TRUETIME

Model 560-5140-2
50 bps - 38.4 kbps SYNTHESIZER MANUAL

SECTION ONE

SECTION TWO

SECTION THREE

SECTION FOUR

October 8, 1996

Serial Number_____

SECTION ONE

1. FUNCTIONAL DESCRIPTION

1.1. PURPOSE OF EQUIPMENT

The TrueTime Model 560-5140-2 Synthesizer generates an output frequency that is locked to the external reference frequency distributed via REF A, B or C on the backplane. The reference is received via the passive combiner, which passes only the currently-highest priority reference to the Synthesizer. If the currently-highest priority reference is changed, the passive combiner shifts to the next-highest priority input and the Synthesizer locks to the new reference.

The generated frequency is output through the backplane connector via six complementary drivers. The output signals are delivered to external cables via the I/O card installed in the rear slot directly behind the Synthesizer. The output mode, single-ended or differential, is determined by the type of I/O card that is installed. Input and Output frequencies are switch-selectable.

1.2. PHYSICAL SPECIFICATIONS

Dimensions:	0.8"w X 3.94"h X 8.66"d (2 cm X 10 cm X 22 cm)
Weight:	Approximately ½ pound (¼ kg)

1.3. ENVIRONMENTAL SPECIFICATIONS

Operating Temp:	0 to +50° C
Storage Temp:	-17 to +100° C
Humidity:	95% relative, non-condensing
Cooling Mode:	Convection

1.4. POWER REQUIREMENTS

Voltage:	48 VDC ±20%
Power:	5 W (all outputs driving 50 ⬇)

1.5. FUNCTIONAL SPECIFICATIONS

1.5.1. REF A, B AND C INPUTS

Signal Type:	Squarewave or Sinewave
Amplitude:	1-5 Vpp
Frequency:	1, 5 or 10 MHz (Switch-selectable)

1.5.2. OUTPUTS, SINGLE-ENDED MODE

Quantity:	6
Signal Type:	Squarewave, TTL-level
Amplitude:	2.8 Vpk into 50 Ohms
Impedance:	30 Ohms

1.5.3.

OUTPUTS, DIFFERENTIAL MODE

Quantity: 6
Signal Type: Squarewave, centered at 2.5 VDC
Amplitude: 2.8 Vpp into 100 Ohms
Impedance: 30 Ohms
Output Drive Compliance:
MIL-STD-188-114A TYPE II BALANCED
RS-422-A

1.5.4. OUTPUT FREQUENCY

Frequencies: (Switch-selectable)
50, 75, 150, 300, 600, 1200, 4800
7200, 9600, 14.4k, 19.2k, 38.4k bps
Frequency Stability:
Long-term: Equal to reference on REF A, B or C
Short-term: Better than 1 part in 10^{9} (1 second average)

1.5.5. DRC CARD COMPATIBILITY

Location: Slot 1-17 with compatible I/O card in rear slot.
Compatibility: See DRC Card Compatibility Matrix.

SECTION TWO

2. INSTALLATION AND OPERATION

2.1. HOT SWAPPING

All cards, input cables and output cables are hot swappable. It is not necessary to remove chassis power during insertion or removal. Hot swapping and reference-source changes are abrupt, the effects difficult to characterize; however, the system is designed to protect against permanent effects and minimize temporary effects of these events.

Typically, adjacent-card hot swapping has a negligible effect on the Synthesizer. Although the hot swapping event directly affects the control voltage of each on-board oscillator, it typically lasts less than one clock-period and has an average of 0 Volts. The effect of redundant power supply switch-over is also negligible.

The effect of a reference-source change is less predictable. The reference frequency is delivered via REF A, B and C on the backplane. The Synthesizer receives the reference via the Passive Combiner. If the currently-highest priority reference is changed, the Synthesizer locks to the new reference. When the new reference is in phase with the old reference, the output frequency is affected by less than 1 part in 10^8 over a 1 second period. When the new reference is of opposite phase, the effect can approach 1 part in 10^6. The frequency-shift occurs relatively softly over a 100 ms period, minimizing any effect on downstream equipment. Note that hot swapping a local frequency source, such as an oscillator or fiber optic receiver, qualifies as a hot swap and reference-source change.

