

APPLICATION NOTE

AN1890

**Using the SA7025 (RevA) and SA8025A
for narrow band systems**

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1997 Aug 20

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INTRODUCTION

The SA7025 (RevA) and SA8025A are improved versions of the SA7025 and SA8025 suitable for narrow band systems like the America Digital Cellular System (IS-54) and Japan Personal Digital Cellular System (PDC). The new design improves the performance of the fractional spurs compensation, which is a by-product of the fractional-N divider. Complete design procedure and performance measurements on both the SA7025 (RevA) and SA8025A are included in this document.

The basics of the fractional-N PLL frequency synthesizers can be found in Philips Semiconductors application note AN1891, "SA8025 Fractional-N synthesizer for 2GHz band applications". AN1891 can be used in conjunction with this document for designing-in the SA7025, SA8025, SA7025 (RevA), and SA8025A.

Fractional Spurs Compensation

The fractional-N divide ratio is achieved by changing the divide ratio between N and N+1. In lock condition, this technique will introduce an instantaneous phase error in the phase detector. This causes the VCO to generate unwanted spurs at the offset of the fractions of the comparison frequency.

On the new SA7025 (RevA) and SA8025A, the fractional compensation circuitry was re-designed to achieve better performance. Three improvements can be found on the SA7025 (RevA) and SA8025A due to this modification:

1. The CN range is much tighter. The CN values are the binary current setting factor for the charge pumps. These values may be varied across the desired frequency band (e.g. 25MHz) for fractional spurs compensation. For the SA7025/SA8025, the CN range is greater than 50 for narrow band systems (e.g. channel spacing, $f_{CH}=30\text{kHz}$). For the new SA7025 (RevA)/SA8025A, this range is much tighter and a **fixed** CN value is usually good enough for all synthesized frequencies on the SA7025 (RevA)/SA8025A.
2. A more accurate calculation of the resistor RF, which determines the amount of fractional compensation current. Eq. 1 gives an approximate value of I_{RF} . RF can be calculated using Eq. 2, which is the same as the one for calculating resistor RN. To obtain an optimum performance, the CN value can be adjusted accordingly.

$$I_{RF} = \frac{3 \cdot I_{RN} \cdot CN \cdot f_{XTAL}}{Q \cdot f_{VCO}} \quad (1)$$

$$RF = \frac{V_{DDA} - 0.9 - 150 \cdot \sqrt{I_{RF}}}{I_{RF}} \quad (2)$$

3. Better performance over temperature. The variation of fractional spurs was minimized over the rated temperature range (-40 to +80°C).

Compatibility Between the SA7025/SA8025 and SA7025 (RevA)/SA8025A

The SA7025/SA8025 and SA7025 (RevA)/SA8025A are pin-to-pin compatible and have exactly the same performance except for the fractional compensation section. When replacing the SA7025/SA8025 with SA7025 (RevA)/SA8025A, new values for CN and resistor RF may have to be used. Users should calculate resistor RF using Eq. 1 and 2 and experiment with it on the bench with the new RF value.

PLL Design Equations

δ : final frequency resolution after settling.

$$\delta = \frac{\text{frequency error after settling}}{\text{switching step}} \quad (3)$$

t_{SW} : switching time (sec)

f_N : natural frequency of the 2nd order system(Hz) ,

$$\omega_N = 2\pi f_N \text{ (rad/s)}$$

N : total divide ratio

ξ : damping factor of the 2nd order system.

Typical value is 0.707.

K_{VCO} : VCO gain (Hz/V) or $2\pi * VCO$ gain (rad/V)

K_ϕ : phase detector gain = $I_{CP}/2\pi$ (A/rad)

$$\omega_N = \frac{-\ln(\delta \cdot \sqrt{1 - \xi^2})}{\xi \cdot t_{SW}} \quad (4)$$

$$C_1 = \frac{K_\phi \cdot K_{VCO}}{N\omega_N^2} \quad (5)$$

$$R_1 = 2 \cdot \xi \left(\frac{N}{K_\phi \cdot K_{VCO} \cdot C_1} \right)^{0.5} \quad (6)$$

$$C_2 \leq \frac{C_1}{10} \quad (7)$$

$$\omega = \frac{1}{C_3 \cdot R_2} \quad \omega \text{ should be at least 10 times larger than } \omega_N \quad (8)$$

Note: The unit of the factor $K_\phi \cdot K_{VCO}$ is unity when all the variables are expressed in radians. Therefore, designers can simply multiply the charge pump output current (I_{CP}) with the VCO gain in Hz/V to obtain this factor.

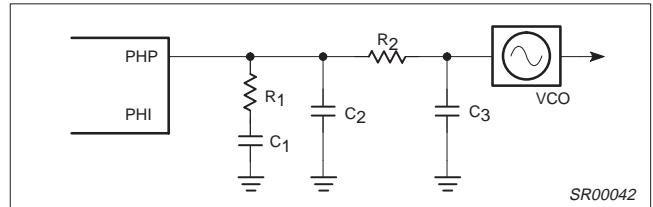


Figure 1. 3-Poles RC Lowpass Loop Filter

SA7025 (RevA) Design Example

This section shows a design example using the SA7025 (RevA) for the IS-54. The system parameters are as follows:

VCO frequency (f_{VCO}) = 913 to 938MHz

Channel spacing (f_{CH}) = 30kHz

Comparison frequency (f_{COMP}) = $8 * 30\text{ kHz} = 240\text{kHz}$

Switching time (t_{SW}) = 1.5ms

Switching step = 25MHz

Frequency error = within 1 kHz

VCO gain (K_{VCO}) = 12MHz/V (measured), Murata MQE001-926

Reference Crystal (f_{REF}) = 14.4MHz

1. Determine total divide ratio N

To synthesize channels from 913 to 938MHz with $f_{COMP}=240\text{kHz}$, N should be between 3804 and 3908. For the same loop components, a larger value of N yields lower natural frequency (ω_N). So, jumping from high-end to low-end (larger N) is slower than from low-end to

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high-end (smaller N). To ensure the same switching time from both directions, we use N=3908 for the worst case.

2. Determine ω_N

Using Eq. 3

$$\delta = \frac{1000}{25e6} = 0.04e-3$$

Pick $\xi = 0.707$ and use $t_{SW} = 1.5ms$.

Using Eq. 4

$$\omega_N = \frac{-\ln(0.04e-3 \cdot 0.707)}{0.707 \cdot 1500e-6} = 9830$$

3. Determine RN and I_{CP}

Pick RN = 51 kΩ and CN = 200. I_{RN} becomes 58μA when V_{DDA}=5V.

