Evaluation Board Documentation

TRF2020 Frequency Synthesizer

APPLICATION BRIEF: SWRA012

Wireless Communications Business Unit

Digital Signal Processing Solutions
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TEXAS INSTRUMENTS

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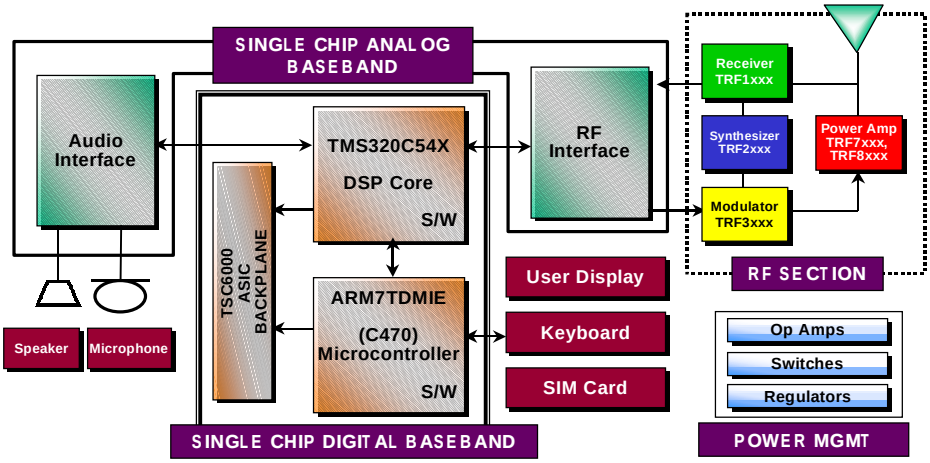
TRF2020 Frequency Synthesizer

Abstract

This document briefly describes the TRF2020 evaluation board and associated software. The combination of the evaluation board and software provides a means to fully exercise the TRF2020 device using common RF bench test equipment.

Product Support

The TI Advantage Extends Beyond RF to Every Other Major Wireless System Block



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TI's single-chip Digital Baseband Platform, combines two high-performance core processors – a digital signal processor tailored for digital wireless applications and a microcontroller designed specifically for low-power embedded systems. The customizable platform helps wireless digital telephone manufacturers lower component counts, save board space, reduce power consumption, introduce new features, save development costs and achieve faster time to market, at the same time giving them flexibility and performance to support any standard worldwide.

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For more information visit the Wireless Communications web site at www.ti.com/sc/docs/wireless/home.htm.

Related Documentation

The following list specifies product names, part numbers, and literature numbers of corresponding TI documentation.

- *Synthesizer for Global System for Mobile (GSM) Cellular Phones*, Literature number SLWS020B.

World Wide Web

Our World Wide Web site at www.ti.com contains the most up to date product information, revisions, and additions. Users registering with TI&ME can build custom information pages and receive new product updates automatically via email.

Email

For technical issues or clarification on switching products, please send a detailed email to sc-infomaster@ti.com. Questions receive prompt attention and are usually answered within one business day.

1. Introduction

The TRF2020 evaluation board is comprised of a multi-layer printed circuit board. The following are included to aid in the assessment of this device:

- The TRF2020 Functional Block Diagram
- The TRF2020 Evaluation Board Mechanical Outline
- The Evaluation Board Schematic
- The Evaluation Board Part List

The voltage regulators, external power, serial interface, and the external reference are explained in detail to ensure functionality of the TRF2020 evaluation board.

A DOS based software driver is supplied with the evaluation board. Once the program is executed the program screen is divided into five main sections:

- Main Loop
- Auxiliary-1 Loop
- Auxiliary-2 Loop
- Device
- Editing Parameters

Common coaxial and multi-conductor connectors allow different types of external test equipment to be used with the TRF2020 evaluation board such as the following:

- The IBM Personal Computer or similar with parallel printer port
- Linear, single output power supply
- 20 MHz stable signal source for reference clock input
- Spectrum analyzer.

2. Evaluation Board

The TRF2020 evaluation board comprises of a multi-layer printed circuit board, TRF2020 device, main channel and auxiliary channel VCOs, opto-isolated serial interface, voltage regulation, SMA connectors, and necessary peripheral discrete components.