The effect of a reference-input perturbation that does not result in a reference-source change (e.g. - removing a cable that is not currently-highest priority) at the passive combiner also has an effect on the Synthesizer. This is due to the fact that the reference frequency used by the Synthesizer is always a weighted sum of REF A, B and C, and any change has some effect on the resultant waveform. The effect is usually negligible, but can approach 1 part in 10^8.

2.2. REMOVAL and INSTALLATION

CAUTION: Individual components on this card are sensitive to static discharge. Use proper static discharge procedures during removal and installation.

Refer to CARD COMPATIBILITY section prior to installing new card.

To remove card, loosen the captive retaining hardware at the top and bottom of the assembly, then firmly pull on the handle, (or on any connector on rear panel adapter cards) at the bottom of the card. Slide

the card free of the frame. Refer to the SETUP section for any required switch settings; or, set them identically to the card being replaced. Reinstall the card in the frame by fitting it into the card guides at the top and bottom of the frame and sliding it in slowly, avoiding contact between bottom side of card and adjacent card front panel, until it mates with the connector. Seat card firmly to avoid contact bounce. Secure the retaining screws at the top and bottom of the card assembly.

2.3. SETUP

The setup of the Synthesizer involves selection of input frequency and output frequency. Select input frequency to match the system-wide reference frequency on REF A, B and C: 1, 5 or 10 Mhz. Select output frequency to match individual Synthesizer output frequency requirements.

2.3.1. INPUT FREQUENCY SELECT

Set SW1 through SW5, and SW6 to select frequency:

	10 MHz	**5 MHz**	**1 MHz**
SW1-1 thru SW5-1	ON	OFF	OFF
SW1-2 thru SW5-2	OFF	ON	OFF
SW1-3 thru SW5-3	OFF	OFF	ON
SW1-4 thru SW5-4	OFF	OFF	OFF
SW6-1	ON	OFF	ON
SW6-2	OFF	ON	ON

2.3.2. OUTPUT FREQUENCY SELECT

Set SW6 and SW7 to select 0-1200 Hz:

Hz	**0**	**50**	**750**	**150**	**300**	**600**	**1200**
SW6-3	ON	ON	ON	ON	ON	ON	ON
SW6-4	OFF	OFF	OFF	OFF	OFF	OFF	OFF
SW7-1	OFF	ON	OFF	ON	OFF	ON	OFF
SW7-2	OFF	OFF	ON	ON	OFF	OFF	ON
SW7-3	OFF	OFF	OFF	OFF	ON	ON	ON
SW7-4	OFF	OFF	OFF	OFF	OFF	OFF	OFF

Set SW6 and SW7 to select 2400-38.4 kHz:

Hz	**2400**	**4800**	**7200**	**9600**	**14.4k**	**19.2k**	**38.4k**
SW6-3	ON	ON	ON	ON	ON	ON	ON
SW6-4	OFF	OFF	OFF	OFF	OFF	OFF	OFF
SW7-1	ON	OFF	ON	OFF	ON	OFF	ON
SW7-2	ON	OFF	OFF	ON	ON	OFF	OFF
SW7-3	ON	OFF	OFF	OFF	OFF	ON	ON
SW7-4	OFF	ON	ON	ON	ON	ON	ON

2.4.

FAULT INDICATIONS

All indicators activate briefly following hot-insertion or power-up. The following paragraphs describe operation during steady-state conditions.

2.4.1. SYNTH FAULT

The Synthesizer Fault indicator may flash briefly during hot swapping and at the addition or removal of REF A, B or C. This is a normal condition which occurs as the Voltage Controlled Oscillator (VCO) experiences a reference perturbation (see HOT SWAPPING section for a discussion of the effects of hot swapping).

A continuously-flashing or solid indication shows a phase-locked loop out-of-lock condition. This could be caused by:

1) Input reference off-frequency.

2) Loss of reference on REF A, B and C . When all references are lost, the VCO slowly drifts to one end of the control range, which is detected as a SYNTH FAULT. This can take seconds or hours, depending on circuit and environmental conditions.

3) Failure of a VCO.

4) Failure of the Synthesizer on-card 5 VDC power supply.

