An 11,424 gate-count dynamic optically reconfigurable gate array with a photodiode memory architecture

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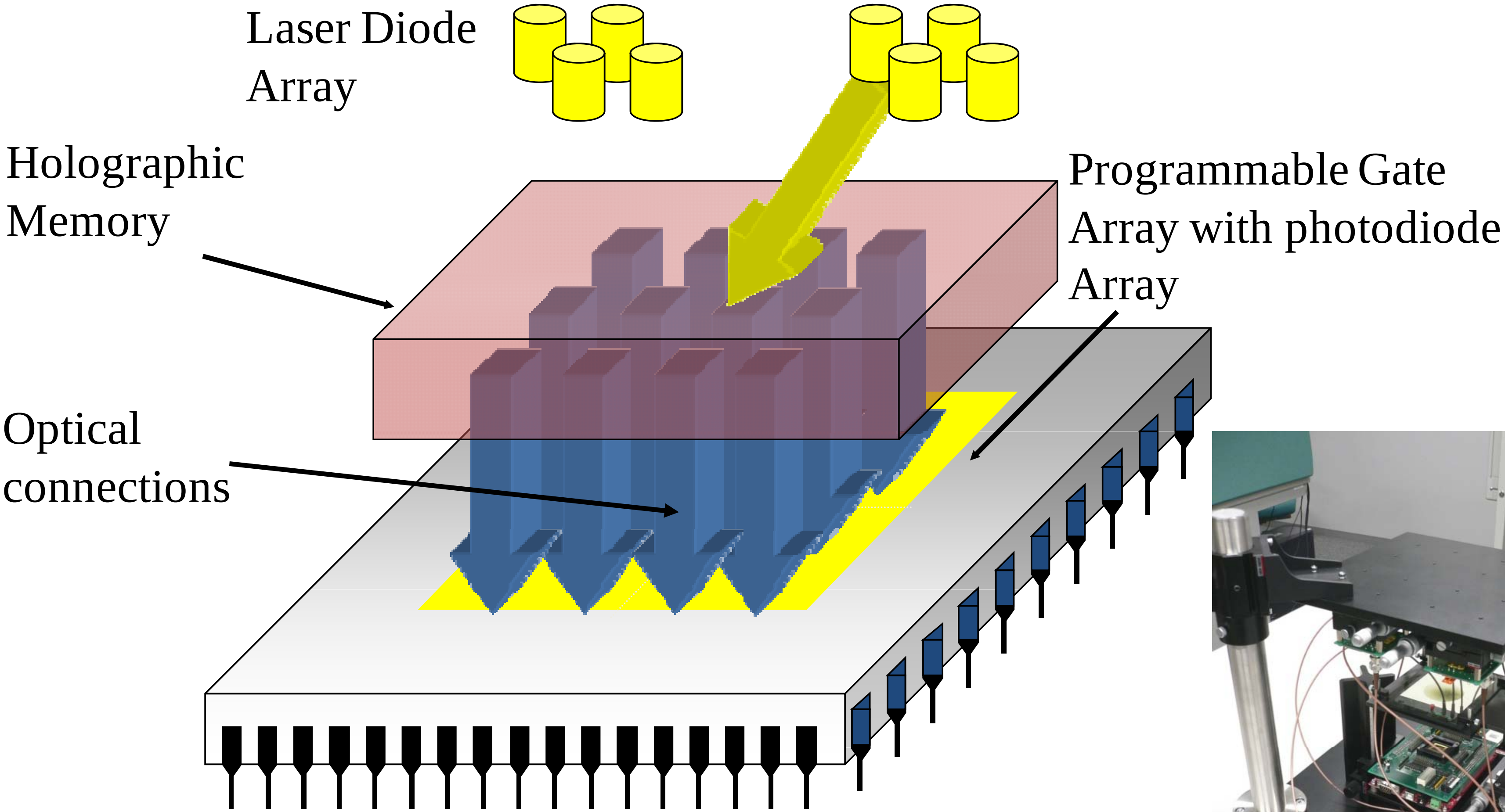
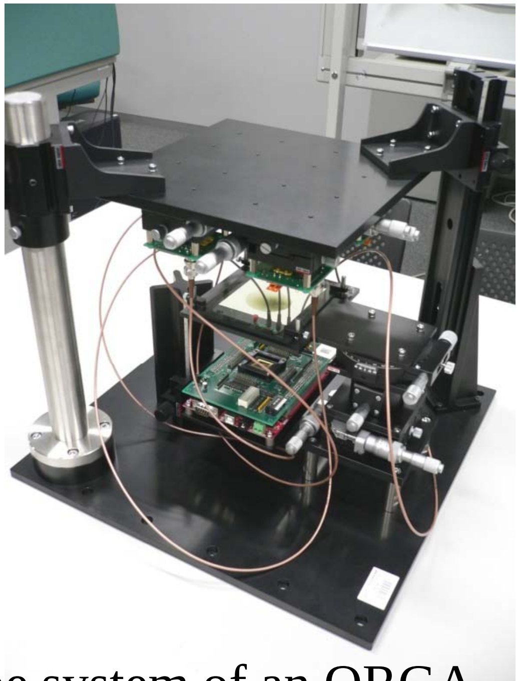
Basic construction of ORGA architecture



