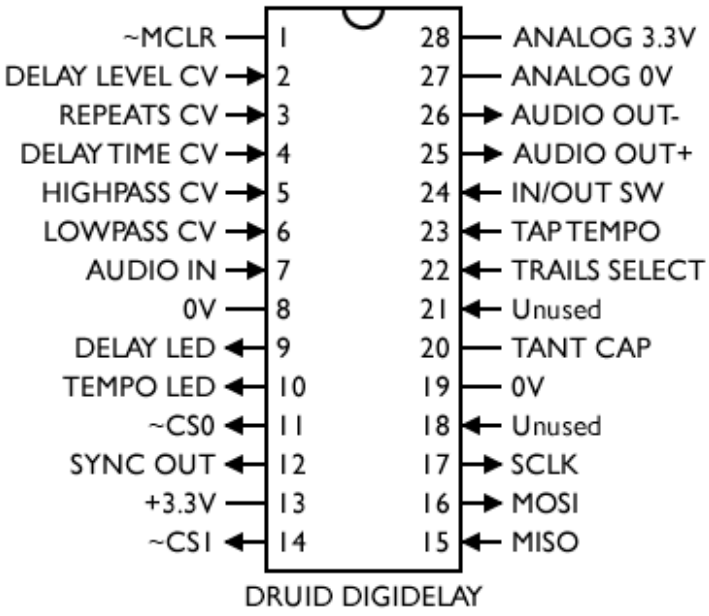
32KHz sample rate and 16-bit processing

The chip uses 12-bit/32KHz analog to digital conversion. Once the signal is digital, all processing is done as 16-bit data, and the final output is 16-bit/32KHz. This provides a good quality output, without becoming super-clean or sterile. For comparison, the specs match rackmount studio delay units of the late 1980s. Don't pay eBay prices for a vintage unit! Build a new one!

Sync Output

The chip also provides a 8msec 3.3V digital pulse output which can be used to synchronise other pedals to the delay rate. It could also synchronize TAPLFO-based pedals to the same tempo.

Pinout Diagram



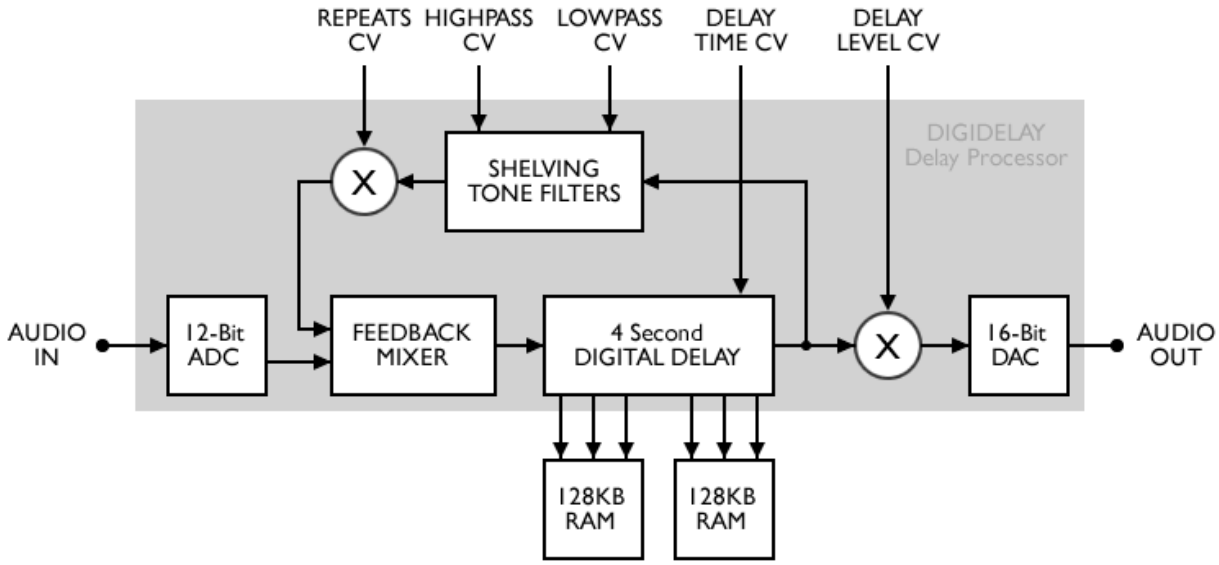
Pin	Function	Details	Notes
1	~MCLR	Chip Reset	Tie to Digital 3.3V with 10K
2	DELAY LEVEL CV	0-3.3V analog input	Controls output level of delay signal
3	REPEATS CV	0-3.3V analog input	Controls amount of feedback (number of echos)
4	DELAY TIME CV	0-3.3V analog input	Controls length of delay from 4msec to 4 seconds
5	HIGHPASS CV	0-3.3V analog input	Sets the cutoff of a highpass shelving filter
6	LOWPASS CV	0-3.3V analog input	Sets the cutoff of a lowpass shelving filter
7	AUDIO INPUT	0-3.3V analog input	Does what it says on the can
8	0V	Digital Ground	
9	DELAY LED	0-3.3V digital output	Indicates whether the delay effect is on or off. 4mA max current.
10	TEMPO LED	0-3.3V digital output	Flashes at the current delay rate (either set by the Delay Time CV or the Tap Input). 4mA max current.
11	~CS0	0-3.3V digital output	Chip Select for the first SRAM

