

### Introduction

This application note describes the requirements for a differential interface being referenced to the VIH (Input High Voltage) of an input signal.

### Advantages of a Differential Interface

- It offers a wide range of input signaling standards and works with a wide range of input offset voltage.
- Greater immunity to common mode noise. Has tolerance to ground offsets or noise.
- Suitability for use with a low voltage application.
- Less power and substrate noise during signal transition. Current switching much less than single ended interface.
- Reduced EMI due to the cancellation in differential traces.

### Requirements of Differential Interface

The input requirement for a differential interface is different from the requirement for a single ended interface. In a single ended interface such as LVCMOS, LVTTTL, single-ended HSTL or single-ended PECL/ECL, the VOH and VOL must meet the VIH and VIL requirements of the receivers. In the differential interface, such as LVPECL, HSTL, HCSL, CML, LVDS, or SSTL, the VIH and VIL are no longer referenced. The input parameters VPP and VCMR are now the requirements. Only VSWING and the VOH of the incoming signal are required to meet both VPP and VCMR.

$$V_{PP} < V_{SWING} < V_{PP\_MAX}$$

$$V_{CMR\_MIN} < V_{OH} < V_{CMR\_MAX}$$

VPP = Input peak-to-peak voltage requirement

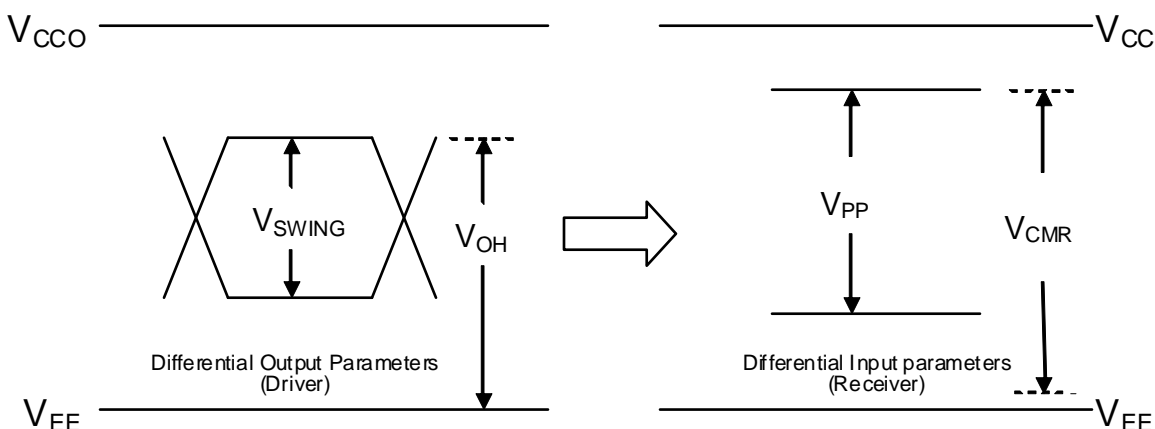
VCMR = Input Common Mode Range Voltage requirement

VSWING = Driver output swing

VOH = Driver output logic high

Figure 1 shows the relationship between VSWING, VOH and VPP, VCMR. The following conditions must be met for a valid input signal: VSWING must be within the required range of the specified VPP and the VOH must be within the VCMR range.

