NATIONAL RADIO ASTRONOMY OBSERVATORY

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ELECTRONICS DIVISION TECHNICAL NOTE NO. 152

Title: **OPTICAL FIBER AT GREEN BANK**

Author(s): Ronald B. Weimer

Date: April 20, 1989

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OPTICAL FIBER AT GREEN BANK

Ronald B. Weimer

Introduction

This note is to put on paper some of the details picked up over the last couple of years working with optical fibers.

Fibers

Two types of fiber are used on site. Both are made by Optical Cable Corporation. The first is part number B02-070D-A6EB/ /900. This is the fiber used with the Fibercom Whisperlan Transceivers for ethernet transmission around the site. The ordering information is as follows:

B	Breakout cable.
02	Fiber count.
070	7 mm cable diameter.
D	Polyvinyl chloride (PVC) outer jacket.
A	Fiber type 50/125 graded index - multimode.
6	6 dB/km attenuation.
E	Bandwidth - 200 MHz - km.
B	Wavelength 850 nm.
/900	900 μm diameter tight buffer.

We have some of the cable left over in the Green Bank warehouse. We use pieces of it to make jumpers for extending the ethernet system and the communication links mentioned later.

Figure 1 shows the ethernet system installed around April 1988. When the 300-ft telescope collapsed, we eliminated that loop by looping back at the control building. Most of this cable is in conduit underground. The link between the Interfereomter CB and 85-1 was direct buried.

The second is an 8 fiber cable purchased by Jim Coe for interferometer use. Four in it are single-mode wide bandwidth fibers that Coe uses for RF/LO transmission. Four are multimode fibers. The part number for Jim's cable is B08-11-D-4S1XC-4A4FB/2FC/900-CST.) According to the part number, the multimode fiber is lower loss and wider bandwidth than the ethernet cable. Jim's cable also has armoring to allow direct burial. The following links were installed:

1	CB	to 85-1
2	CB	to 85-2
3	CB	to 85-3
4	85-1	to 140-ft

We use the Interferometer multimode fibers for communication links. Listed below are the links now in use.

1	CB to 85-3	PC to receiver monitor/control
2	CB to 85-3	PC to telescope monitor/control
3	CB to 85-1	FEDAL to FEDAL
4	CB to 140-ft	PC to PC for carbon copy

We used ST type connectors on all of our multimode cables. The Amp part number is 501380-1. The compatible feed-through is Amp part number 501381-1.

We have a kit for installing this type of connectors. Jerry Turner, Bill Vrable and I are familiar with the installation procedure. Check with Jim Coe or Bill Shank for details of the single mode connector system used.

Electronics: Again, check with Jim Coe or Bill Shank for information on the electronics systems used on the single-mode fibers.

We have used three different electronic interfaces into the cable, depending on distance to be covered. All use an optical full duplex coupler made by ADC. ADC part number is CAF-H2A and CAF-H2B. The coupler uses filters and mirrors to send light at 730 nm wavelength one direction and 865 nm wavelength the reverse direction. The advantage is that you can send and receive on one fiber. The disadvantage is that transmission in the 730 nm direction has higher loss than the 865 nm direction. The coupler comes with a ST connector. A data sheet is included with this note.

The first interface is shown in Figures 2A and 2B. This was used for the control building to the 85-3 links. The distance was short; loss was low. The PC end was built on a small board and placed inside the PC.

The second interface was used to interconnect two modified FEDAL units used to control and monitor the 85-1. Optically-isolated twisted-pairs were being used, but lightning tended to knock the link out. Since the loss was higher, the first interface would not work. Figure 3 shows the schematic for one end of the link. The circuit was built on a small board and mounted on the rear of the FEDAL unit. We used power from the FEDAL unit. Baud rate was approximately 20 kHz. I doubt if the circuit would work much above that frequency.

The third interface is being used to transmit RS-232 from the PC at the control building to a PC at the 140-ft. During Navy VLBI runs, a Carbon Copy program allows the operators at the 140-ft to monitor the 85-3 telescope parameters. The schematic for this interface is shown in Figure 4. A scope is needed to adjust the 200 K pot for various optical path losses. If the circuit is used on a short path, cut the gain in the first op amp stage by shorting out the 2 meg resistor. I did not put a pot there because of concern for the added capacity in the feed back loop cutting high baud rate response. I would recommend that any future links use a circuit similar to the one in Figure 4. Input and output might need modified, depending on RS-232 vs. TTL vs. balanced line.

I have included some data sheets on miscellaneous parts described and used in the systems.

Fiber com Limits.