Pin	Function	Details	Notes
12	SYNC OUT	0-3.3V digital output	Provides a 8msec digital pulse at the current tempo.
13	+3.3V	Digital Power Supply	This should be separate from the analog supply for best noise performance.
14	~CS1	0-3.3V digital output	Chip Select for the second SRAM
15	MISO	0-3.3V digital input	These three pins are the SPI connection to the two serial RAM chips.
16	MOSI	0-3.3V digital output	
17	SCLK	0-3.3V digital output	
18	Unused	0-3.3V digital input	
19	0V	Digital Ground	
20	TANT CAP	Digital Power Supply	This should have a 10u tantalum capacitor connected to pin 19, 0V. This is a power smoothing cap for the chip's core.
21	Unused	0-3.3V digital input	
22	TRAILS SELECT	0-3.3V digital input	Switches Delay Trails on/off 1= Off, 0=On
23	TAP TEMPO	0-3.3V digital input	Another way to enter the delay time - tap it on this button! Use momentary switch to ground with 10K pull-up to digital 3.3V
24	IN/OUT	0-3.3V digital input	Toggles the delay effect on/off. Use momentary switch to ground with 10K pull-up to digital 3.3V
25	AUDIO OUT+	0-3.3V analog output	Differential audio output
26	AUDIO OUT-	0-3.3V analog output	
27	ANALOG 0V	Analog Power Supply	Analog supply pins for the on-chip ADC and DAC. The analog supply should be separate from the digital supply for best noise performance.
28	ANALOG +3.3V	Analog Power Supply	

Application Notes

Block Diagram

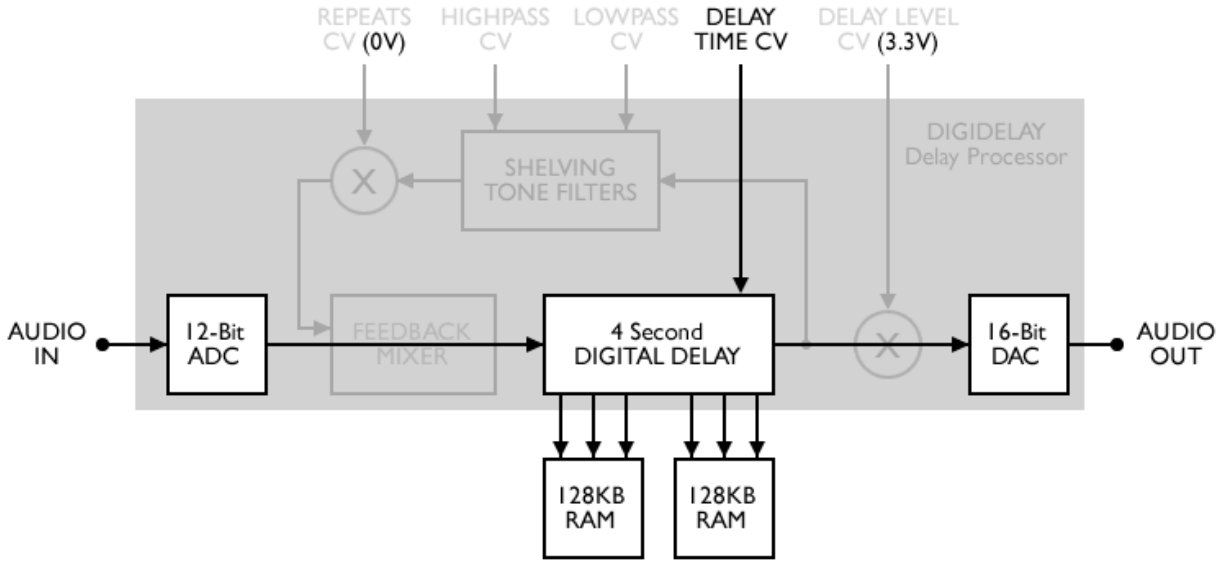
The digital features of the chip look like this:



