Sequencing 5 Supplies Using the X80200

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Introduction

This application brief provides three approaches to the task of sequencing five power supplies for point of load applications. The supplies in this application are 5V or 3.3V, 2.5V, 1.25V, 1.8V, and 0.9V. Two X80200 devices from Intersil and a few external components create a flexible approach to sequencing.

The X80200 is a device that provides three input voltage threshold comparators with three voltage references. It includes charge pumps to provide the 9 to 12V FET gate drive outputs that allow the use of N-Channel FETs for power switching. The X80200 also includes logic to power up the core voltage before the I/O voltage and power down the core voltage after the I/O voltage.

Sequencing Requirements

This application is based around the following requirements:

1. N-Channel FETS control the output voltage,
2. Each input voltage needs to be present and above a desired threshold before the FET turns on,
3. If any input or output fails, all supplies turn off,
4. The 0.9V, 1.8V, 1.25V and 2.5V input voltage thesholds need to be trimmable to adjust for changes in the trim of these supplies.
5. The 2.5V and 1.25V supplies are closely linked and the 1.8V and 0.9V supplies are closely linked, but these are loosely coupled to each other and to the 5V/3.3V supply.

Design Approaches

There are three approaches in this brief. These are not complete designs, but instead consist of block diagrams that show basic configurations and the main components required and an associated timing diagram that illustrates the concept.

The circuits are based on the X80200 triple voltage sequencer from Intersil (See Figure 3) All three circuits use an external reference voltage and comparators for monitoring the outputs, or for providing a higher accuracy threshold on the input. The chosen references are either the X60250 or the X60003-25, from Intersil. The X60250 reference provides either a fixed 1.25V output or an output that is adjustable from 0 to 1.25V or 0.625V to 1.25V in 256 steps. The X60003-25 provides a highly accurate, fixed 2.5V reference in an SOT23 package.

Circuit 1 (See Figure 3)

In the first approach, the 2.5V, 1.25V, 1.8V, and 0.9V supplies are monitored by an external quad comparator. This is done for two reasons. First, an external reference provides greater accuracy on the threshold than the internal reference of the X80200, especially for the lowest voltages. Second, the internal comparators of the X80200 do not have an output indicating when all supplies are good. If the design requires that no output goes active until all input supplies are above their minimum threshold, then this input voltage comparator is required.

Four digital potentiometers (DCPs) are used in this application to calibrate the exact threshold needed for each power supply. These DCPs can be “bracketed” by additional resistors to give a very narrow range of adjustment, providing more resolution for calibration (See example in Figure 1) Using a DCP means that if a power supply is trimmed, the respective voltage monitor can also be trimmed. This circuit shows the use of the X9409 Quad 64 tap DCP with 2-wire interface, however, single or dual devices with fewer taps can also be used to reduce cost or board space.

