OPERATION AND MAINTENANCE MANUAL

MODEL 150-702-2

FIBER OPTIC RECEIVER

5 MHz OPTION

Serial Number _____

February 1, 2000
Revision N/C

NOTICE ON SCHEMATICS

Please be advised that there may or may not be references in the text of this manual to schematic drawings. TrueTime's general policy is to not include schematics because they may contain proprietary information. If you require copies of any schematic, please contact:

Customer Service
Service@Truetime.com
Phone: (707) 528-1230
Fax: (707) 527-6640

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(Continued)

1. GENERAL INFORMATION

1.1. SCOPE OF MANUAL

This manual contains the information necessary to operate and maintain a TrueTime Model 150-702 Fiber Optic Receiver.

1.2. PURPOSE OF EQUIPMENT

The Model 150-702 can be used as part of a system to provide a secure, low loss method of receiving a CW sine or squarewave signal between 100 KHz and 11 MHz. It can be employed wherever a security boundary must be entered, or when protection against lighting strikes is desired, or where the two equipment must be located a long distance apart.

1.2.1. Physical Specifications

1.2.1.1. Fiber Optic Receiver Unit

Form:	One small enclosure, alodined and painted aluminum.
Dimensions:	4.28"w X 1.50"h X 2.13"d
Weight:	Approximately 12 ounces
Fiber Length:	1 to 2000 M (6560 ft.)

1.2.1.2. Optional Power Supply

Form:	Plastic desktop enclosure
Dimensions:	2.96"w X 5.83"l X 1.78"d
Weight:	Approximately 1.04 pounds.

1.2.2. Environmental Specifications

1.2.2.1. Fiber Optic Receiver Unit

Operating Temp:	0° to +50°C
Storage Temp:	-40° to +100°C
Humidity:	95% relative, non-condensing
Cooling Mode:	Convection

1.2.2.2. Optional Power Supply

Operating Temp:	-0° to +40°C
Storage Temp:	-40° to +70°C
Humidity:	20-90% relative, non-condensing
Cooling Mode:	Convection

1.2.3. Power Requirements

1.2.3.1. Fiber Optic Receiver

Voltage:	12 VDC ±5% (external source)
Power:	3 Watts maximum

1.2.3.2. Optional Power Supply

Input Voltage:	90-265 VAC
Output Voltage:	12 VDC
Power:	30 Watts maximum

1.2.4. Signal Specifications

1.2.4.1. Input (150-702)

Type:	Optical Fiber, 62.5/125 μM, 850 nM carrier
Amplitude:	-16 dbm (typical) - 3db/km fiber length
Frequency:	100 KHz to 11 MHz

1.2.4.2. Output (150-702)

Type:	Coaxial
Amplitude:	3 Vpp ±20% (with 10 db loss in fiber)
Load Impedance:	50Ω
Frequency:	100 KHz to 11 MHz

2. INSTALLATION AND OPERATION

2.1. INSTALLATION

2.1.1. General

The TrueTime Model 150-702 Fiber Optic Receiver requires consideration of certain parameters prior to installation. The simplest installation requires that a suitable length of Optical Fiber be installed between the equipment sites. Mounting the fiber optic receiver on a suitable surface, connecting the fibers and the coax cables and installing the power supply and hooking up its power cables completes the installation. **Note that the mounting holes in the mounting flange were designed to mate with any two vertical holes in a standard 19" equipment rack or cabinet.** They may also be used to mount the modules to any flat surface. Be careful to allow enough room for the fibers to make any required bends in a gentle radius. Typically no bend radius should be less than 10X the cable outside diameter. The optical connectors are the "ST" style. See Appendix A for a list of recommended electrical and optical cables and suppliers. TrueTime may also have supplied cable or cable assemblies as part of the order. Be especially careful when handling the optical fibers to avoid the inclusion of dirt or any other contaminant in the optical fiber connectors since this will have a negative impact on system performance.

2.1.2. Method 1

The OPTIONAL power supply is a desktop unit that will accept all world wide power. It is not designed for extreme environmental conditions, and so must be located in a benign location. See Specifications. It comes with a 1M long cable with installed connector for direct connection to the fiber optic receiver.

