



# NATIONAL RADIO ASTRONOMY OBSERVATORY

POST OFFICE BOX 2 GREEN BANK, WEST VIRGINIA 24944-0002  
TELEPHONE 304 456-2011 TWX 710 938-1530 FAX 304 456-2271

## 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  $\mu$ m 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 Interferometer 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  $5409 \times 2 = 10818$

2 Loop  $10179 \times 2 = 20358$

Total 31176

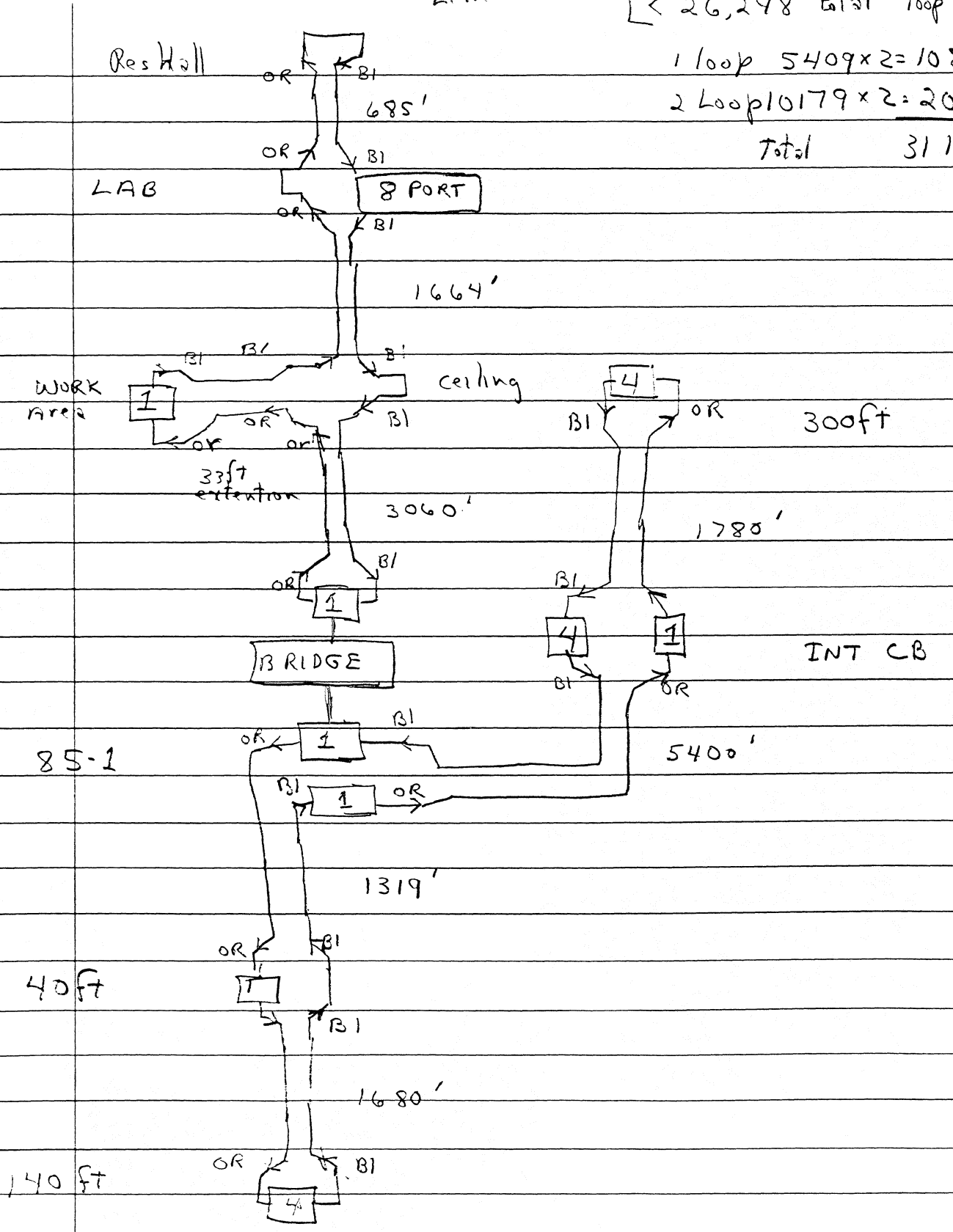
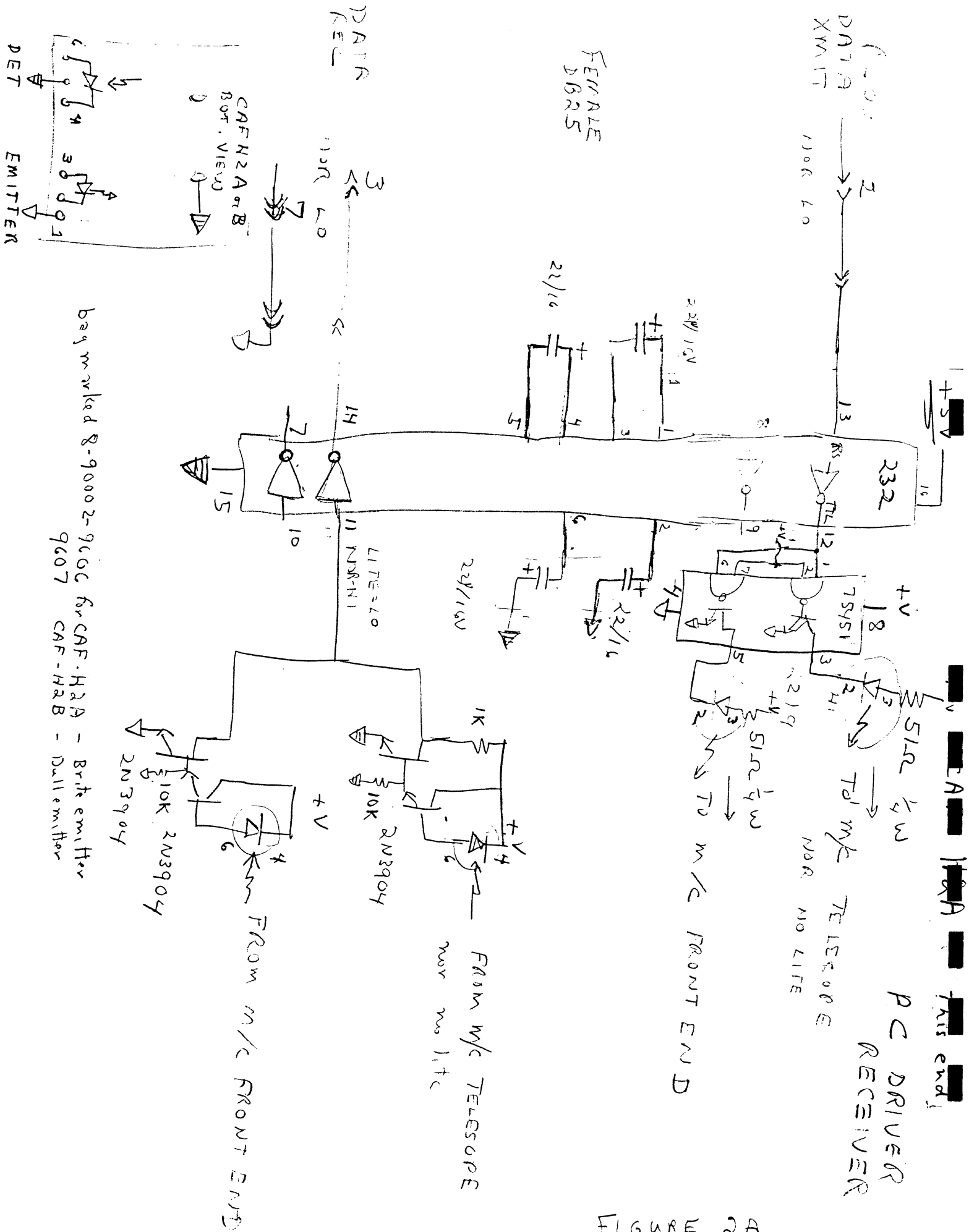
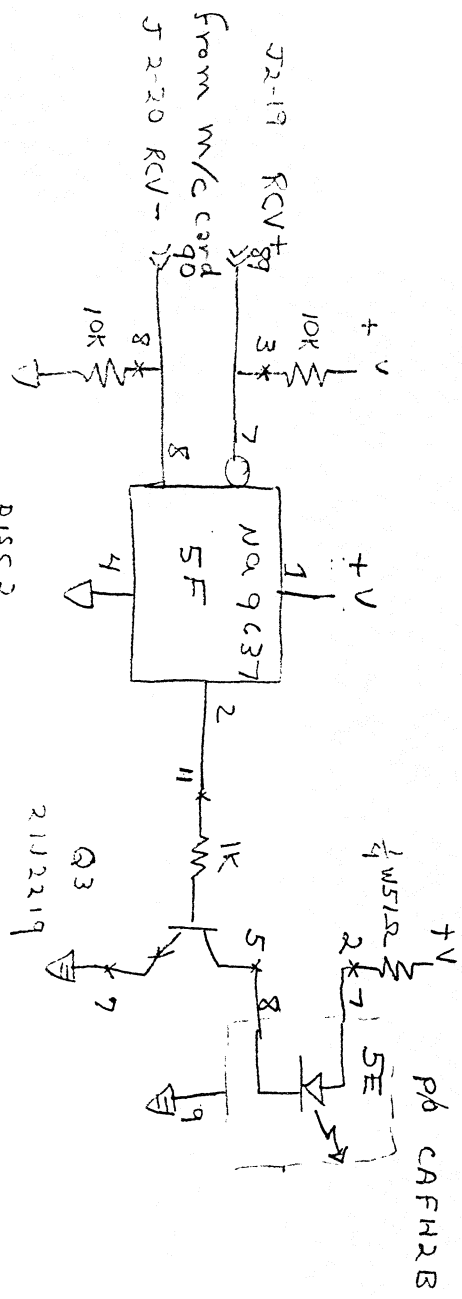
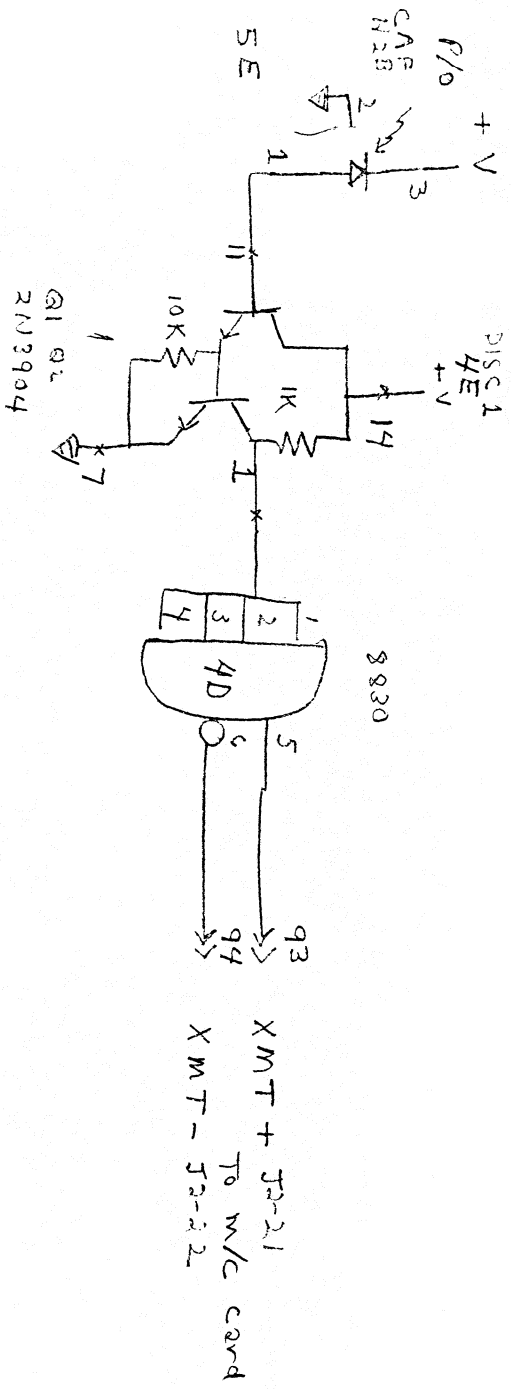


