



US006307607B1

(12) **United States Patent**
Jepsen et al.

(10) **Patent No.:** **US 6,307,607 B1**
(45) **Date of Patent:** **Oct. 23, 2001**

(54) **REFLECTIVE LIQUID CRYSTAL DISPLAY WITH INTEGRATED COMPENSATION FOR SKEW ANGLE ROTATION AND BIREFRINGENCE EFFECTS**

(75) Inventors: **Mary Lou Jepsen**, San Francisco, CA (US); **Sjoerd Stallinga**, Eindhoven (NL); **Peter J. Janssen**, Scarborough; **Jeffrey A. Shimizu**, Peekskill, both of NY (US)

(73) Assignee: **Philips Electronics North America Corporation**, New York, NY (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **09/469,456**

(22) Filed: **Dec. 21, 1999**

(51) Int. Cl.⁷ **G02F 1/1335**

(52) U.S. Cl. **349/117; 349/5; 349/119; 349/120**

(58) Field of Search 349/117, 121, 349/5, 119, 120

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,119,220	*	6/1992	Narita et al.	359/73
5,327,270	*	7/1994	Miyatake	359/63
5,490,003	*	2/1996	Van Spring	359/63
5,658,490	*	8/1997	Sharp et al.	252/299.01
5,777,709	*	7/1998	Xu	349/120

5,829,852		11/1999	Jung	353/20
5,940,155	*	8/1999	Yang et al.	349/120
5,978,055	*	11/1999	Van De Wittle et al.	349/119
5,990,997	*	11/1999	Jones et al.	349/120
6,057,901	*	5/2000	Xu	349/121
6,078,374	*	6/2000	Sharp et al.	349/119
6,094,246	*	7/2000	Wong et al.	349/99
6,144,432	*	11/2000	Hatanaka et al.	349/119
6,144,433	*	11/2000	Tillin et al.	349/123

FOREIGN PATENT DOCUMENTS

0390511		10/1990	(EP)	G03B/21/00
0898196		2/1999	(EP)	G02F/11/39
02-37319-A	*	2/1990	(JP)	.
05-66384-A	*	3/1993	(JP)	.
07-301794-A	*	11/1995	(JP)	.

OTHER PUBLICATIONS

“Projection display throughput: Efficiency of optical transmission and light-source collection” by F. E. Doany et al., in IBM J. Res. Develop. vol. 42 No. 34, pp. 387-399.

* cited by examiner

Primary Examiner—William L. Sikes

Assistant Examiner—Tarifur R. Chowdhury

(57) **ABSTRACT**

A reflective liquid crystal (R-LCD) display device in which both the residual retardance of an R-LCD and the skew-angle effect of the analyzer may be compensated by a single compensator which has its optical axis oriented at an angle of from 1 to 30 degrees to the plane of polarization of the incident beam, eliminating the need for two separate compensators.

15 Claims, 5 Drawing Sheets

