## MANUAL OR OPTION SECTION

**NAME:** **560-5155-3 DIGITAL 1, 5, 10 MPPS FREQUENCY SYNTHESIZER MANUAL**

## APPROVALS

| | |
|---|---|
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Symmetricom

# Model 560-5155-3
# 1, 5, 10 MPPS
# FREQUENCY SYNTHESIZER MANUAL



April 17 , 2003 Serial Number _______________

# 560-5155-3 Addendum

## Overview

The 560-5155-3 is a modification of the standard 560-5155 1, 5, 10 MHz Frequency Synthesizer card. The modification includes FPGA firmware as well as minor hardware changes. The 560-5155-3 card eliminates the passive combiner (mixer) network that was used on the original card. Note that the 56K CPU reports the original card identifications, either 5155-1 (sine wave output) or 5155-2 (square wave output).

## Original card

The passive combiner was used to produce a “hitless switch” to switch backplane frequency references REFA, REFB or REFC for use by the card. This composite signal was used as either a disciplining source for the on card PLL (in PLL mode) or as the output frequency (in bypass mode). The CPU had the ability to disable any of the backplane REF signals from the combiner when that source was considered “bad” (refer to manual). When all REF sources were active and considered “good” by the CPU, all 3 references were combined (mixed), with the resulting output containing a weighted amount from each source. This signal could therefore contain mixing products that were undesirable by downstream equipment (phase noise sensitive).

## Modified card

The passive combiner has been replaced with an electronic switch (FPGA) that has an algorithm that connects the highest weighted reference (REFA, REFB, REFC in that order) to on-card PLL or to the bypass mode output. Upon loss of reference in use, either by a physical disconnect or by CPU control (disable reference), the FPGA will switch to the next highest weighted active enabled reference. This switching allows only one reference to be used at a time (no mixing products on the outputs). Note that the switch from one reference to another is not “hitless” but has been designed to switch as quickly as possible to minimize the impact of changing references.

## Modified card setup

As noted earlier, the modified 560-5155 card may be configured for either sine wave (5155 -1) or square wave (5155-2) operation. The card may also be operated in either PLL or Bypass modes. All passive combiner switches (SW3 through SW7) should be set to the OFF position (SW3 and SW4 are actually don’t cares). Note that this card is factory pre-configured to provide the Sine/Square/PLL/Bypass modes. Also note that like the original card, the modified card requires that all frequency references MUST be at the same frequency.

# SECTION ONE

## 1 FUNCTIONAL DESCRIPTION

### 1.1 PURPOSE OF EQUIPMENT

The Symmetricom 560-5155-3 1, 5, 10 MPPS Frequency Synthesizer is a plug-in option card for the Model 56000 DRC. This option card offers the user six square wave logic level outputs at either 1, 5 or 10 MPPS (user configurable). The outputs provide either RS-422 differential or TTL into 50 Ohm single ended outputs (user configurable).

The 560-5155-3 Frequency 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 phase locks to the new reference.

The input frequency that is used to lock the Frequency Synthesizer's PLL (1, 5, or 10 MHz) is switch-selectable. The PLL's oscillator operates at 10 MHz and is the source, in PLL mode for the 1, 5, or 10 MPPS signals. The 560-5155-3 card can also operate in Bypass Mode. Bypass Mode means that the signal from the REF ABC switches' output is the source of the card's outputs, not the on-board PLL / 10 MHz oscillator.

The output frequency is switch-selectable for 1, 5, or 10 MPPS. The selected output frequency is output through the backplane connector via six output drivers (six driver pairs in the case of RS-422). The output signals are delivered to external cables via the I/O card installed in the rear slot directly behind the 1, 5, 10 MPPS Frequency Synthesizer.

The 560-5155-3 card can operate without a Fault Monitor CPU card installed in the system. In this mode, the 560-5155-3 card offers automatic REF A, B, C switch operation as previously stated. When the 560-5155-3 card is used in a system that includes the Fault Monitor CPU card, the REF A, B, C inputs are also controlled by the CPU. When a REF A source's Fault Status is detected (monitored by the CPU), the REF A input on the 560-5155-3 card is disabled. The REF B and REF C inputs are operated similarly -- they are turned off whenever a Fault Status condition for that reference exists. The CPU's REF A, B, C control feature ensures that only a viable reference oscillator is used on the 560-5155-3 card.