2.4.2. OUT FAULT

The OUT A through OUT F Fault indicators activate when the associated drivers have failed. A failure of either the +Output or -Output will activate the indicator, whether or not both outputs are available at the rear I/O Card connector. Note that the detector is designed to detect failed drivers and, typically, will not detect a shorted output.

2.4.3. INIT. FAULT

This is an on-card fault indicator which is not externally visible; although it can be seen by installing the card next to an empty slot. It indicates a failure of the card to initialize properly during power-up. Activation of this LED is accompanied by activation of all of the front panel indicators, except OUT B. Occasionally, this fault is caused by a temporary condition related to the cycling of power and can be cleared by a power or hot swap cycle. If this is unsuccessful, the card is defective.

2.4.4. BACKPLANE FAULT OUTPUT

Each slot supports a Fault output, which can be read by the optional Fault Monitor CPU. This signal is activated by the Synthesizer while any one of the Fault Indicators is active.

2.4.5. DETAILED FAULT STATUS VIA CPU

The Fault Monitor CPU has access to detailed Synthesizer card status. This status is available via the Fault Monitor CPU serial port. When it is presented in a 2-byte format, with individual bit definitions are as follows:

	Bit	Status (1=Active)
Low Nibble, Low Byte	0	OUT A Fault
	1	OUT B Fault
	2	OUT C Fault
	3	OUT D Fault
High Nibble, Low Byte	4	OUT E Fault
	5	OUT F Fault
	6	Synthesizer Fault
	7	No Output Frequency Selected
Low Nibble, High Byte	8	Unused, Always 0
	9	Unused, Always 0
	10	Unused, Always 0
	11	Unused, Always 0
High Nibble, High Byte	12	Unused, Always 0
	13	Unused, Always 0
	14	Unused, Always 0
	15	Composite Fault

SECTION THREE

3. THEORY OF OPERATION

3.1. GENERAL INFORMATION

This section contains a detailed description of the circuits in the Synthesizer card. Use these descriptions in conjunction with the drawings in SECTION FOUR.

3.2. HARDWARE DESCRIPTION

The Synthesizer incorporates a Passive Combiner, a DC-to-DC Converter, 1 to 4 phase-locked VCOs, 1-4 mixer-filters, 12 Output Drivers, Fault-detection circuitry and 8 Fault Indicators.

3.3. DETAILED DESCRIPTION

Reference drawing 560-5140-2.

3.3.1. PASSIVE COMBINER (sheet 4)

The passive combiner is a circuit that strives to always output the desired signal, derived from the three separate inputs REF A, B and C (named FREQA, B and C on the schematic), without introducing any switching transient or glitch when one or two of the inputs are lost. It is composed of three input filter sections, three high speed comparators, a weighting network and a passive combining network. The filters and the combining network employ tuned circuits and therefore have to have their values adjusted depending on the required input frequency of either 1, 5 or 10 MHz. This is accomplished by the use of SW1 through SW6, which are 4PST DIP switches. The input filters and the comparators serve to produce a very clean squarewave with very good symmetry. These squarewaves are then buffered by U6 and applied to the weighting network (R15, R16 & 17 and C17, C18 & C19) where they are summed with different weights in order to give the primary source the greatest influence on the final result. This summing results from an interaction between the weighting network and the combining network which is composed of a parallel resonant tank and a series resonant tank. These tanks are tuned slightly off center to lower the Q so that amplitude variations are minimized when input signals are changed. The final output voltage is then buffered by U13:A and squared up by U36:A to produce the final signal called FREQIN.

3.3.2. POWER SUPPLY (sheet 12)

The DC-to-DC Converter converts 48 VDC backplane power to local ±5 VDC power. It is fully-isolated from the backplane power and referenced to signal GND on the Synthesizer card. Backplane power is supplied via a Polyswitch fuse device, diode and Pi-section L-C filter. The poly-fuse

protects the backplane power bus from internal DC-to-DC shorts. The diode and L-C filter serve a triple purpose. During live-insertion, the high-current inductor minimizes in-rush current to the DC-to-DC being inserted; and, the diode and capacitor serve to hold up the local voltage at the input to each currently-installed DC-to-DC. During steady-state conditions, the L-C filter minimizes switching noise coupled back into the backplane power bus. During live-extraction, the 0.1 uF capacitor absorbs the inductive-kick of the opened circuit, minimizing contact-arcing. The -5 VDC side of the supply is artificially loaded, providing a minimum load to improve output voltage regulation. The power-up reset generator, assures that RESET is active while the +5 VDC supply is between 1 and 4.5 VDC. This guarantees proper configuration of the Xilinx FPGA during hot swapping and power-up.