2.1.3. Method 2

For other than standard conditions, the power supply needs to provide 12 VDC ±5% at the connector to the fiber optic receiver. I^2R losses in the DC power cable must not reduce the voltage at the fiber optic receiver below 11.4 VDC worst case. The maximum gauge wire that will fit in the power connector is 20 AWG. Typical 20 AWG wire has a DC resistance of about 10Ω per 1000'. This must be doubled since the current goes both directions. If the fiber optic receiver is 1000' away from the transmitter, the voltage loss is .25 X 20 = 4V in the power cable. If the power supply must be located more than 50' from the fiber optic receiver module, we recommend that a remote sensing supply be used with Kelvin sense leads on both the Plus and Minus leads. This should be attached to the current carrying leads right at the fiber optic receiver. Please refer to the power supply operating instructions for hook up information. Also found in the instructions are methods that may be required to frequency-compensate the supply and prevent oscillations that may occur in this mode of operation. Another option is to set the power supply voltage higher than nominal to compensate for the line losses. This works because the load is fairly constant and tight regulation is not required. In this case adjust the power supply voltage so that there is 12VDC ±5% measured right at the power connector on the fiber optic receiver while the receiver is operating.

2.1.4. Finish

Install the fiber optic receiver (150-702) near the destination equipment and connect the receiver to the destination with the provided coax cable. Secure the optical cable near the fiber optic receiver and attach it to the receiver.

2.2. OPERATION

Other than insuring that power is applied to the fiber optic receiver, there are no other operating instructions. However, if the fiber is a long one you may want to compensate the destination equipment for its length using the standard cable length compensation function of the equipment. The propagation delay of the fiber is roughly the same as the coax that would normally be installed. It is more precisely equal to the speed of light (2.998×10^8) divided by the group refractive index of the fiber. For the fiber we recommend, the group refractive index is 1.496 at 850 nM and 1.491 at 1300 nM. Thus, at 850 nM, the correction factor for the recommended optical cable is 1.52 ns per foot. Don't forget to add in any coax between the source equipment and the fiber optic transmitter end and the propagation delay of the fiber optic modules. The exact delay through the modules (using only 1 M of fiber) is marked on the rear panel of the fiber optic receiver(150-702).

3. THEORY OF OPERATION

3.1. GENERAL INFORMATION

This section contains the theory of operation of the 150-702 Fiber Optic Receiver. The receiver is used as part of a fiber optic system to provide a secure connection between source and destination equipment for Tempest or other secure facilities. It is also used to provide an extra long link (up to 2 KM), or to provide an EMI immune link in a noisy environment. The fiber optic receiver can be used to provide a lightning proof link where lightning is a problem.

3.2. HARDWARE DESCRIPTION

The 150-702 Assembly is intended to be used in systems that need the advantages of fiber in transmitting sine or square wave signals between 100 KHz and 11 MHz. A fiber optic transmitter serves to send the signal to the 150-702 receiver by amplitude modulating a cw lightwave and launching it into a 62 micron glass optical fiber. The 150-702 receiver takes the lightwave signal and converts it to an electrical copy then it passes through a limiting amplifier to compensate for fiber and conversion losses. A buffer/filter capable of driving a 50 Ω load follows the limiter section. Refer to the schematic (86-702) for the following discussion.

3.2.1. Receiver (86-702)

Twelve VDC is applied to the board at P2. It passes through a low pass filter consisting of C13, L3, F1, C15, and C18. CR1 is a Transorb, which serves to clip any positive-going input transient to a nominal 15V, and any negative-going transient to -0.6V. It also serves to protect against power supply polarity reversal by conducting very hard and causing F1 to enter a high impedance state, where it will remain until the power is removed. F1 is a polyswitch device which acts as a fuse but which self-resets when the overload that causes it to operate is removed. The filtered 12 VDC is then regulated down to +5 VDC by U4, whose output is filtered by C14. C1, C2, C16 and C17 are decoupling capacitors located close to each IC. U3 is a Fiber Optic Receiver, which contains a photodiode and a trans-impedance amplifier. The amp's output is AC-coupled to the input of U1:A by C6. R2, R3, and R4 bias the inverters into their linear operating region. C7 and C8 are interstage coupling capacitors that couple the signal through successive stages of voltage amplification until, at pin 6 of U1:C, there is a 5 volt swing. U1:D through U1:F form a power amp, and serve to further limit the signal to a squarewave shape. From here, until the output, things are done differently for each of the supported types of signals, depending on whether the output is to be sine or square wave, and if sine, what frequency. The simplest case first. For squarewaves of any supported frequency: L1, L2, C9, C10, and C5 are replaced with short circuits, and C3, C4, R5, R7, and C12 are not installed. U2 is then configured as a DC coupled power buffer capable of driving 50Ω to +5V levels. It is also short circuit protected with built in current limiting. Some minor variations on this theme are possible such as a series-terminating resistor installed in L2's place, and a low pass filter consisting of L2 and C12. All of these variations are covered by dash numbers, each of which has its own Bill of Materials which calls out the values of all these optional components. Note that the schematic shows the sine wave configuration, and here the values of various components are