The REPEATS CV, HIGHPASS CV and LOWPASS CV affect the number of repeats and their tone. The DELAY LEVEL CV affects the overall output level of the chip. Note that there is no digital path for the dry signal - the dry signal must be analog, and needs to be mixed outside the chip.

Adding analog feedback and/or analog level control

It is simple to disable most of the digital features if all that is required is a simple delay line. The REPEATS CV should be connected to Analog Ground (0V). This disables the digital repeats signal path and the tone filters which are part of it. The DELAY LEVEL CV can be tied to the Analog 3.3V supply. This makes the chip output its maximum level and allows use of an analog level control after the delay line.



Momentary/Latching switches

The IN/OUT and TAP TEMPO inputs expect momentary switches to ground. The TRAILS ON input expects a latching switch. All three inputs need 10K pull-up resistors to the digital 3.3V supply.

If a switch is not required for TRAILS ON/OFF, it can be connected directly to Digital 3.3V or Ground with a 10K resistor.

Differential Audio output

The DIGIDELAY chip provides a differential audio output to reduce noise from the digital sections of the chip. It is recommended these outputs are fed to a differential amplifier as shown in the example circuit below.

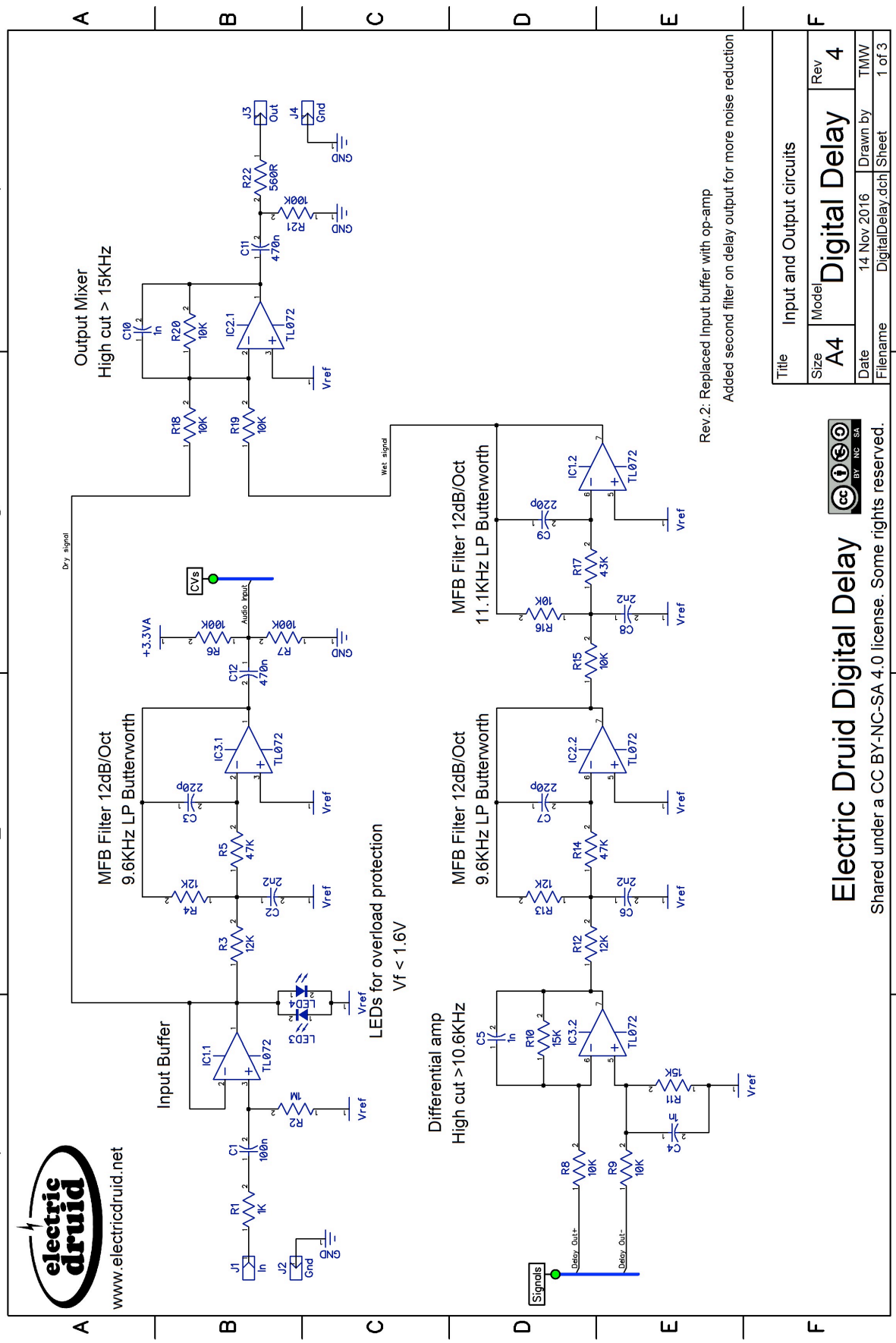
SPI Comms with SRAMs

The five pins ~CS0, ~CS1, SCLK, MOSI, and MISO are used to communicate with the SRAMs using the Serial Peripheral Interface (SPI). This is almost as simple as just connecting up the lines. However, it is important that the MISO line has a 10K pull-up to Digital 3.3V to stop it floating when neither SRAM is selected.

The SPI lines have high speed signals present on them, so if designing a PCB layout, try to ensure that these lines are kept as short as possible and as far from sensitive analog circuits as possible.

Digital Delay example circuit diagram

The example schematic below uses all of the digital features of the chip to make a full-featured delay with minimum parts. Potentiometers used to control all five available parameters. For particular applications, it may not be necessary to use all the controls. For example, the highpass and lowpass filter CVs could be used to give a pedal a fixed voicing.