Using the PHP charge pump current equation

$$I_{CP} = 200 \left(\frac{58e-6}{32} \right) = 363\mu A$$

4. Determine R₁, C₁, and C₂

Using Eq. 5 with the 2π's from K_{VCO} (rad/V) and K_φ (A/rad) cancel out

$$C_1 = 12e6 \left(\frac{363e-6}{3908 \cdot 9830^2} \right) = 11.5nF$$

Using Eq. 6

$$R_1 = 2 \cdot 0.707 \cdot \left(\frac{3908}{12e6 \cdot 363e-6 \cdot 11.5e-9} \right)^{0.5} = 13k\Omega$$

Using Eq. 7

$$C_2 = \frac{11.5e-9}{10} = 1.15nF$$

5. Determine R₂ and C₃

R₂ and C₃ can help attenuate the comparison spurs at 240kHz offset.

Using Eq. 8

$$\omega = \frac{1}{R_2 \cdot C_3} \geq 10\omega_N$$

6. Determine RF

Crystal frequency (f_{XTAL}) = 14.4MHz

Mid VCO frequency (f_{VCO}) = 926MHz

Q (fractional modulus) = 8

Using Eq. 1 and Eq. 2

$$I_{RF} = \frac{3 \cdot 58e-6 \cdot 200 \cdot 14.4e6}{8 \cdot 926e6} = 67.65\mu A$$

$$RF = \frac{5 - 0.9 - 150 \cdot \sqrt{67.65e-6}}{8 \cdot 926e6} = 43k\Omega$$

A minor adjustment of CN maybe required if optimum fractional spurs suppression is needed across the 25MHz band. The experimental results yielded the best spurious suppression at a value of RF=47kΩ.

Component values used on the SA7025(Rev A) demo board:

C31 = 10 nF

R23 = 13 kΩ

C32 = 1 nF

R24 = 100 kΩ
C33 = 18 pF
R21 = 47 kΩ (RF)
R22 = 51 kΩ (RN)
CN = 200
Strobe width = 260μs

Measurement Results of the SA7025 (RevA)

Figure 2 shows the measured close-in noise at 940.05MHz. The phase noise at 1kHz carrier offset is $-49.4 - 10 \log(100) = -69.4$ dBc/Hz. Fractional spurs performance is shown in Figures 3 to 6. The worst case spurs occur when NF=1 and NF=7 are less than -60dBc. Spurs at the alternate channel, the 60kHz carrier offset required by the IS-54, are totally suppressed. Figures 7 and 8 show the measured switching times. These results show that the PLL can jump a 25MHz step in less than 1.5ms from both directions.

Table 1 shows the difference in performance between the SA7025 and SA7025 (RevA) using the same demoboard. Unless otherwise mentioned, CN=200, RN=51kΩ, RF=47kΩ.

Speed-up Design for Achieving Better Close-in Noise

Better close-in noise can be achieved at the expense of operational current. The PHP charge pumps on the SA7025 (RevA) and SA8025A are both capable of delivering more than 1.5mA in the speed-up mode. To stay in this mode, the STROBE signal has to be kept high after the programming word 'A' is sent. The CL register sets the amount of charge pump current which is either 3 times (CL=0), 5 times (CL=1), or 9 times (CL=2) higher than the current in normal mode. Assume that we want to modify the previous design and use speed-up with CL=1. This implies that the charge pump output current becomes $5 \cdot 363\mu A = 1.8mA$. In order to maintain the same natural frequency, the value of C31 and C32 is increased by a factor of 5 and R23 is decreased by the same factor of 5.

Therefore, the new values used on the demo board are:

C31 = 100nF in parallel with 100nF

C32 = 4.7nF

R23 = 2.4kΩ

Figure 9 compares the close-in phase noise of the two designs with the same natural frequency. The bottom trace has a 4dB improvement in the close-in noise when speed-up mode (higher current) is used. Since the phase noise beyond the loop bandwidth is solely determined by the VCO phase noise, two traces start to merge together at about 5kHz offset.

SA8025A Design Example

This section shows a design example using the SA8025A for the Personal Digital System (PDC1500), a narrow band system. The design procedure is the same as the previous section. The system parameters are as follows:

VCO frequency (f_{VCO}) = 1607 to 1631 MHz

Channel spacing (f_{CH}) = 25kHz

Comparison frequency (f_{COMP}) = $8 \cdot 25\text{kHz} = 200\text{kHz}$

Switching time (t_{SW}) = 1.5ms

Switching step = 24MHz

Frequency error = within 1kHz

VCO gain (K_{VCO}) = 24 MHz/V (measured), Murata MQE060-1619

Reference Crystal (f_{REF}) = 19.2MHz

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Table 1. Performance Comparison: SA7025 to SA7025 (Rev A)

	SA7025	SA7025 (Rev A)	Figure
Fractional spurs (dBc) @30kHz, VCO=912.99MHz	-57.6 (CN=200, RF=2MΩ)	-63.6	3
Fractional spurs (dBc) @60kHz, VCO=912.99MHz	not present (CN=200, RF=2MΩ)	not present	3
Fractional spurs (dBc) @30kHz, VCO=939.87MHz	-63.5 (CN=100, RF=2MΩ)	-63.9	5
Fractional spurs (dBc) @60kHz, VCO=939.87MHz	not present (CN=100, RF=2MΩ)	not present	5
Close-in noise (dBc/Hz) @1kHz, VCO=1631.025MHz	-69	-69	2
I _{TOTAL} (mA) for the demo board	21.2	21.2	
Switching time (ms)	<1.5	<1.5	7, 8

1. Determine total divide ratio N

$$N = \frac{1631\text{MHz}}{200\text{kHz}} = 8155$$

2. Determine ω_N

Using Eq. 3 $\delta = \frac{1000}{24e6} = 0.042e-3$

Pick $\xi = 0.707$ and use $t_{SW} = 1.5\text{ms}$.

Using Eq. 4 $\omega_N = \frac{-\ln(0.042e-3 \cdot 0.707)}{0.707 \cdot 1500e-6} = 9830$

3. Determine R_N and I_{CP}

Pick $R_N = 51\text{k}\Omega$ and $CN = 200$. I_{RN} becomes $58\mu\text{A}$ when $V_{DDA}=5\text{V}$.

Using the PHP charge pump current equation

$$I_{CP} = 200 \left(\frac{58e-6}{32} \right) = 363\mu\text{A}$$

4. Determine R_1 , C_1 , and C_2

Using Eq. 5

$$C_1 = 24e6 \left(\frac{363e-6}{8155 \cdot 9830^2} \right) = 11.1\text{nF}$$

Using Eq. 6

$$R_1 = 2 \cdot 0.707 \cdot \sqrt{\left(\frac{8155}{24e6 \cdot 363e-6 \cdot 11.1e-9} \right)} = 13\text{k}\Omega$$

Using Eq. 7

$$C_2 = \frac{11.1e-9}{10} = 1.1\text{nF}$$

5. Determine R_2 and C_3

R_2 and C_3 can help attenuate the comparison spurs at 200kHz offset.