frequency-dependent and also are controlled through the Bill of Materials. In the sine wave version, R5 and R7 serve to bias U2 in the middle of its operating range, so that a bipolar signal may be applied to it. L1, C3, R6, and optionally C9 form a maximally flat bandpass filter which serves to convert the single-ended 5 Vpk signal coming from U1:D through U1:F into a sine shaped signal of the same frequency. C3 is tuned for a peak at the frequency of interest, as seen at the output connector P1. *Do not use a scope to probe this filter when tuning, as the scope probe capacitance will detune the circuit.* L2, C4, the output terminating resistor, and optionally C10 form a maximally flat bandpass filter, which serves to further refine the sinewave as seen on the output. C4 is tuned for a peak at the frequency of interest as seen at the output connector P1. C12 is used as a low-pass filter to further suppress harmonic content of the signal. All of these components are frequency dependent, and so there is a separate Bill of Materials for each supported sine shaped frequency. While it is conceivable to alter the tuning in the field, many of these components are surface mounted and require special techniques to safely change.

4. MAINTENANCE AND TROUBLESHOOTING

4.1. INTRODUCTION

Effective maintenance and troubleshooting of this equipment requires a thorough understanding of equipment characteristics, operating procedures, theory of operation and knowledge of both linear and logic circuit elements. The equipment characteristics, operating procedures and the theory of operation for the system processor (if one exists) are provided in SECTION ONE through SECTION THREE of this manual. A working knowledge of Fiber Optics theory and connection methods is also required.

4.2. PREVENTIVE MAINTENANCE

A systematic preventive maintenance routine can reduce the possibility of a malfunction. This routine should include inspection, qualification and cleaning of the instrument.

4.2.1. Inspection

Exercise care when handling this equipment. It contains sensitive parts that can be damaged by improper handling. Do not touch connector pin surfaces because of the danger of static discharge, also deposits on contact surfaces can cause corrosion, resulting in equipment damage or failure. Inspect the unit for damaged components, loose or frayed connections and corrosion on metal surfaces. If damage is found, correct it immediately. Be especially careful not to get any foreign material into fiber optic connections as it will degrade or destroy the connection. Keep in mind that the active signal path in the fiber is only 62.5 microns in diameter (thinner than a human hair), and so requires only a trace quantity of material to disrupt it.

4.2.2. Cleaning

Accumulations of dust and dirt can impair cooling and cause performance degradation. The equipment may be cleaned by the use of a vacuum cleaner or compressed air, and if the problem is bad enough, with a cloth dampened with clean water and a mild detergent. Thoroughly rinse the cloth with clean water after washing, and wipe off washed areas to remove any residue. Be careful not to get water into switches or pots or *Fiber Optic connectors*.. Thoroughly dry the equipment with compressed air, and/or time permitting, by air drying. Circuit cards may be cleaned using the procedure in their manuals. If you suspect that a fiber connector has been fouled, it may be cleaned with *clean* isopropyl alcohol in spray form, followed by a jet of *clean, dry air*. Do not use any form of cloth or tissue to attempt cleaning, as this may only aggravate the problem.

4.2.3. Qualification

Verify that the unit meets all of the applicable specifications listed in Section One. Failure to meet a specification is an indication of malfunction and should be corrected immediately.

The following suggestions are general in nature. When followed, they will minimize equipment down time. Use these suggestions in conjunction with the drawings in Section Five and the circuit descriptions in Section Three to diagnose equipment malfunctions.

4.2.4. General Troubleshooting Procedures

Since an apparent problem may actually be the result of operator error, misunderstanding or misuse, the technician will need a thorough understanding of the normal operation. Refer to SECTION TWO for a description of normal operation. Thoroughly evaluate the procedures used by the operator when the malfunction occurred.

4.2.5. Power Circuits

Verify that the power supply is as specified. Verify that the primary power fuse has not blown and that primary power is present. Check external loads where applicable. In dual supply systems, verify that both are functional.

4.2.6. Locating Drawings

Reduced drawings of all mechanical assemblies and schematics are located in SECTION FIVE of this manual. The index contains a list of the drawings and circuit card manuals included in this manual.

4.2.7. Locating Circuits

SECTION THREE provides a written description of this equipment. Use this information in conjunction with the schematics while troubleshooting.