3.3.3. VOLTAGE CONTROLLED OSCILLATORS (sheet 5 & 6)

The card is equipped with 1 to 4 VCOs of various center-frequencies, depending on configuration. Each VCO is locked to a reference frequency via a phase-comparator located within the Xilinx FPGA. The filtered phase comparison is compared to a 2.5 VDC reference and the phase error is used to vary the capacitance of a varactor, which tunes the VCO to match frequency of the reference.

The card also has 1 to 4 mixer-filters with various center-frequencies, depending on configuration. Each filter is connected to the output of a mixer located within the FPGA. In each case, the filter rejects the sum frequency and passes the difference frequency, which is fed to divider chains in the FPGA.

Each VCO is locked to a different reference frequency. VCOA is always locked to FREQIN from the Passive Combiner. The other VCOs are locked to some sub-multiple that is traceable, via counters and mixers to VCOA. The VCO frequencies and counter chains, and the mixer frequencies are selected to provide the particular output frequency required by the card configuration. The FPGA is configurable via switches SW6 and SW7, which control internal multiplexers and divide ratios to select input and output frequencies.

3.3.4. OUTPUT DRIVERS (sheet 7 & 8)

The Synthesizer is equipped with 12 output drivers. These are configured as 6 differential pairs. Each individual driver consists of 8 parallel CMOS buffers. Each buffer is isolated from the output with a 270 Ohm series resistor, which serves two purposes. Taken together, the 8 parallel drivers and resistors form a rail-to-rail driver with a 33 Ohm output impedance. Additionally, the 270 Ohm resistor limits the current through the CMOS protection diodes, allowing the output to withstand the application of +6 VDC with the driver power off; and, limits short circuit current to 150 mA. To minimize switching transients, the drivers are implemented with 4 buffers of each differential pair sharing a common IC

package. They are used in single-ended or differential mode, depending on the I/O card installed in the rear slot.

The output signal, whether single-ended or differential, is a 2.8 Vpp squarewave. In single-ended mode, driving 50 Ohms to ground, the output levels are basically TTL: 0 VDC and 3 VDC. In differential mode, driving 100 Ohms between +Output and -Output, the output levels are RS-422 compatible: 1 VDC and 4 VDC.

3.3.5. FAULT DETECTION (sheet 9, 10 & 11)

There are two categories of fault detection: Output Driver faults and synthesizer faults. Both use a combination of discrete components and Xilinx FPGA logic to perform the detection task.

The driver fault detector is an edge-detector with a capacitive-coupled input and a bias network that maintains the average input voltage at the center of the 74AC14 Schmitt-trigger switching threshold. This assures that both single-ended and differential output levels can be detected. The buffer output, basically a copy of the driver wave-form is fed to the Xilinx FPGA. Logic inside the FPGA continually verifies that each of the 12 outputs are switching. Failure to detect a signal from either output of any pair results in activation of the appropriate indicator.

The synthesizer (SYNTH FAULT) detector utilizes four voltage comparators per VCO. These verify that the VCO control voltage and filtered phase comparator voltage are within defined limits. The detectors for each VCO are wire-ORed. If any voltage is out of tolerance, the common line to the FPGA is activated.

3.3.6.

BACKPLANE FAULT OUTPUT

Inside the FPGA, all faults are combined to form a composite fault signal which is used to drive the Fault line to the Fault Monitor CPU. Additionally, the following status is available to the CPU via the Fault signal on the backplane. STB and D3:0 are used to control a multiplexer within the FPGA to access the various status bits. Fault-signal active indicates status-bit true. (Note that FAULT signal is active-low on the backplane.)

