Virtually *Glitch-free* Bipolar crosspoint Switches

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INFORMATION NOTE

INTRODUCTION

Bipolar video crosspoint switches manufactured by Gennum Corporation are virtually *glitch-free* when compared to switches using CMOS and DMOS technologies.

The reason?

Gennum designed a make-before-break switching circuit to keep the output switching transients small. In addition, the bipolar, unidirectional transmission path offers extremely high output to input signal isolation.

MOS BREAK-BEFORE-MAKE SWITCHING

Both CMOS and DMOS switching are accomplished by altering the channel resistance of the switching transistors from a high impedance off-state to a low impedance on-state. The on-state, (whether or not the switch is configured as a 'T') allows bidirectional transmission of signals from the input to output as well as output to input.

When switching to a second channel, a dead-time must be incorporated to ensure that both channels are not on at the same time. If they are, the two inputs would be effectively shorted together by the on-channel resistances. This break-before-make switching action causes severe *glitches* on the output which are in part coupled to the input by the bidirectional transmission path.

BIPOLAR MAKE-BEFORE-BREAK SWITCHING

In bipolar crosspoints, the output to the input isolation in the enabled or on-state is typically in excess of 85 dB. A series of emitter followers and level shifting diodes produce a transmission path which is inherently unidirectional. Turning on two crosspoints at once results in the signals mixing at the output but interferes little with the input signals. This allows the use of make-before-break switching which keeps the output transient very small.

COMPARISON OF TRANSIENTS BETWEEN CMOS, DMOS AND BIPOLAR SWITCHES

The test set-up to compare the switching transients of a buffered MOS, a T-configured MOS and Gennum's bipolar GX414 monolithic crosspoint is shown in Figure 1.

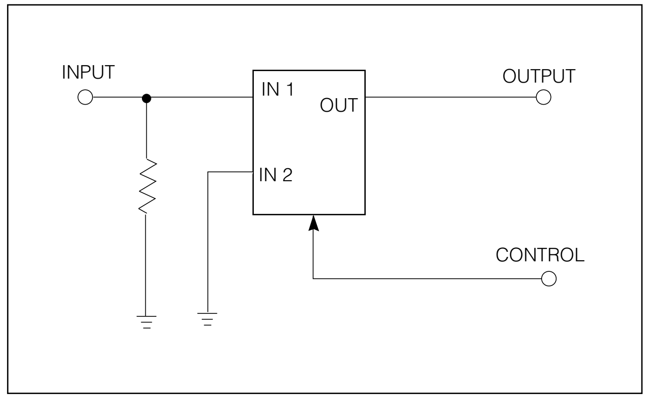

Fig. 1

The signal causes the switches to alternate between Input 1 and Input 2. IN 1 is tied to ground by a 75 Ω resistor so that the voltage on it can be monitored by an oscilloscope, while IN 2 is tied directly to ground.

Figures 2, 3 and 4 show the results of these tests. The left hand side of each of these figures show IN 1 and output waveforms when the switch is toggled from IN 1 to IN 2. The right hand side shows the same points when the switch is toggled back from IN 2 to IN 1.

In the buffered CMOS example of Figure 2, an output *glitch* appears which exceeds 250 mV in both the positive and negative direction and a reflected input *glitch* of approximately 10 mV. This output transient is reflected back to the input because the channel is still ON for a short period of time. When switching back from IN 2 to IN 1 the input *glitch* is smaller, since the channel from IN 1 to the output is not yet made. The duration of the input *glitch* is approximately 20 ns, while the output transient rings for an additional 100 ns.