The main channel circuit layout supports a Vari-L VCO190-U series VCO or similar. The auxiliary channel circuit layouts support a Vari-L VCO190-S series VCO or similar.

Figure 1 describes the TRF2020 functional block and related input/output pins of the device. Figure 2 reveals the TRF2020 evaluation board mechanical outline and Figure 3 details the TRF2020 evaluation board schematic.

Figure 1. TRF2020 Functional Block Diagram

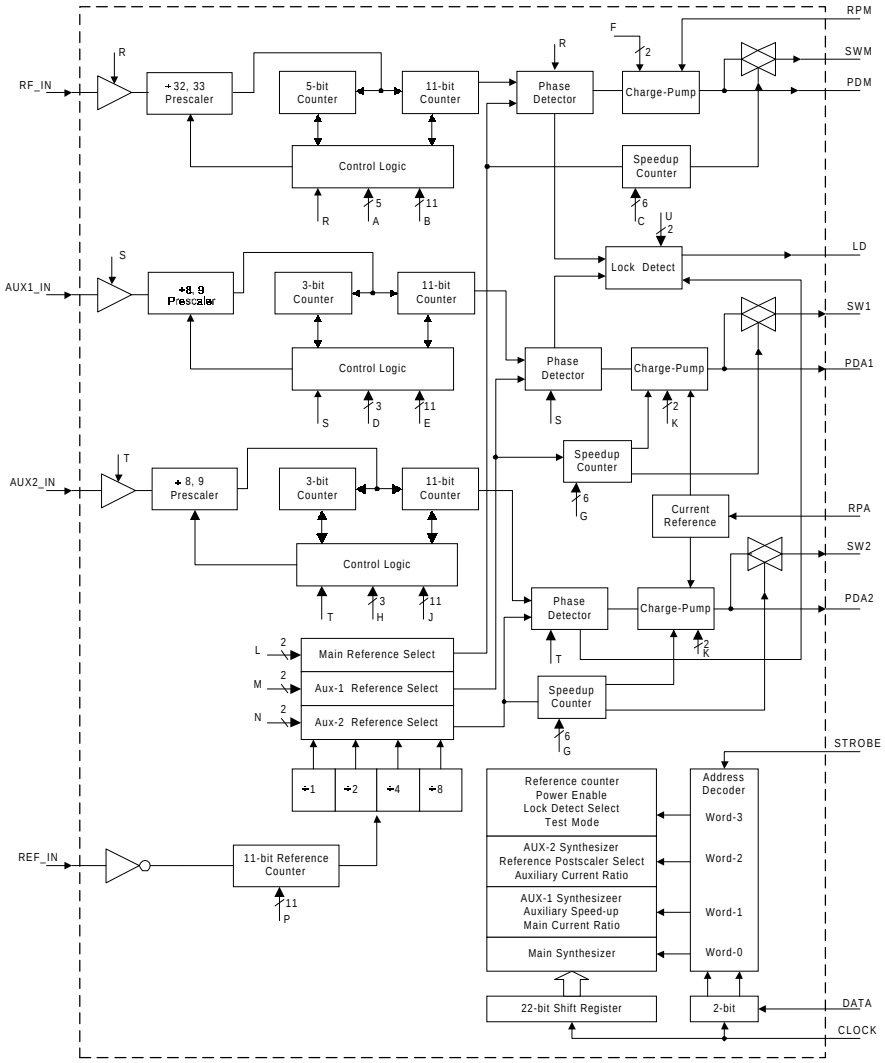


Figure 2. TRF2020 Evaluation Board Mechanical Outline

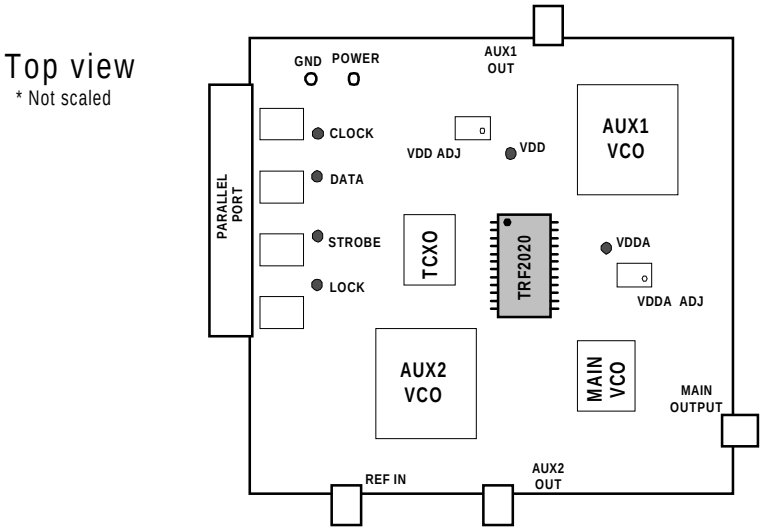
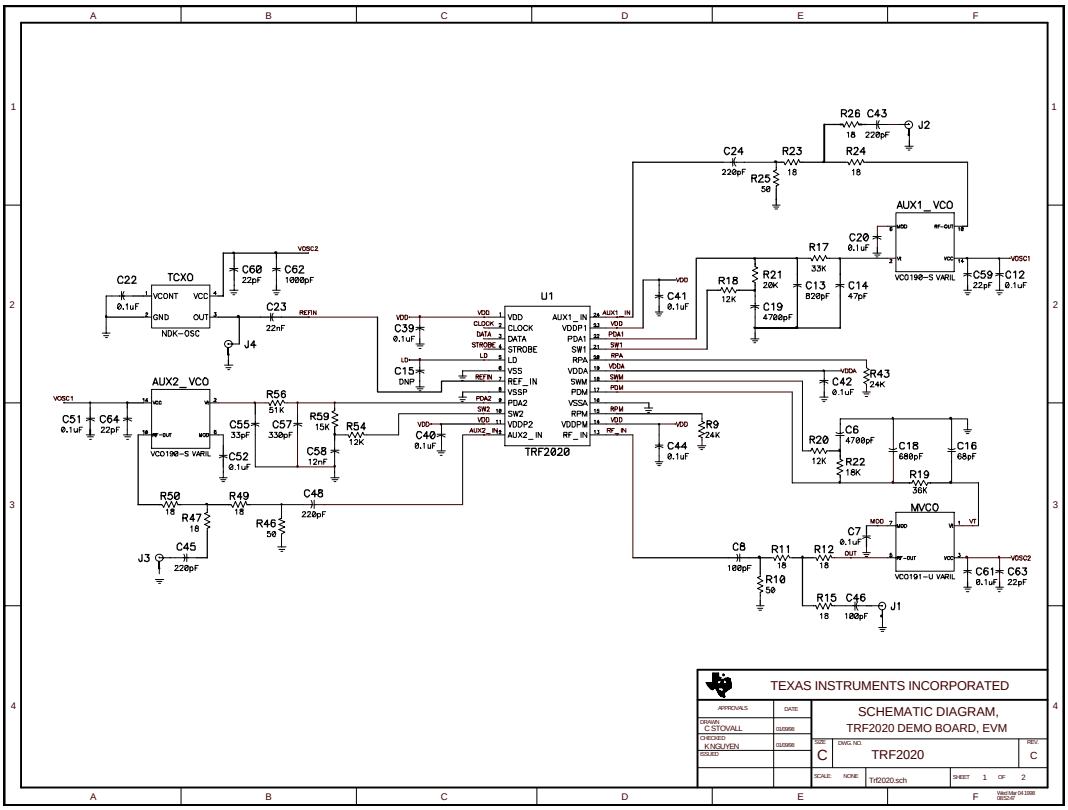