RS-422 NOTE: Output drive capability is switch-selectable for RS-422 100 Ohm or TTL 50 Ohm. <u>The TTL setting provides enhanced drive capability, but allows the short circuit current to exceed the RS-422 specification.</u> The output mode, single-ended or differential, is determined by the type of I/O card that is installed.

## 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: | -40° to +85°C |
| Humidity: | Up to 95% relative, non-condensing |
| Cooling Mode: | Convection |
| Altitude: | Sea level to 10,000 ft. |

## 1.4 POWER REQUIREMENTS

| | |
|---|---|
| Voltage: | 18-72 VDC |
| Power | 5 W (all outputs driving 50 Ω), TTL |

## 1.5 FUNCTIONAL SPECIFICATIONS

### 1.5.1 REF A, B, C INPUTS

| | |
|---|---|
| Signal Type: | Squarewave or sinewave |
| Amplitude: | 2-5 Vp-p |
| Frequency: | 1, 5 or 10 MHz (switch-selectable) |

### 1.5.2 OUTPUT ACCURACY

| | |
|---|---|
| Long-term: | Equal to reference on REF A, B, or C |
| Short-term: | Better than 1 part in $10^9$ (1 second average) |

### 1.5.3 TTL OUTPUTS (SWITCH SELECTABLE)

| | |
|---|---|
| Quantity: | 6 |
| Signal Type: | Square wave, TTL-level |
| Amplitude: | 2.8 Vpk into 50 Ohms |

### 1.5.4 RS-422 OUTPUTS (SWITCH SELECTABLE)

| | |
|---|---|
| Quantity: | 6 pairs |
| Signal Type: | Squarewave, centered at 2.5 VDC |
| Amplitude: | 2.8 Vp-p into 100 Ohms |
| Output Drive Compliance: | |
| | MIL-STD-188-114A TYPE II BALANCED<br>RS-422-A |

### 1.5.5 DRC CARD COMPATIBILITY

| | |
|---|---|
| Location: | Slot 1-17 with compatible I/O card in rear slot. |
| Compatibility: | See 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 1, 5, 10 MPPS Frequency 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 1, 5, or 10 MPPS Frequency Synthesizer receives the reference via the ABC switches. 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 1, 5 or 10 MPPS Frequency 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 560-5155-3 1, 5, or 10 MPPS square wave output card involves selection of the following DIP switches:

1. 560-5155-3 Required Settings (SW8 & SW9)
2. Passive Combiner Select Switches (SW3 through SW7)
3. Input Frequency Select Switch (SW1)
4. PLL / Bypass Mode Select Switch(SW1)
5. Output Frequency Select Switch (SW2)

### 2.3.1 560-5155-3 REQUIRED SETTINGS (SW8 & SW9)

SW8 and SW9 must be set as follows:

| | | | |
|---|---|---|---|
| SW9 switches 1 through 8 | OFF | | |
| SW8 switches 1 through 7 | ON | | |
| SW8 switch 8 | OFF | = | RS-422 |
| SW8 switch 8 | ON | = | TTL |

### 2.3.2 PASSIVE COMBINER SELECT SWITCHES (SW3 through SW7)

Set SW3 through SW7 to match the input frequency in use -- REF A, B, and C frequency reference:

| Passive Combiner | 10 MHz | 5 MHz | 1 MHz |
|---|---|---|---|
| SW3-1 thru SW7-1 | ON | OFF | OFF |
| SW3-2 thru SW7-2 | OFF | ON | OFF |
| SW3-3 thru SW7-3 | OFF | OFF | ON |
| SW3-4 thru SW7-4 | OFF | OFF | OFF |

### 2.3.3 INPUT FREQUENCY SELECT SWITCH (SW1)

Set SW1 to select the proper input frequency. This selection sets FPGA U4 for the proper divide ratio (for the PLL's phase detector).

| Input Frequency | 10 MHz | 5 MHz | 1 MHz |
|---|---|---|---|
| SW1-1 | ON | OFF | OFF |
| SW1-2 | OFF | ON | OFF |
| SW1-3 | OFF | OFF | ON |