D3	D2	D1	D0	STB INACTIVE	STB ACTIVE
0	0	0	0	0 (BD TYPE 0)	OUT A FAULT
0	0	0	1	1 (BD TYPE 1)	OUT B FAULT
0	0	1	0	0 (BD TYPE 2)	OUT C FAULT
0	0	1	1	0 (BD TYPE 3)	OUT D FAULT
0	1	0	0	0 (BD TYPE 4)	OUT E FAULT
0	1	0	1	0 (BD TYPE 5)	OUT F FAULT
0	1	1	0	0 (BD TYPE 6)	SYNTH FAULT
0	1	1	1	0 (BD TYPE 7)	NO OUTPUT FREQ
1	0	0	0	0 (BD TYPE 8)	0
1	0	0	1	0 (BD TYPE 9)	0
1	0	1	0	0	0
1	0	1	1	0	0
1	1	0	0	0	0
1	1	0	1	1	0
1	1	1	0	0	0
1	1	1	1	COMPOSITE FAULT	0

3.3.7. FAULT INDICATORS (sheet 11 & 12)

The INIT. FAULT indicator is driven by the FPGA Initialization-done signal. It activates during initialization, and remains active if initialization does not complete. This is an extremely unusual occurrence.

The SYNTH. FAULT indicator is powered directly from the backplane 48 VDC power buss; thus, if local 5 VDC power is lost, the indicator will activate. The indicator is held off by the fault detection logic while all VCOs are functioning within limits. It is controlled via an opto-isolator to maintain 48 VDC isolation.

The OUT fault indicators are controlled directly by the fault detection logic.