Figure 3. TRF2020 Evaluation Board Schematic



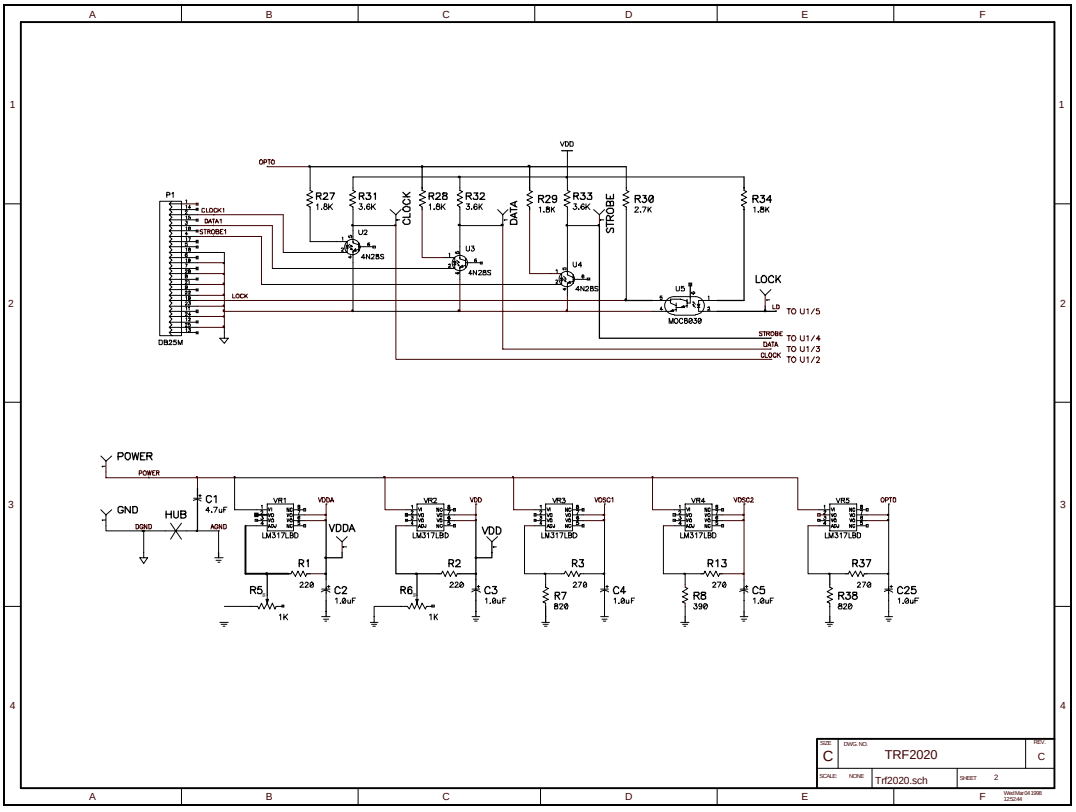


Table 1. Evaluation Board Part List

REF DESIGNATOR	VALUE		SIZE	QTY	MANU P/N	MANUFACTURER
C 1	4.7	uF	"A" 3.2x1.6	1	TA010TCM475KAR	VENKEL
C 2,3,4, 5, 25	1.0	uF	"A" 3.2x1.6	5	TA025TCM105KAR	VENKEL
C 6, 19	4700	pF	0603 1.6x.08	2	GRM39X7R Series	muRATA
C 7, 12, 20, 22, 39, 40, 41, 42, 44, 51, 52, 61	0.1	uF	0603 1.6x.08	12	GRM39X7R Series	muRATA
C 8,46	100	pF	0603 1.6x.08	2	GRM39X7R Series	muRATA
C 13	820	pF	0603 1.6x.08	1	GRM39X7R Series	muRATA
C 14	47	pF	0603 1.6x.08	1	GRM39X7R Series	muRATA
C 15	DNP		0603 1.6x.08	1	NOT USED	
C 16	68	pF	0603 1.6x.08	1	GRM39X7R Series	muRATA
C 18	680	pF	0603 1.6x.08	1	GRM39X7R Series	muRATA
C 23	22	nF	0603 1.6x.08	1	GRM39X7R Series	muRATA
C 24, 43, 45, 48	220	pF	0603 1.6x.08	4	GRM39X7R Series	muRATA
C 55	33	pF	0603 1.6x.08	1	GRM39X7R Series	muRATA
C 57	330	pF	0603 1.6x.08	1	GRM39X7R Series	muRATA
C 58	12	nF	0603 1.6x.08	1	GRM39X7R Series	muRATA
C 59, 60, 63, 64	22	pF	0603 1.6x.08	4	GRM39X7R Series	muRATA
C 62	1000	pF	0603 1.6x.08	1	GRM39X7R Series	
R 1,2	220	Ω	0603 1.6x.08	2	ERJ-3GSYJ Series	PANASONIC
R 3, 13, 37	270	Ω	0603 1.6x.08	3	ERJ-3GSYJ Series	PANASONIC
R 5, 6	1	kΩ	.25" SQUARE	2	ERJ-3GSYJ Series	BOURNS
R 7, 38	820	Ω	0603 1.6x.08	2	ERJ-3GSYJ Series	PANASONIC
R 8	390	Ω	0603 1.6x.08	1	ERJ-3GSYJ Series	PANASONIC
R 9, 43	24	kΩ	0603 1.6x.08	2	ERJ-3GSYJ Series	PANASONIC
R 10, 25, 46	49.9	Ω	0603 1.6x.08	3	ERJ-3EKF49R9	PANASONIC
R 11, 12, 15, 23, 24, 26, 47, 49, 50	18	Ω	0603 1.6x.08	9	ERJ-3GSYJ Series	PANASONIC
R 17	33	kΩ	0603 1.6x.08	1	ERJ-3GSYJ Series	PANASONIC