### 2.3.4 PLL / BYPASS MODE SELECT SWITCH (SW1)

Set SW1 switch 4 for the operating mode of choice. NOTE: When the operating mode is Bypass, SYNTH fault reporting (PLL lock) will be suppressed.

| Operating Mode | PLL | Bypass |
|---|---|---|
| SW1-4 | OFF | ON |

### 2.3.5 OUTPUT FREQUENCY SELECT SWITCH (SW2)

Set SW2 to select the desired output frequency. This selection enables the appropriate sine wave shaping circuit.

| Output Frequency | 10 MHz | 5 MHz | 1 MHz |
|---|---|---|---|
| SW2-1 | ON | OFF | OFF |
| SW2-2 | OFF | ON | OFF |
| SW2-3 | OFF | OFF | 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 INDICATOR

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 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 will drift to one end of the control range, which is detected as a SYNTH FAULT.
3) Failure of a VCO.

A solid ON SYNTH LED indicates a local power supply failure.

### 2.4.2 OUT FAULT INDICATOR

The OUT A through OUT F Fault indicators activate when the associated drivers have failed. Note that the detector is designed to detect failed drivers and, typically, will not detect a shorted output.

2.4.3 INIT. FAULT INDICATOR

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. 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 DETAILED STATUS VIA CPU

The Fault Monitor CPU has access to detailed 560-5155-3 card status. When the CPU card provides the verbose mode serial report, fault status is available in a 2-byte format, with each binary nibble displayed as a hexadecimal (HEX) character.

The Verbose report displays the Fault status. In this context, a reported fault indicates a problem. The Machine report, when used, reports the current status (settings) of the switches and faults in hexadecimal characters. Together, they pinpoint problems and help the technician view the switch settings on the cards.

2.4.5 VERBOSE REPORTS

The following is an example of a Fault Monitor CPU report in Verbose mode:

Symmetricom 56000 Site 01
Automatic Reports **Enabled**
Periodic Reports **Disabled**
Primary Inputs Selected REFA No REFB No REFC Off PRI OK SEC OK TER Off

| | | | |
|---|---|---|---|
| 1. Undefined | OK | Undefined | OK |
| 2. Undefined | OK | Undefined | OK |
| **3. 5155-3 ABC** | **ANA FRQ** | **CUo** | **OK** |
| 4. Undefined | OK | Undefined | OK |

The above sample tells you that:
Automatic reports are enabled and Periodic reports are disabled.
Primary inputs REF A and REF B are not bussing Aux. Ref. REF C is off.
Primary and Secondary status inputs OK, Tertiary is OFF.

Numbers 1-4 are slots (not all slots are shown in the example). Slots 1,2,and 4 are undefined (empty) and functional (OK).

Slot 3 is read as follows:
5155-3 is the abbreviation of the 560-5155-3 card. Refs ABC are Analog frequency. Note: If Digital, it would read DIG FRQ.

2.4.6 MACHINE REPORTS

The Fault Monitor CPU has another serial output mode called machine report mode. This mode is usually used with a computer program to interrogate the 56000 system status.
The machine report mode displays hexadecimal (HEX) characters like the verbose mode report.

The following is an example of a Fault Monitor CPU report in Machine Mode:

Symmetricom 56000 Site 01
AR1
PR10
P A1 B1 Co P1 S1 To
01 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
02 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
**03 30 51 00 07 0122** 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
04 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
(card slots 05 through 14 HEX not shown)

Example from card slot 3 above:

**03 3051 00 07 01 22 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00**

**Fault Byte 1 (F1)**
**Fault Byte 0 (F0)**
**SW1 Switch Status (S1)**
**SW2 Switch Status (S0)**

Slot 3 shows that the Fault status is 0007 (F1, F0). The Status report read-out is 0122(S1,S0).

2.4.7 REPORT CONVERSIONS

This section deals with how to read and convert the Fault and Status read-outs using various tables and binary conversions. To decipher a Fault Status report, use Fig. A.
For Status reports (S1, S0) use Fig. B.