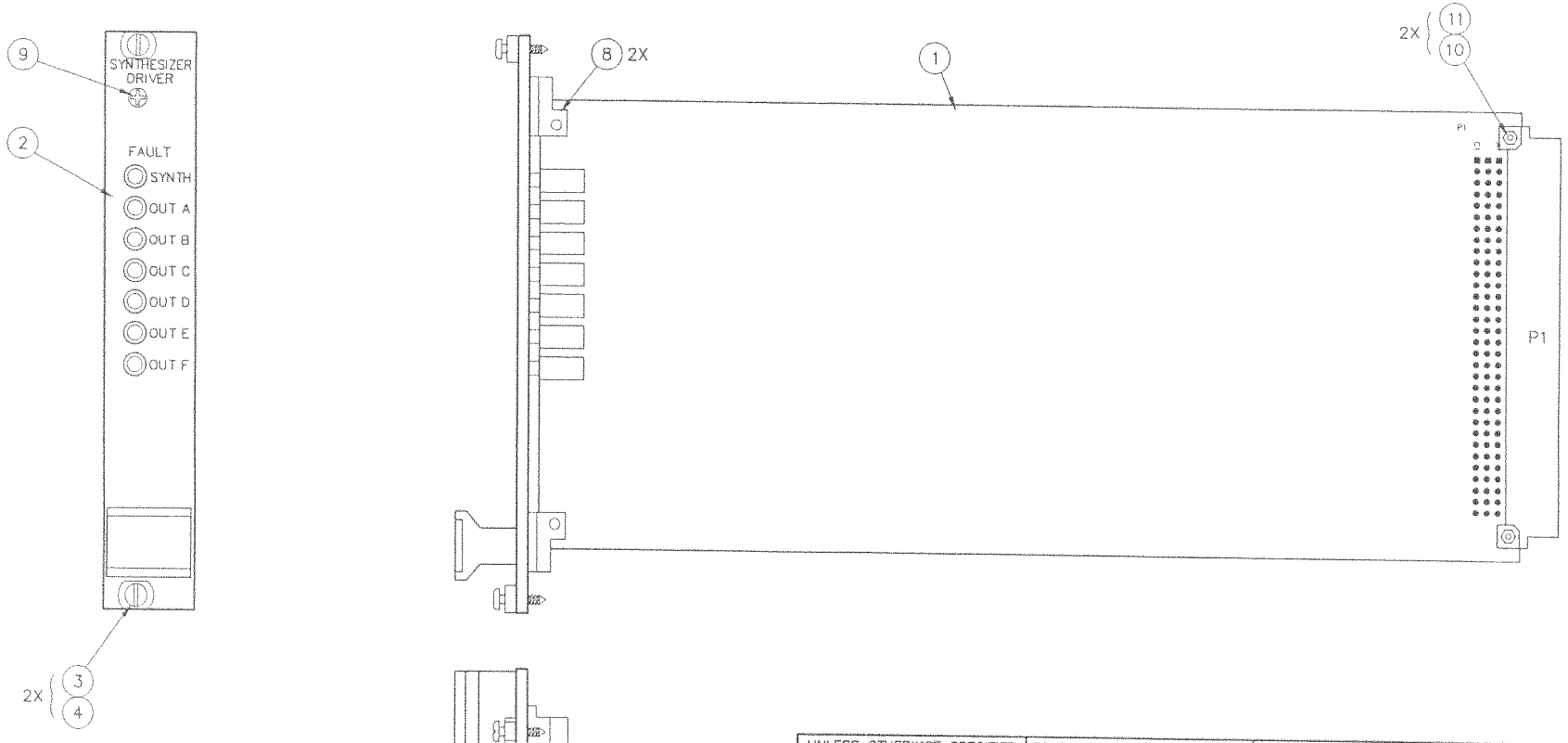
SECTION FOUR

4. DETAILED DRAWINGS

4.1. 560-5140-2 DETAILED DRAWINGS / BILL OF MATERIALS

REVISIONS

REV	DESCRIPTION	DATE	APPROVED
A	NEW REV PCB	8/30/96	DJZ 8/30



UNLESS OTHERWISE SPECIFIED	CONTRACT NO,	TrueTime 2835 DUKE CT. SANTA ROSA CA 95407	
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.	APPROVALS / DATE DRAWN BY SEIFERT 8/96 CHECKED BY APPROVED BY DJZ 8/96	PASSIVE COMBINER/ SYNTH. 50-38.4KBPS	
MATERIAL	NEXT ASSY	SIZE B	CODE IDENT NO.
FINISH		DRAWING NO. 560-5140-2	REV A
FILENAME: \560\5140-2 DATE: 8-30-96		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
560-5140-2	PASSIVE COMBINER/SYNTH	50-38.4KBPS				EA		
0000-APPROVAL	PARTS LIST APPROVAL				1.0000	EA		
0000-PL	PARTS LIST REV LEVEL				1.0000	EA		REV A (09-16-96)
0000-PRINT	REFERENCE PRINT				1.0000	EA		560-5140-2 REV A
0001-PRINT	REFERENCE PRINT				1.0000	EA		SEE 560-5140
002S-000	RES 0 OHM 0805	NIC NRC10Z0TR			7.0000	EA		
	R73,R113,C33,C43,C109,C136,C153							
008S-1002	RES 10K OHM 1/8W 1% 0805	NIC NRC12R1002FTR			1.0000	EA		R116
008S-104	RES 100K OHM 1/8W 1% 0805	NIC NRC12R104FTR			1.0000	EA		R79
008S-1211	RES 1.21K 1/8W 1% 0805	NIC NRC12R1211FTR			1.0000	EA		R11
008S-473	RES 47K OHM 1/8W 0805	NIC NRC12R473TR			1.0000	EA		R80
008S-4753	RES 475K OHM 1/8W 0805	NIC NRC12R4753FTR			3.0000	EA		R78,117,118
008S-9091	RES 9.09K OHM 1/8W 1%	NIC NRC12R9091FTR (0805)			1.0000	EA		R12
036S-NP0102	CAP .001UF NPO 100V 0805	NIC NMC0805NP0102J100TR			2.0000	EA		C8,115
036S-NP0151	CAP 150PF NPO 100V 0805	NIC NMC0805NP0151J100TR			1.0000	EA		C9
036S-X7R103	CAP .01UF X7R 50V 0805	NIC NMC0805X7R103K50TR			2.0000	EA		C38,96
036S-X7R104-50	CAP .1UF X7R 50V 0805	NIC NMC0805X7R104K50TR			3.0000	EA		C70,72,97
059-20000A	XTAL 20.000 MHZ	CROVEN #A187DEF-32			1.0000	EA		Y4
059-9.216	XTAL 9.216 MHZ	CROVEN A187DEF-32			1.0000	EA		Y2
184-038	XILINX SYNTHESIZER B				1.0000	EA		FOR U21
223-138	SCREW SH CH ZN M2.5X10	SCHROFF #21100-138			2.0000	EA		10
223-144	NUT M2.5	SCHROFF #21100-144			2.0000	EA		11
223-181	HOLDER (PB) DIE CAST	SCHROFF 60807-181			2.0000	EA		08
223-295	HANDLE	SCHROFF #20809-295			1.0000	EA		07
223-379	SCREW CAP NP M2.5 X 11	SCHROFF #21100-379			2.0000	EA		03
223-464	SLEEVE, STAINLESS	SCHROFF 21100-660			2.0000	EA		04
223-500	SCREW PH FH NP M2.5X10	SCHROFF #21100-500			1.0000	EA		09
249-005	SCREW M2.5 X 8	SCHROFF #21100-140			2.0000	EA		05
249-007	SCREW SH CH ZN M2.5X12	SCHROFF 21100-148			1.0000	EA		06
290-001	TAPE FOAM DBL SIDE.5X1/16	3M# Y-4950			0.4000	SI		FOR Y2,Y4
305-022	WIRE 22AWG BUS BAR	BELDEN #8021			0.3000	FT		FOR Y2,4
560-1216	PANEL, FRT (SYNTHESIZER)	FAB/SCREEN			1.0000	EA		02
560-5140	ASSY SYNTHESIZER BASIC	MADE FROM 560-2140			1.0000	EA		01
LA	LABOR ASSEMBLY COST HRS				0	EA		
LT	LABOR TEST COST HOURS				0	EA		
NOTE 1					1.0000	EA		
	RESISTORS AND CAPACITORS LISTED ABOVE ARE INSTALLED ON THE SOLDER SIDE.							
NOTE 2					1.0000	EA		
	SEE NEXT PAGE							