4.3. CORRECTIVE MAINTENANCE

4.3.1. Replacing Components

It is critical that the ICs are replaced with exactly the same type of component. *Do not guess in this area.* Use the parts lists to find the exact IC part number. Use only a vacuum powered solder extractor to desolder parts. These boards have ground planes which make it virtually impossible to desolder some pins of a part using solder wick, or the spring or rubber bulb powered solder suckers, without damaging the PCB. Using any but the recommended method will void any warranty on the card. If in doubt, return the card to the factory for repair or replacement. Be sure not to bend the IC legs under when replacing them. While it is conceivable to repair these boards in the field, many of these components are **surface mounted** and require special techniques to safely change. Therefore, unless you have access to the specially trained and equipped personnel to change these components, it is recommended that you return the unit to the factory for repair.

4.3.2. Soldering Components

When replacing soldered components use a low wattage 700°F iron and be careful not to overheat the etch or use excessive pressure. Remember that heat and pressure is all that it takes to lift the etch and possibly even the plated

through-hole of the connection. Use solder with a water soluble flux core such as Kester QQS-571 and clean the soldered joints carefully with water. Do not allow water to penetrate the pots or switches. Thoroughly dry the PCB after cleaning using compressed air, a low temperature (100°F) oven, or just plain sunlight. The flux is hydroscopic and must be removed to avoid corrosion of the PCB traces. Rosin core solders are not recommended because of the hazards posed by the required cleaning solvents.

5. DETAILED DRAWINGS

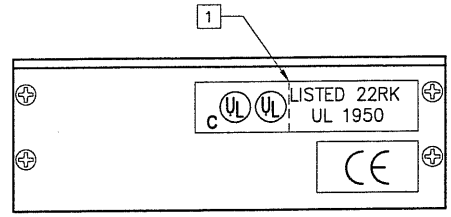
5.1.	150-702	TOP ASSEMBLY, RECEIVE END
5.2.	150-702-2	BOM, RECEIVE END
5.3.	088-PSA122-1	POWER CONNECTOR INSTALLATION
5.4.	86-702	PCB TOP ASSEMBLY, BOM RECEIVE END
5.5.	86-702-2	BOM, PCB, RECEIVE END MODS.