FIGURE 1



bag marked 8-90002-960C for CAF-H2A - Brit emitter  
 9607 CAF-H2B - Dullemitter

FIGURE 2A



Remove board pins to fit Single inline package

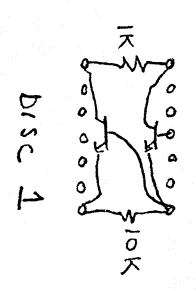
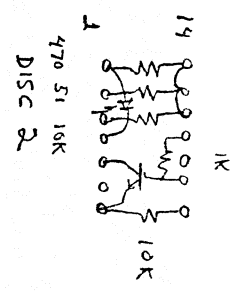
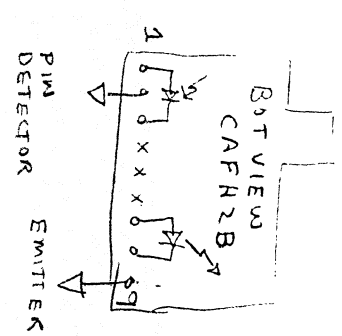
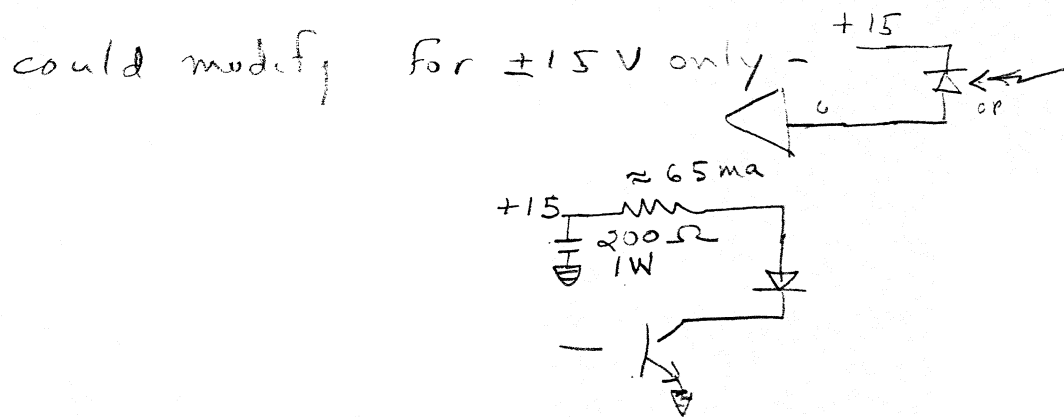
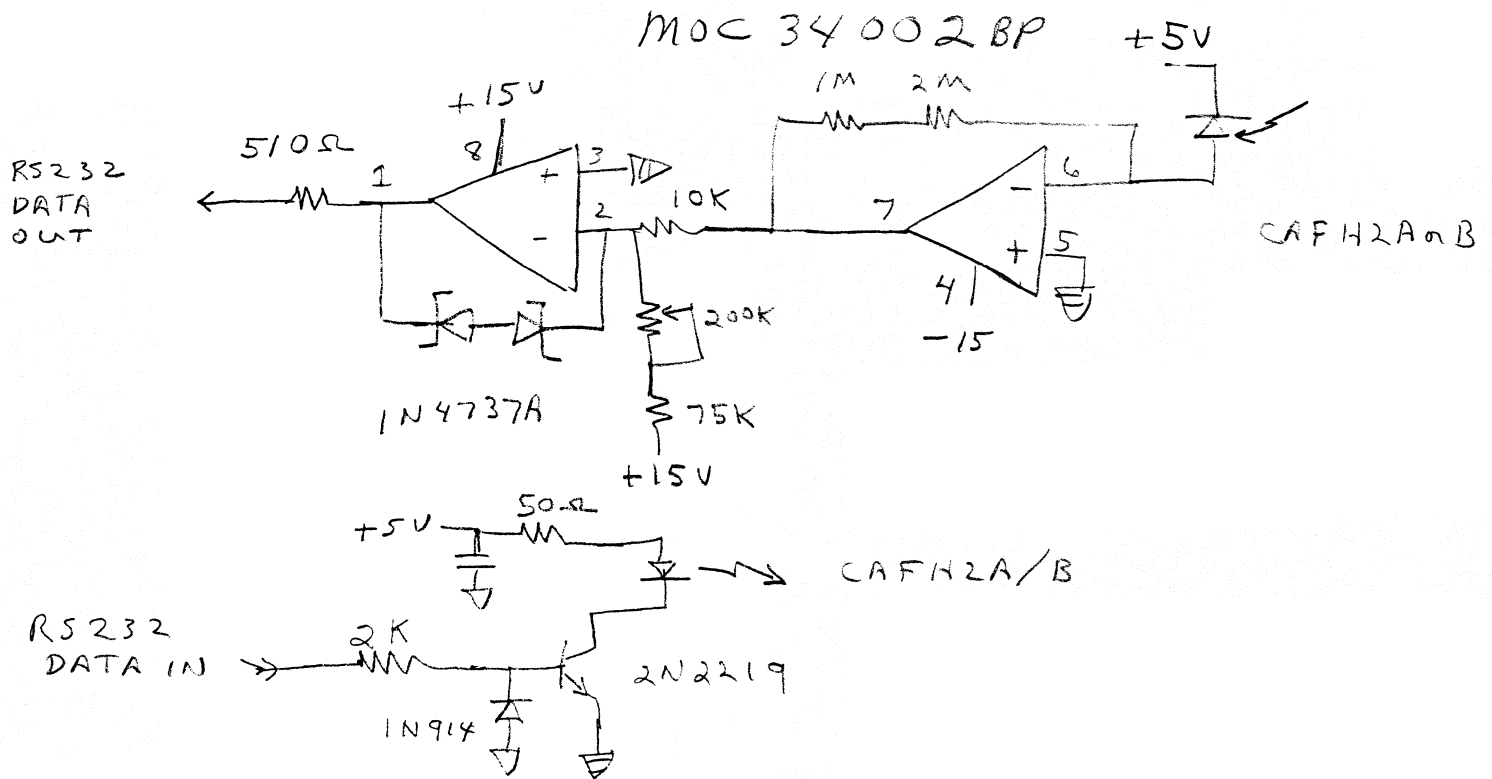