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

SWITCH SETTINGS:

	0HZ	50HZ	75HZ	150HZ	300HZ	600HZ	1200HZ	2400HZ
SW6-3	ON	ON	ON	ON	ON	ON	ON	ON
SW3-4	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF
SW7-1	OFF	ON	OFF	ON	OFF	ON	OFF	ON
SW7-2	OFF	OFF	ON	ON	OFF	OFF	ON	ON
SW7-3	OFF	OFF	OFF	OFF	ON	ON	ON	ON
SW7-4	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF

	4800HZ	7200HZ	9600HZ	14.4KHZ	19.2KHZ	38.4KHZ
SW6-3	ON	ON	ON	ON	ON	ON
SW6-4	OFF	OFF	OFF	OFF	OFF	OFF
SW7-1	OFF	ON	OFF	ON	OFF	ON
SW7-2	OFF	OFF	ON	ON	OFF	OFF
SW7-3	OFF	OFF	OFF	OFF	ON	ON
SW7-4	ON	ON	ON	ON	ON	ON

NOTE 3 1.0000 EA

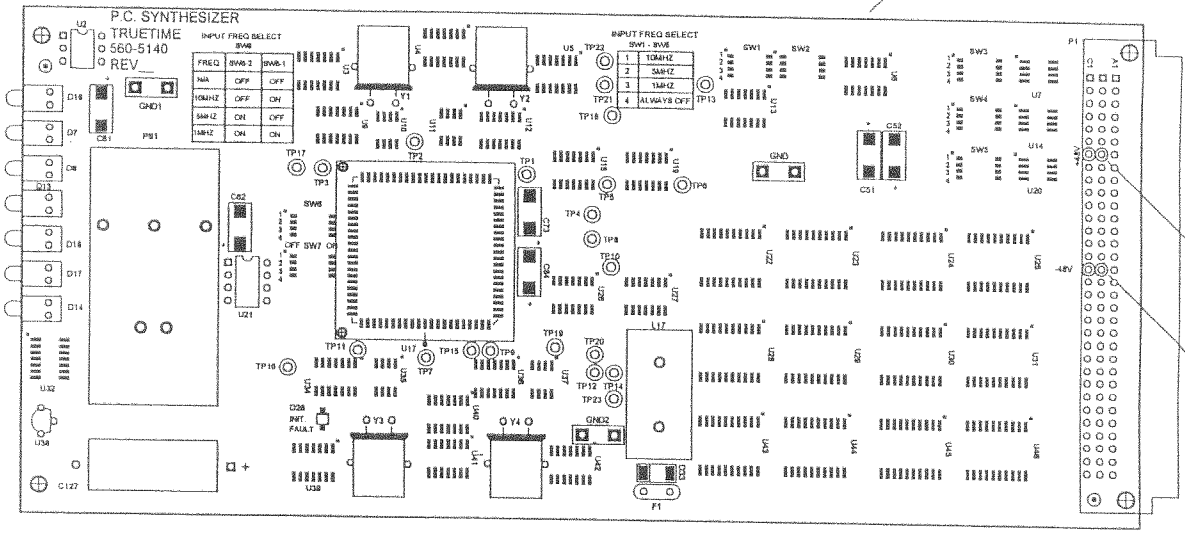
C148,C151 ARE SELECT AT TEST.