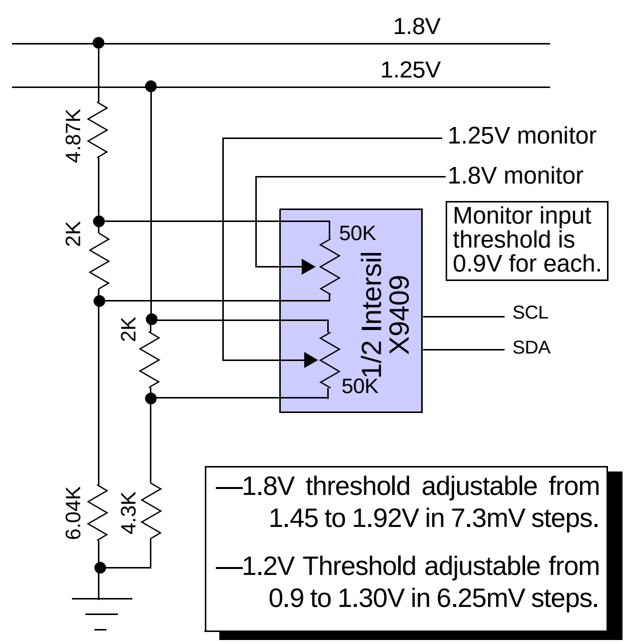


FIGURE 1. EXAMPLE LOW VOLTAGE THRESHOLD ADJUSTMENT

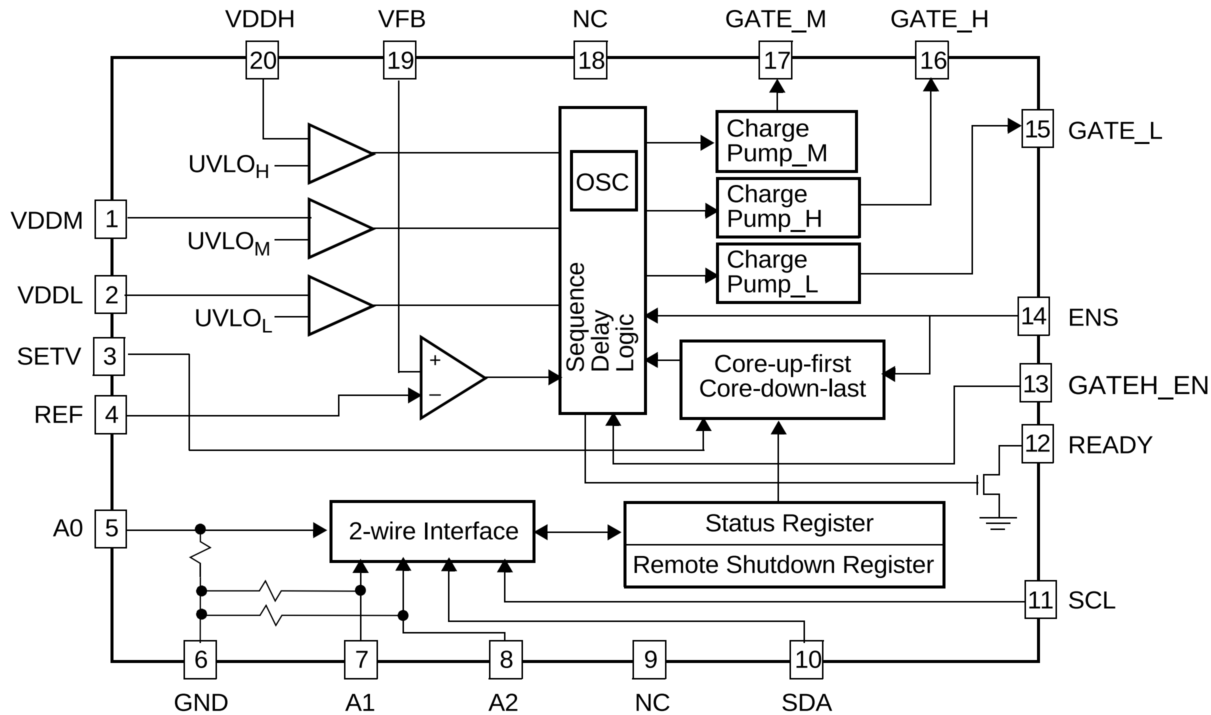


FIGURE 2. X80200 BLOCK DIAGRAM

In circuit 1, a READY signal, which goes active when all inputs are good, starts the sequence by turning on the 5V/3.3V FET, the 1.25V FET and the 0.9VFET at roughly the same time. An RC delay on any of these inputs can be used to control the relative timing of the output voltages. The 2.5V and 1.8V FETs turn on after an internal delay in the X80200. This delay is fixed and is about 750us in duration.

Once all of the supplies turn on, five comparators monitor the outputs. Once all of these supplies go active, any output supply falling below its threshold toggles an edge triggered flip flop, which turns off READY. This causes all outputs to turn off. To again turn on the output supplies requires a reset signal to clear the shutdown latch.

Circuit 2 (Figure 5)

In this second approach, the input comparators and references of the X80200 are used. The exception is 0.9V monitor. An external comparator and reference are used for this supply because the lowest reference voltage in the X80200 ranges from 0.875 to 0.925V, which gives no operating margin for this supply.

External DCPs are again used to be able to trim the input voltage monitor thresholds. This design shows two dual DCPs, such as the X93256.

In this configuration, the power supplies turn on a little different than in the first case. In effect, circuit 2 consists of three voltage banks; 5V/3/3V (5V bank), 2.5V and 1.25V (1.25V bank,) and 1.8V and 0.9V (0.9V bank.)

Turn on of the 5V bank is independent of the other two. If the 5V bank input supply powers up before the other banks, then its output turns on before the others, unless the turn-on is slowed by an RC time constant between READY and GATEH_EN. If the 5V bank powers up after the other banks, then all output supplies will power up in the same way as Circuit 1.

The turn-on of the 1.25V bank is also decoupled from the turn on of the 0.9V bank. That is, once both the 2.5V and the 1.25V input supplies are good (and the 5V/3.3V is on), the 2.5V and 1.25V FETs turn on, regardless of whether the 1.8V and 0.9V input supplies are good. This is also true the other way around, where the 1.8V and 0.9V controls do not wait for a good voltage on the 2.5V and 1.25V inputs before turning on.