FIGURE 2B



# 140 ft CONTROL BUILDING RS232 LINK

Same both ends



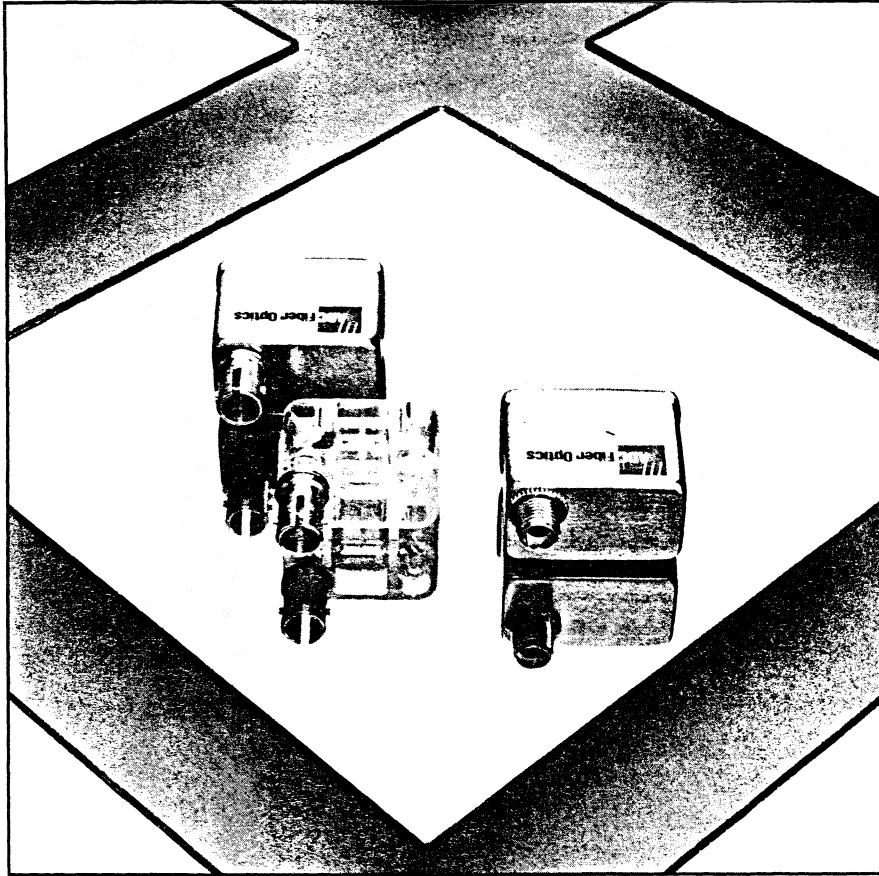
Adjust 200K pot for good crossover points.  
 Range OK for  $\approx 1V$  to 4VPP out of first amp. If  
 low-loss link, short out 2meg in first stage to  
 cut gain. Tested to 56Kbaud, 140ft  
 to INT control building.