Using Eq. 8

$$\omega = \frac{1}{R_2 \cdot C_3} \geq 10\omega_N$$

Pick $R_2 = 360\text{k}\Omega$, then $C_3 = 18\text{pF}$.

6. Determine RF

Crystal frequency (f_{XTAL}) = 19.2MHz

Mid VCO frequency (f_{VCO}) = 1619MHz

Q (fractional modulus) = 8

Using Eq. 1 and Eq. 2

$$I_{RF} = \frac{3 \cdot 58e-6 \cdot 200 \cdot 14.4e6}{8 \cdot 926e6} = 67.65\mu\text{A}$$

$$RF = \frac{5 - 0.9 - 150 \cdot \sqrt{67.65e-6}}{8 \cdot 926e6} = 43\text{k}\Omega$$

Minor adjustment of CN is required if optimum fractional spurs suppression is needed.

Component values used on the demo board:

C31 = 10nF

R23 = 13kΩ

C32 = 1nF

R24 = 360kΩ

C33 = 18pF

R21 = 56kΩ (RF)

R22 = 51kΩ (RN)

CN = 200

Strobe width = 260μs

Measurement Results of the SA8025A

Close-in phase noise spectrum is shown in the Figure 10. At 1kHz carrier offset, the phase noise is $-45.3 - 10^*\log(100) = -65.3\text{ dBc/Hz}$. The 3dB loop bandwidth is 3kHz, which is about twice as much as the loop natural frequency (f_N). Fractional spurs performance is shown in Figure 11 to 14. Worst case spurs when NF=1 and NF=7 for the low and high bands are all less than -59dBc. Spurs at 50kHz carrier offset, the alternate channel for PDC1500, were totally suppressed. Switching time measurements are shown in Figure 15 and 16. The PLL can reach the desired frequency for a 24MHz jump in less than 1.5ms from both directions.

Table 2 shows the difference in performance between the SA8025 and SA8025A using the same demoboard. Unless otherwise mentioned, CN=200, RN=51kΩ, RF=56kΩ.

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Table 2. Performance Comparison: SA8025 to SA8025A

	SA8025	SA8025A	Figure
Fractional spurs (dBc) @25kHz, VCO=1606.625MHz	-41.5 (CN=250, RF=560kΩ)	-60.6	11
Fractional spurs (dBc) @50kHz, VCO=1606.625MHz	not present (CN=250, RF=560kΩ)	not present	11
Fractional spurs (dBc) @25kHz, VCO=1631.025MHz	-59.0 (CN=200, RF=560kΩ)	-59.5	13
Fractional spurs (dBc) @50kHz, VCO=1631.025MHz	not present (CN=200, RF=560kΩ)	not present	13
Close-in noise (dBc/Hz) @1kHz, VCO=1631.025MHz	-65	-65	10
I _{TOTAL} (mA) for the demo board	28.3	28.3	
Switching time (ms)	<1.5	<1.5	15, 16

SA8025A for the PHS System

Philips Semiconductors applications note AN1891, "Using the SA8025 in 2GHz band applications", shows a design for the PHS system based on the SA8025. If the SA8025A is used in the same design, only RF needs to be changed.

Crystal frequency (f_{XTAL}) = 19.2MHz

Mid VCO frequency (f_{VCO}) = 1665MHz

Q (fractional modulus) = 8

I_{RN} = 80μA

CN = 100

Using Eq. 1 and Eq. 2

$$I_{RF} = \frac{3 \cdot 80e-6 \cdot 100 \cdot 19.2e6}{8 \cdot 1865e6} = 34.6\mu A$$

$$RF = \frac{3 - 0.9 - 150 \cdot \sqrt{34.6e-6}}{34.6e-6} = 35.2k\Omega$$

On the demo board, RF=36kΩ was used. The measured fractional spurs when NF=1 and NF=7 are both better than -70dBc.

Table 3 summarizes the components change for the SA7025/SA8025 and the SA7025 (RevA)/SA8025A demo boards.

Table 3. Summary of Component Changes

Component	SA7025	SA7025 (Rev A)	SA8025	SA8025A
R21	560kΩ	47kΩ	560kΩ	36kΩ
R22	33kΩ	51kΩ	10kΩ	10kΩ
R23	24kΩ	13kΩ	10kΩ	10kΩ
R24	22kΩ	100kΩ	18kΩ	18kΩ
R25	22kΩ	0Ω	0Ω	0Ω
C30	330pF	NL	NL	NL
C31	3.3nF	10nF	3.9nF	3.9nF
C32	220pF	1nF	390pF	390pF
C33	220pF	18pF	150pF	150pF
C34	100pF	NL	NL	NL