Once all output supplies are turned on, a failure in any supply causes all outputs to turn off in the same way as the first case. To again turn on the output supplies requires a reset signal to clear the shutdown latch.

Circuit 3

This version of the sequencer uses the same input monitoring method as Circuit 2, which uses the comparators and references in the X80200 devices. In this case, as well as the previous one, there are effectively three voltage banks, 5V/3.3V, 2.5V and 1.25V, 1.8V and 0.9V. In this case, however, the sequencing is different and uses the X60003-25 (2.5V) voltage reference into a voltage divider to provide a variety of reference voltages.

As soon as the 5V/3.3V input supply reaches its threshold, the READY goes active and turns on the 5V/3.3V FET. This output voltage is monitored by a comparator and when it exceeds the desired threshold, the comparator output turns on the 0.9V and 1.25V output supplies through the SETV pin of the X80200, assuming these input voltages are above their threshold.

The 0.9V and 1.25V outputs feed back to the VFB pins on the X80200's. When these voltage reaches the REF voltage (the voltage good threshold as set by an external voltage reference), the 2.5V and 1.8V output supplies turn on (again assuming the inputs voltages have reached their turn on thresholds.)

Now all of the outputs are on. If the 5V/3.3V output fails, then the SETV input to the X80200s goes low. This turns off the 0.9V and 1.25V outputs. The loss of these output voltages then turn off the 2.5V and 1.8V supplies based on internal X80200 logic.

If the 0.9V output supply fails, then the X80200 automatically turns off the 1.8V output supply. When the 1.8V output turns off, the external comparator detects the condition and turns off the GATEH_EN signal, which turns off the 5V/3/3V output, which turns off the 1.25V and 2.5V outputs. A similar sequence follows if the 1.25V output supply fails instead of the 0.9V supply.

Additional Features

By using the X80200 devices and Digitally Controlled Potentiometers, the system designer gains some additional benefits. The X80200 devices have a 2-wire interface that allow the system to monitor the power supply status and remotely shut down the power supply outputs. They also have general purpose EEPROM to provide information on board configuration, serial numbers, fault conditions and service records, plus any pre-set comparator threshold settings. The programmable DCPs offer the ability of adjusting the voltage good thresholds on the various power supplies. This can be important if the power supply is being trimmed and a tight tolerance on the voltage good threshold needs to be maintained.