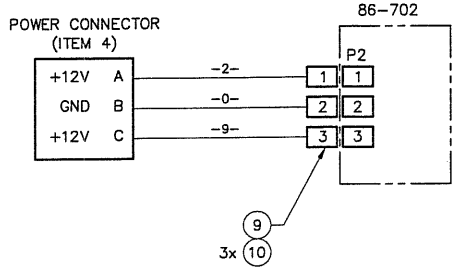
MAX * BILL OF MATERIALS * SINGLE-LEVEL EXPLOSION BY PART IDENTIFIER W/REFERENCE

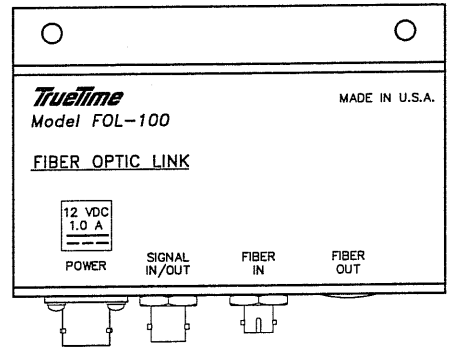
PART IDENTIFIER	DESCRIPTION 1	DESCRIPTION 2	EFF DATE	ECN #	QTY/ASSY	UOM	REV LVL	REFERENCE DESCRIPTION
150-702-2	FNL ASSY FIBER OPTIC LINK 5 MHZ SINE					EA		
0000-APPROVAL	PARTS LIST APPROVAL		000000		1.0000	EA		~~SB~~ 2-2-00
0000-PL	PARTS LIST REV LEVEL		000000		1.0000	EA		~~REV~~ A (02-02-00)
0000-PRINT	REFERENCE PRINT		000000		1.0000	EA		SEE 150-702
048-4411	FIBER OPT NUT W/WASHER	HP HFBR-4411	000000		1.0000	EA		13
093-692-1	CASE FIBER OPTIC LINK	FAB/PAINT/SCREEN	000000		1.0000	EA		01
206-692	PNL,FRT FOL ANTENNA	FAB/PAINT	000000		1.0000	EA		02
216-692	PNL,REAR FIBER OPTIC LINK	FAB/PAINT	000000		1.0000	EA		03
240-004-002	SCREW PH PN SS 4-40X1/4	SCREW PAN	000000		4.0000	EA		12
249-003	SCREW PH FH SS 4-40 X 3/8	100 DEG BLK	000000		8.0000	EA		08
254-.312	WSHR SPLIT #4 SS	STAINLESS	000000		4.0000	EA		11
274-005	PLUG HOLE NYL 3/8 DIA	HH SMITH 3091/HEYCO 2617	000000		1.0000	EA		14
315-022-002	WIRE 22AWG PVC INS RED	UL1429-22/7-2	000000		0.5000	FT		4 IN. SEE WIRING
315-022-009	WIRE 22AWG PVC INS WHITE	UL1429-22/7-9	000000		0.5000	FT		4 IN. SEE WIRING
315-022-010	WIRE 22AWG PVC INS BLACK	UL1429-22/7-0	000000		0.5000	FT		4 IN. SEE WIRING
372-03R	CONN,3-P RECEPTACLE	CANNON KPT02E8-3S	000000		1.0000	EA		04
375-022	LOCKWASHER,BNC PC MT	AMP 1-329632-2	000000		1.0000	EA		05
375-023	NUT BNC PC MT	AMP 1-329631-2	000000		1.0000	EA		06
400-043	LABEL,F/O V/A DC	MADE FROM 400-031	000000		1.0000	EA		SEE DRAWING
400-051	LABEL,CE SYMBOL	MADE FROM 400-031	000000		1.0000	EA		SEE DRAWING
400-056	LABEL,UL/CUL LISTED	MADE FROM 400-030	000000		1.0000	EA		SEE DRAWING
400-067	LABEL, FCC (F/O MODULE)	MADE FROM 400-030	000000		1.0000	EA		APPLY TO REAR PANEL
402-001	PIN 22-30 AWG MINI-KK	MOLEX 08-65-0805	000000		3.0000	EA		10
403-003L	CONN 3-P CBL MT LCK .100	MOLEX 22-01-3037	000000		1.0000	EA		09
86-702-2	ASSY FOL RX	5 MHZ SINE	000000		1.0000	EA		07
LA	LABOR ASSEMBLY COST HRS		000000		0	EA		
LT	LABOR TEST COST HOURS		000000		0	EA		

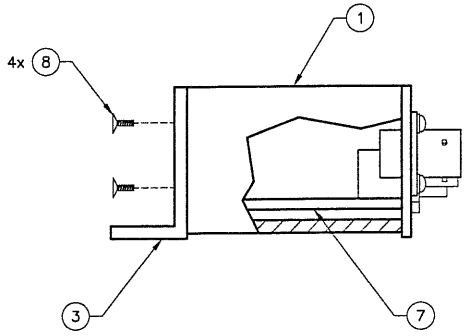
REVISIONS

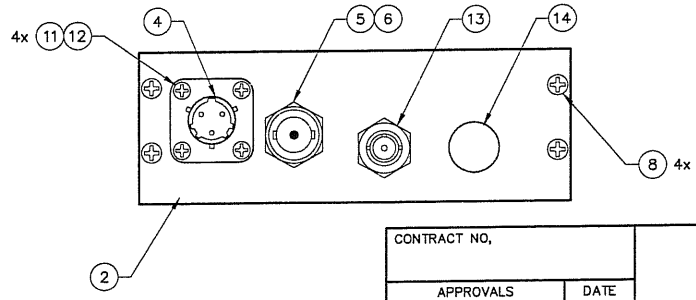
REV	DESCRIPTION	DATE	APPROVED
A	CAR 491 ADD LABELS	03-16-98	
B	CHANGE POWER CONNECTION LABELS	05-21-98	











1 TO FIT "UL" LABEL CUT WHERE INDICATED BY DASHED LINE.

NOTES: UNLESS OTHERWISW SPECIFIED

CONTRACT NO,	
APPROVALS	DATE
DRAWN BY SEIFERT	4/96
CHECKED BY	
APPROVED BY	5-21-98
NEXT ASSY	

TrueTime®
"Where Customer Satisfaction is our Highest Priority"
2835 Duke Ct. Santa Rosa, CA 95407