[< 6562' between repeaters
< 26,248 total loop distance

1 loop 5409 x 2 = 10818
2 Loop 10179 x 2 = 20358
Total 31176

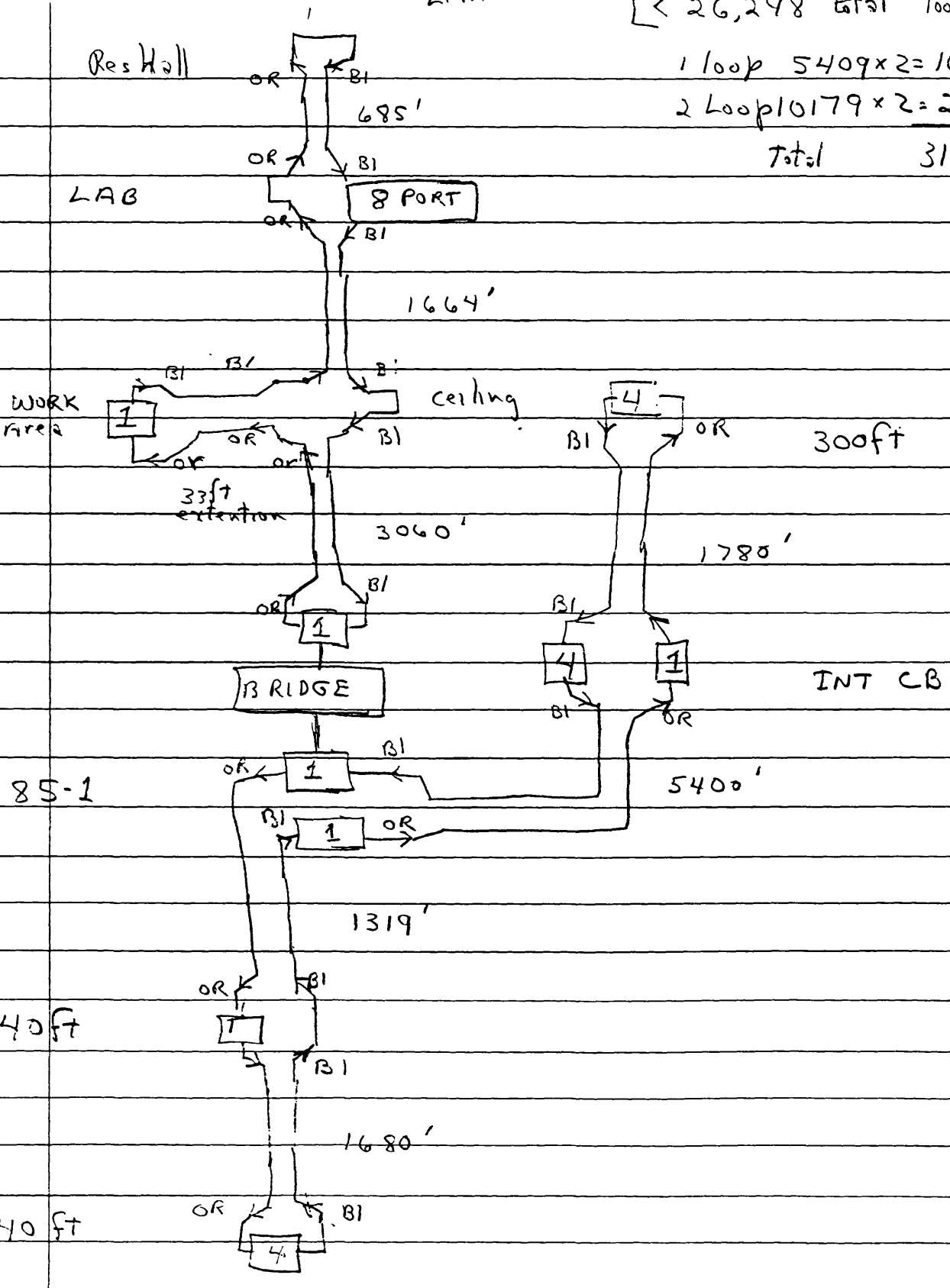


FIGURE 1

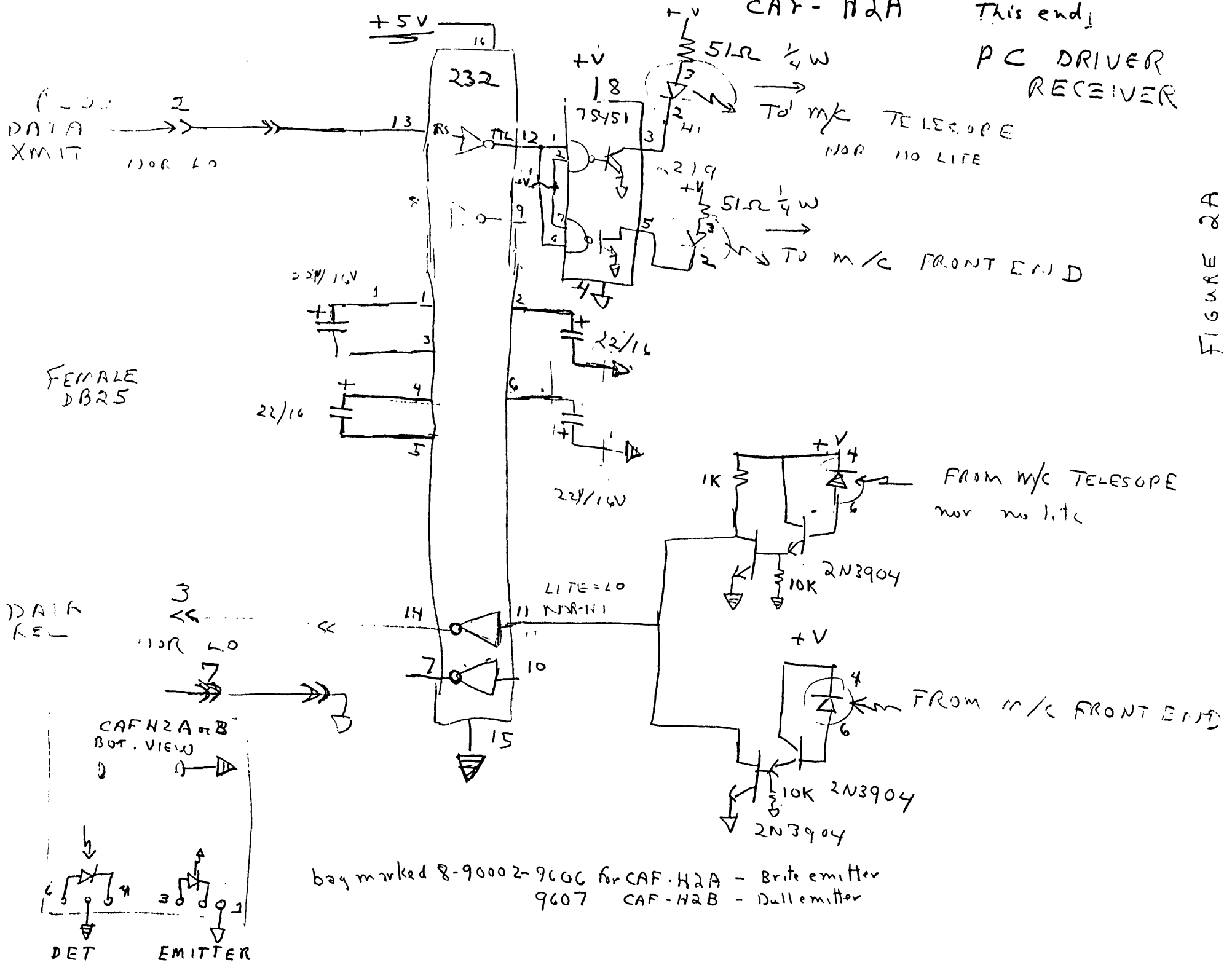

CAF- H2A
This end
PC DRIVER RECEIVER
+5V
232
+V
18
75451
51Ω 1/4 W
TO M/C TELESCOPE NOR NO LITE
DATA XMIT
NOR LO
TTL