FIGURE 4





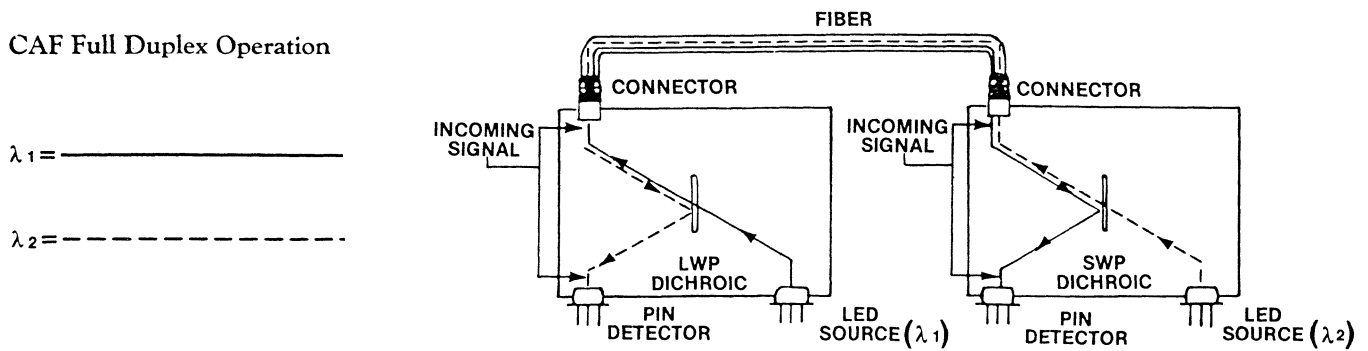
# Bidirectional Connectorized Active Full Duplex Coupler Model CAF



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



## 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

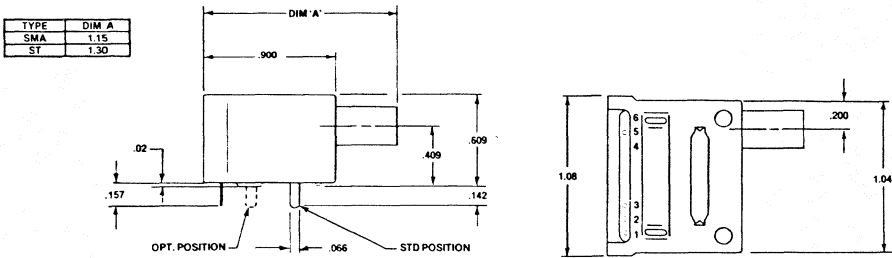
No fiber pigtail routing or termination problems; reduced P.C. Board real estate requirements

Fewer separate components; more efficient system performance

CAF FULL DUPLEX

Electro-optical Specifications		MIN	TYP	MAX	UNIT
Optical Power Coupled into Fiber (1) (I <sub>f</sub> = 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 (Emitter I <sub>f</sub> = 100 mA at 50% duty cycle)		-	+0.5	+1.0	dB
		-	-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 <sub>f</sub> = 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 <sub>f</sub> = 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 <sub>f</sub> )	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.



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

each coupler 137  
 137  
 25 sets / 50 couplers  
 112 / coupl

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

Handwritten notes and a circled plus sign (+).