**Figure 1. Relationship between Interface Parameters**



**Figure 2. Typical Datasheet for V<sub>CMR</sub> and V<sub>PP</sub>**

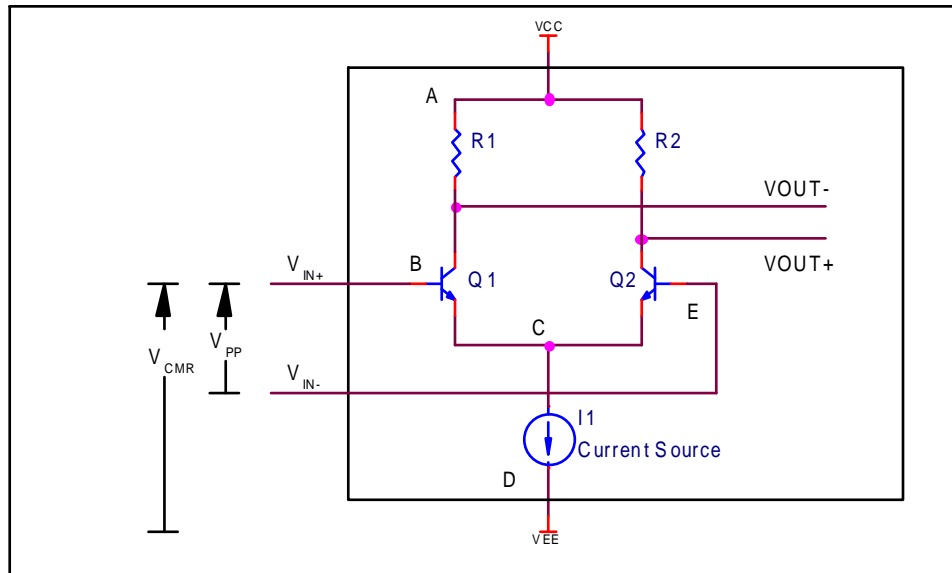
Symbol	Parameter	Minimum	Typical	Maximum	Units
V <sub>PP</sub>	Peak-to-Peak Input Voltage	0.15		1.3	V
V <sub>CMR</sub>	Common Mode Input Voltage	V <sub>EE</sub> + 0.5		V <sub>CC</sub> - 0.85	V

### Example

Figure 2 shows a typical datasheet specification for both V<sub>PP</sub> and V<sub>CMR</sub>. As an example, let's use an input driver with an amplitude (V<sub>SWING</sub>) of 200mV and a V<sub>OH</sub> level at 2V. Will this work? First, the V<sub>SWING</sub> should be verified that it is within the V<sub>PP</sub> specification. Yes, 200mV falls between 0.15V and 1.3V. Second, the V<sub>OH</sub> of the signal must fall within the V<sub>CMR</sub> range. Assuming the V<sub>CC</sub> is 3.3V and V<sub>EE</sub> is 0V, the V<sub>CMR</sub> range will be 0.5V and 2.45V. Again, 2V fall within the V<sub>CMR</sub> range. Both of the conditions are met. This is a valid input. Though not specified, it is not recommended that the V<sub>IL</sub> goes below V<sub>EE</sub>. This could happen with the V<sub>PP</sub> at 1.3V and the V<sub>IH</sub> at V<sub>EE</sub>+0.5. That would put the V<sub>IL</sub> at 800mV below V<sub>EE</sub>.

### Limitations of V<sub>CMR</sub> and V<sub>PP</sub>

This section will describe the limitation of both V<sub>CMR</sub> and v from a circuit perspective. When V<sub>CMR</sub> is referenced to V<sub>IH</sub>, the analysis is purely DC. Some inputs also reference V<sub>CMR</sub> to the input signals cross-point. This would be a similar except it would be an AC analysis.

**Figure 3. Simplified Typical Differential Input Interface Circuit**


For the following analysis, refer to Figure 3. In determining V<sub>PP</sub>, both V<sub>PP(min)</sub> and V<sub>PP(max)</sub> specification must be examined. For both cases, V<sub>IN+</sub> is greater than V<sub>IN-</sub>, where V<sub>IN+</sub> is a logic high and V<sub>IN-</sub> is a logic low.

- V<sub>PP(min)</sub> is determined by the minimum voltage difference required to correctly operate the differential amplifier by keeping the Q1 transistor on and Q2 off.
- V<sub>PP(max)</sub> is determined by the maximum voltage swing allowable which will not forward bias either Q1 or Q2.

Similar to V<sub>PP</sub>, both V<sub>CMR(max)</sub> and V<sub>CMR(min)</sub> must be examined.

- V<sub>CMR(min)</sub> is determined by the minimum V<sub>CD</sub> required to keep the constant current source I1 function properly.
- V<sub>CMR(max)</sub> is determined by the minimum V<sub>AB</sub> required to prevent the forward biasing of Q1.



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