ORGA's advantages

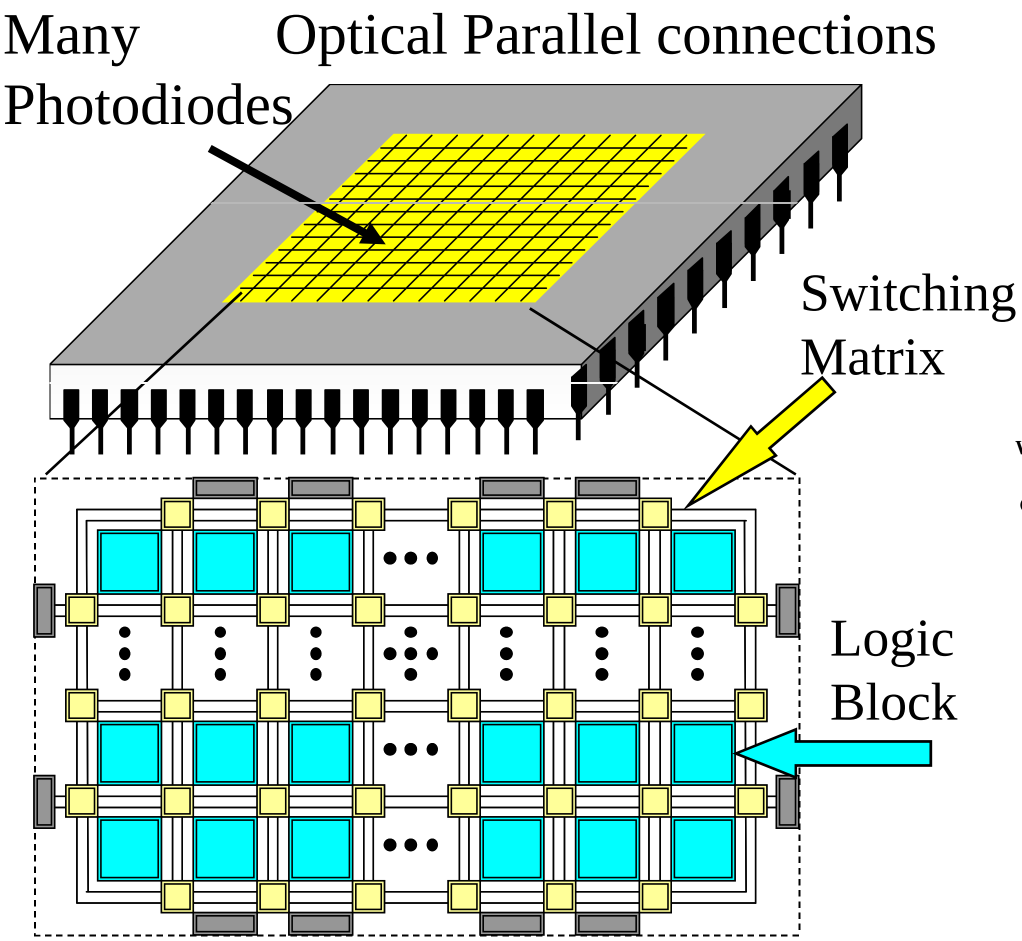
1) Fast reconfiguration capability.
2) Numerous reconfiguration contexts.