Handwritten note: 50 mark



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

Handwritten pricing and part numbers:  
 137  
 6  
 \$ 822  
 CAF H 2A (730/ST) Brighter but more less  
 CAF H 2B (865/ST)

# 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

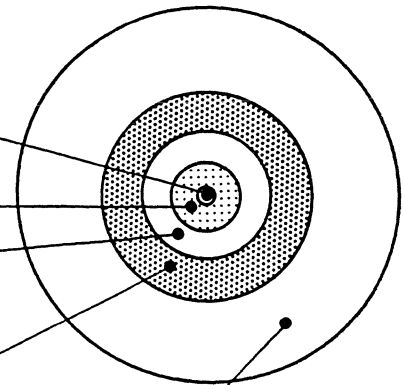
Isolates fiber coating from moisture

(Not available on Micro Breakout Cable)

## ARAMID FIBER STRENGTH MEMBER

(DuPont Kevlar)

## EXAMPLE: SUB-CABLE



## ELASTOMERIC SUB-CABLE JACKET

Provides excellent  
environmental performance.

(Drawing no

## SPECIFICATIONS COMMON TO ALL B-SERIES BREAKOUT CABLES

MINIMUM BEND RADIUS

UNDER NO TENSILE LOAD:

UNDER RATED TENSILE LOAD:

OPERATING TEMPERATURE:

STORAGE TEMPERATURE:

CRUSH RESISTANCE:

IMPACT RESISTANCE:

CYCLIC FLEXING:

10 X O.D. x 7 = 70 mm = 2.75"

20 X O.D. x 7 = 140 mm = 5.5"

-20°C TO +85°C

-40°C TO +85°C

440 N/cm

50 IMPACTS (EIA-RS-455-25)

2000 CYCLES

$N \times .2248 = \#$

		UNITS	2	4	6	8
<b>STANDARD BREAKOUT CABLE</b>	OUTSIDE DIAMETER	mm	7.0	8.0	9.5	11.0
	WEIGHT	kg/km	39	51	70	92
	TENSILE LOAD RATING*	N	1000	1600	2200	2500
	RESIDUAL TENSILE LOAD RATING	N	225# 200 45#	320	440	500
<b>MINI BREAKOUT CABLE</b>	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
<b>MICRO BREAKOUT CABLE</b>	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 recommended.

## B SERIES FIBER OPTIC CABLE ORDERING INFORMATION

<b>CABLE PART NUMBER:</b> <span style="float: right;">■■■-■■■■-■■■■/■■■/■■■-■■■</span>	
CABLE SERIES CODE _____	
B: MULTIFIBER BREAKOUT CABLES	
FIBER COUNT _____	
CABLE DIAMETER IN TENTHS OF A MILLIMETER <u>7 mm 070</u>	
CABLE OUTER JACKET MATERIAL CODE _____	
<input checked="" type="radio"/> D: Polyvinylchloride (PVC) <input type="radio"/> C: Polyurethane <input type="radio"/> A: Polyethylene	
FIBER TYPE CODE _____	
S: 8.7/125 Step Index Single-Mode <input checked="" type="radio"/> 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 <u>6 dB/km</u>	
BANDWIDTH CODE _____	
B: 20 MHz-km	C: 50 MHz-km
D: 100 MHz-km	S: 160 MHz-km
<input checked="" type="radio"/> 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 _____	
<input checked="" type="radio"/> B: 850 nm C: 1300 nm	
OPTIONAL: ATTENUATION AND BANDWIDTH AT SECOND WAVELENGTH _____	
BUFFER CODE _____	
/250: 250 um Diameter	
/500: 500 um Diameter	
<input checked="" type="radio"/> /900: 900 um Diameter Tight Buffer	
OPTIONAL: SPECIAL CONSTRUCTION CODE _____	
<p>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.</p> <p>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.</p>	

# OPTICAL CABLE CORPORATION

870 Harrison Avenue, Salem, Virginia 24153

Telex: 705-290

FAX: (703) 389-9846

(703) 389-9900

\* Q U O T A T I O N \*

**OPTICAL CABLE CORPORATION**

870 Harrison Avenue, Salem, Virginia 24153

CUSTOMER: National Radio Astronomy Observatory      DATE: October 20, 1987  
P.O. Box 2  
Green Bank, W.VA. 24944      PHONE: 304-456-2127  
FAX: 304-456-2271

CONTACT: ED CHILDERS

<u>ITEM</u>	<u>DESCRIPTION &amp; SPECIFICATIONS</u>	<u>QTY</u>	<u>PRICE</u>	<u>TOTAL</u>	<u>DAYS TO SHIP</u>
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