NL = Not Loaded

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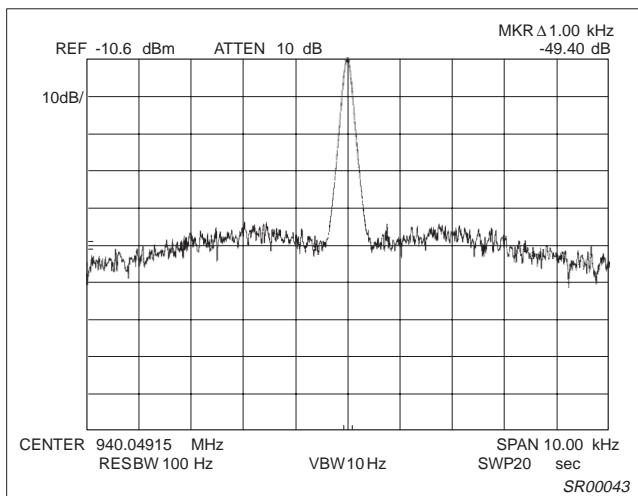
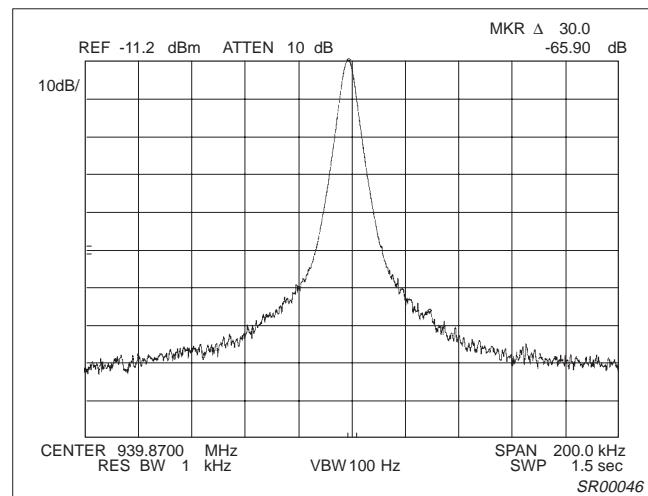
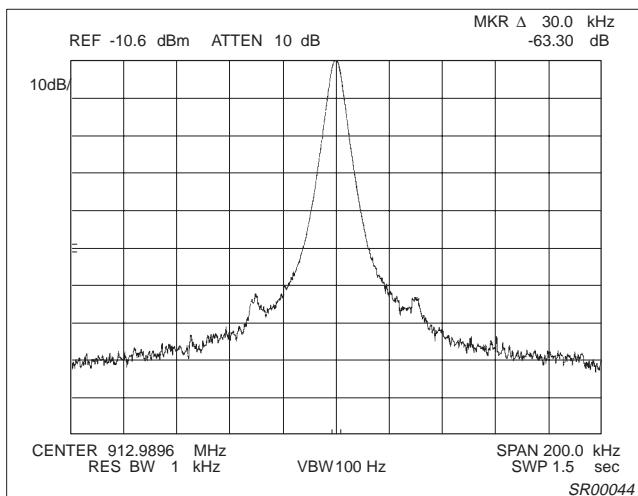
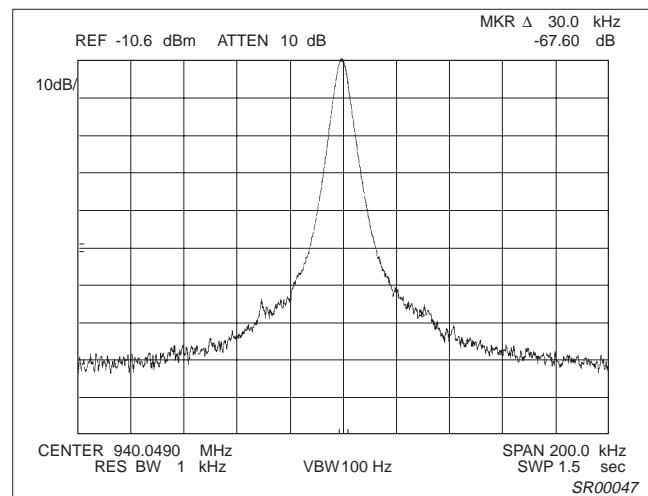
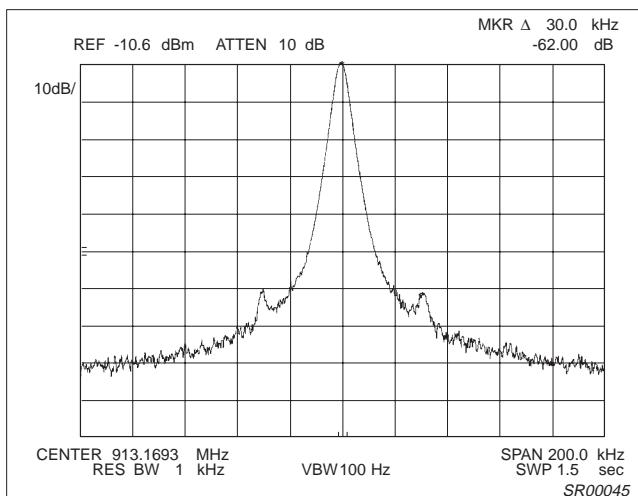
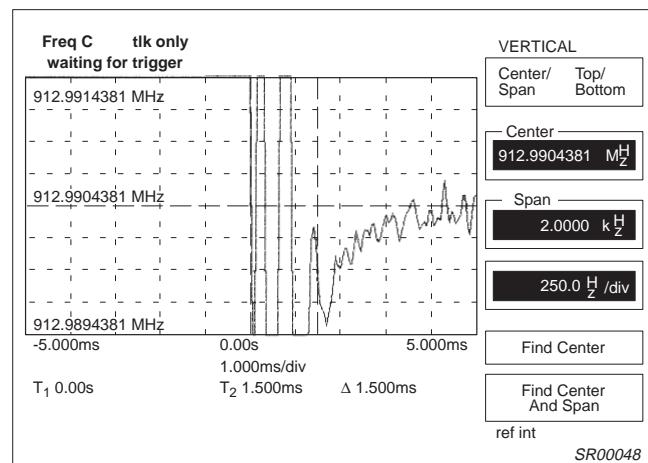
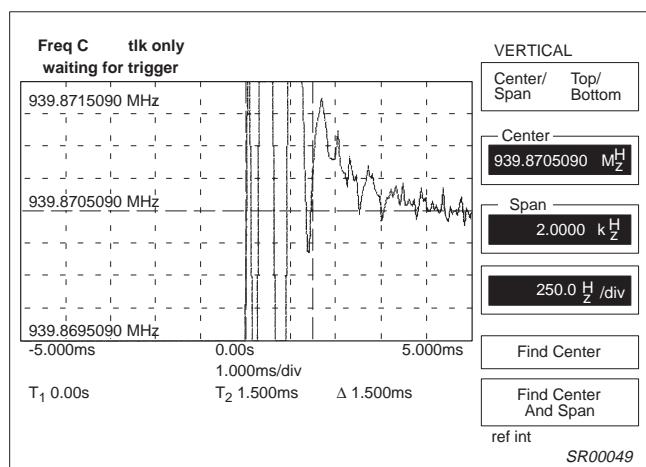


Figure 2. Close-In Noise at 940.05MHz

Figure 5. Fractional Spurs, ($f_{VCO} = 939.87\text{MHz}$; $NF = 1$)Figure 3. Fractional Spurs, ($f_{VCO} = 912.99\text{MHz}$; $NF = 1$)Figure 6. Fractional Spurs, ($f_{VCO} = 940.05\text{MHz}$; $NF = 7$)Figure 4. Fractional Spurs, ($f_{VCO} = 913.17\text{MHz}$; $NF = 7$)Figure 7. Switching Time
(939.87 to 912.99MHz Step to Within 1kHz)

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**Figure 8. Switching Time
(912.99 to 939.87MHz Step to Within 1kHz)**

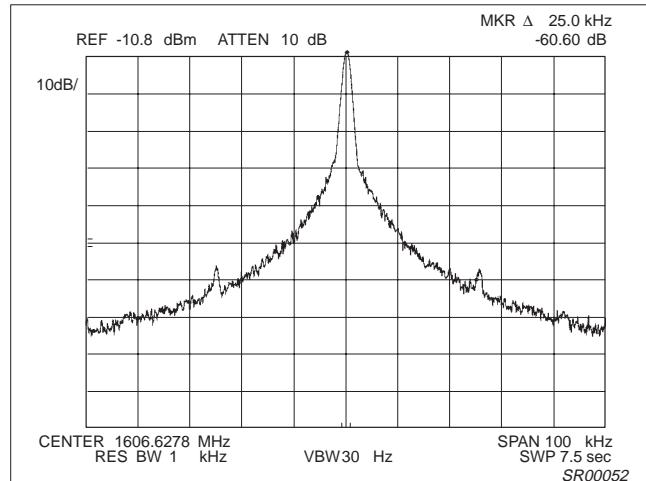


Figure 11. Fractional Spurs, (f_{VCO} = 1606.625MHz; NF = 1)

