

## Introduction

In some systems, there is a need to provide multiple voltages that track each other on power up and on power down. In this application note, the X80200 device is used to drive three N-channel FETs and provide some of the tracking logic. External RC components and FETs are used to “synchronize” the outputs and external comparators provide additional fault shutdown of the circuit.

This circuit was constructed and sample waveforms are provided in the document.

## Circuit Requirements

The following are the criteria for the circuit.

1. None of the outputs turn on until all inputs are above a minimum voltage.
2. The outputs turn on with a slew rate of between 100V/sec and 1000V/sec (0 to 5V in 5 to 50ms.)
3. The outputs turn on together with maximum voltage differential of 500mV.
4. If any input or output fails, all outputs turn off.

## Circuit Description

The circuit used is shown as a block diagram in Figure 1 and as a schematic in Figure 3. This circuit tracks 5V, 3.3V, and 1.2V on power-up. Other voltages can be used with the appropriate selection of components. In this circuit the X80200 READY output indicates if the 5V is good. External comparators in U2 indicate if the 3.3V and 1.2V supplies are good. These outputs are wire-ANDed with READY to generate a control signal.

Detecting the three inputs as good starts the turn-on sequence. Since the X80200 is an “open-loop” control element, controlling the outputs is done by adjusting the inputs. On the X80200, the response to GATEH\_EN is faster than the response to SETV. Because of this, changing the delay of a start signal on GATEH\_EN relative to SETV provides matching of the 5V and 1.2V output ramps. Matching the 3.3V and the 1.2V timing is controlled by changing the relative thresholds on SETV and VFB, by changing the comparator reference voltage on REF. This circuit uses potentiometers to adjust the input timing and thresholds, but the pots can be replaced with individual fixed resistors. By trimming these inputs, the outputs can be made to track on power up.

As each output voltage is commanded to turn on, the X80200 provides a constant current into the gate of each power FET. In this case the FET is an IRF1404. To control the slew rate, capacitors are added to the gates of the Power FETs.

In operation, the constant current charges up the capacitor on the gate of the FET and is clamped at a maximum voltage. Since each output provides identical current and each FET is the same, the ramp of the FETs is ideally equal. In actual practice, the X80200 provides faster turn-on time for FETs requiring a higher gate voltage. To better match the outputs, slightly higher capacitors are added to the gates of the higher voltage power supply FETs.

While this circuit does not track the supplies on power down, it does turn them off relatively quickly and within 1 ms of each other. To make sure the outputs turn off fairly close together, a diode is added to the GATEH\_EN input to speed the turn-off of the 5V output.

The 74HC74 flip flop provides turn-off control in case any of the outputs should fail. The flip-flop is cleared on initial power up by the flip-flop clear logic. The clock input comes from the output of three open collector comparators. After all three output voltages exceed a minimum threshold (indicating proper operation) a failure of any supply clocks the flip-flop, turning off the input controls and shutting down all outputs.

A DPST switch is added to both reset the flip flop in the event an output fails and generate a manual reset.

Bypass capacitors on each supply line reduce the noise induced by the X80200s internal charge pumps on the input reference voltages and makes the turn-on option more repeatable.

## Power Supply Tracking Results

The circuit describe was used to power up three supplies, 5V, 3.3V, and 1.2V. The responses begin with a trimmed circuit to minimize the output voltage differential on power-up. To avoid the need to trim each unit, the response was also checked with several variations. These are listed on the following pages.