2N3904
TO M/C FRONT END
22/16V
FEMALE DB25
FROM M/C TELESCOPE nor no lite
1K
10K
LITE=LO NOR-NI
DATA REC
FROM M/C FRONT END
CAF H2A or B BOT. VIEW
DET
EMITTER
bag marked 8-90002-9606 for CAF-H2A - Brite emitter
9607 CAF-H2B - Dull emitter

FIGURE 24

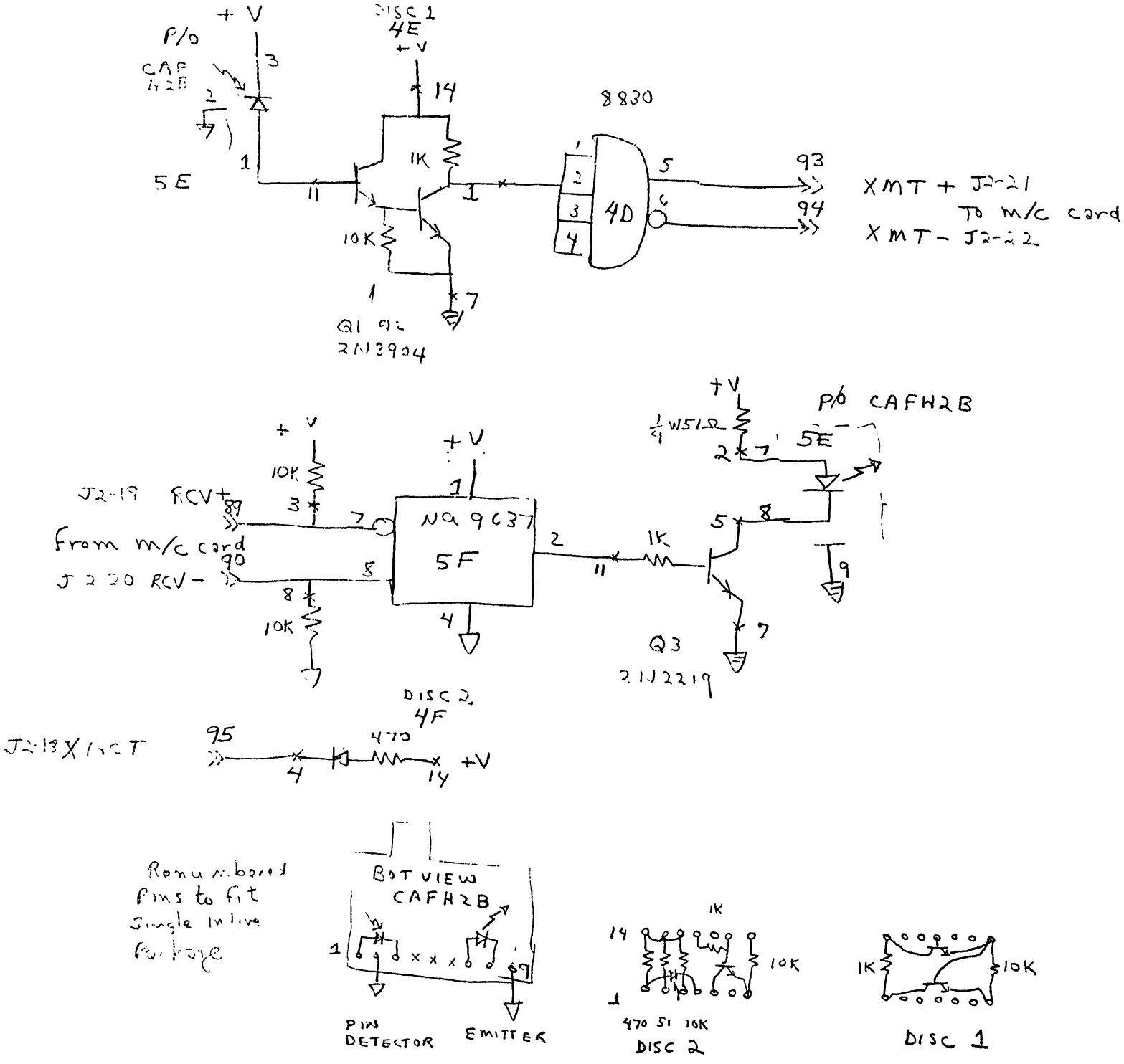
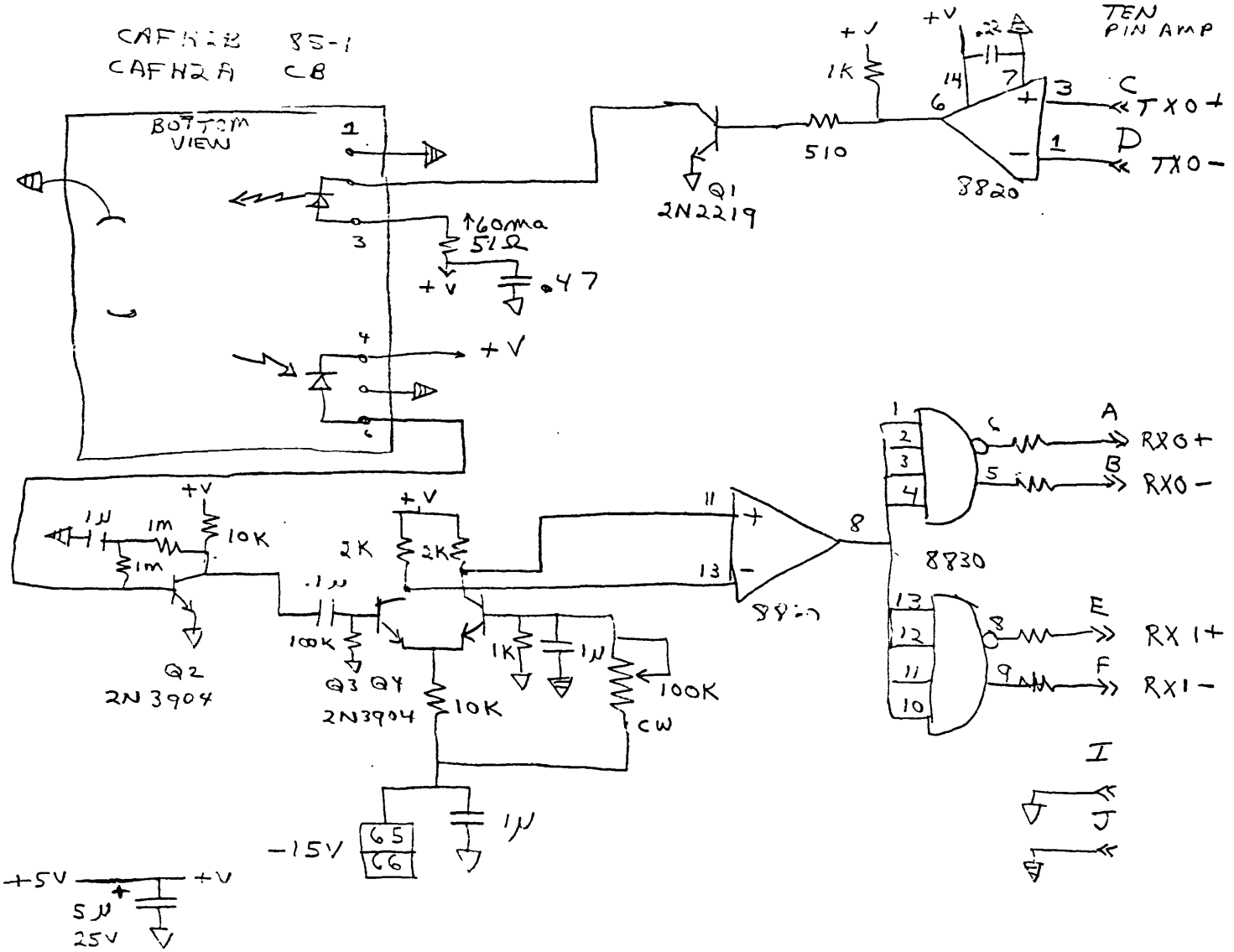


