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LA-UR - 89-3289

CONF-871007-45

Received by OSTI

NOV 0 1989

Los Alamos National Laboratory is operated by the University of California for the United States Department of Energy under contract W-7405-ENG-36

LA-UR--89-3289

DE90 002345

TITLE FIBER OPTIC CONTROL AND DIAGNOSTIC FAMILY OF HARDWARES
FOR THE CONFINEMENT PHYSICS RESEARCH FACILITY (CPRF)
TOROIDAL FIELD AND DC INTERRUPTER SYSTEMS

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SUBMITTED TO presented to the IEEE 13th Symposium on Fusion Engineering,
Knoxville, TN, October 2-6, 1989

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LA-UR-89-3289

**FIBER OPTIC CONTROL AND DIAGNOSTIC FAMILY
OF HARDWARES FOR THE
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TOROIDAL FIELD AND DC INTERRUPTER SYSTEMS**

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Los Alamos National Laboratory, Los Alamos, NM 87545

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FIG. 2

FIG. 3

NOTE 1: R1, R2, R3, R4, R5, R6, R7, R8, R9, R10, R11, R12, R13, R14, R15, R16, R17, R18, R19, R20, R21, R22, R23, R24, R25, R26, R27, R28, R29, R30, R31, R32, R33, R34, R35, R36, R37, R38, R39, R40, R41, R42, R43, R44, R45, R46, R47, R48, R49, R50, R51, R52, R53, R54, R55, R56, R57, R58, R59, R60, R61, R62, R63, R64, R65, R66, R67, R68, R69, R70, R71, R72, R73, R74, R75, R76, R77, R78, R79, R80, R81, R82, R83, R84, R85, R86, R87, R88, R89, R90, R91, R92, R93, R94, R95, R96, R97, R98, R99, R100.
NOTE 2: C1, C2, C3, C4, C5, C6, C7, C8, C9, C10, C11, C12, C13, C14, C15, C16, C17, C18, C19, C20, C21, C22, C23, C24, C25, C26, C27, C28, C29, C30, C31, C32, C33, C34, C35, C36, C37, C38, C39, C40, C41, C42, C43, C44, C45, C46, C47, C48, C49, C50, C51, C52, C53, C54, C55, C56, C57, C58, C59, C60, C61, C62, C63, C64, C65, C66, C67, C68, C69, C70, C71, C72, C73, C74, C75, C76, C77, C78, C79, C80, C81, C82, C83, C84, C85, C86, C87, C88, C89, C90, C91, C92, C93, C94, C95, C96, C97, C98, C99, C100.
NOTE 3: R6 AND R8 NOT REQUIRED FOR M1110.
NOTE 4: R1, R2, R3, R4, R5, R6, R7, R8, R9, R10, R11, R12, R13, R14, R15, R16, R17, R18, R19, R20, R21, R22, R23, R24, R25, R26, R27, R28, R29, R30, R31, R32, R33, R34, R35, R36, R37, R38, R39, R40, R41, R42, R43, R44, R45, R46, R47, R48, R49, R50, R51, R52, R53, R54, R55, R56, R57, R58, R59, R60, R61, R62, R63, R64, R65, R66, R67, R68, R69, R70, R71, R72, R73, R74, R75, R76, R77, R78, R79, R80, R81, R82, R83, R84, R85, R86, R87, R88, R89, R90, R91, R92, R93, R94, R95, R96, R97, R98, R99, R100.
NOTE 5: R MEANS INSTANTANEOUS AND VALUE AS REQUIRED.

Testing of this circuits also yields:

- CMRR $> 75\text{db}$
(DC-100kHz and any gain)
- r_r -Rise time $< 3\mu\text{S}$
- Output Drift $< 40\mu\text{V}/^\circ\text{C}$
(gain independent)

Receiver

The heart of the receiving system is the F/V "daughter" board, schematically shown in Fig. 4. This design features a nine pole active Bessel filter, thermal compensation, no input shutdown (output clamp), and a 50 Ω , 200 mA line driver output. Excellent triangle and square wave responses may be seen in Figs. 5, 6, and 7. The overall system parameters are as follows:

TABLE 1

Signal to noise (typical)	69db
Error (worst case, all causes)	.5%
Rise time (no overshoot)	4 μS
Design rise time	3.3 μS

FIG. 4

FIG. 5

1 KHZ. 10 V TRIANGLE WAVE
SYSTEM OUTPUT RESPONSE

FIG. 6

10V SYSTEM OUTPUT STEP RESPONSE

FIG. 7

10V 1KHZ. SQUARE WAVE OUTPUT RESPONSE

FIG. 8

FIG. 9

We have chosen the lower bandwidth 85 kHz response because of the lack of significant overshoot. The 100 kHz bandwidth is easily available to us, but has a more pronounced overshoot. The daughter board does not include any optic signal processing. The optical and/or pre-signal processing is performed by the mother board. An example of a 2 channel chassis mounted mother board is depicted in Fig. 8. This board provides pre-signal processing with link monitor indicators and an output for remote link status. Fiber optic or opto-coupled differential current loop inputs may be processed by the pc boards shown in Fig. 9. These boards then give the appropriate input to the mother board. For diagnostic use, a six channel fiber optic input Camac system was also developed (Fig. 10). This Camac mother board provides front panel "Link OK" monitors as well as K-Loc coax connector outputs.

FIG. 10

To calibrate the various transmitters and receivers, calibration fixtures have also been developed (Fig. 11). This chassis contains in addition to waveform and frequency synthesizers, a 4 1/2 digit voltage source, 4 1/2 digit voltmeter, and a precision digital frequency meter. Front panel selection switches provide a flexible assembly capable of testing any hardware set-up.

FIG. 11

Conclusion

Los Alamos developed a sophisticated set of precision hardware with sufficient flexibility to standardize control and diagnostic systems. The hardware sets have proven their reliability, quality, and flexibility in a high voltage, high current pulse power environment.