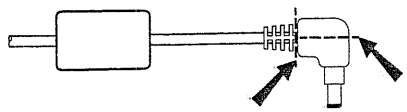
TOP ASSEMBLY FOL RX, FM

SIZE	CODE IDENT NO.	DRAWING NO.	REV
B		150-702	B

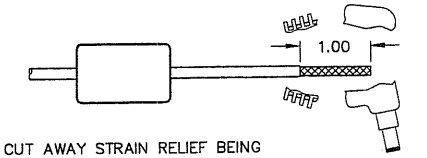
SCALE NONE | SHEET 1 OF 1

FILENAME: \100\50-702
DATE: 05-21-98

REVISIONS			
REV	DESCRIPTION	DATE	APPROVED
A	ADDED SHRINK TUBING	1/3/97	
B	CAR453	10/27/97	
C	ADD PWR CORD TO BOM	5/12/98	
D	ADD PIN OUT LABELING	5/21/98	
E	CAR 897	6/22/98	DR
F	CAR 1352	1/11/99	BVH/DR
G	PR 3859	06/02/00	

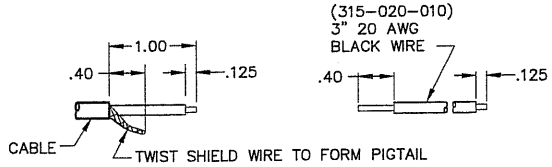


1. BEGIN CUT HERE TO REMOVE CONNECTOR TO EXPOSE INNER WIRES.

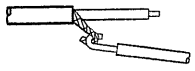


2. CUT AWAY STRAIN RELIEF BEING CAREFUL NOT TO CUT CABLE. STRIP OUTER INSULATION TO DIMENSION SHOWN.

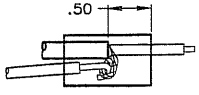
SEE NOTE B.



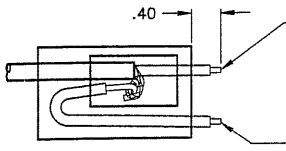
STRIP AND TIN WIRES AND PIGTAIL TO DIMENSIONS SHOWN.



FORM HOOKS, LATCH TOGETHER, SOLDER AND CLEAN THE SHIELD PIGTAIL AND .40 END OF BLACK WIRE (315-020-010, 3") AS SHOWN.

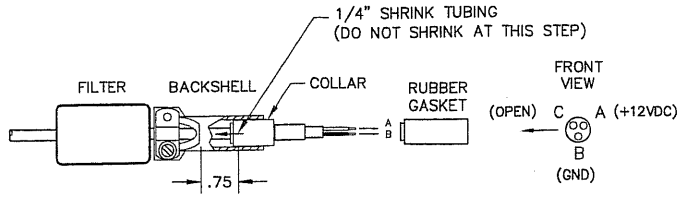


BEND BLACK PIGTAIL BACK ALONG CABLE AND PLACE .187 X 1.00 SHRINK TUBING OVER JOINT AS SHOWN.

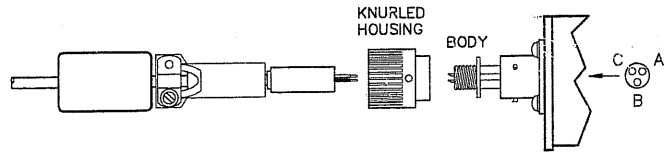


BEND PIGTAIL AGAIN TOWARDS STRIPPED END OF WHITE WIRE AND PLACE .250 X 2.00 SHRINK TUBING OVER JOINT AND BENT BLACK WIRE AS SHOWN.

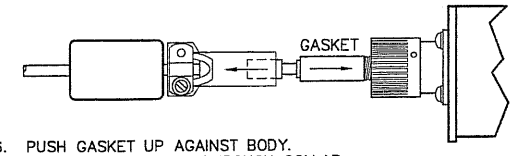
3. CABLE AND PIGTAIL TERMINATION.



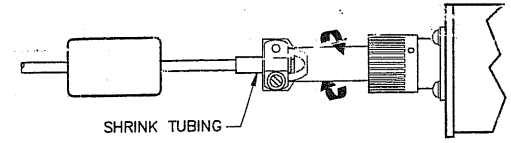
4. TEMPORARILY INSTALL BACKSHELL UP AGAINST FILTER. SLIDE COLLAR INSIDE BACKSHELL. INSTALL WHITE (+) WIRE INTO HOLE "A" OF GASKET. INSTALL BLACK (-) WIRE INTO HOLE "B" OF GASKET.



5. INSERT BODY INTO KNURLED HOUSING BEFORE SOLDERING WIRES. SOLDER WHITE WIRE INTO SOLDER CUP "A". SOLDER BLACK WIRE INTO SOLDER CUP "B". MATING CONNECTOR SHOULD BE USED TO HOLD BODY DURING SOLDERING.
NOTE THAT SOME MANUFACTURERS COMBINE THE HOUSING AND BODY INTO ONE MOULDED UNIT- NOT SEPARATED AS SHOWN.