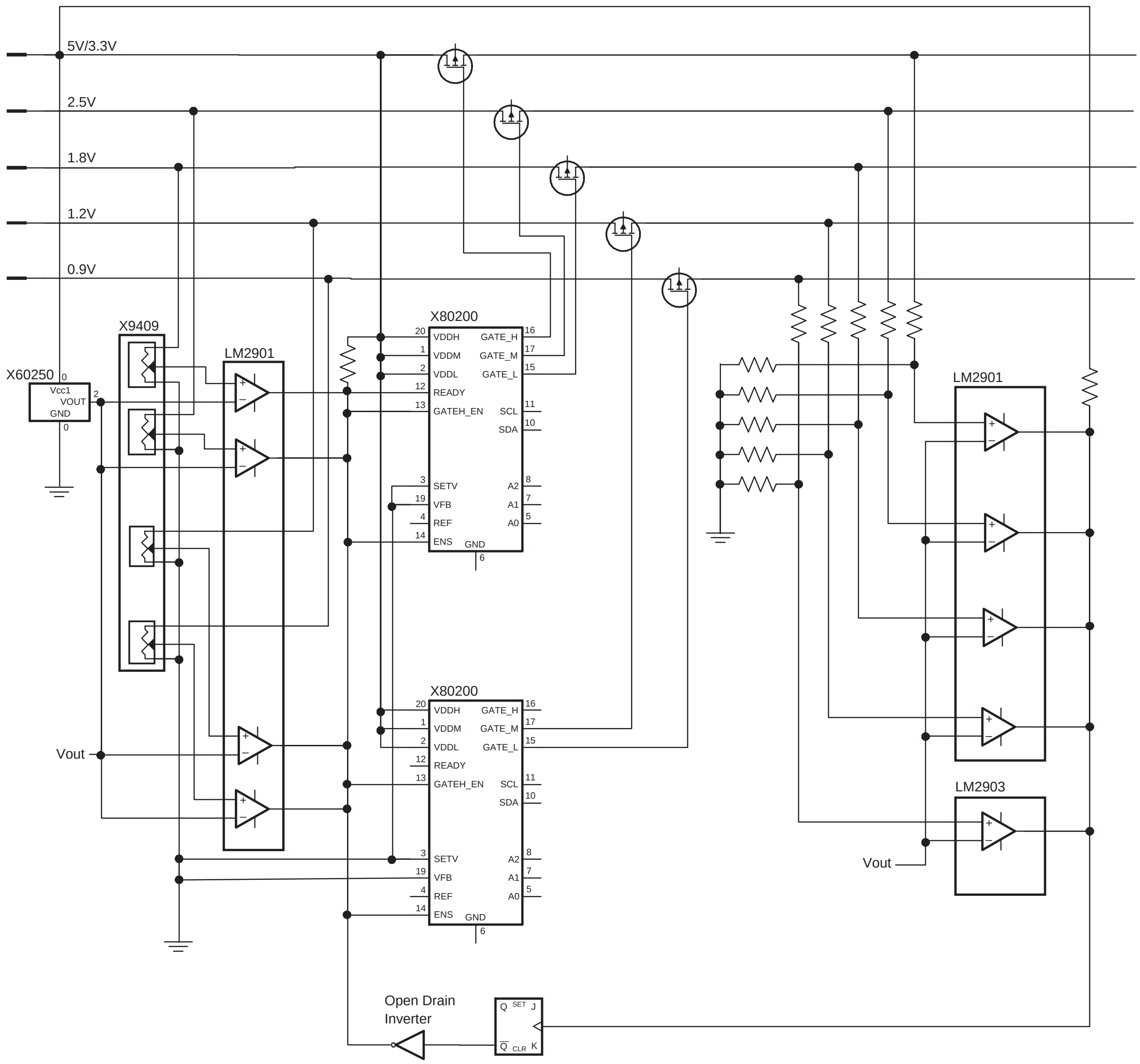


FIGURE 3. CIRCUIT 1 BLOCK DIAGRAM