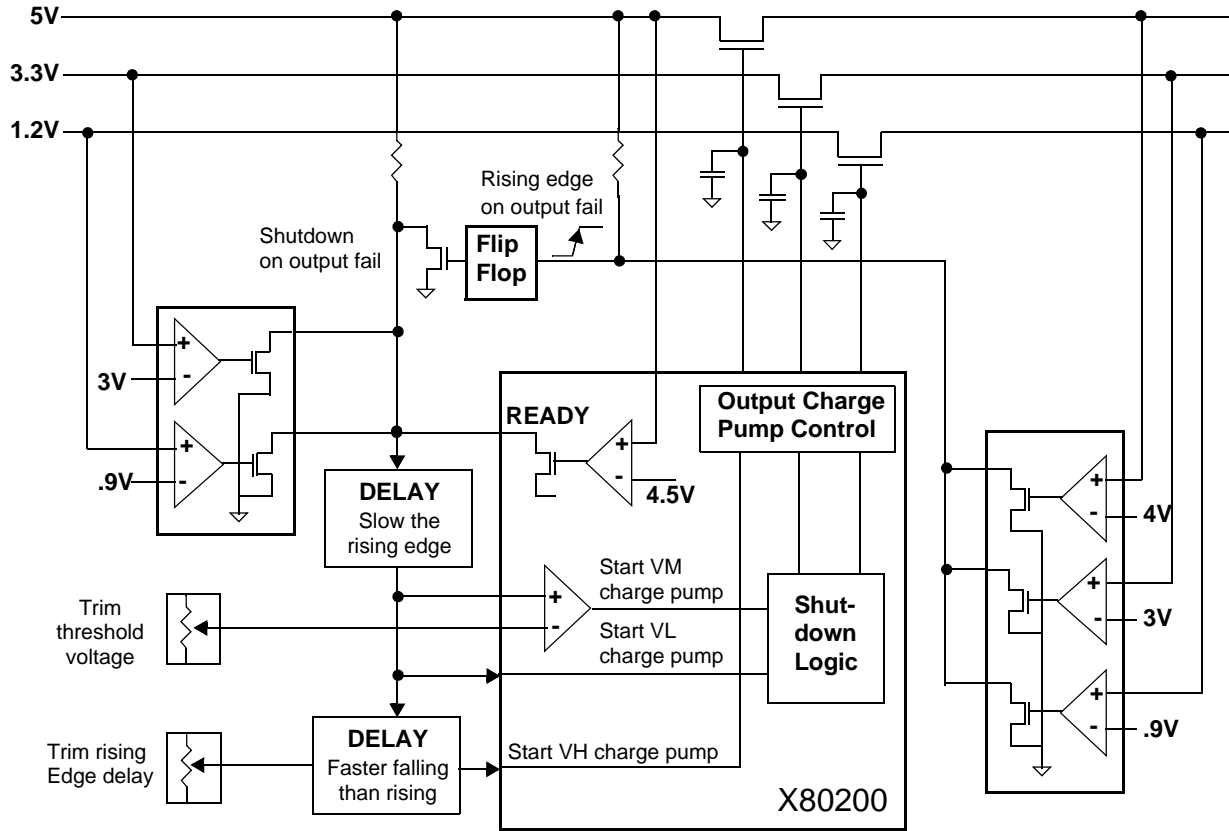


FIGURE 1. X80200 VOLTAGE TRACKER BLOCK DIAGRAM

1. Change the delay on the GATEH\_EN input by 20%. This simulates the variation of the RC time constant over production.
2. Change the reference voltage on the X80200 VFB comparator by 2%. This simulates both the variation on the resistor divider, but the variation on the input threshold from device to device.
3. Trim the circuit for one device and replace it with others to examine the variation from device to device.
4. Add a load to one of the outputs to explore the effects of a load on turn-on.

In addition to power-up, the power down response is shown below, assuming failure of each supply.

**Trimmed Response**

The following figures illustrate the performance of this circuit. In Figure 2, the outputs are trimmed using the potentiometers. This figure shows that the maximum deviation from one supply to another is less than 100mV. In the following figures, the turn off response of the circuit is shown for failures of the 5V supply, 3.3V supply and the 1.2V supply.