6. PUSH GASKET UP AGAINST BODY. PUSH SHRINK TUBING THROUGH COLLAR.



7. SLIDE BACKSHELL FORWARD AND SCREW INTO BODY USING MATING CONNECTOR AS A WRENCH TO HOLD BODY TO TIGHTEN BACKSHELL SECURELY. PUSH SHRINK TUBING AGAINST RUBBER GASKET. SHRINK HEAT SHRINK TUBING. TIGHTEN CABLE CLAMP SCREWS.

B. STEPS 1 AND 2 ARE NOT REQUIRED IF CUSTOMER PROVIDES THEIR OWN POWER SUPPLY.

A. DIMENSIONS ARE IN INCHES.

NOTES: UNLESS OTHERWISE SPECIFIED.

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ARE: FRACTIONS ± DECIMALS .XX=±.01 .XXX=±.005 ANGLES ±2° ALL THREADS TO BE CLASS 2 PER ANSI Y14-6 MACH COR-.005 TO .015R OR CHAM SH MATL-DEBURR & BREAK EDGES .015 MAX R DIM. AND TOL. APPLY FIN. TREAT. MATERIAL FINISH FILENAME: \100\PSAPWR DATE: 06-02-00	CONTRACT NO. APPROVALS - DATE DRAWN BY SEIFERT 10/95 CHECKED BY XL TEAM 8/98 APPROVED BY DR 8/98 NEXT ASSY	TrueTime® "Where Customer Satisfaction is our Highest Priority" 2835 Duke Ct. Santa Rosa, CA 95407 POWER CONNECTOR INSTALLATION INSTRUCTIONS SIZE B | CODE IDENT NO. | DRAWING NO. 088-PSA122-1 | REV G SCALE NONE | SHEET 1 OF 1

MAX * BILL OF MATERIALS * SINGLE-LEVEL EXPLOSION BY PART IDENTIFIER W/REFERENCE

PART IDENTIFIER	DESCRIPTION 1	DESCRIPTION 2	EFF DATE	ECN #	QTY/ASSY	UOM	REV LVL	REFERENCE DESCRIPTION
088-PSA122-1	PWR SUPPLY 12V 30W REG	088-PSA122 MODIFIED				EA		
0000-APPROVAL	PARTS LIST APPROVAL		000000		1.0000	EA		DAK 6-8-00
0000-PL	PARTS LIST REV LEVEL		000000		1.0000	EA		REV G (06-06-00)
0000-PRINT	REFERENCE PRINT		000000		1.0000	EA		088-PSA122-1 REV G
088-PSA122	PWR SUPPLY 12V 30W REG	PHIHONG PSA-30U-120(P)	000000		1.0000	EA		
315-020-010	WIRE 20AWG PVC INS BLACK	UL1429	000000		0.2500	FT		SEE DRAWING
326-002	SHRINK TUBING CLR 3/16 IN	MOUSER 5174-13163(4FT PC)	000000		0.2000	FT		SEE DRAWING
326-008	SHRINK TUBING CLR 1/4 IN.	MOUSER 5174-1143 (4FT PC)	000000		0.2500	FT		SEE DRAWING
332-002	CORD POWER	BELDEN 17250	000000		1.0000	EA		SHIPPING KIT
372-03P	CONN,3-P PLUG (CABLE)	CANNON KPT06F8-3P	000000		1.0000	EA		
LA	LABOR ASSEMBLY COST HRS		000000		0	EA		
LT	LABOR TEST COST HOURS		000000		0	EA		