Input Buffer
MFB Filter 12dB/Oct
9.6KHz LP Butterworth
LEDs for overload protection
Vf < 1.6V
Differential amp
High cut >10.6KHz
MFB Filter 12dB/Oct
9.6KHz LP Butterworth
MFB Filter 12dB/Oct
11.1KHz LP Butterworth
Output Mixer
High cut > 15KHz
Dry signal
Wet signal
Rev.2: Replaced Input buffer with op-amp
Added second filter on delay output for more noise reduction
Electric Druid Digital Delay
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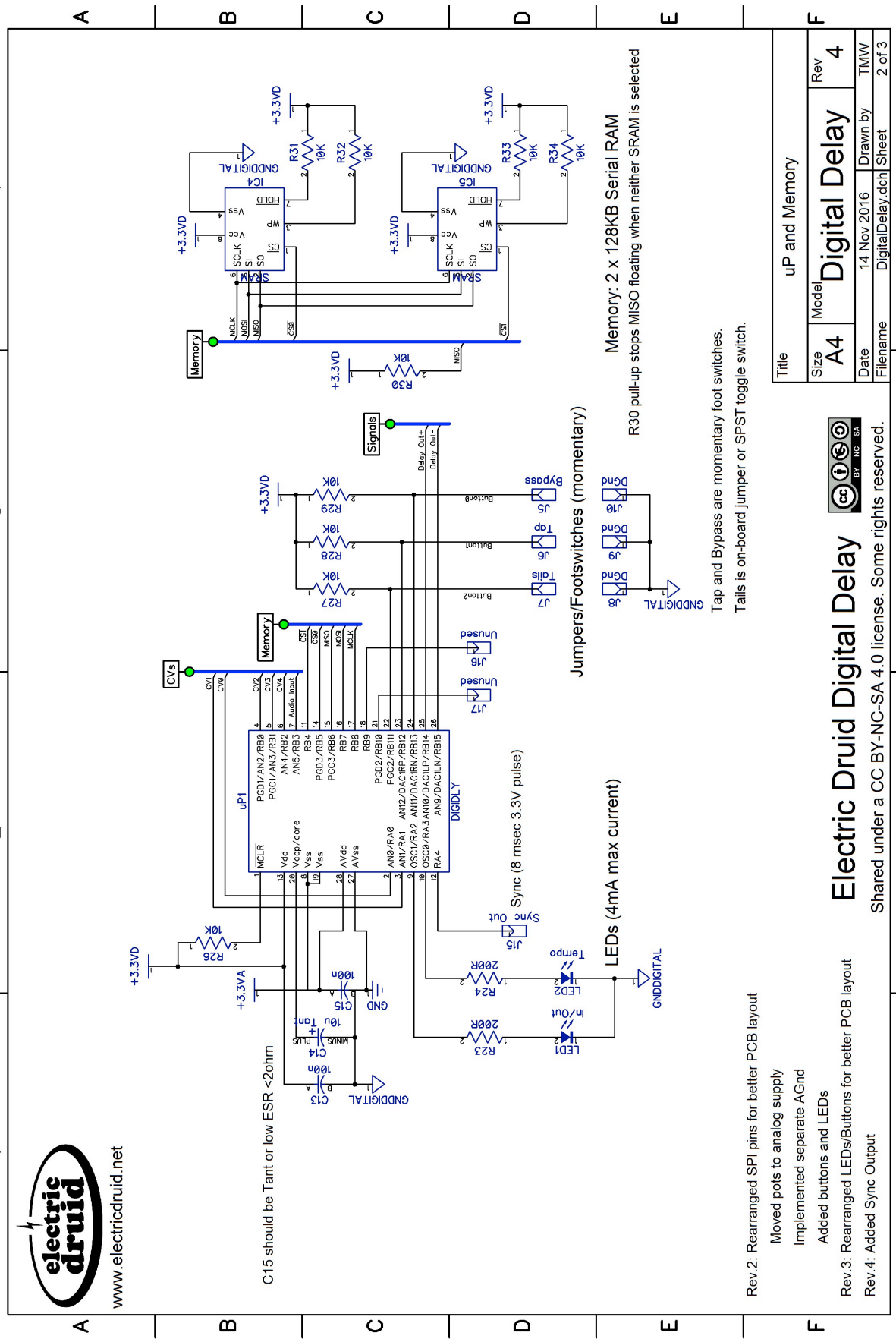
www.electricdruid.net
Title Input and Output circuits
Size A4
Model Digital Delay
Rev 4
Date 14 Nov 2016
Drawn by TMW
Filename DigitalDelay.dch
Sheet 1 of 3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C15 should be Tant or low ESR <2ohm