INPUT (5 mV/div)

OUTPUT (200 mV/div)

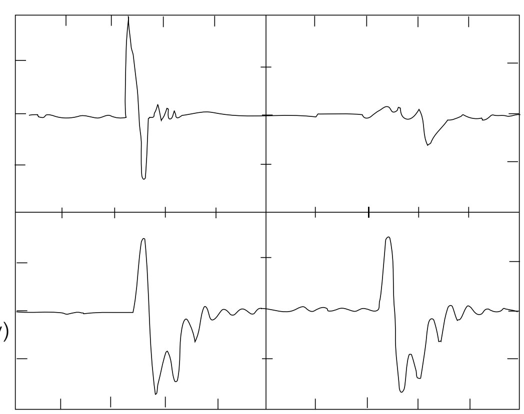

Fig. 2 T-Buffered CMOS (50 ns/div)

Figure 3 shows that under similar switching conditions, the T-configured DMOS device has a large negative transient of over 100 mV at the input when switched from channel 1 to channel 2, and a smaller positive transient when the device is toggled back. The large negative pulse at the output represents the dead-time and clearly shows the break-before-make switching action. However, it should be noted that a large amount of overshoot occurs on the rising edge of the output signal. Again, the duration of the input glitches is quite short and varies between 20 ns to 40 ns, while the output dead-time exceeds 70 ns.

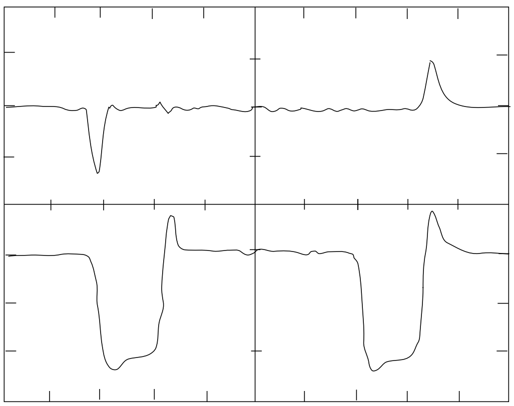

Fig. 3 T-Configured DMOS (50 ns/div)

The last figure shows the minimal transients produced by the bipolar crosspoint. Note the change in scales for both the amplitude and time duration. The input glitches are not due to the output transients, but are a function of the bias current on the input emitter follower transistor. The negative going output transient is less than 20 mV peak, and has a duration of approximately 100 ns. It is followed by a damped waveform of less than 20 mV peak, having a fundamental period of about 600 ns. These low frequency transients do not create any out-of-band noise and do not need to be filtered.

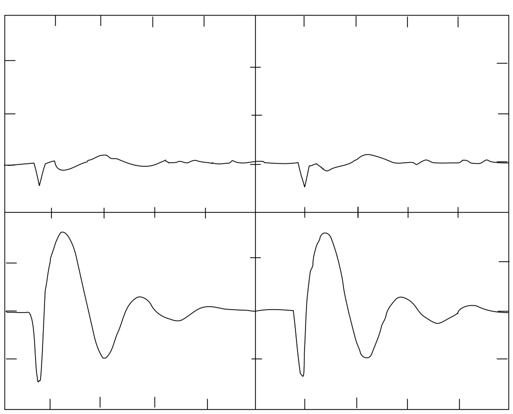

Fig. 4 GX414 Bipolar (500 ns/div)

CONCLUSIONS

For MOS switches to be used as video crosspoints, extra external circuitry is always needed. The external circuitry usually consists of input buffers (having very low output impedance) and an output clamping circuit.

In DMOS circuits, the input buffer (which is usually an emitter follower) is used to provide isolation from the switching transients present at the input of each switch. If the buffer was not included and multi-inputs were used in a matrix configuration, glitches would appear on the input bus and affect all other crosspoints connected to that bus. Gennum's GX414, GX414A, GX424 and GX434 bipolar crosspoints have that buffer built-in.

The ratio of ON to OFF capacitance at the input of a MOS switch can be an order of magnitude or more. The absolute capacitance could change from 4 pF to 45 pF. This means the input drive signal sees an undesireable, widely changing impedance. With the built-in buffer the Gennum products listed have an input ON to OFF capacitance ratio near unity, with absolute values of only 2.0 pF and 2.4 pF.

The serious output glitches produced by the MOS switches could be interpreted as sync pulses by subsequent equipment. To remove this problem, the output must be clamped during the switching dead-time. The output transients generated by Gennum crosspoints are extremely small and clamping is not needed.

Even though MOS crosspoint switches consume less power, the saving is negated by the external circuitry necessary to make the switch function properly in a video system. Gennum's family of bipolar crosspoints require no extra circuitry since they are designed specifically for video routing and switching applications.