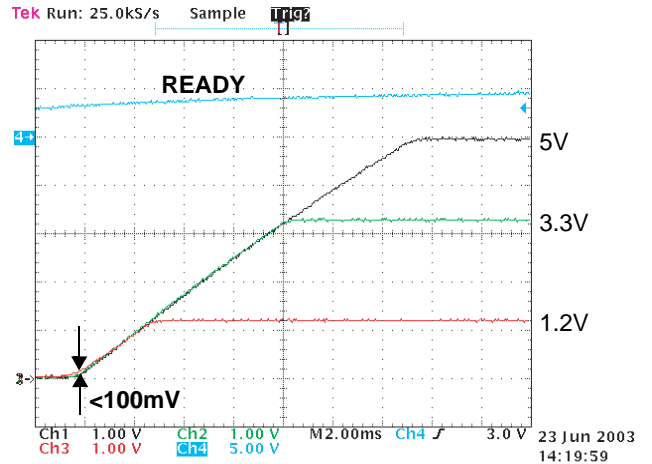


FIGURE 2. VOLTAGE TRACKING – POWER-ON (TRIMMED)

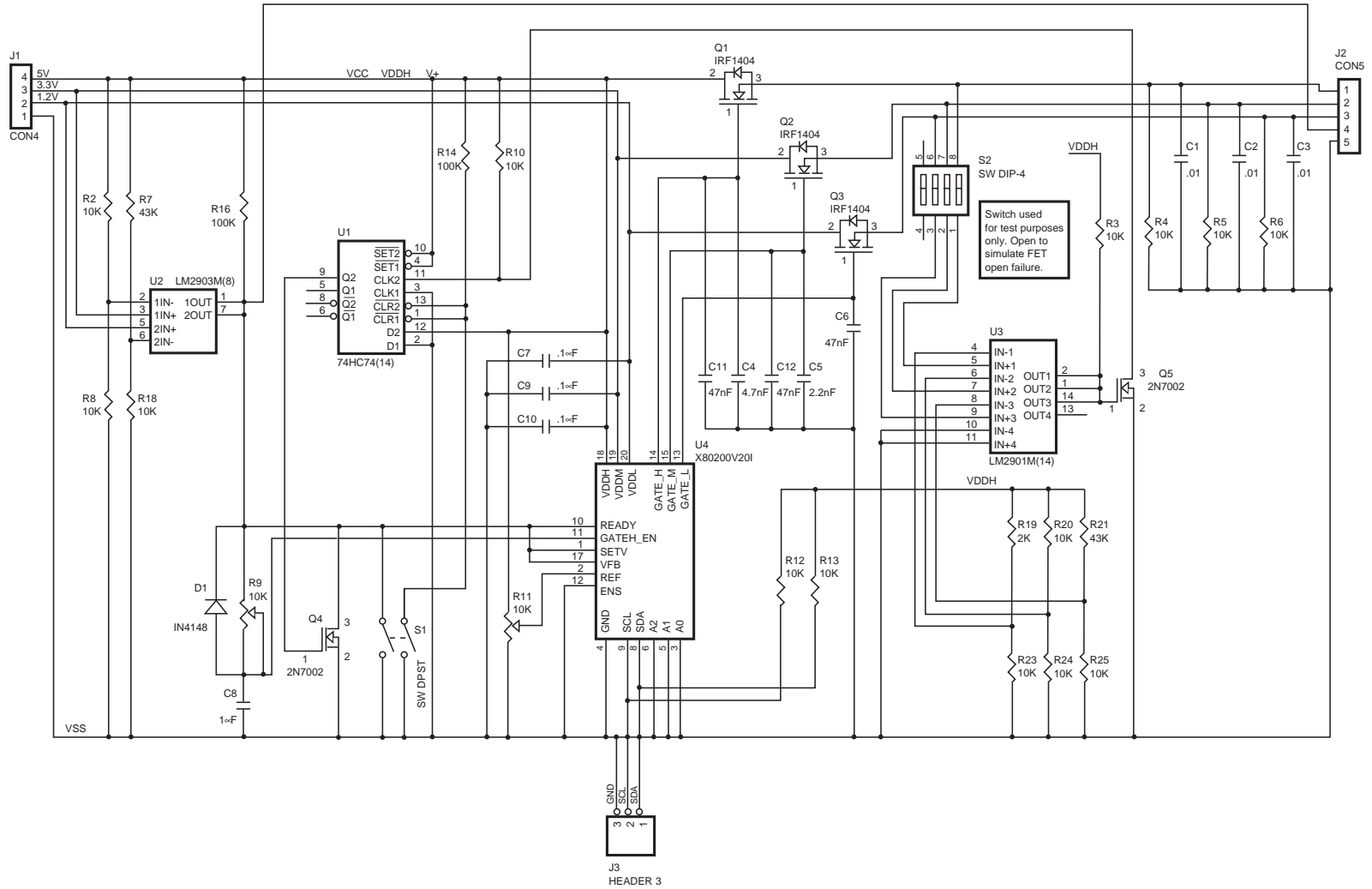


FIGURE 3. X80200 BASED TRIPLE VOLTAGE TRACKER

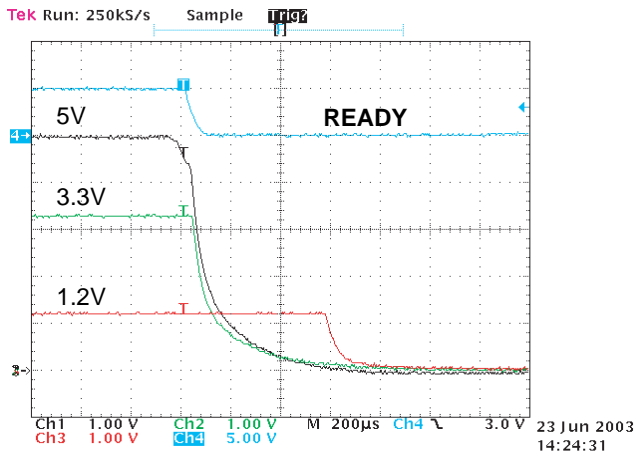


FIGURE 4. VOLTAGE TRACKING – POWER-OFF (5V FAILS)

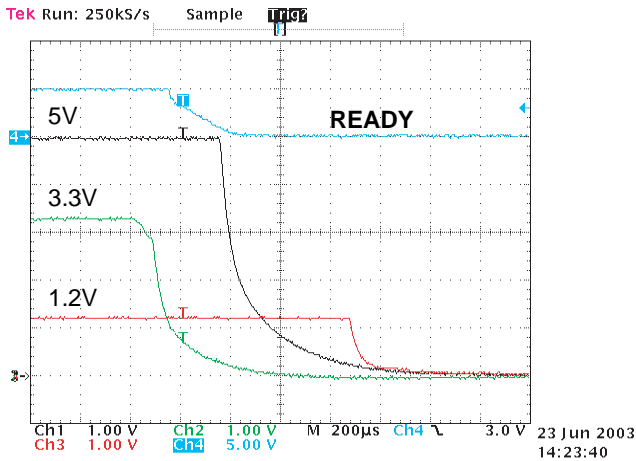


FIGURE 5. VOLTAGE TRACKING – POWER-OFF (3.3V FAILS)

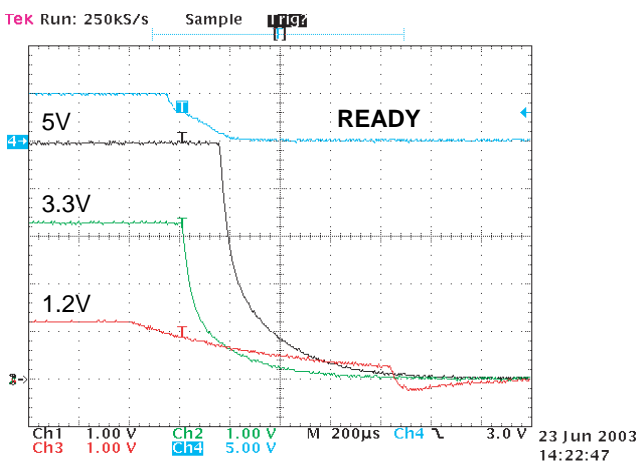


FIGURE 6. VOLTAGE TRACKING – POWER-OFF (1.2V FAILS)

**Error Due to Component Variations**

In the next two figures, the input timing and threshold are changed to reflect possible changes in production. Figure 7

shows the power-on tracking if the RC time constant for the GATEH\_EN input changes by 20%. This is done by changing the resistor value from 2.45kΩ to 2.7kΩ. With this change, there is about 100mV change in the output tracking correlation.