Over 1 Tera gete count VLSI will be realized.

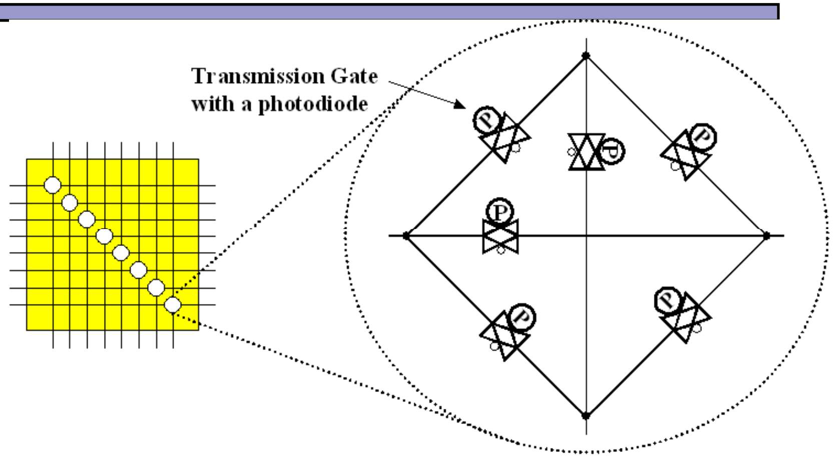


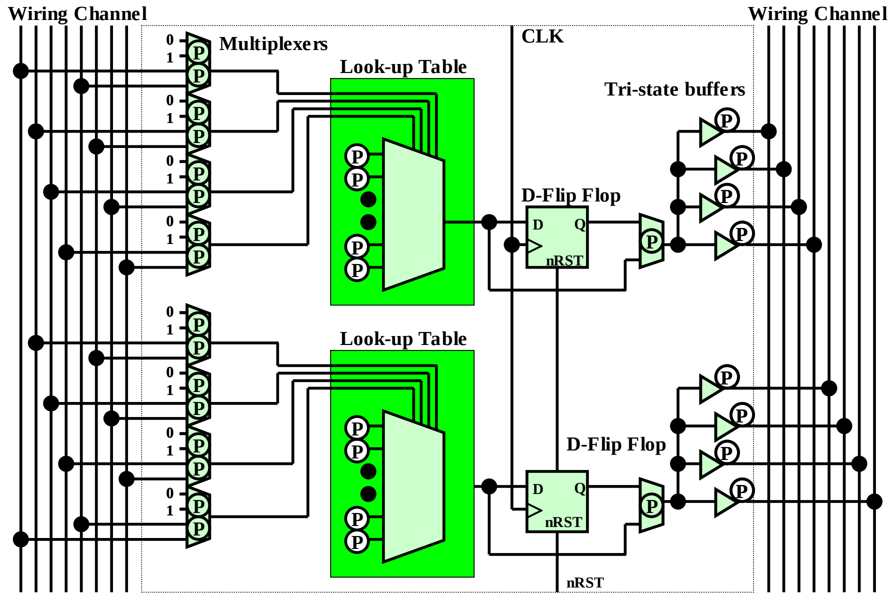
Prototype system of an ORGA.

Gate array structure



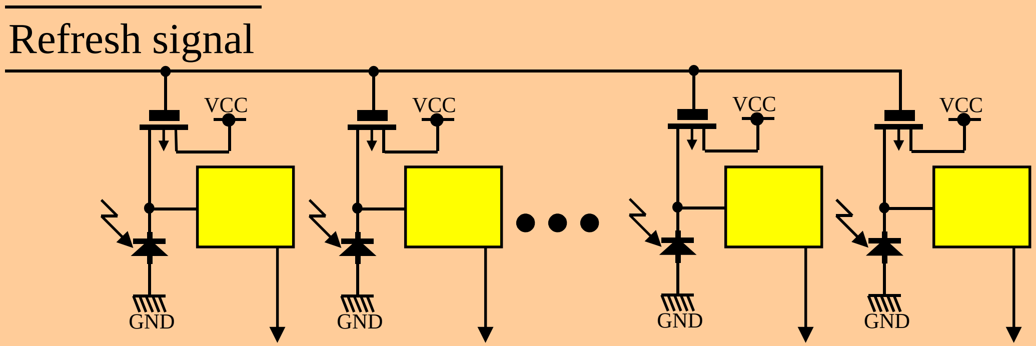
Island Gate Array Style





An ORGA takes Island-Style gate array. The basic structure is same as that of current FPGAs. However, each programming element of the gate array is connected to a photodiode (independent). Thereby, all state of the gate array can be programmed in perfectly parallel.