**Fig. A**



| **Spare** | **Spare** | **Spare** | **Spare** | **Spare** | **Power Cycled** | **Synthesizer*** | **Output F*** | **Output E*** | **Output D*** | **Output C*** | **Output B*** | **Output A*** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|

| Spare | Spare | | | | | | | Spare | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **8** | **4** | **2** | **1** | **8** | **4** | **2** | **1** | **8** | **4** | **2** | **1** | **8** | **4** | **2** | **1** |
| $2^3$ | $2^2$ | $2^1$ | $2^0$ | $2^3$ | $2^2$ | $2^1$ | $2^0$ | $2^3$ | $2^2$ | $2^1$ | $2^0$ | $2^3$ | $2^2$ | $2^1$ | $2^0$ |
| *0* | *0* | *0* | *0* | *0* | *0* | *0* | *0* | *0* | *0* | *0* | *0* | *0* | *1* | *1* | *1* |
| | | | | | | | | | | | | | | | |

| Upper Byte High Nibble | Upper Byte Low Nibble | Lower Byte High Nibble | Lower Byte Low Nibble |
|---|---|---|---|
| **0** | **0** | **0** | **7** |

## Fault Status F1 Report

## Fault Status F0 Report

**Key:**

Above each 8,4,2,1 is the corresponding fault for that bit. For instance, above the 8 bit in the Upper byte/Low nibble reads Rub. Lockmon, which is the fault .

* = Latched Fault Bit (Reset via Fault Monitor CPU)

**Shaded area**

Informational only. The upper row: Bit value hex weights (8,4,2,1) The Lower row corresponds to the hex weight above. For instance, a 7 readout equals 111 in binary and 4+2+1 in hex weight.

Each section of 8,4,2,1 is a nibble of either an Upper or Lower byte and separated for easy recognition. Each nibble = 4 bits and each byte = 8 bits. "00" is the F1 report, "07" the F0 report.

**Non-shaded area**

This area is used according with the report read-out after a report is converted to binary. The 0007 is an example from a report.

Always read the report from Upper (High) byte to Lower (Low) Byte.

**Status (S1, S0) Conversion Table** **FIG. B**

| STATUS REG 0 | Bit | Bit Value | Switch | |
|---|---|---|---|---|
| Low | 0 | 1 | 10 MPPS Output | |
| Nibble | 1 | 2 | 5 MPPS Output | **2** |
| Low | 2 | 4 | 1 MPPS Output | |
| Byte | 3 | 8 | Not Defined | |
| High | 4 | 1 | 10 MHz Input | |
| Nibble | 5 | 2 | 5 MHz Input | |
| Low | 6 | 4 | 1 MHz Input | **2** |
| Byte | 7 | 8 | Bypass Mode ON | |
| **STATUS REG 1** | | | | |
| Low | 0 | 1 | Always 0 | |
| Nibble | 1 | 2 | Always 1 (TTL) | |
| High | 2 | 4 | Not Defined | **1** |
| Byte | 3 | 8 | Not Defined | |
| High | 4 | 1 | Not Defined | |
| Nibble | 5 | 2 | Not Defined | |
| High | 6 | 4 | Not Defined | **0** |
| Byte | 7 | 8 | Not Defined | |

## BINARY CONVERSION TABLE

| Decimal | Displayed in report as | Binary |
|---|---|---|
| 0 | 0 | 0 |
| 1 | 1 | 1 |
| 2 | 2 | 10 |
| 3 | 3 | 11 |
| 4 | 4 | 100 |
| 5 | 5 | 101 |
| 6 | 6 | 110 |
| 7 | 7 | 111 |
| 8 | 8 | 1000 |
| 9 | 9 | 1001 |
| 10 | A | 1010 |
| 11 | B | 1011 |
| 12 | C | 1100 |
| 13 | D | 1101 |
| 14 | E | 1110 |
| 15 | F | 1111 |

Binary:
1 = Fault/Switch On
0 = No Fault/Switch Off

Use the Binary Conversion table to convert a read-out from the monitor to binary. For instance, if the report read-out was 3C15, this would be:

11\1100\1\101 in binary.

### USING THE FAULT STATUS REPORT (F0,F1)

The hex weight (fault importance) has been assigned 8, 4, 2, 1. Beneath each number is the corresponding fault. Use Fig. A. The report example read 0007. The 0 is high byte/high nibble, the 0, high byte/low nibble, the 0, low byte/high nibble and 7, low byte/low nibble. Each nibble falls under a section on Fig. A, high to low or left to right.