FIGURE 2B

REC CONTROL - OPTIC UNIT

FINAL FEDAL

SAME BOTH ENDS



TXO+ nor LOW - HIGH ≈ 12% TIME Baud period ≈ 50μs at interferometer link now.

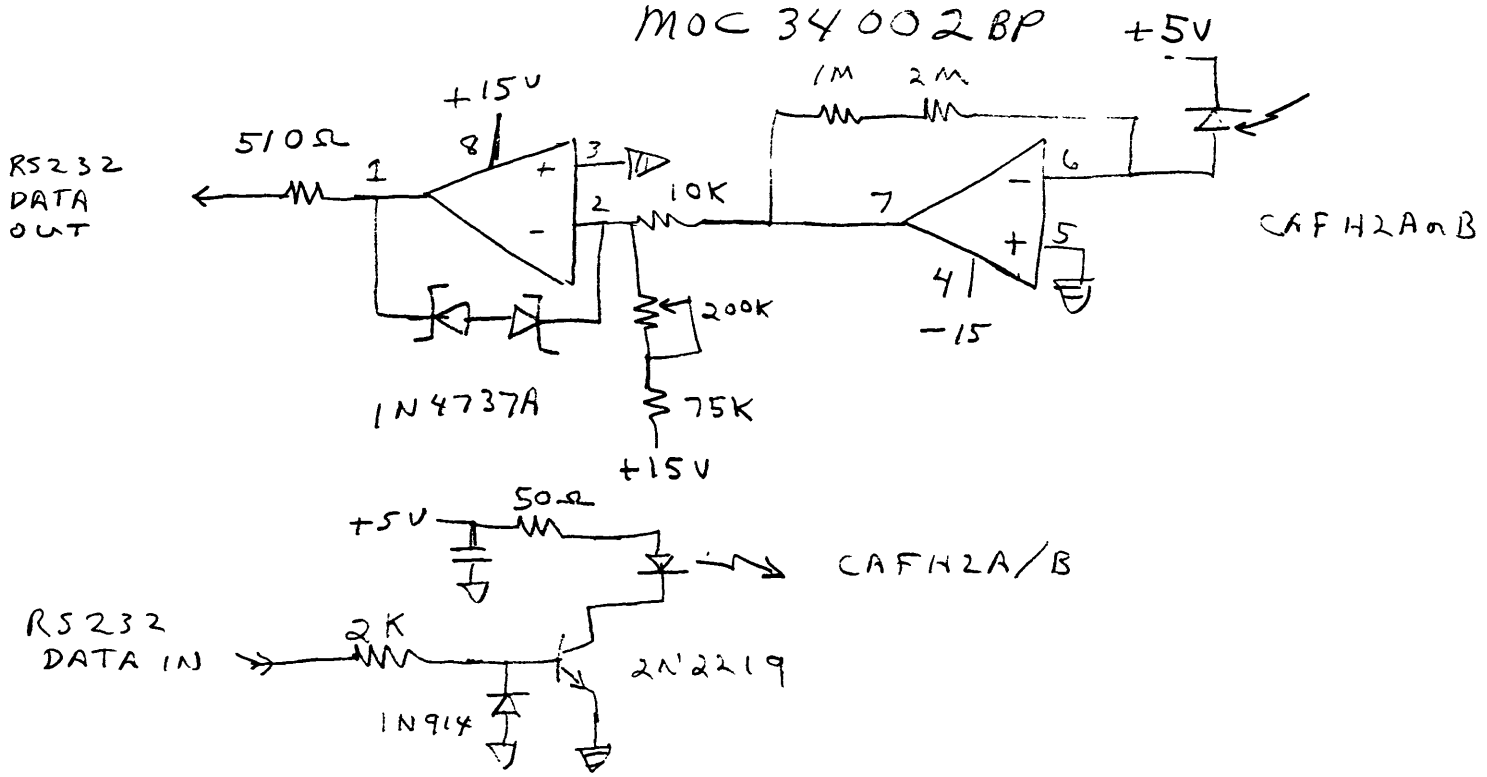
TXO+ high → Q1 on → 60 ma thru LED → cur thru PIN DIODE receiver → Q2 COL neg going → Q4 nor biased high goes negative → 8 of 8820 LOW → RXO+ High.