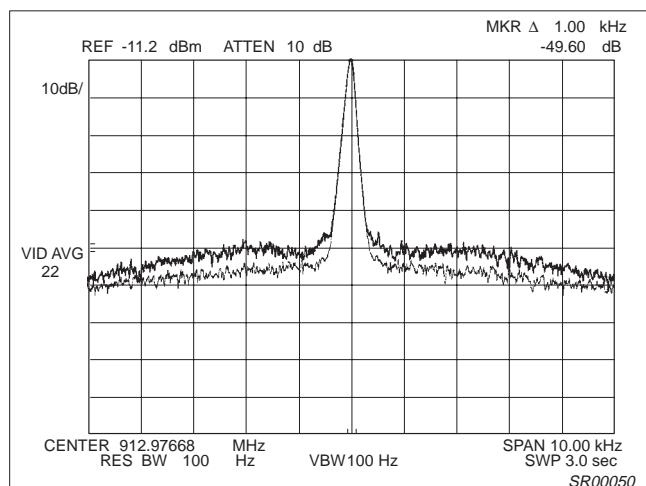


Figure 9. Close-In Phase Noise When CL = 1

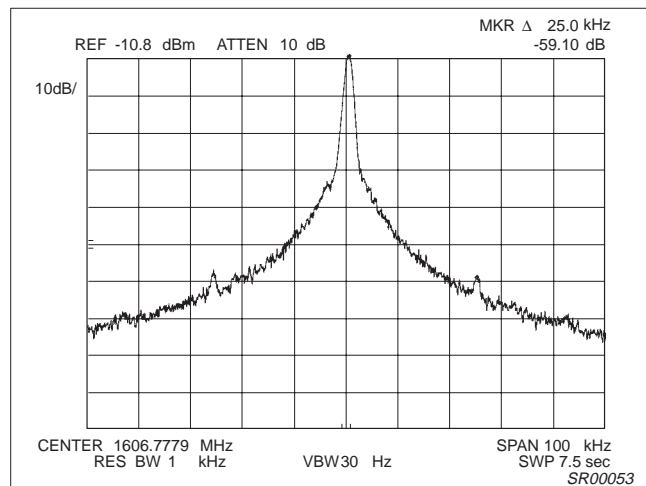


Figure 12. Fractional Spurs, (f_{VCO} = 1606.775MHz; NF = 7)

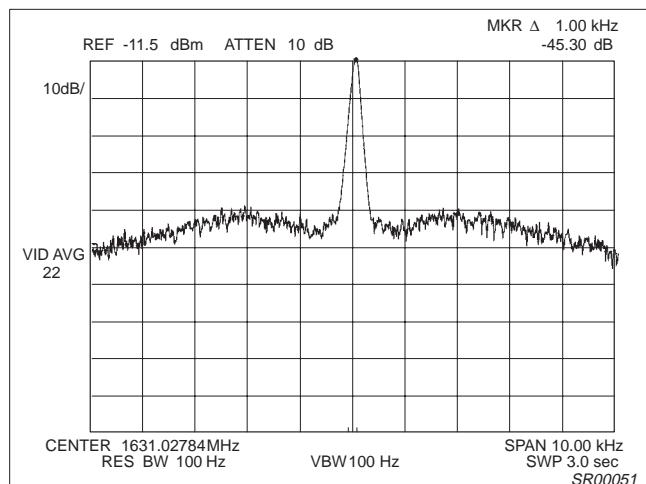


Figure 10. Close-In Phase Noise at 1631.025MHz

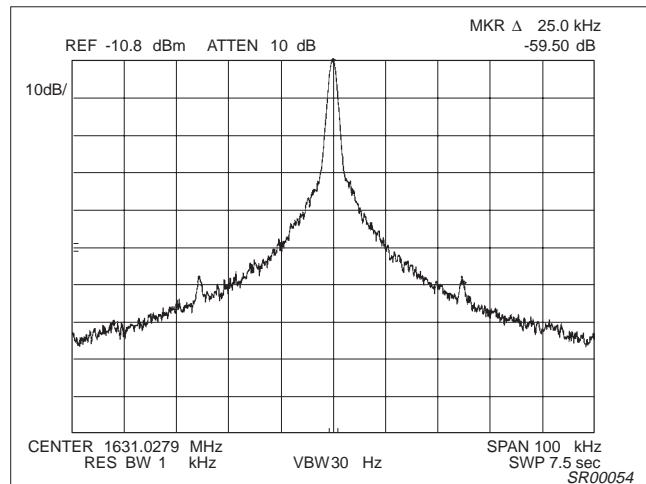
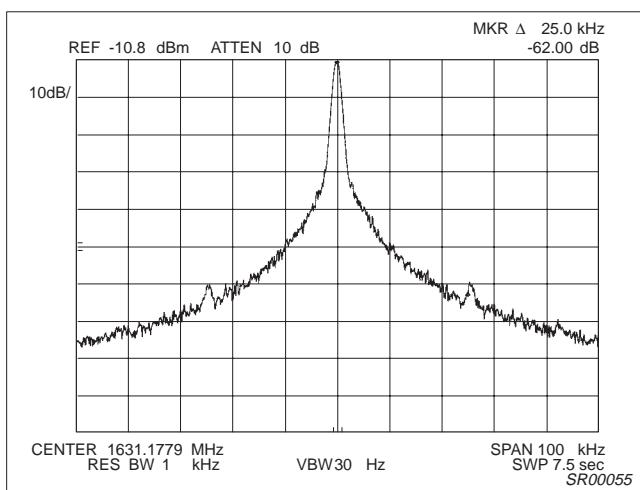
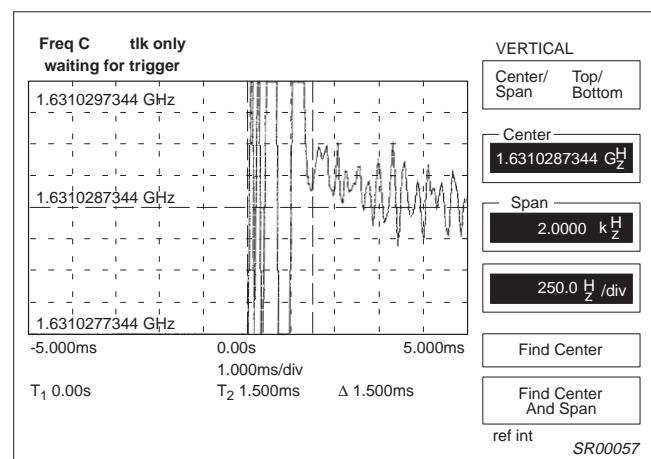
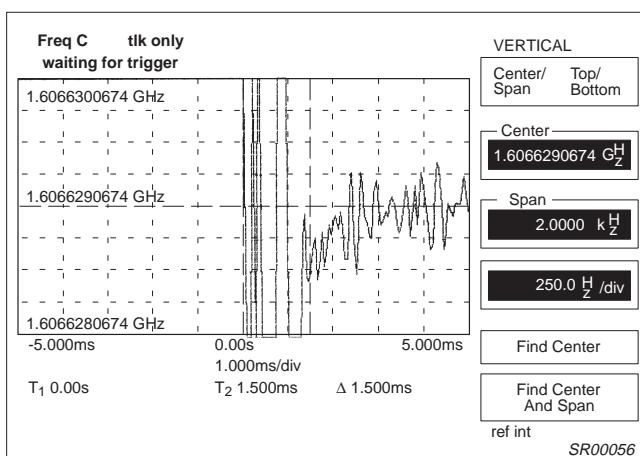