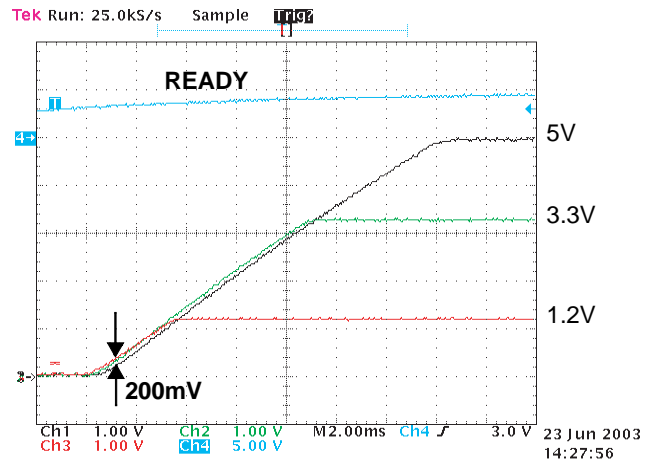


FIGURE 7. VOLTAGE TRACKING – POWER-ON (GATEH\_EN TIMING CHANGED)

The circuit is re-trimmed and the threshold on the VFB comparator is changed by 2%. This changes the point at which the 3.3V output starts relative to the 1.2V output. The response is shown in Figure 8. In this case, the output tracking error changes by about 80mV, worst case.

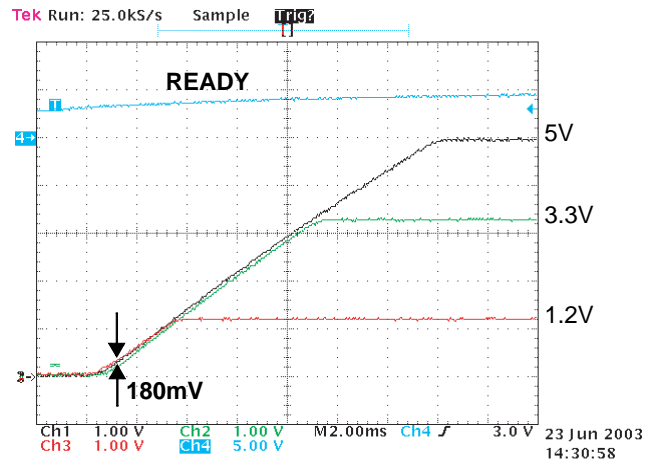


FIGURE 8. VOLTAGE TRACKING – POWER-ON (VREF THRESHOLD CHANGED)

**Error Due to The Use of Different Devices**

The preceding figure showing the trimmed circuit shows the response using device A. The following two figures show the results of units B and C. For these figures the circuit was not re-trimmed. Any errors are due to variations in input thresholds and internal delays. The lack of errors here is important, because maintaining accuracy without trim saves the addition of test time and the cost of potentiometers. From Figure 9 and Figure 10, there is very little change as a result of using different

devices. This test can be expanded using at least 3 units from three different lots and be tested over a wider temperature range, but the results from these random units are encouraging.

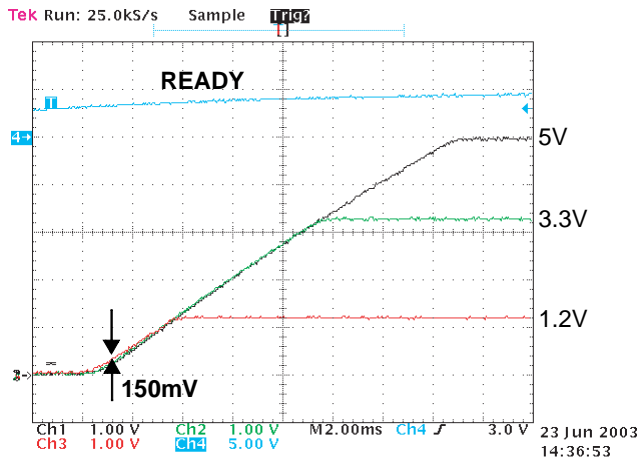


FIGURE 9. VOLTAGE TRACKING – POWER-ON (UNIT B)