100K resistor adjusted to slice 12 output to keep Baud period out = Baud period in — in this case 50μs.

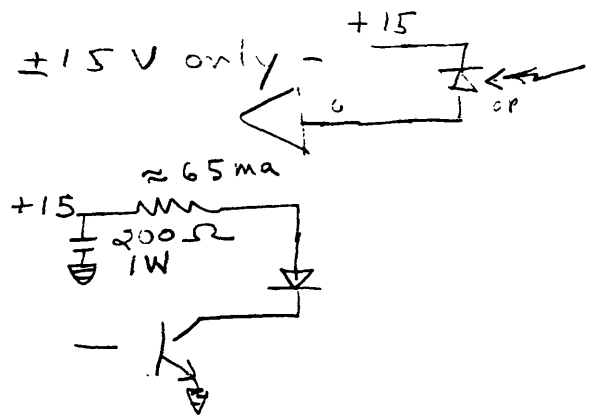
FIGURE 3

140 ft CONTROL BUILDING RS232 LINK

Same both ends



could modify for ±15V only -



Adjust 200K pot for good crossover points.
Range OK for ≈1V to 4V PP out of first amp. If low loss link, short out 2meg in first stage to cut gain. Tested to 56Kbaud, 140ft to IIT control building.

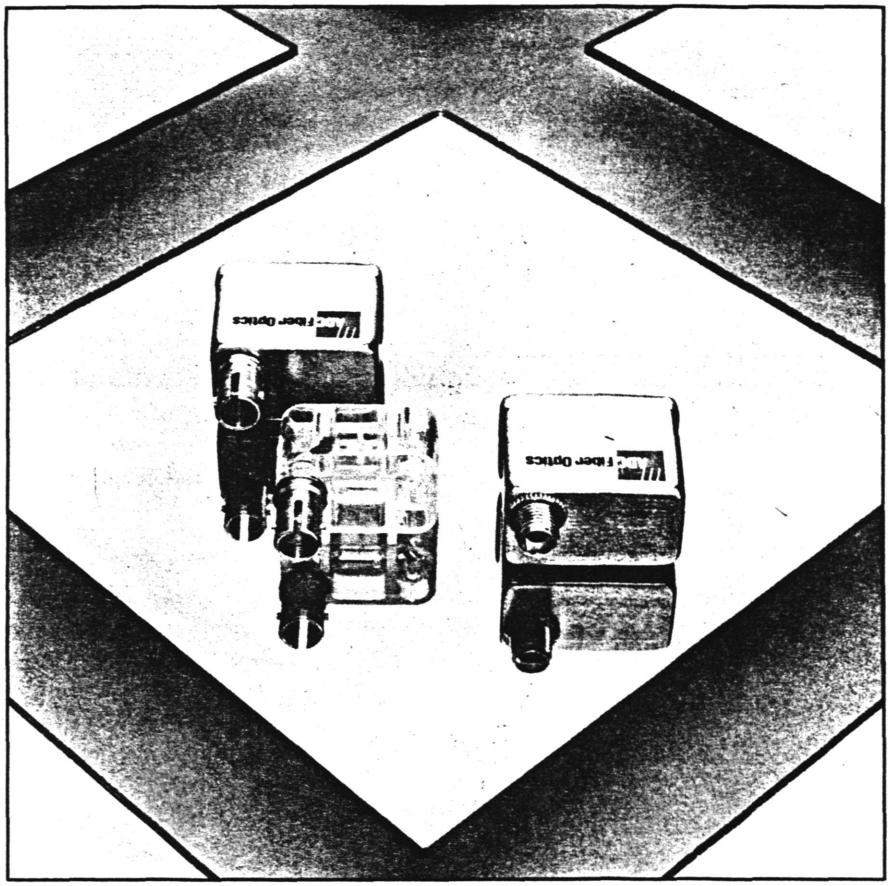
FIGURE 4

ADC®
Fiber Optics

Bidirectional

Connectorized Active Full Duplex Coupler

Model CAF



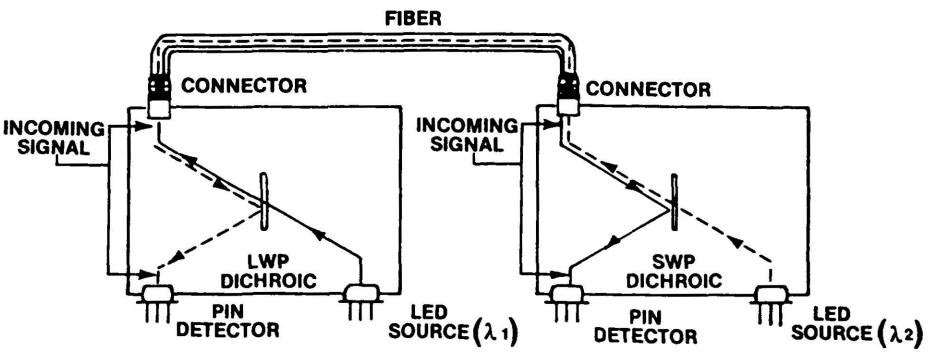
ADC's CAF component permits bidirectional full duplex signal transmission over a single fiber. The CAF operates at dual wavelengths employing a WDM beam separation technique. The transmit and receive signals, operating at different wavelengths, are separated by the use of the CAF's internal reflective surfaces and specially designed optical coatings that result in excellent optical isolation. The CAF's premounted LED source, PIN detector and SMA or ST connector make it compatible with almost any fiber or cable type. Through the high precision plastic molded body used in this design ADC has simplified the technology of combining and distributing optical signals.