Look at Fig. A. Below this is a sample read-out. This read-out would appear on the monitor when a Verbose report is requested. In the example, there are no faults in the upper byte/high nibble or in the lower byte/high nibble because both are zero (0). In the lower byte/low nibble a 7 is reported. There is no 7 listed, only a 1, 2, 4, 8. Use the Binary Conversion table to determine the faults.

Seven (7) is converted to 111 in Binary. In Binary, a 1 = fault and 0 = no fault. Read 111 from bottom (low bit) to top (high bit) using the lower byte/low nibble group. The first three (from low bit to high bit) are 1's, indicating there is a fault with the Output Faults A, B and C.

Note that the hex weight assigned totals to 7 (4+2+1). If the 7 had been a 6, in binary this is 110. Reading from low bit to high bit, the 1's (i.e., faults) fall under hex weight 4 and 2, which equals a hex weight of 6. Of course, glancing at the lower byte/low nibble, you can quickly see (without converting to binary) that under 4 and 2 (i.e., 6) are the Output Faults B and C that are in fault.

Each of the four nibbles is grouped by category for easy visual identification of an offending fault. Each nibble has 15 possible fault combinations. All faults are asserted as a logic 1. The faults are latched on the Oscillator card and must be cleared by the 560-5179-1 Fault Monitor CPU “CL” command.

**USING THE STATUS REPORT (S1, S0)**

The method used for reading the Fault report is the same when reading the Status report. Refer to Fig. B.

Using the read-out, 0122, but because the table is different, the 0 is located at the bottom (high byte). The rest of the numbers follow upward towards the low byte (Status 0). In this case, the 2 falls in the high nibble\low byte section of Status 0 and in the low nibble\high byte. The 1 falls in the low nibble\low byte section of Status 0

1 = Active, a 0 = Not active.

The 2 (in the high nibble\low byte) converts to 10 in binary. This indicates that the 10 MHz and 1 MHz are active.

| | |
|---|---|
| 10 MHz | 0 |
| 5 MHz | 1 |
| 1 MHz | 0 |

The 1 (in the low nibble\low byte) requires no conversion. This indicates that the 10 MPPS is active.

| | |
|---|---|
| 10 MPPS | 1 |
| 5 MPPS | 0 |
| 1 MPPS | 0 |

**QUICK REFERENCE SHEET FOR READING FAULT AND STATUS REPORTS**

1. Run a report. This is a portion of a sample Machine report.

```
Symmetricom 56000 Site 01
AR1
PR10
P A1 B1 Co P1 S1 To
01 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
02 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
03 30 51 00 07 0122 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
04 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
(card slots 05 through 14 HEX not shown)
```

0007 is the Fault Status read-out
0121 is the Status read-out report

**03 3051 00 07 01 2 2 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00**

**Fault Byte 1 (F1)**
**Fault Byte 0 (F0)**
**SW1 Switch Status (S1)**
**SW2 Switch Status (S0)**

Slot 3 shows that the Fault status is 0007 (F1, F0). The Status report read-out is 0122(S1,S0).

00 = Fault Status 1 (F1) report
07 = Fault Status 0 (F0) report
01 = Status 1 (S1) report
22 = Status 0 (S0) report

What's in a number?

| **0** | **4** | **0** | **7** |
|---|---|---|---|
| High Byte High Nibble | High Byte Low Nibble | Low Byte High Nibble | Low Byte Low Nibble |

2. When required, convert Decimal to Binary using the Binary Conversion Table.

## BINARY CONVERSION TABLE

| Decimal | Displayed in report as | Binary |
|---|---|---|
| 0 | 0 | 0 |
| 1 | 1 | 1 |
| 2 | 2 | 10 |
| 3 | 3 | 11 |
| 4 | 4 | 100 |
| 5 | 5 | 101 |
| 6 | 6 | 110 |
| 7 | 7 | 111 |
| 8 | 8 | 1000 |
| 9 | 9 | 1001 |
| 10 | A | 1010 |
| 11 | B | 1011 |
| 12 | C | 1100 |
| 13 | D | 1101 |
| 14 | E | 1110 |
| 15 | F | 1111 |

Binary:
1 = Fault/On/Active
0 = No Fault/Off/Not Active

# SECTION THREE

## 3 THEORY OF OPERATION

### 3.1 GENERAL INFORMATION

This section contains a detailed description of the circuits used on the 560-5155-3 1, 5, 10 MPPS Frequency Synthesizer card. Use these descriptions in conjunction with the drawings in SECTION FOUR.