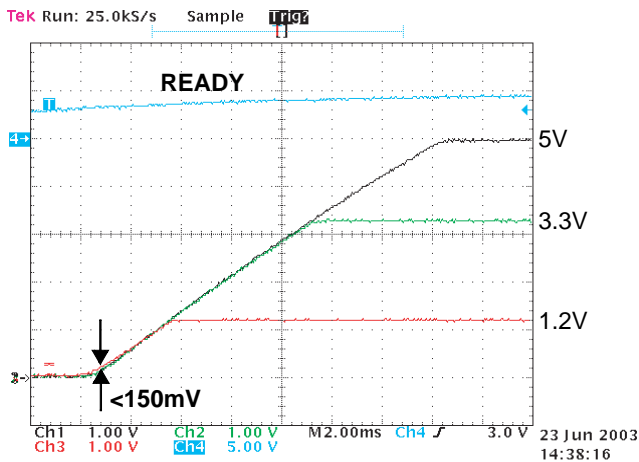


FIGURE 10. VOLTAGE TRACKING – POWER-ON (UNIT C)

**Error Due to Output Loading**

In this final test, a 15Ω resistor is connected to the 5V output prior to power-on. This is equivalent to a 330mA load being applied to the 5V output as the FET turns on. Though the resistor may not be a good representation of an actual load, this circuit performs optimally with minimal (or equal) loads on all power supplies. The addition of a load on the FETs before they have fully turned on can significantly affect the output tracking. This effect results from the interaction of the gate drive on the FET and the load current. The loading on the FET does not change the input voltage reference threshold or relative timing of the drive signals on the FET gates.

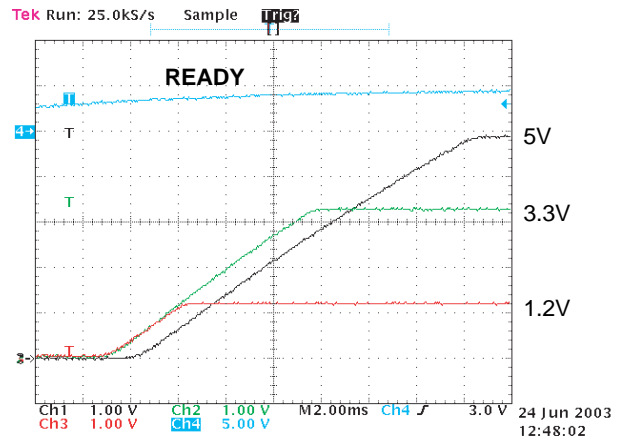


FIGURE 11. VOLTAGE TRACKING – POWER-ON (15Ω LOAD ON 5V OUTPUT)

**Additional Comments**

This circuit has some additional characteristics.

- 1) In the event of a short circuit on the output of the 5V FET, none of the outputs will turn on. If either the 3.3V output or the 1.2V output is shorted, neither will turn on, but 5V will power up.
- 2) The circuit will not detect a condition in which one of the FETs is open on power up. It will detect a failure condition in which an FET opens after power up. To detect the initial power on failure condition, use the second flip flop. Connect a long RC time constant to CLK1, connect the D1 input of the flip flop to the same signal as on CLK2 and connect Q1 to the gate of an additional 2N7002. These additions act like a watchdog timer. If the RC times out before all outputs are good, the Q1 output goes high. This turns on the 2N7002, then the 2N7002 drain pulls READY low, shutting down all outputs. The unused comparator could be used to “clean-up” the long RC time constant.
- 3) The turn-off characteristics, shown above for the trimmed circuit, do not change appreciably for changes in the RC, changes on the input threshold, or changes from device to device.

**Conclusion**

As shown in this application note, the X80200 can be used as a simple voltage tracking device for two or three power supplies. It has some limitations, but overall it does a good job of tracking voltages within the specified limits. It achieves this with the use of very few components and with a low total cost.

Intersil Corporation reserves the right to make changes in circuit design, software and/or specifications at any time without notice. Accordingly, the reader is cautioned to verify that the Application Note or Technical Brief is current before proceeding.