Figure 13. Fractional Spurs, (f_{VCO} = 1606.775MHz; NF = 7)

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Figure 14. Fractional Spurs, ($f_{VCO} = 1631.175\text{MHz}$; $NF = 7$)Figure 16. Switching Time
(1606.625 to 1631.025MHz Step to Within 1kHz)Figure 15. Switching Time
(1631.025 to 1606.625MHz Step to Within 1kHz)

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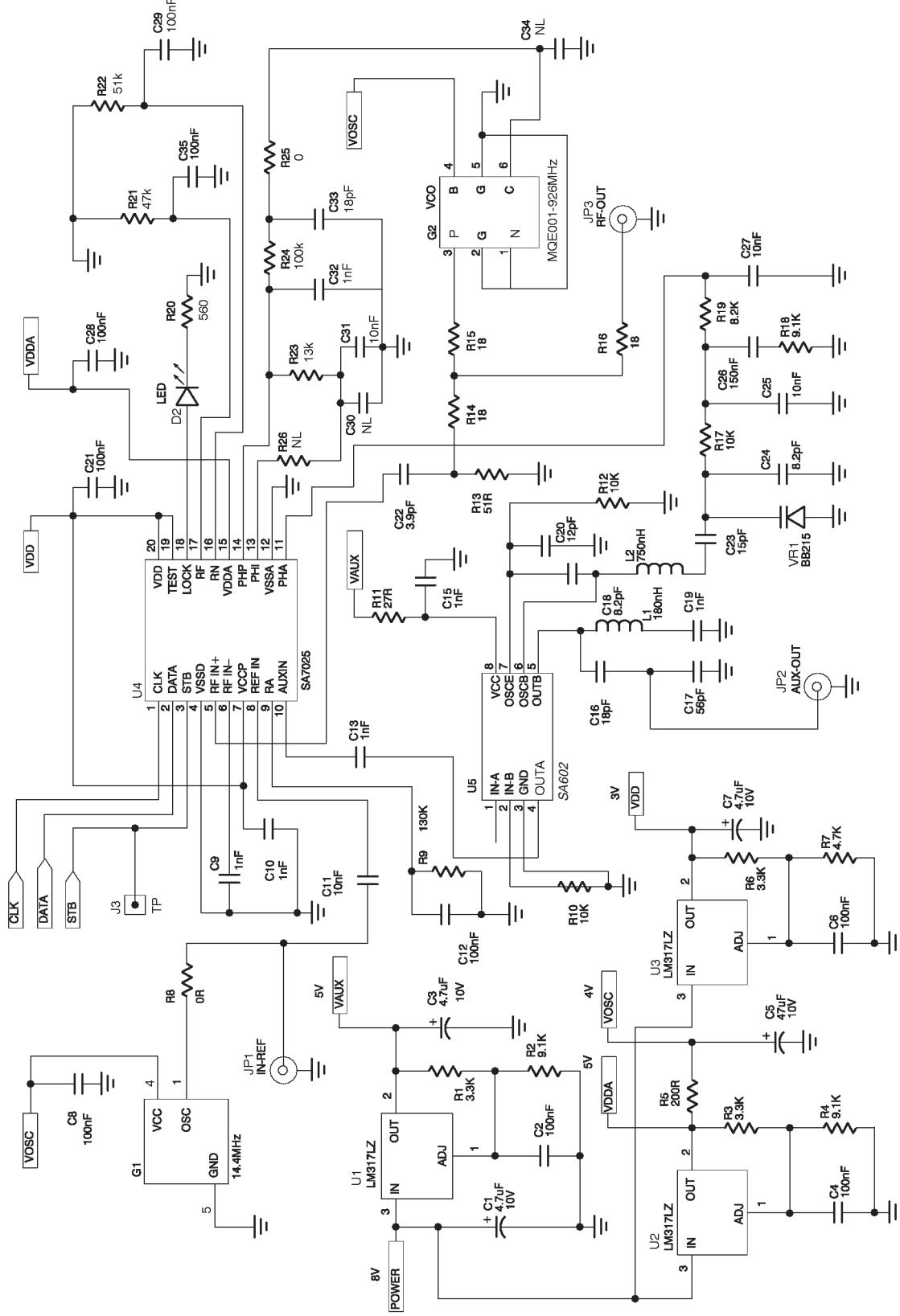