### 3.2 HARDWARE DESCRIPTION

The 1, 5, 10 MPPS Frequency Synthesizer incorporates a Passive Combiner, a DC-to-DC Converter, a phase-locked VCO, six output drivers (six driver pairs in the case of RS-422), fault-detection circuitry and 7 Fault Indicators.

### 3.3 DETAILED DESCRIPTION (Reference Drawing 560-5155)

#### 3.3.1 PASSIVE COMBINER

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 SW3 through SW7, which are 4PST DIP switches. The input filters and the comparators serve to produce a very clean square wave with very good symmetry. These square waves are then buffered and applied to the weighting network 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 and squared up to produce the final signal called FREQIN.

#### 3.3.2 POWER SUPPLY

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 OSCILLATOR

The card is equipped with a 10 MHz VCO. This VCO is locked to a 1 MHz reference frequency (derived from REF A, B, or C) via a phase-comparator located within the Xilinx FPGA. The filtered phase comparison output from the PLL's integrator is connected to the voltage control input of the 10 MHz oscillator, closing the loop. The 10 MHz output from the on-board oscillator is the clock source for the 1, 5, or 10 MHz output when the card is set for PLL Mode.

### 3.3.4 FPGA

The Field Programmable Gate Array (FPGA) is the interface between the 1, 5, 10 MPPS frequency synthesizer card and the CPU (if installed). The FPGA provides the timing and control signals for the synthesizer card in both stand-alone and CPU operating modes.

### 3.3.5 OUTPUT DRIVERS

The XMPPS signal is either 1, 5 or 10 MPPS depending on the setting of SW2, the Output Frequency select switch. In PLL Mode, the XMPPS signal is derived from the on-board 10 MHz oscillator. In the Bypass Mode, the XMPPS frequency rate is the signal that gets through the passive combiner circuit thus the SW2 settings must match the input frequency in this mode.

The XMPPS signal from the FPGA connects to two quad RS-422 drivers which are the only drivers enabled in the RS-422 output mode. When the output mode is switched to TTL, SW8-8 ON, the paralleled outputs of three other drivers are enabled. The six non-complimentary outputs (A through F) are connected through Digital output switch SW8 to the backplane connector P1. The RS-422 complimentary outputs (/A through /F) connect directly to the backplane connector P1.

### 3.3.6 FAULT DETECTION

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 signal outputs monitored on the 560-5155-3 card are DRIVOUT A through DRIVOUT F when in the TTL output mode. When the card is in the RS-422 output mode, /DRIVOUT A through /DRIVOUT F are also monitored. The six (or twelve in RS-422 mode) DRIVOUT signals connect to peak detectors and voltage comparators. The voltage comparator outputs provide a logic low when the associated output is OK and a logic high when the output is bad. The comparator outputs are connected to the FGPA which recognizes the logic level, activates the appropriate fault status indicator and reports the DRIVOUT failure to the CPU card.

The 1, 5, or 10 MPPS Frequency Synthesizer (SYNTH FAULT) detector utilizes four voltage comparators to detect an out-of-lock condition in the 10 MHz VCO. These comparators verify that the VCO control voltage and filtered phase comparator voltage are within defined limits. If the control voltage is out of tolerance, circuitry in the FPGA is activated.

### 3.3.7 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. Fault-signal active indicates status-bit true. (Note that the FAULT signal is active-low on the backplane.) Refer to manual section 2.4.4 for detailed information on the fault reporting.

### 3.3.8 FAULT INDICATORS

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 and is controlled via an opto-isolator to maintain 48 VDC isolation. If local 5 VDC power is lost, the SYNTH. FAULT indicator will be ON. The indicator is held off by the fault detection logic while the 10 MHz VCO is functioning within limits. When the 10 MHz VCO is locked, the indicator will be OFF. When the 10 MHz VCO is not locked, the SYNTH. FAULT indicator will blink ON and OFF.

The OUT fault indicators are controlled directly by the fault detection logic. NOTE: In RS-422 mode, OUT A through F LEDs indicate when either a non-complimented or complimented output fault condition exists

# SECTION FOUR

## 4 DETAILED DRAWINGS