R 18,20, 54	12.0	kΩ	0603 1.6x.08	3	ERJ-3GSYJ Series	PANASONIC
R 19	36	kΩ	0603 1.6x.08	1	ERJ-3GSYJ Series	PANASONIC
R 21	20	kΩ	0603 1.6x.08	1	ERJ-3GSYJ Series	PANASONIC
R 22	18	kΩ	0603 1.6x.08	1	ERJ-3GSYJ Series	PANASONIC
R 27,28,29,34	1.8	kΩ	0603 1.6x.08	4	ERJ-3GSYJ Series	PANASONIC
R 30	2.7	kΩ	0603 1.6x.08	1	ERJ-3GSYJ Series	PANASONIC
R 31,32,33	3.6	kΩ	0603 1.6x.08	3	ERJ-3GSYJ Series	PANASONIC
R 56	51	kΩ	0603 1.6x.08	1	ERJ-3GSYJ Series	PANASONIC
R 59	15	kΩ	0603 1.6x.08	1	ERJ-3GSYJ Series	PANASONIC
U 1				1	TRF 2050	TEXAS INSTRUMENTS

Evaluation Board Part List (cont.)

U 2, 3, 4			730C-04	3	4N28S	MOTOROLA
U 5			730C-04	1	MOC8030S	MOTOROLA
VR 1, 2, 3, 4, 5			SO-8	4	LM317LBD	NATIONAL SEMICONDUCTOR
P 1				1	747238-4	AMP
J 1, 2, 3, 4				3	142-0701-831	EF JOHNSON
DATA, VDDA, VDD, LOCK, POWER, CLOCK, GND, STROBE				8	TP-105-01 Series	COMPONENTS CORPORATION
MVCO	1091 ± 18 MHz	Vt = .5 to 3 Vdc		1	VCO190-U	VARI-L COMPANY
AUX1_VCO	250 ± 5 MHz	Vt = 1 to 4 Vdc		1	VCO190-S	VARI-L COMPANY
AUX2_VCO	45 ± 1 MHz	Vt = 1 to 4 Vdc		1	VCO190-S	VARI-L COMPANY
TCXO	16.8 MHz			1	TCO-980 Series	Toyocom

2.1. Voltage Regulators

The on-board regulators provide independent, linear voltage regulation to the TRF2020, the Main VCO, the Auxiliary VCOs, and the serial interface opto-couplers. Regulators VR1 (VDDA) and VR2 (VDD) are adjustable using variable resistors R5 and R6 respectively. VR3 (VOSC1), VR4 (VOSC2) and VR5 (OPTO) can be adjusted by changing the combination of the resistor pairs R3/R7, R8/R13 and R37/R38. Tantalum capacitors are used to enhance ripple and noise rejection in the regulators.