Dynamic optical reconfiguration circuit



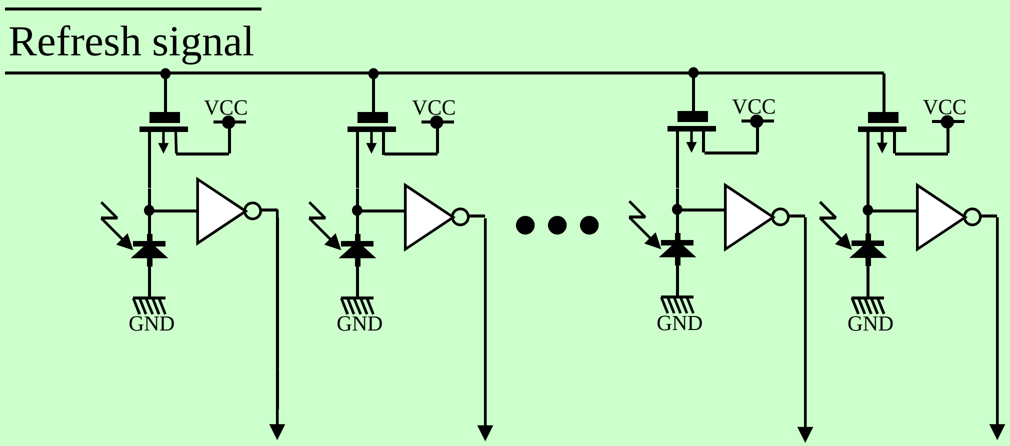
Configuration signals for Gate Array

Latch, Flip-Flop, or Memory

1bit-Reconfiguration Circuit with a static memory function

297 [μm^2]

Dynamic optical reconfiguration circuit

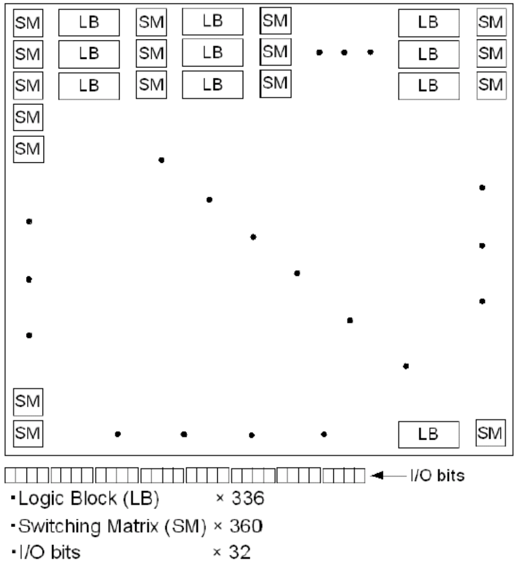


Configuration signals for Gate Array

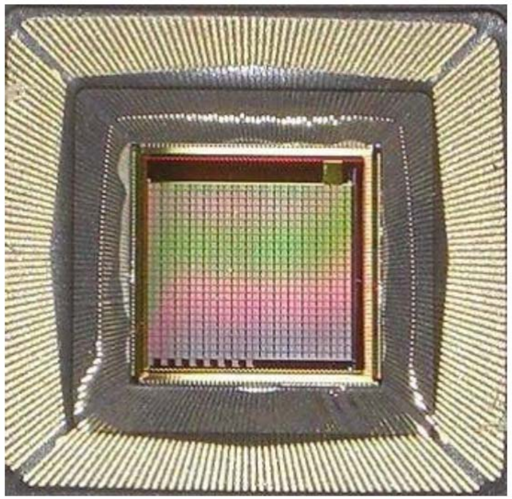
1bit-Dynamic Type Reconfiguration Circuit

36 [μm^2]