OSV560-5140-2 OUTSIDE LABOR 560-5140-2 PCA 1.0000 EA

NOTES: UNLESS OTHERWISE SPECIFIED

1. STAMP ASSEMBLY REVISION LEVEL.
2. RESISTORS VALUES ARE IN OHMS AND CAPACITORS ARE IN uf.

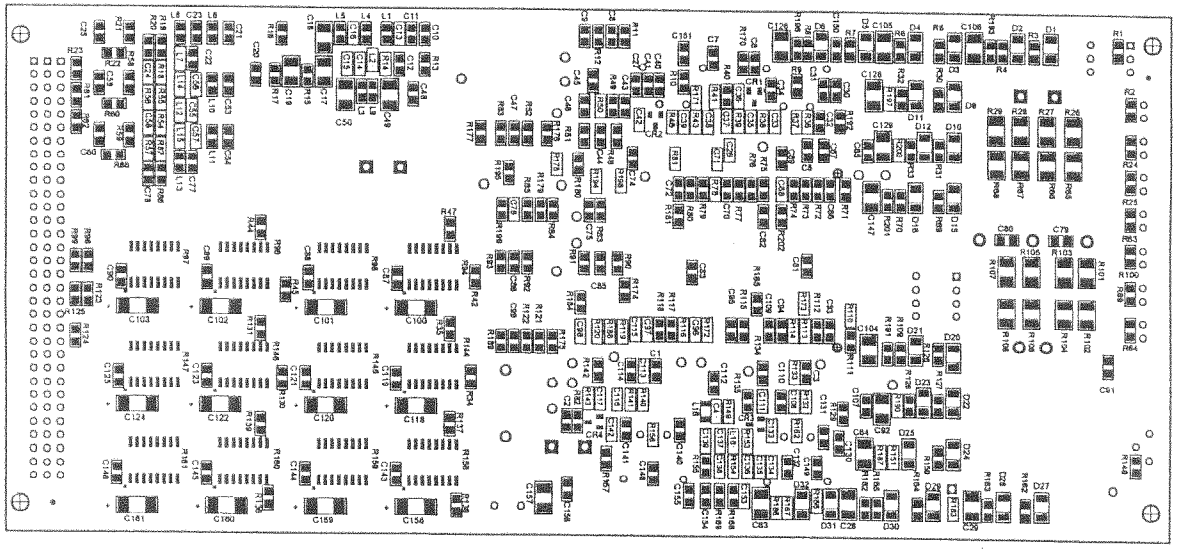
REVISIONS			
LTR	DESCRIPTION	DATE	APPROVED
B	DESIGN CHANGES	8-23-96	
C	CAR #747	10-20-98	
D	ECO #1200	02-24-99	



TOP SIDE

PLACE FERRITE BEADS AROUND CONNECTOR LEADS BEFORE SOLDERING TO PC BOARD.

CONTRACT NO.		Title	PASSIVE COMBINER/SYNTHESIZER ASSY DRAWING
APPROVALS	DATE		
DRAWN BY R.E.C.	8-19-98	Size B	Number 560-5140 Rev D
CHECKED			
APPROVED	4/99	Date	02-24-99
NEXT ASSY		Filename	2140C.PCB Sheet 1 of 12



BOTTOM SIDE

CONTRACT NO.		
APPROVALS	DATE	
DRAWN BY	R.E.C.	6-19-96
CHECKED		6/99
APPROVED		
NEXT ASSY		

TRUETIME INC.
Santa Rosa, California

Title	PASSIVE COMBINER/SYNTHESIZER ASSY DRAWING	
Size B	Number 560-5140	Rev D
Date 10-20-96		
Filename 2140B.PCB		Sheet 2 of 12