ADC's model CAF, full duplex coupler can be used in a wide range of multimode optical network applications, including, various optical local area networks, data bus extenders, single fiber communication links and optical sensors.

CAF Full Duplex Operation

λ_1 = ————————

λ_2 = – – – – – – – – – –



Features

Single fiber bidirectional communication

Small PC Board mountable package

Single package that incorporates the LED, PIN, SMA or ST compatible connector and fiber optic coupler

Benefits

Lower system costs; flexible system design; increased system reliability

No fiber pigtail routing or termination problems; reduced P.C. Board real estate requirements

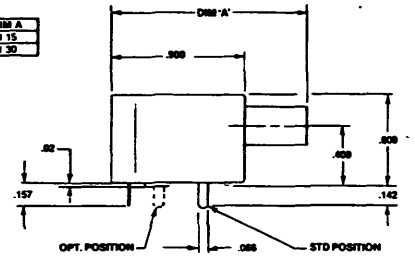
Fewer separate components; more efficient system performance

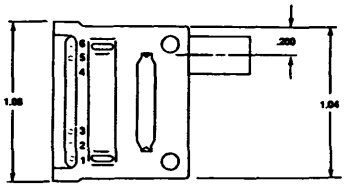
CAF FULL DUPLEX

Electro-optical Specifications		MIN	TYP	MAX	UNIT
Optical Power Coupled into Fiber (1) (I_f = 100 mA)	50/125 G.I.	−19.2 (12)	−17.0 (20)	−15.2 (30)	dBm (μW)
	62.5/125 G.I.	−17.0 (20)	−14.0 (40)	−12.2 (60)	dBm (μW)
	100/140 G.I.	−13.0 (50)	−10.0(100)	−8.2(150)	dBm (μW)
	200/240 S.I.	−7.0(200)	−4.6(350)	−2.6(550)	dBm (μW)
Coupled Power Variation (Over temperature range)					
−40°C to +80°C.		—	+0.5	+1.0	dB
		—	−1.0	−1.5	dB
0°C to +60°C		—	+0.5	+1.0	dB
(Emitter I_f = 100 mA at 50% duty cycle)		—	−0.5	−1.0	dB
Coupler Responsivity		0.35	0.45	0.55	A/W
Responsivity Variation (Over operating temperature range)					
−40°C to +80°C		—	±0.25	±1.0	dB
0°C to +60°C		—	±0.25	±1.0	dB
Crosstalk Current to Detector (Over operating temperature range)					
(Emitter I_f = 100 mA, Detector Bias = −5V)		—	2	20	nA
Operational Wavelength	Type 01	715	730	745	nm
	Type 02	845	865	890	nm
Emitter Bandwidth (+20 mA P-P, I_f = 100 mA)					
−1.5dB from 1 MHz	Type 01	10	20	—	MHz
	Type 02	10	30	—	MHz
−3.0dB from 1 MHz	Type 01	—	40	—	MHz
	Type 02	—	70	—	MHz
Detector Bandwidth (−3dB @−5V Bias)		50	70	—	MHz
Operational Temperature Range		−40	—	+80	°C
Emitter Forward Current (I_f)	Type 01	—	—	120	mA dc
	Type 02	—	—	120	mA dc
Detector Bias Voltage		−5	—	−50	V
Detector Dark Current (@−5V Bias)		—	1	5	nA
Storage Temperature		−40	—	+85	°C

Note (1): Optical Power measured after 1 meter of specified fiber. Connector: SMA (Amphenol 905 style or equivalent) or ST (AT&T type) compatible.

TYPE	DIM A
SMA	1.15
ST	1.30





PIN IDENTIFICATION	
PIN NO.	DESCRIPTION
1	EMITTER CASE
2	EMITTER CATHODE NEG
3	EMITTER ANODE POS
4	DETECTOR CATHODE POS
5	DETECTOR CASE
6	DETECTOR ANODE NEG

Above specifications are for coupler using ADC Fiber Optics standard emitters and detectors. Other devices may be substituted to obtain various operational characteristics. Consult ADC Fiber Optics for further information.

Ordering Information

CAF-X X X - XX

NOT APPLICABLE (ALWAYS X)

NOT APPLICABLE (ALWAYS X)

01 = 730nm Transmission, SMA Connector
02 = 865nm Transmission, SMA Connector
03 = 730nm Transmission, ST Connector
04 = 865nm Transmission, ST Connector

WAVELENGTH

H = 730/865nm, Full Duplex

ADC Fiber Optics reserves the right to make changes to the product(s) or circuit(s) described herein without notice. No liability is assumed as a result of their use or application. No rights under any patent accompany the sale of any such product or circuit.

843 1/87

ADC Telecommunications, Inc.
4900 West 78th Street
Minneapolis, Minnesota 55435

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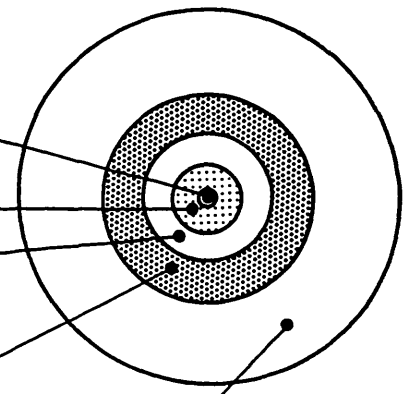
OPTICAL CABLE CORPORATION

OPTICAL FIBER
All communication grades are available.
See Optical Cable Corporation's Fiber Specification Guide for details.