The voltage regulators are factory set as follows:

VR1 - 3.0 VDC ..... VDDA

VR2 - 3.0 VDC ..... VDD

VR3 - 5.0 VDC VOSC1

VR4 - 3.2 VDC VOSC2

VR5 - 5.0 VDC ..... VOPTO

2.2. External Power

External power is connected to the evaluation board at the test points *SUPPLY* and *GND*. It is recommended that a **linear** power supply set between +7Vdc to +9Vdc is used for external power.

2.3. Serial Interface

A DB25M connector is provided for connection to a standard PC parallel port using a 25-conductor cable. The PC parallel port is used to emulate a synchronous serial data interface consisting of *CLOCK*, *DATA*, and *STROBE*. The *LOCK* signal is fed back to the PC parallel port to indicate synthesizer loop lock status of the TRF2020. The three serial interface signals and the *LOCK* signal are all opto-isolated from the PC parallel port. In this manner, the TRF2020 device may be operated at a supply voltage that is different than the standard +5 VDC voltage level of the PC parallel port.

The serial interface signals are routed to the DB25M connector as follows:

CLOCK - Pin 2,

DATA - Pin 3,

STROBE - Pin 4,

LOCK - Pin 10.

2.4. External Reference

The factory installed TCXO (Temperature Compensated Crystal Oscillator) can be removed and an external reference signal source can be connected to J4 (REF_IN) for operation at reference frequencies other than the one at which the TCXO operates. Typically, a low phase noise, stable, synthesized signal generator such as an HP8665 or similar would be used as an external reference. For typical GSM applications, a 13.00 MHz signal at – 6 dBm is suitable. A 16.8MHz TCXO has been installed.

3. Software Driver

A DOS based software driver is supplied with the evaluation board. The software is intended for use in a MS-DOS environment. No special memory is required to use the software. Two files are contained on the provided disk: TRF2020.EXE and INIT.CFG. Both of these files should be placed in the same directory on a hard disk or the program may be executed from the disk provided. To execute the program from the provided disk, simply type the following

A:\ ↵ *(Enter)*

TRF2020 ↵ *(Enter)*

The program executes from the TRF2020.EXE file. The INIT.CFG file is read by the program to setup the program parameters. The INIT.CFG file may be changed to suit your needs; see **F9 Save File** description.

3.1. Program Screen

The program screen is divided into five main sections: *Main Loop*, *Auxiliary Loop #1*, *Auxiliary Loop #2*, *Device* and *Editing Parameters*. The *Main Loop* section displays all of the pertinent parameters concerning the main synthesizer. The *Auxiliary Loop* sections display all of the pertinent parameters concerning the auxiliary synthesizers. The *Device* section displays all of the pertinent parameters concerning the device enables, modes, and reference frequency. And the bottom two lines of the display suggests appropriate keys to use or actions to take based on *the user inputs*

3.1.1. Main Loop Section

The main loop section displays the current main synthesizer loop parameters. All parameters displayed in the main loop section can be modified except the *Phase Detector Freq*, which is informative only. The *Phase Detector Freq* parameters are calculated from the reference frequency (*Refrnc Freq*) and reference counter (*Refrnc Count P*) parameters in the *Device* section.

3.1.1.01. VCO Frequency

The main *VCO Frequency* parameter is not actually a TRF2020 device parameter, but it may be used to cause the program to automatically find a solution, if possible, for *NM1-NM2* based on the entered *VCO frequency* parameter and others. The correct reference frequency (*Refrnc Freq)*, and the reference count (*P*) should be entered before using the *VCO Frequency* parameter to calculate a channel solution.

3.1.1.02. Speedup Time C

The *C* field selects the duration of speedup mode for the main synthesizer. The duration of speedup mode is determined as follows:

$$\text{Duration} = \frac{C * 2}{\text{Reference frequency}},$$

where reference frequency is typically 200 kHz for GSM or 30 kHz for AMPS.

3.1.1.03. Current Ratio F

The *F* field selects the desired main synthesizer speed-up/normal mode current ratio.

The choices are:

F = 3	8 (2 mA/0.25 mA),
F = 2	4 (2 mA/0.5 mA),
F = 1	2 (2 mA/1 mA),
F = 0	1 (2 mA/2 mA).

3.1.1.04. Enable Loop R

The *R* field enables/disables the main synthesizer as follows:

R = 0	enabled,
R = 1	disabled.