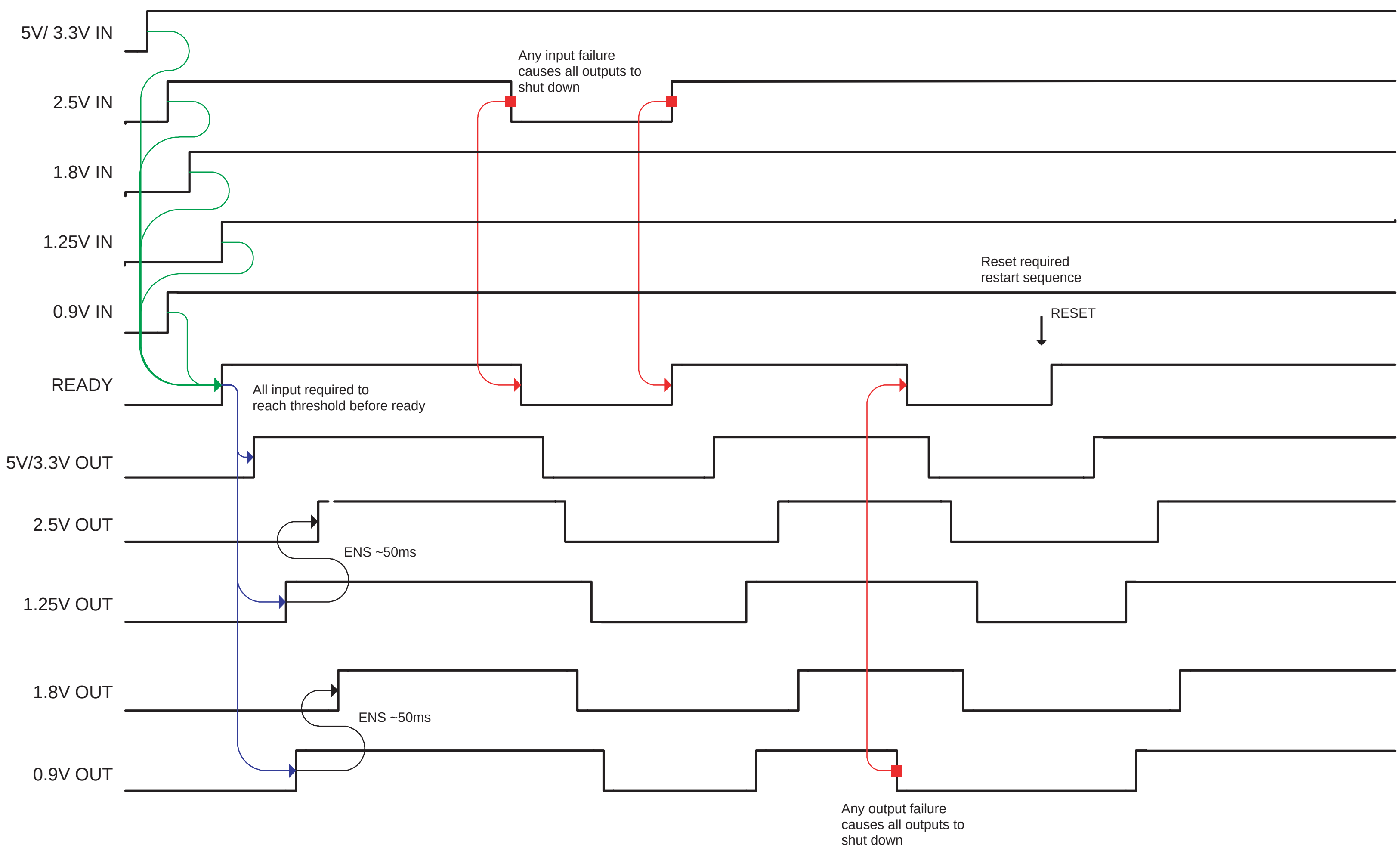
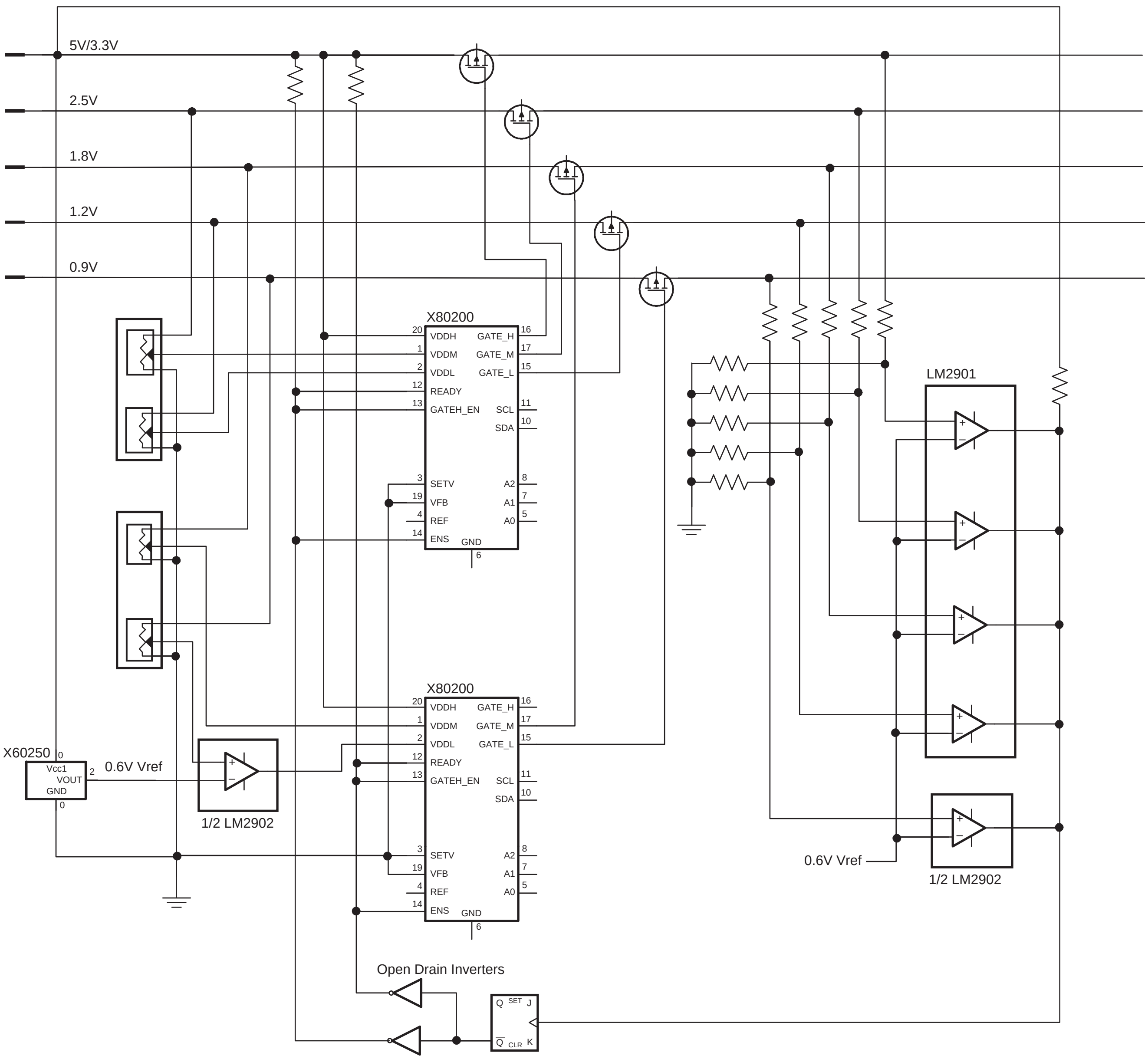