Rev.2: Rearranged SPI pins for better PCB layout
Moved pots to analog supply
Implemented separate AGnd
Added buttons and LEDs
Rev.3: Rearranged LEDs/Buttons for better PCB layout
Rev.4: Added Sync Output
Electric Druid Digital Delay
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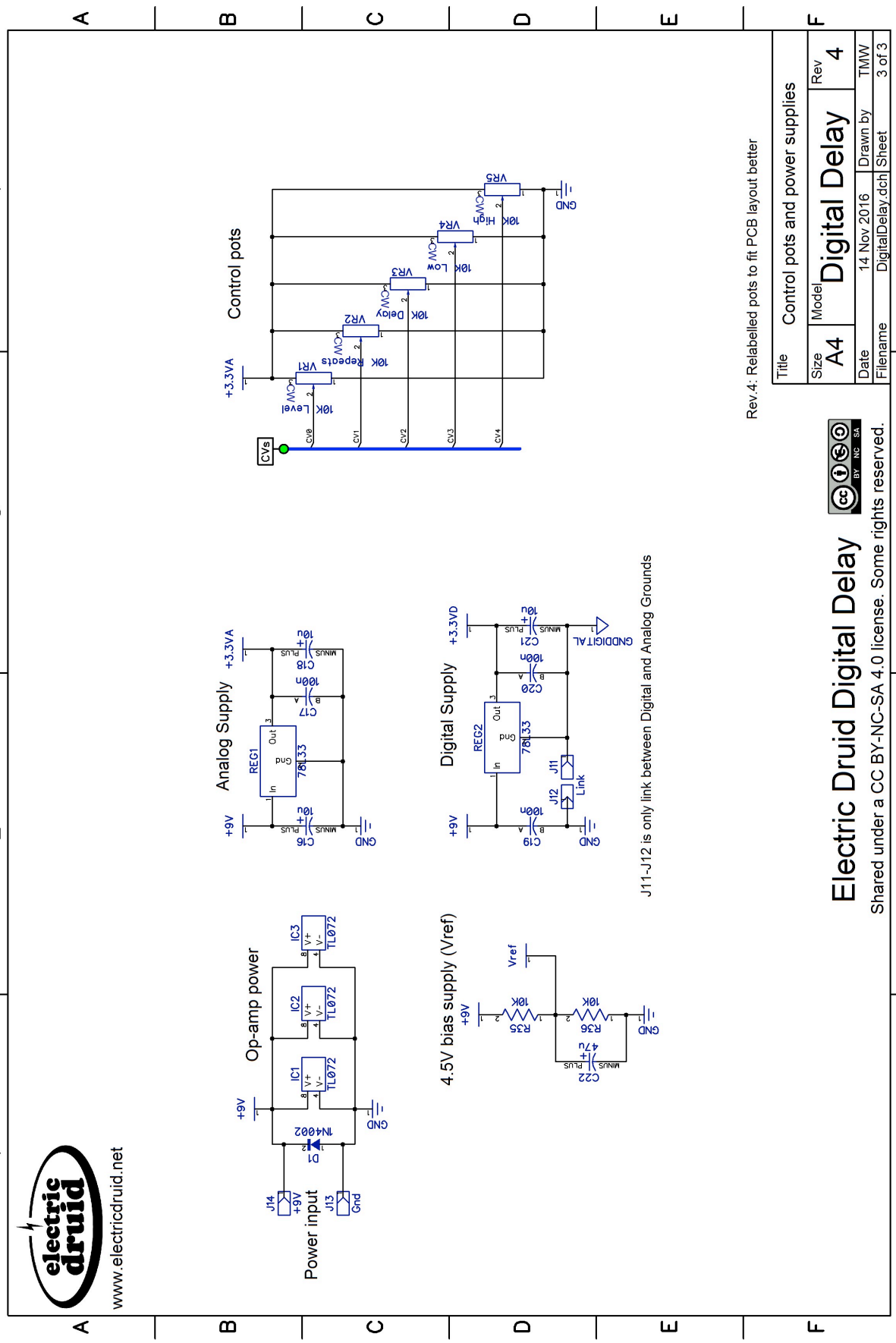
Memory: 2 x 128KB Serial RAM
R30 pull-up stops MISO floating when neither SRAM is selected
Jumpers/Footswitches (momentary)
Tap and Bypass are momentary foot switches.
Tails is on-board jumper or SPST toggle switch.
LEDs (4mA max current)
Sync (8 msec 3.3V pulse)
Title uP and Memory
Size A4
Model Digital Delay
Rev 4
Date 14 Nov 2016
Drawn by TMW
Filename DigitalDelay.dch
Sheet 2 of 3


Control pots
+3.3VA
CVs
CV0
CV1
CV2
CV3
CV4
VR1
10K Level
VR2
10K Repeats
VR3
10K Delay
VR4
10K Low
VR5
10K High
GND
Analog Supply
+3.3VA
+9V
REG1
78L33
In
Gnd
Out
C16
10u
C17
100n
C18
10u
GND
Digital Supply
+3.3VD
+9V
REG2
78L33
C19
100n
C20
100n
C21
10u
J11
J12
Link
GNDDIGITAL
J11-J12 is only link between Digital and Analog Grounds
Op-amp power
+9V
D1
1N4002
IC1
IC2
IC3
TL072
GND
Power input
J14
+9V
J13
Gnd
4.5V bias supply (Vref)
+9V
R35
10K
R36
10K
Vref
C22
47u
GND
Rev.4: Relabelled pots to fit PCB layout better
Title Control pots and power supplies
Size A4
Model Digital Delay
Rev 4
Date 14 Nov 2016
Drawn by TMW
Filename DigitalDelay.dch
Sheet 3 of 3
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