3.1.1.05. NM1-2 B and A

The *B* and *A* fields can be programmed manually to any valid number. These fields are also automatically updated when the *VCO Frequency* field is used to enter a valid main synthesizer channel frequency.

3.1.1.06. Reference Post Select L

The *L* field selects the main synthesizer reference postscaler select as follows:

L = 0	Reference/1,
L = 1	Reference/2,
L = 2	Reference/4,
L = 3	Reference/8.

3.1.2. Auxiliary-1 Loop Section

The auxiliary-1 loop section displays the current auxiliary-1 loop parameters. All parameters displayed in the auxiliary-1 loop section can be modified except for *Phase Detector Freq*. This parameter is calculated from the reference frequency (*Refrnc Freq*) and reference counter (*Refrnc Count P*) parameters in the Device section.

3.1.2.01. VCO Frequency

The auxiliary-1 *VCO Frequency* parameter is not actually TRF2020 device parameter but may be used to cause the program to automatically find a solution, if possible, for *NM1-2* based on the entered VCO frequency parameter and others. The correct reference frequency (*Refrnc Freq)* and the reference count (*P*) should be entered before using the *VCO Frequency* parameter to calculate a channel solution.

3.1.2.02. Speedup Time G

The *G* field selects the duration of speedup mode for **both** auxiliary-1 and auxiliary-2 synthesizers. The duration of speedup mode is determined as follows:

$$\text{Duration} = \frac{G * 2}{\text{Reference frequency}},$$

where the reference frequency is typically 200kHz for GSM and 30kHz for AMPS.

3.1.2.03. Current Ratio K

The *K* field selects the desired speed-up/normal mode current ratio for **both** auxiliary-1 and auxiliary-2 synthesizers. The choices are:

K = 3	8 (2 mA/0.25 mA),
K = 2	4 (2 mA/0.5 mA),
K = 1	2 (2 mA/1 mA),
K = 0	1 (2 mA/2 mA).

3.1.2.04. Enable Loop S

The *S* field enables/disables the auxiliary-1 synthesizer as follows:

S = 0	enabled,
S = 1	disabled.

3.1.2.05. NM1-2 E and D

The *E* and *D* fields can be programmed manually to any valid number. These fields are also automatically updated when the *VCO Frequency* field is used to enter a valid auxiliary-1 synthesizer channel frequency.

3.1.2.06. Reference Post Select M

The *M* field selects the main synthesizer reference postscaler select as follows:

M = 0	Reference/1,
M = 1	Reference/2,
M = 2	Reference/4,
M = 3	Reference/8.

3.1.3. Auxiliary-2 Loop Section

The auxiliary-2 loop section displays the current auxiliary-2 loop parameters. All parameters displayed in the auxiliary-2 loop section can be modified except for *Phase Detector Freq*. This parameter is calculated from the reference frequency (*Refrnc Freq*) and reference counter (*Refrnc Count P*) parameters in the Device section.

3.1.3.01. VCO Frequency

The auxiliary-2 *VCO Frequency* parameter is not actually a TRF2020 device parameter but may be used to cause the program to automatically find a solution, if possible, for *NM1-2* based on the entered VCO frequency parameter and others. The correct reference frequency (*Refrnc Freq)* and the reference count (*NR*) should be entered before using the *VCO Frequency* parameter to calculate a channel solution.

3.1.3.02. Speedup Time G

See 3.1.2.02 section

3.1.3.03. Current Ratio K

See 3.1.2.03 section

3.1.3.04. Enable Loop T

The *T* field enables/disables the auxiliary-2 synthesizer as follows:

T = 0 enabled,

T = 1 disabled.

3.1.3.01. NM1-2 J and H

The *J* and *H* fields can be programmed manually to any valid number. These fields are also automatically updated when the *VCO Frequency* field is used to enter a valid auxiliary-2 synthesizer channel frequency.

3.1.3.01. Reference Post Select N

The *N* field selects the main synthesizer reference postscaler as follows:

N = 0 Reference/1,

N = 1 Reference/2,

N = 2 Reference/4,

N = 3 Reference/8.