FIGURE 4. CIRCUIT 1 TIMING



- The 2.5V and 1.25V follow each other with a time delay after the 5V/3.3V.
- The 1.8V and 0.9V follow each other with a time delay after the 5V/3.3V.
- If 5V/3.3V is not ‘good’, then no other supplies power up.
- If either 1.8V or 0.9V is not active, the 2.5V and 1.25V supplies can still power on.
- If either 2.5V or 1.25V is not active, the 1.8V and 0.9V supplies can still power on.
- Any output failure after all supplies are good, cause all supplies to turn off.

FIGURE 5. CIRCUIT 2 BLOCK DIAGRAM

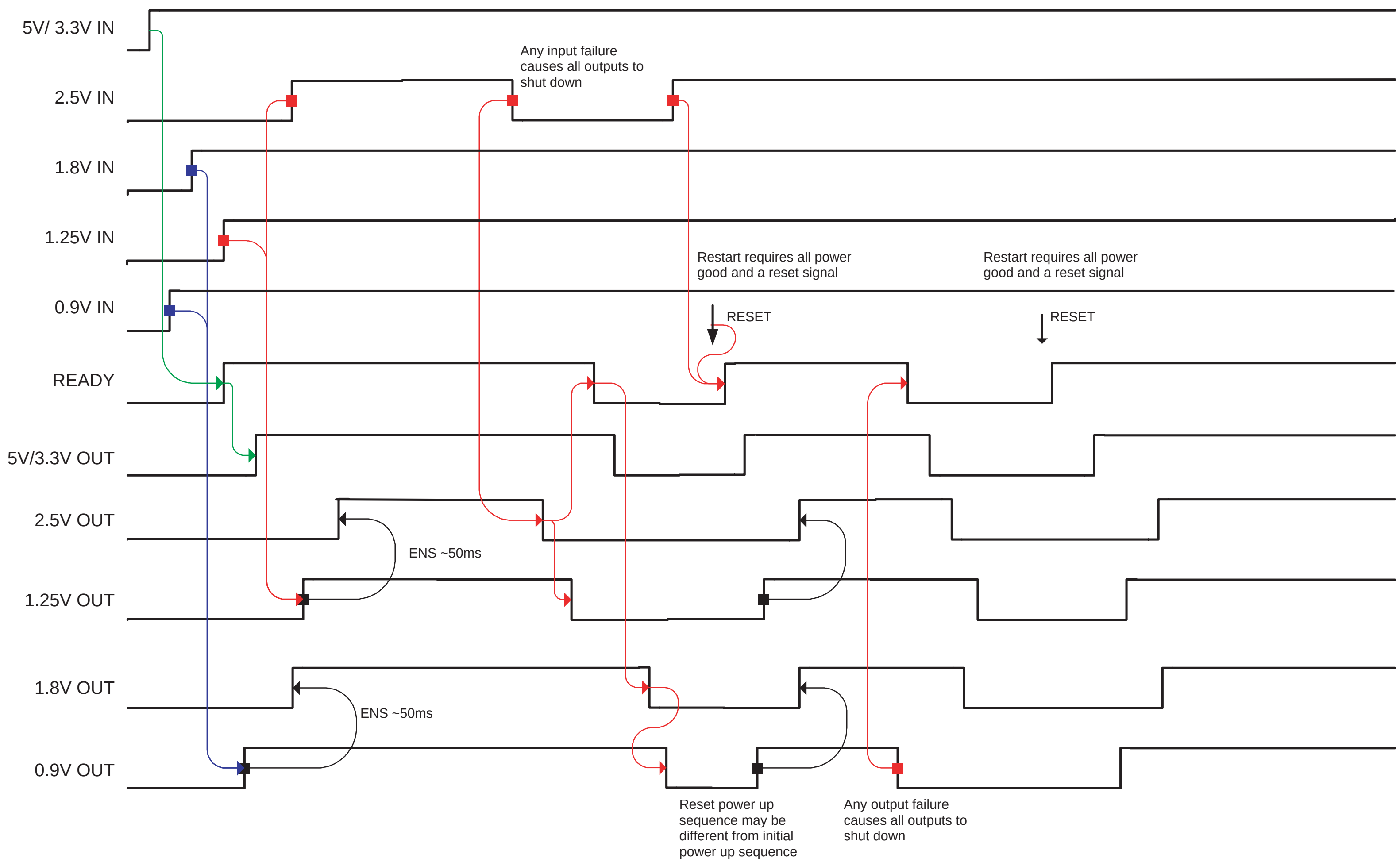
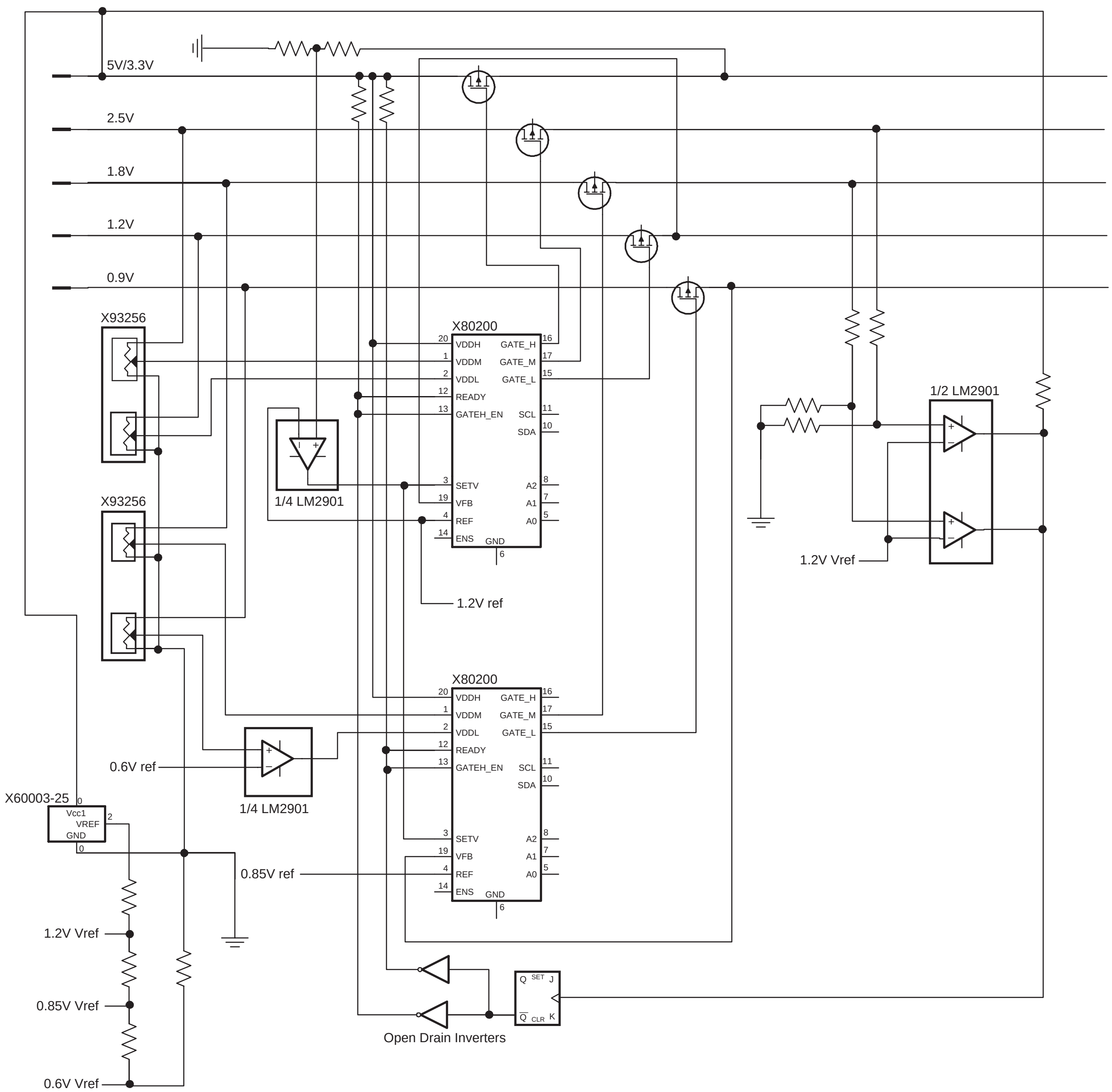


FIGURE 6. CIRCUIT 2 TIMING



- The 2.5V follows 1.25V which follows the 5V/3.3V. 1.25V needs to reach threshold before 2.5V output starts. 1.25V output failure turns off 2.5V, but not 5V/3/3V. 2.5V failure turns off all supplies.
- The 1.8V follows 0.9V which follows the 5V/3.3V. 0.9V needs to reach threshold before 1.8V output starts. 0.9V output failure turns off 1.8V, but not 5V/3/3V. 1.8V failure turns off all supplies.
- If 5V/3.3V is not 'good', then no other supplies power up.
- If either 1.8V or 0.9V is not active, the 2.5V and 1.25V supplies can still power on.
- If either 2.5V or 1.25V is not active, the 1.8V and 0.9V supplies can still power on.