Figure 17. SA7025DK Application Circuit

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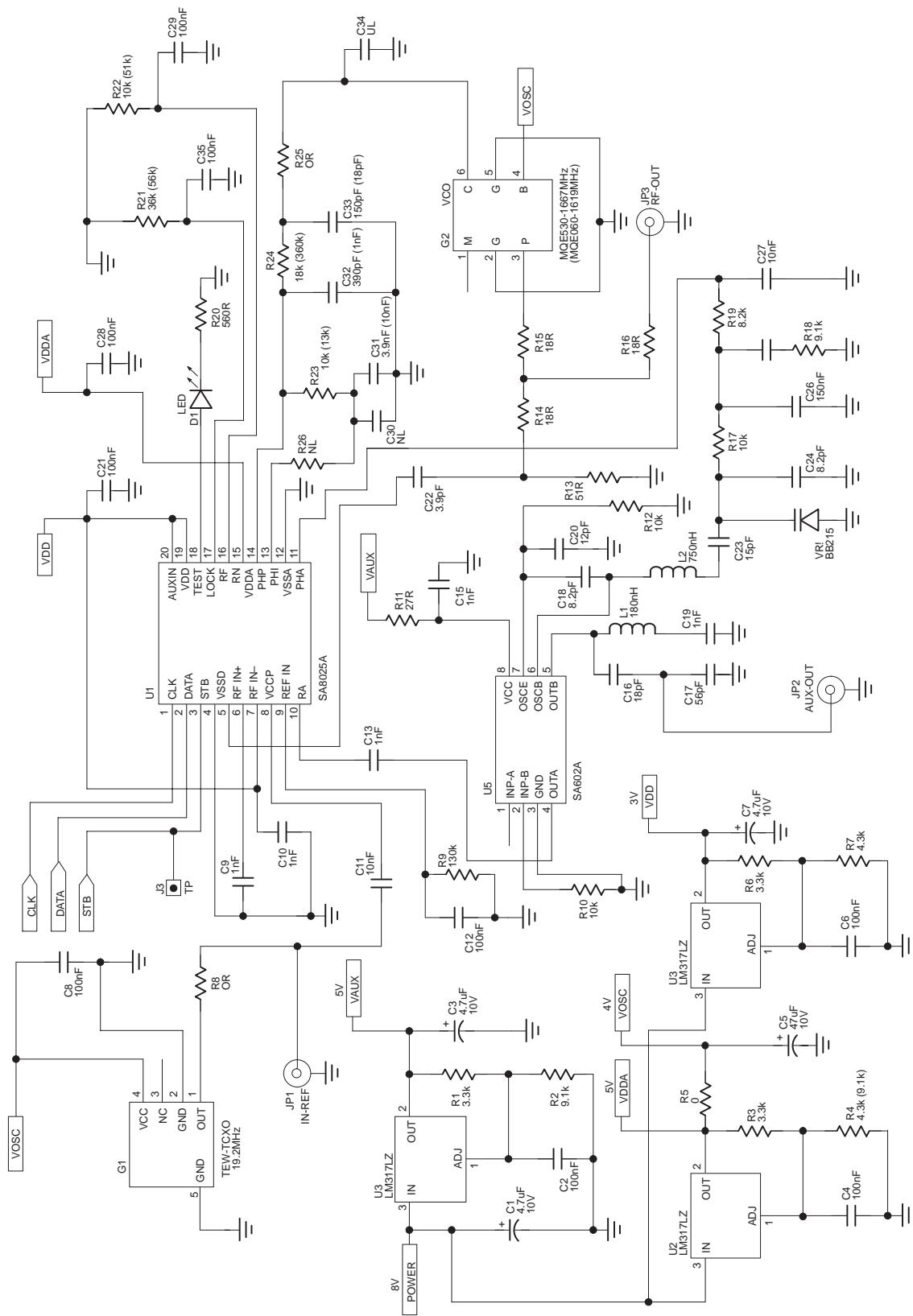
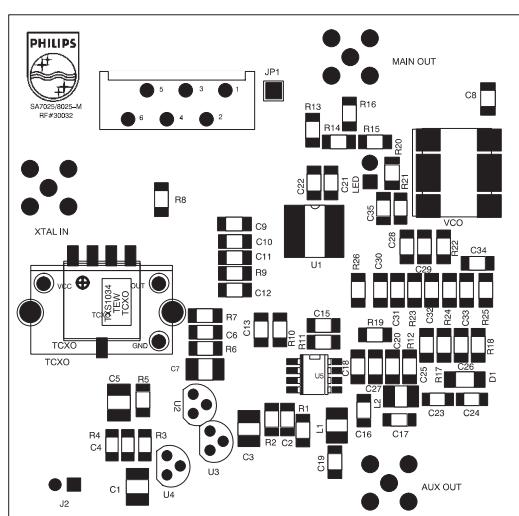


Figure 18. SA8025ADK Application Circuit

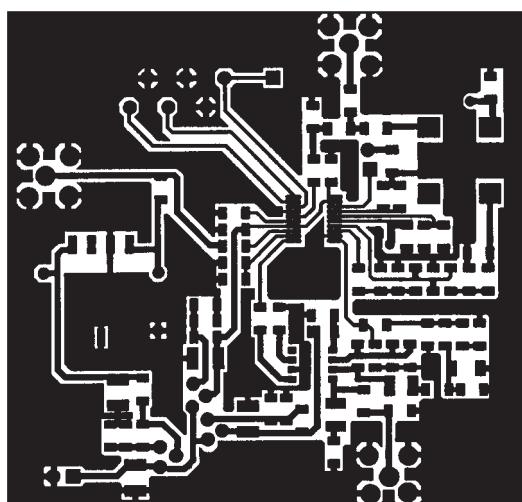
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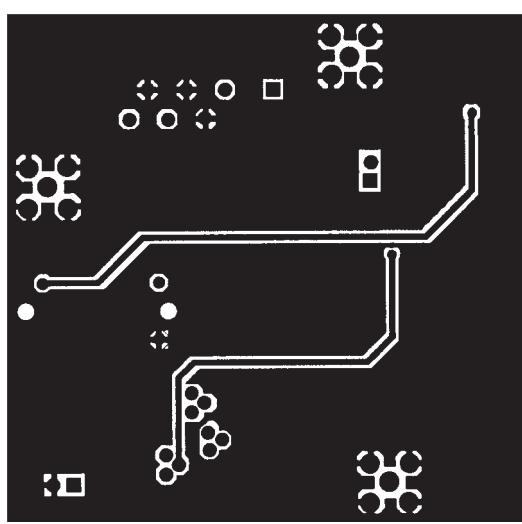
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TOP SILK SCREEN



TOP VIEW



BOTTOM VIEW

SR01020

Figure 19. SA8025ADK Demoboard Layout (NOT ACTUAL SIZE)

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Table 4. Customer Application Component List for SA7025DK