3.1.4. Device Section

The device section displays the current device parameters. All parameters displayed in the device section can be modified except *Synthesizer Status* , which is a read-back from the *Lock* terminal on the TRF2020 device.

3.1.4.01. Lock Detect U

The lock detect *U* field selects the function of the lock detect circuitry as follows:

U = 0	Main,
U = 1	Aux-1,
U = 2	Aux-2,
U = 3	AND-ed.

3.1.4.02. Device Test V

The device test *V* field is reserved evaluation and should normally remain set to zero. When this field is set to zero, the *LOCK* terminal is operating normally. Otherwise, the *LOCK* terminal is connected to internal nodes in the TRF2020.

3.1.4.03. Reference Frequency (Refrnc Freq)

The external reference frequency or installed TCXO frequency used with the evaluation board should be entered in this location in order that other parameters such as the phase detector reference frequency can be properly calculated and displayed.

3.1.4.04. Reference Count P

The *P* field selects the division ratio of the reference frequency counter.

3.1.4.05. Synthesizer Status

The *Synthesizer Status* is a read-back only field that reflects the current status of the LOCK terminal.

3.1.5. Editing parameters

To edit any one of the program parameters displayed, the user first selects an appropriate function key (described below) to select a section of the display such as the Main Loop section. The arrow *(←, ↑, →, ↓)* and Tabulation (*TAB*) keys are used to move the cursor to the parameter to be edited. Once the cursor is located at the proper location, press *Enter* (or *Return*) to select the parameter. Next, enter the new value and press Enter again. Once all of the parameters within a particular section of the display have been edited as desired, press the Escape (*ESC*) key to return to the main menu. For example, to edit the *Post Select* parameter in the *Main Loop* section from the main menu, the following keystrokes are performed:

1) *F1* to select the *Main Loop* section

2) → to move to the right column

3) ↓ to move down the right column

4) ↓ to move down the right column

5) *Enter* to select the *Post Select* field

6) Data enter the desired data such as 2

7) *Enter* to complete the field edit

8) *ESC* to leave the *Main Loop* section and return to the main menu

3.1.5.01. Function Keys

Function keys are used to select sections of the display for editing purposes or to perform a program function as follows:

F1: Edit PLL Main - Selects the M*ain Loop* section of the display for editing.

F2: Edit PLL Aux-1 - Selects the *Auxiliary-1 Loop* section of the display for editing.

F3: Edit PLL Aux-2 - Selects the *Auxiliary-2 Loop* section of the display for editing.

F4: Edit Device - Selects the *Device* section of the display for editing.

F5: View Bit Map - Used to view the current multi-word bitmap.

F7: Select Port - Used to select the PC parallel port. This function "looks" at the ROM BIOS to find all parallel ports. Follow the directions to select a particular port if more than one is found.

F8: Load File - Used to load a configuration file to reset the program parameters to a user specified condition. This function will look for the entered file on the same disk and in the same directory from which the program is executing. Any existing, allowable DOS name can be used. The INIT.CFG file may also be loaded using this function to restore to original program configuration.

F9: Save File - Used to save a configuration file containing the current program parameters to a user-specified file. This function will write the program parameters to the specified file name on the same disk and in the same directory from which the program is executing. Any allowable DOS name can be used. The INIT.CFG file may also be re-written using this function to change the boot program configuration.

F10: Send to Device - Used to program the TRF2020 device. When F10 is selected, the current bitmap is displayed and the user enters the letter (A, B, C, D, E, G) of the word to be sent to the TRF2020. The default sequence of G, D, C, B, and A in order can be sent to the TRF2020 by simply pressing *Enter* without first selecting a letter.

3.1.5.02. Quitting the Program

CTL-Q: Quit - The Control *(Ctrl)* key is depressed and held while the *Q* key is pressed to exit the program and return to DOS.

Evaluation Board Disclaimer

Please note that the enclosed evaluation boards are experimental Printed Circuit Boards and are therefore only intended for device evaluation.

We would like to draw your attention to the fact that these boards have been processed through one or more of Texas Instruments' external subcontractors who have not been production qualified.

Device parameters measured, using these boards, are not representative of any final datasheet or of a final production version. Texas Instruments does not represent or guarantee that a final version will be made available after device evaluation.

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