FIBER COATING
500 um diameter (250 um on Micro Breakout Cable)

TIGHT BUFFER
900 um diameter
Elastomeric material
Superior strippability and handling
Superior crush and impact resistance
Isolates fiber coating from moisture
(Not available on Micro Breakout Cable)

EXAMPLE: SUB-CABLE



(Drawing not

ARAMID FIBER STRENGTH MEMBER
(DuPont Kevlar)

ELASTOMERIC SUB-CABLE JACKET
Provides excellent environmental performance.

SPECIFICATIONS COMMON TO ALL B-SERIES BREAKOUT CABLES

MINIMUM BEND RADIUS	
UNDER NO TENSILE LOAD:	10 X O.D. x 7 = 70 mm = 2.75"
UNDER RATED TENSILE LOAD:	20 X O.D. x 7 = 140 mm = 5.5"
OPERATING TEMPERATURE:	-20° C TO +85° C
STORAGE TEMPERATURE:	-40° C TO +85° C
CRUSH RESISTANCE:	440 N/cm
IMPACT RESISTANCE:	50 IMPACTS (EIA-RS-455-25)
CYCLIC FLEXING:	2000 CYCLES

N x .2248 = #

		UNITS	2	4	6	8
STANDARD BREAKOUT CABLE	OUTSIDE DIAMETER	mm	7.0	8.0	9.5	11.0
	WEIGHT	kg/km	39	51	70	92
	TENSILE LOAD RATING*	N	1000 (225#)	1600	2200	2500
	RESIDUAL TENSILE LOAD RATING	N	200 (45#)	320	440	500
MINI BREAKOUT CABLE	OUTSIDE DIAMETER	mm	6.0	7.0	8.0	9.5
	WEIGHT	kg/km	31	42	53	74
	TENSILE LOAD RATING*	N	600	1000	1300	1700
	RESIDUAL TENSILE LOAD RATING	N	120	200	260	340
MICRO BREAKOUT CABLE	OUTSIDE DIAMETER	mm	5.0	6.0	6.5	7.5
	WEIGHT	kg/km	23	33	36	46
	TENSILE LOAD RATING*	N	600	1000	1300	1700
	RESIDUAL TENSILE LOAD RATING	N	120	200	260	340

*Tensile load ratings are actual performance data. Installation loads in excess of 2700 N (600 lbs.) are not recom

B SERIES FIBER OPTIC CABLE ORDERING INFORMATION

CABLE PART NUMBER: ■■■-■■■■-■■■■/■■■/■■■-■■■

CABLE SERIES CODE
B: MULTIFIBER BREAKOUT CABLES

FIBER COUNT

CABLE DIAMETER IN TENTHS OF A MILLIMETER

CABLE OUTER JACKET MATERIAL CODE
(D): Polyvinylchloride (PVC)
C: Polyurethane
A: Polyethylene

FIBER TYPE CODE
S: 8.7/125 Step Index Single-Mode
(A): 50/125 Graded Index
W: 62.5/125 Graded Index
C: 100/140 Graded Index
H: 200 um PCS Step Index

ATTENTION IN dB/km 6db/km

BANDWIDTH CODE

B: 20 MHz-km	C: 50 MHz-km
D: 100 MHz-km	S: 160 MHz-km
(E): 200 MHz-km	T: 300 MHz-km
F: 400 MHz-km	U: 500 MHz-km
G: 600 MHz-km	V: 700 MHz-km
H: 800 MHz-km	W: 900 MHz-km
I: 1000 MHz-km	X: SINGLE-MODE

WAVELENGTH CODE
(B): 850 nm
C: 1300 nm

OPTIONAL: ATTENUATION AND BANDWIDTH AT SECOND WAVELENGTH

BUFFER CODE
/250: 250 um Diameter
/500: 500 um Diameter
/900: 900 um Diameter Tight Buffer

OPTIONAL: SPECIAL CONSTRUCTION CODE

EXAMPLE 1: B12-120D-A4FB/2FC/900 = 12 CHANNEL (12 mm DIAMETER) PVC JACKETED MINI BREAKOUT CABLE with 50/125 GRADED INDEX FIBER with a 900 um TIGHT BUFFER
ATTENUATION of 4 dB/km @ 850 nm and 2 dB/km @ 1300 nm
BANDWIDTH of 400 MHz-km @ 850 nm and 400 MHz-km @ 1300 nm.

EXAMPLE 2: B06-095C-W4EB/2GC/900 = 6 CHANNEL (9.5 mm DIAMETER) STANDARD BREAKOUT CABLE with 62.5/125 GRADED INDEX FIBER with a 900 um TIGHT BUFFER
ATTENUATION of 4 dB/km @ 850 nm and 2 dB/km @ 1300 nm
BANDWIDTH of 200 MHz-km @ 850 nm and 600 MHz-km @ 1300 nm. OPTIONAL POLYURETHANE JACKET.

OPTICAL CABLE CORPORATION
870 Harrison Avenue, Salem, Virginia 24153
Telex: 705-290
FAX: (703) 389-9846 (703) 389-9900

QUOTATION

OPTICAL CABLE CORPORATION

870 Harrison Avenue, Salem, Virginia 24153

CUSTOMER: National Radio Astronomy Observatory
P.O. Box 2
Green Bank, W.VA. 24944

DATE: October 20, 1987
PHONE: 304-456-2127
FAX: 304-456-2271

CONTACT: ED CHILDERS

ITEM	DESCRIPTION & SPECIFICATIONS	QTY	PRICE	TOTAL	DAYS TO SHIP
1	B02-070D-A6EB/ /900	16,000f	$0.40/f	$6,400.00	21

Special Requirements:

OPTICAL CABLE CORPORATION STANDARD TERMS & CONDITIONS OF SALE ON REVERSE

EXCEPTIONS TO STANDARD TERMS & CONDITIONS ON REVERSE:

Local Representative _____

Optical Cable Corporation Contact Chuck Surat

Chuck Surat — National Accounts Executive — October 20, 1987
Chuck Surat — TITLE — DATE

OPTICAL CABLE CORPORATION
870 Harrison Avenue, Salem, VA 24153 (703)389-9900

'ICA

PACKING LIST

SHIPPED TO:
Nat'l Radio Astronomy Obs
Route 28/92

Green Bank, WV 24944-0002
Attn: LEN HOWELL 304-456-2296

ORDER # 3193-A
Customer's P.O.#: G15268
Date of shipment: 04/26/88
Date of order: 04/06/88
Sent Via: CUSTOMER PICK UP

Number of items in this order: 2

ITEM NO. 1- FIBER OPTIC CABLE	NO. OF PIECES	PIECE LENGTH	TOTAL LENGTH	UNIT
B08-110D-4S1XC-4A4FB/2FC/900-CST	1	165.0	165.0	M
	1	1,785.0	1,785.0	M
	1	957.0	957.0	M
	1	748.0	748.0	M
	4		3,655.0	

ITEM NO. 2- FIBER OPTIC CABLE	NO. OF PIECES	PIECE LENGTH	TOTAL LENGTH	UNIT
B04-080C-S1XC/900	1	441.0	441.0	M
	1		441.0	

PICKED UP BY_____

DATE_____

TSC232 Dual RS-232 Transmitter/Receiver

General Description

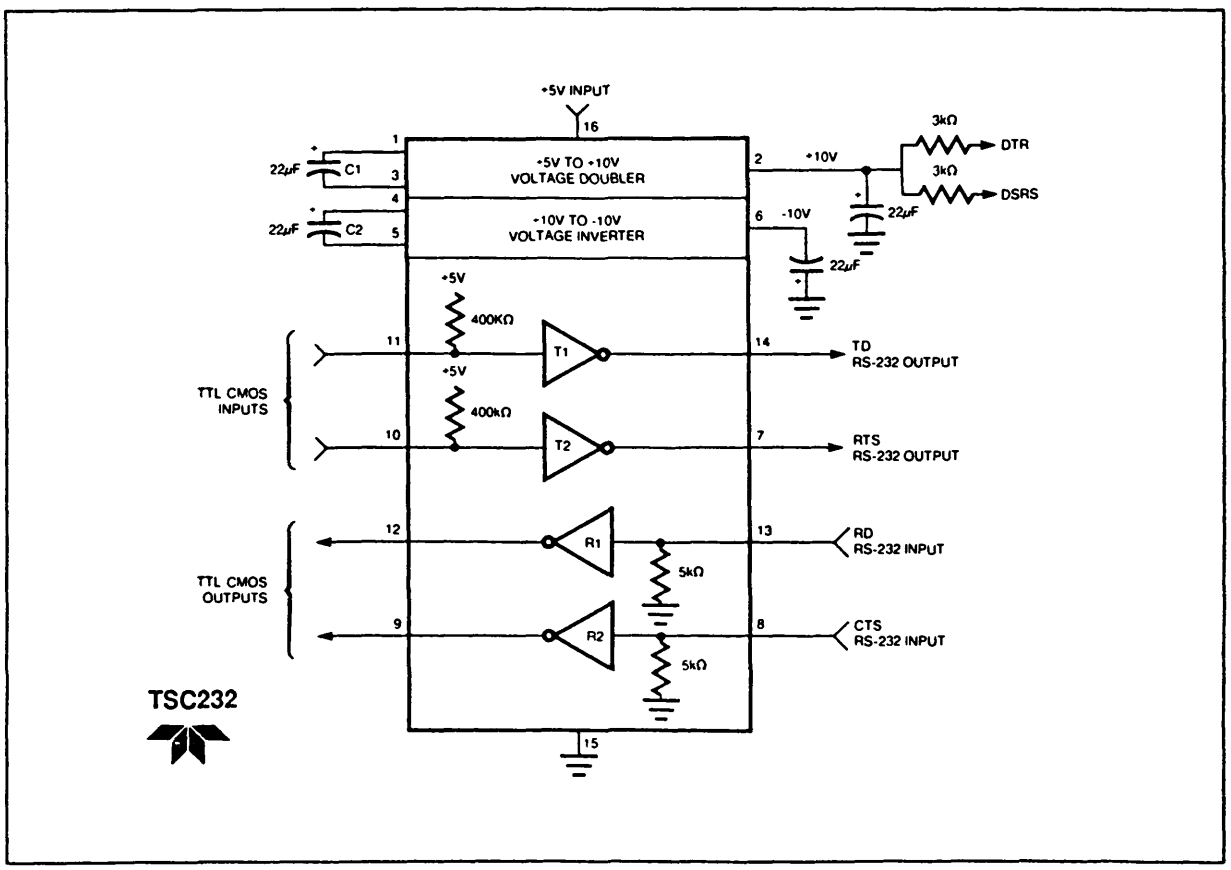
The TSC232 from Teledyne Semiconductor is a dual RS-232 transmitter/receiver that complies with EIA RS-232C guidelines and is ideal for all RS-232C communication links. This device has a 5 V power supply and two charge pump voltage converters that produce +10 V/-10 V power supplies.

The TSC232 has four level translators. Two are RS-232 transmitters that convert TTL/CMOS input levels to 9 V RS-232 outputs. The other two translators are RS-232 receivers that convert RS-232 inputs to 5 V TTL/CMOS output levels. The receivers have a nominal threshold of 1.3V, a typical hysteresis of 0.5 V, and can operate with up to ±30 V inputs.

Features

- **Meets all RS-232C Specifications**
- **Operates from Single 5 V Power Supply**
- **2 Drivers and 2 Receivers**
- **Onboard Voltage Quadrupler**
- **±30 V Input Levels**
- **±9 V Output Swing with +5 V Supply**
- **Low Power CMOS: 5 mA**

Functional Diagram



Teledyne Semiconductor

CALL 1-800-888-9966

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