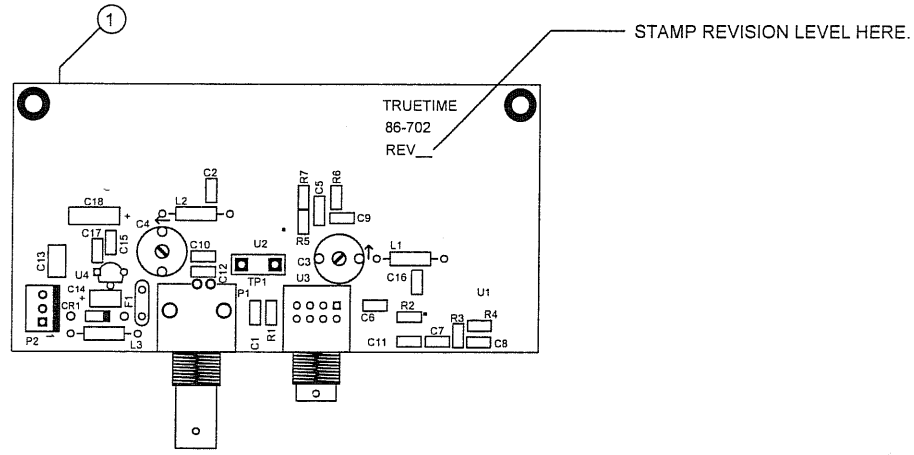
MAX * BILL OF MATERIALS * SINGLE-LEVEL EXPLOSION BY PART IDENTIFIER W/REFERENCE

PART IDENTIFIER	DESCRIPTION 1	DESCRIPTION 2	EFF DATE	ECN #	QTY/ASSY	UOM	REV LVL	REFERENCE DESCRIPTION
86-702-2	ASSY FOL RX	5 MHZ SINE				EA		
0000-APPROVAL	PARTS LIST APPROVAL		000000		1.0000	EA		JB 2-2-00
0000-PL	PARTS LIST REV LEVEL		000000		1.0000	EA		REV A (02-02-00)
0000-PRINT	REFERENCE PRINT		000000		1.0000	EA		SEE 86-702
008S-151	RES 0805 150 OHM 5% 1/8W	CAL-CHIP RM10J151CT (NAV)	000000		1.0000	EA		R6
008S-472	RES 0805 4.7K OHM 5% 1/8W	CAL-CHIP RM10J472CT (NAV)	000000		2.0000	EA		R5,7
036S-NP0100	CAP 10PF NPO 100V 0805	NIC NMC0805NP0100J100TR	000000		1.0000	EA		C9
036S-NP0390	CAP 39PF NPO 0805	NIC NMC0805NP0390J100TR	000000		1.0000	EA		C10
036S-NP0910	CAP 91PF NPO 100V 0805	NIC NMC0805NP0910J100TR	000000		1.0000	EA		C12
036S-Y5V104	CAP CER .1UF Y5V 50V 0805	NIC NMC0805Y5V104Z50TR	000000		1.0000	EA		C5
045-22UH-78F	INDUCTOR, 22UH	J W MILLER 78F220J	000000		2.0000	EA		L1,2
86-702	ASSY FOL RX CW	MADE FROM 085-702	000000		1.0000	EA		
LA	LABOR ASSEMBLY COST HRS		000000		0	EA		
LT	LABOR TEST COST HOURS		000000		0	EA		

REVISIONS			
LTR	DESCRIPTION	DATE	APPROVED

NOTES: UNLESS OTHERWISE SPECIFIED

1. ASSEMBLE PER ASSEMBLY REQUIREMENTS DOCUMENT 421-11.
2. RESISTOR VALUES IN OHMS, CAPACITORS IN MICRO FARADS.



CONTRACT NO.		
APPROVALS		DATE
DRAWN BY	R.E.C.	3-27-95
CHECKED		
APPROVED		5-17-96
NEXT ASSY		

TrueTime, Inc.
Santa Rosa, California

Title	FIBER OPTIC LINK, RX ASSEMBLY DRAWING	
Size	Number	Rev
B	86 -702	N/C
Date	3-14-96	
Filename	702.PCB	Sheet 1 of 2

6. APPENDIX A

6.1. RECOMMENDED FIBER OPTIC CABLE

The fiber optic cable recommended for most indoor/outdoor installations is: **BX002-070D-W3SB/1TC/900-R**

MANUFACTURER IS **OPTICAL CABLE CORPORATION**

This is a riser rated indoor/outdoor tightly buffered breakout cable which is very easy to install compared with any other options. Due to the fact that it is a riser rated cable, it does not require any special handling to run it inside from outside. It is rated for direct burial and aerial installations (with the addition of a suitable messenger). It is also available in an armored version should protection from vermin be required. Where existing fiber cable is used, it must be 62.5/125 micron fiber. The fiber optic receiver uses 850 nM wavelength optical devices and has a 10DB power budget. All fiber links used must have <=10db loss @ 850 nM. This is a two fiber cable which provides an installed spare.

6.2. RECOMMENDED COAX CABLE

TrueTime normally supplies and recommends : **Belden 8219**

MANUFACTURER IS **BELDEN ELECTRONIC WIRE AND CABLE**

6.3. RECOMMENDED OPTICAL CONNECTORS

TrueTime normally supplies and recommends: **Amp 504034-1**

MANUFACTURER IS **AMP INCORPORATED**

This is a crimp style connector that requires no epoxy or other difficult assembly.