DORGA-VLSI Specifications



Placement

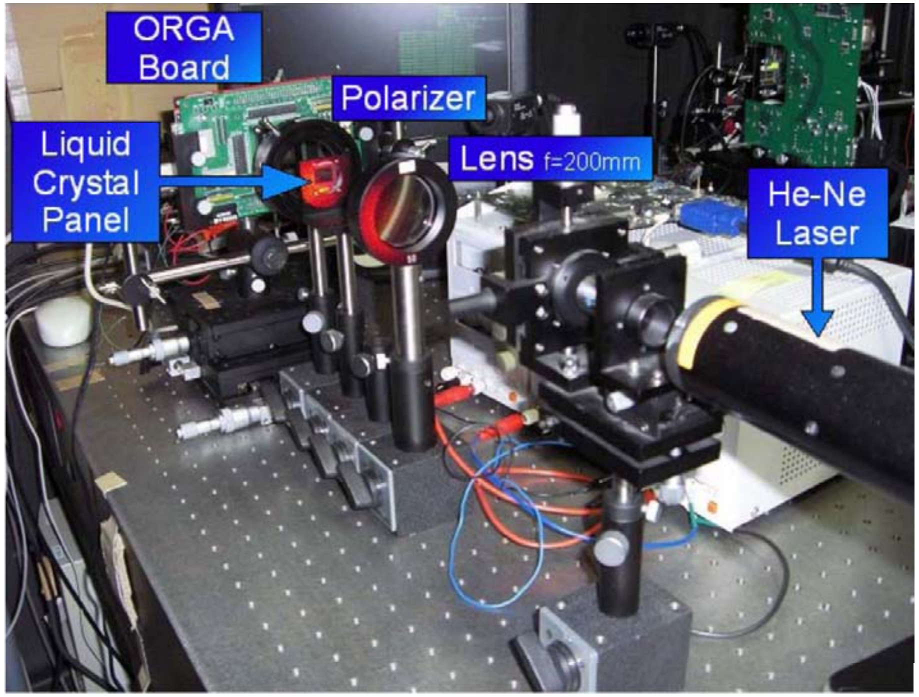


Chip Photograph

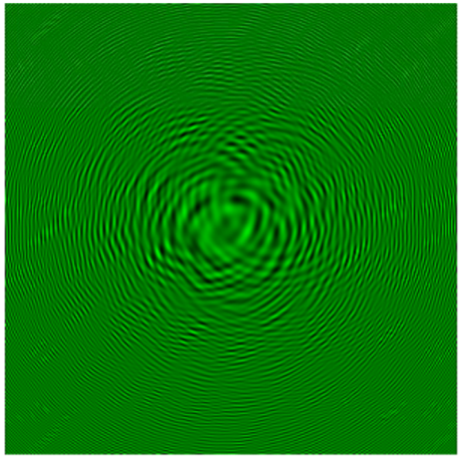
Specification of a DORGA-VLSI

Technology	0.35 μm double-poly triple-metal CMOS process
Chip size	9.8 × 9.8 [mm]
Supply Voltage	Core 3.3V, I/O 3.3V
Photodiode size	9.5 × 8.8 [μm]
Distance between Photodiodes	h.=34.5, v.= 33.0 [μm]
Number of Photodiodes	37,856
Number of Logic Blocks	336
Number of Switching Matrices	360
Number of Wires in a Routing Channel	8
Number of I/O blocks	8 (32 bit)
Gate Count	11,424

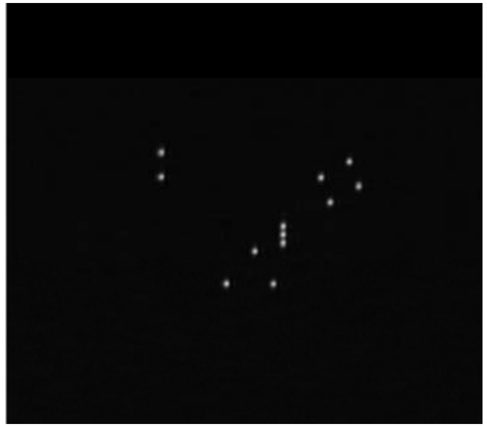
Experimental results



Optical system



Holographic memory



Context pattern

AND circuit implementation

Laser:	632.8nm 20mW He-Ne laser
Holographic memory	Liquid crystal –spatial light modulator
Retention time	45 s.
Photodiode response time	12.7pJ/Laser power