Rec'd 4/29/88

ICATE

P A C K I N G L I S T

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.	DESCRIPTION	NO. OF PIECES	PIECE LENGTH	TOTAL LENGTH	UNIT
1-	FIBER OPTIC CABLE				
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
		<u>1</u>	<u>748.0</u>	<u>748.0</u>	M
		4		3,655.0	

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

PICKED UP BY \_\_\_\_\_

DATE \_\_\_\_\_

ITEM 1 Single Mode Fibers Colors Blue, Orange, Green, Pink

## 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.

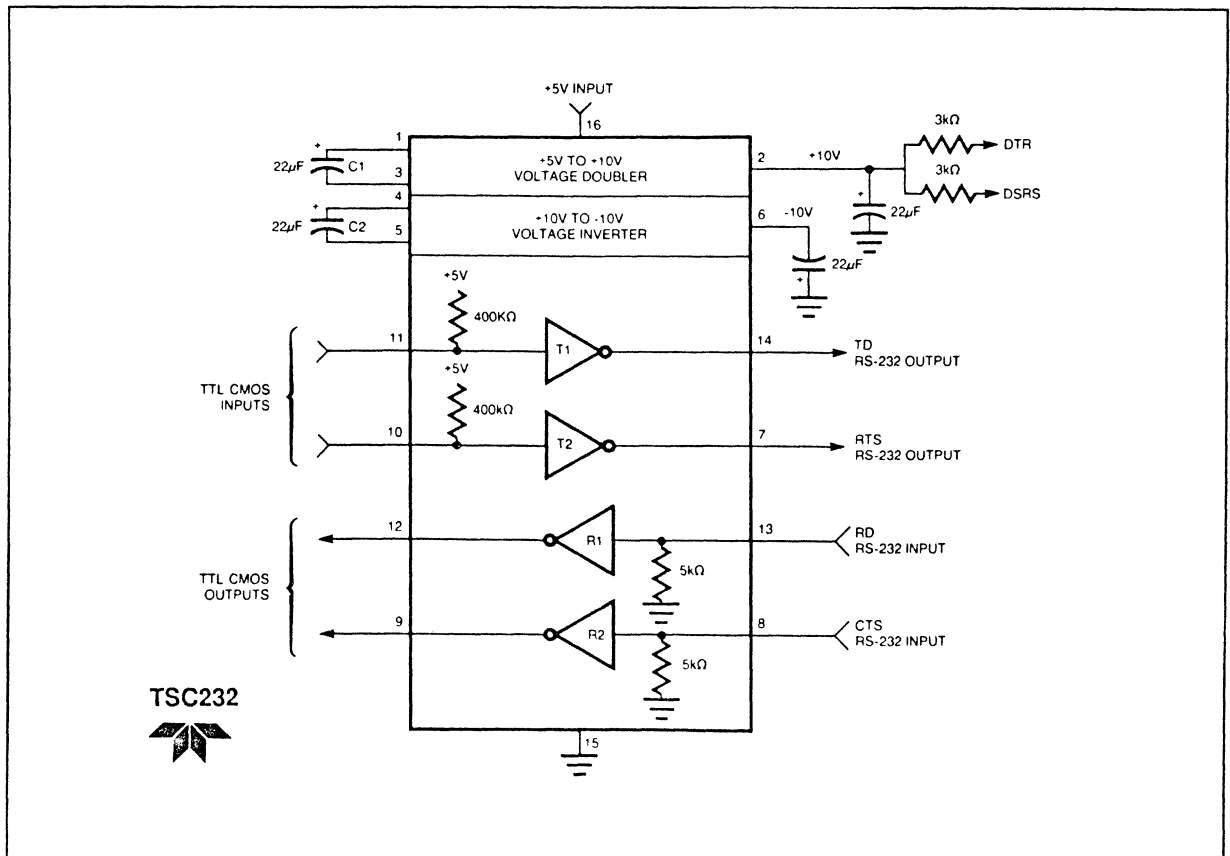
The TSC232 has four level translators. Two are RS-232 transmitters that convert TTL/CMOS input levels to 9 V RS-232 outputs. The other two translators are RS-232 receivers that convert RS-232 inputs to 5 V TTL/CMOS output levels. The receivers have a nominal threshold of 1.3V, a typical hysteresis of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

### Features

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

### Functional Diagram

Teledyne Semiconductor



CALL 1-800-888-9966