FIGURE 7. CIRCUIT 3 BLOCK DIAGRAM

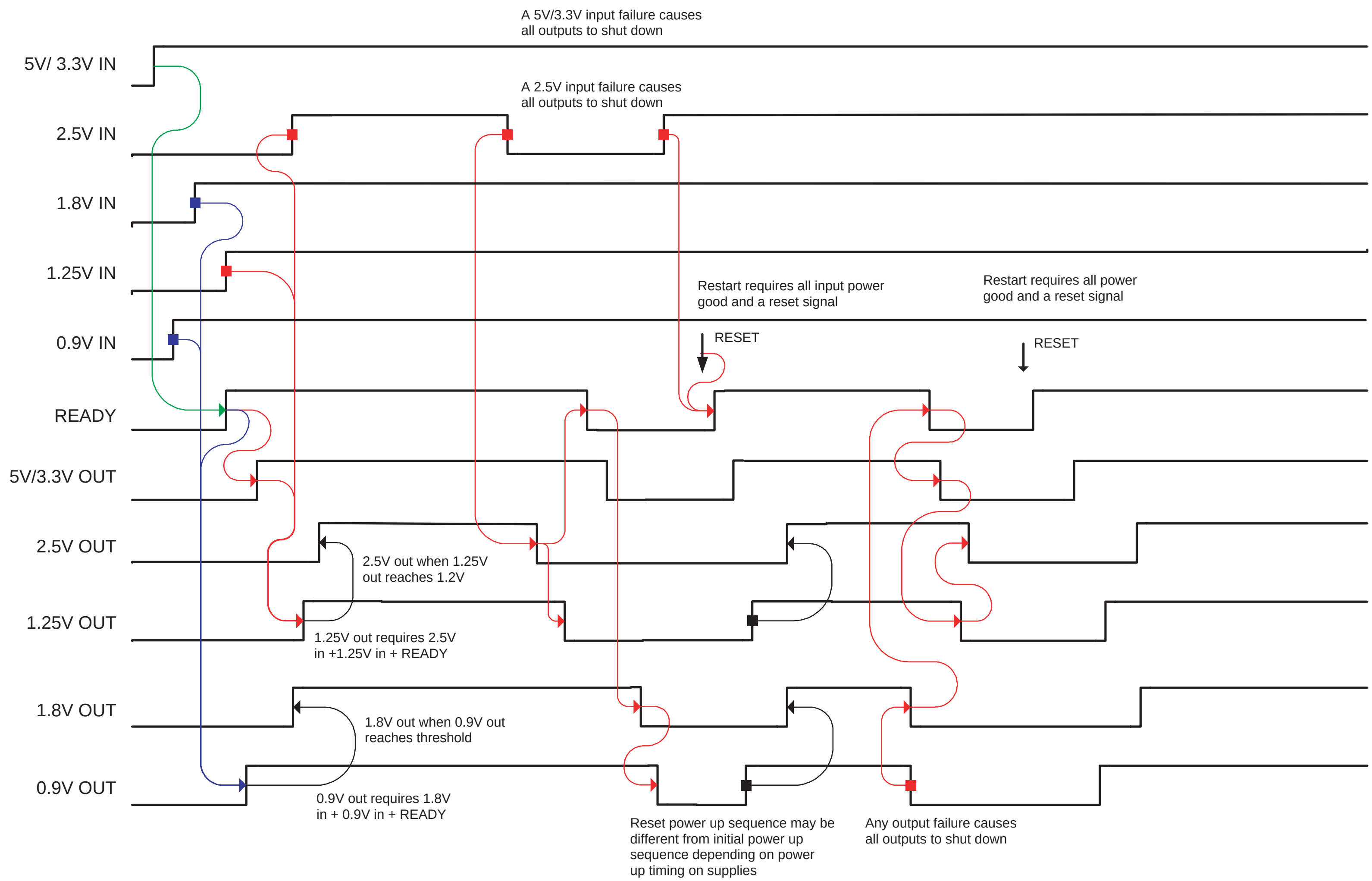


FIGURE 8. CIRCUIT 3 TIMING