Qty.	Value	Volt	Part Reference	Part Description	Vendor	Mfg	Part Number
Surface Mount Capacitors							
1	3.9pF	50V	C22	Cap. cer. 1206 NPO $\pm 0.5\text{pF}$	Garrett	Rohm	MCH315A3R9CK
2	8.2pF	50V	C24, C18	Cap. cer. 1206 NPO $\pm 0.5\text{pF}$	Garrett	Rohm	MCH315A8R2CK
1	12pF	50V	C20	Cap. cer. 1206 NPO $\pm 5\%$	Garrett	Rohm	MCH315A120JK
1	15pF	50V	C23	Cap. cer. 1206 NPO $\pm 5\%$	Garrett	Rohm	MCH315A150JK
2	18pF	50V	C16, C33	Cap. cer. 1206 NPO $\pm 5\%$	Garrett	Rohm	MCH315A180JK
1	56pF	50V	C17	Cap. cer. 1206 NPO $\pm 5\%$	Garrett	Rohm	MCH315A560JK
6	1000pF	50V	C9, C10, C13, C15, C19, C32	Cap. cer. X7R $\pm 10\%$	Garrett	Rohm	MCH315A102JP
4	0.01 μF	50V	C11, C25, C27, C31	Cap. cer. X7R $\pm 10\%$	Garrett	Rohm	MCH315C103KK
9	0.1 μF	50V	C2, C4, C6, C8, C12, C21, C28, C29, C35	Cap. cer. X7R $\pm 10\%$	Garrett	Rohm	MCH315C104KP
1	0.15 μF	16V	C26	Cap. cer. X7R $\pm 10\%$	Garrett	Rohm	MCH315C154KP
4	4.7 μF	10V	C1, C3, C5, C7	Tant. chip cap. A 3216 $\pm 10\%$	Garrett	Philips	49MC475B010KOAS
Surface Mount Resistors							
2	0 Ω	50V	R8, R25	Res. chip 1206 1/8W $\pm 5\%$	Garrett	Rohm	MCR18JW000E
3	18 Ω	50V	R14, R15, R16	Res. chip 1206 1/8W $\pm 5\%$	Garrett	Rohm	MCR18JW180E
1	27 Ω	50V	R11	Res. chip 1206 1/8W $\pm 5\%$	Garrett	Rohm	MCR18JW270E
1	51 Ω	50V	R13	Res. chip 1206 1/8W $\pm 5\%$	Garrett	Rohm	MCR18JW510E
1	100 Ω	50V	R5	Res. chip 1206 1/8W $\pm 5\%$	Garrett	Rohm	MCR18JW101E
1	560 Ω	50V	R20	Res. chip 1206 1/8W $\pm 5\%$	Garrett	Rohm	MCR18JW561E
3	3.3k Ω	50V	R1, R3, R6	Res. chip 1206 1/8W $\pm 5\%$	Garrett	Rohm	MCR18JW332E
1	4.7k Ω	50V	R7	Res. chip 1206 1/8W $\pm 5\%$	Garrett	Rohm	MCR18JW472E
1	8.2k Ω	50V	R19	Res. chip 1206 1/8W $\pm 5\%$	Garrett	Rohm	MCR18JW822E
3	9.1k Ω	50V	R2, R18, R4	Res. chip 1206 1/8W $\pm 5\%$	Garrett	Rohm	MCR18JW912E
3	10k Ω	50V	R10, R12, R17	Res. chip 1206 1/8W $\pm 5\%$	Garrett	Rohm	MCR18JW103E
1	13k Ω	50V	R23	Res. chip 1206 1/8W $\pm 5\%$	Garrett	Rohm	MCR18JW133E
1	47k Ω	50V	R21	Res. chip 1206 1/8W $\pm 5\%$	Garrett	Rohm	MCR18JW473E
1	51k Ω	50V	R22	Res. chip 1206 1/8W $\pm 5\%$	Garrett	Rohm	MCR18JW513E
1	100k Ω	50V	R24	Res. chip 1206 1/8W $\pm 5\%$	Garrett	Rohm	MCR18JW104E
1	130k Ω	50V	R9	Res. chip 1206 1/8W $\pm 5\%$	Garrett	Rohm	MCR18JW134E
1	560k Ω	50V	R21	Res. chip 1206 1/8W $\pm 5\%$	Garrett	Rohm	MCR18JW564E
Surface Mount Diodes							
1			VR1 (Varactor)	Variable capacitance SMD diode	Digikey	Philips	BB215
1			D1	SM Led	Digikey		
Surface Mount Inductors							
1	0.18 μH		L1	Chip inductor 1008 $\pm 10\%$	Coilcraft	Coilcraft	1008CS-181XKBB
1	0.75 μH		L2	Chip inductor 1008 $\pm 10\%$	Coilcraft	Coilcraft	1008CS-751XKBB
Voltage Regulators							
3	100mA		U1, U2, U3	Voltage regulator	Digikey	National	LM317LZ
TCXO							
1	14.4MHz		G1	Temp. controlled crystal osc.	TEW	TEW	TXS0924M-14.4MHz
VCO							
1	926MHz		G2	Voltage controlled osc.	Murata	Murata Erie	MQE001-926
Surface Mount Integrated Circuits							
1			U4	1GHz Fractional-N Synthesizer	Philips	Philips	SA7025DK
1			U5	Double Balanced Mixer Oscillator	Philips	Philips	SA602A
Miscellaneous							
3			JP1, JP2, JP3	SMA right angle jack receptacle	Newark	EF Johnson	142-0701-301
1			J1	Male 6-pins connector	STOCKO	STOCKO	MKS1956-6-0-606
1			J2	Male 2-pins connector	STOCKO	STOCKO	MKS1851-6-0-202
1			J3	Test point	Digikey	3M	929647-36
1				Printed circuit board	Philips	Philips	SA7025/8025-M
75 Total Parts							

Using the SA7025(RevA) and SA8025A for narrow band systems

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Table 5. Customer Application Component List for SA8025ADK

Qty.	Part Value	Volt	Part Reference	Part Description	Vendor	Mfg	Part Number
Surface Mount Capacitors							
1	3.9pF	50V	C22	Cap. cer. 1206 NPO $\pm 0.5\text{pF}$	Garrett	Rohm	MCH315A3R9CK
2	8.2pF	50V	C24, C18	Cap. cer. 1206 NPO $\pm 0.5\text{pF}$	Garrett	Rohm	MCH315A8R2CK
1	12pF	50V	C20	Cap. cer. 1206 NPO $\pm 5\%$	Garrett	Rohm	MCH315A120JK
1	15pF	50V	C23	Cap. cer. 1206 NPO $\pm 5\%$	Garrett	Rohm	MCH315A150JK
1	18pF	50V	C16	Cap. cer. 1206 NPO $\pm 5\%$	Garrett	Rohm	MCH315A180JK
1	56pF	50V	C17	Cap. cer. 1206 NPO $\pm 5\%$	Garrett	Rohm	MCH315A560JK
1	150pF	50V	C33	Cap. cer. 1206 NPO $\pm 5\%$	Garrett	Rohm	MCH315A151JK
1	390pF	50V	C32	Cap. cer. 1206 NPO $\pm 5\%$	Garrett	Rohm	MCH315A391JK
5	1000pF	50V	C9, C10, C13, C15, C19	Cap. cer. X7R $\pm 10\%$	Garrett	Rohm	MCH315A102JP
1	3900pF	50V	C31	Cap. cer. X7R $\pm 10\%$	Garrett	Rohm	MCH315C392KK
3	0.01 μF	50V	C11, C25, C27	Cap. cer. X7R $\pm 10\%$	Garrett	Rohm	MCH315C103KK
9	0.1 μF	50V	C2, C4, C6, C8, C12, C21, C28, C29, C35	Cap. cer. X7R $\pm 10\%$	Garrett	Rohm	MCH315C104KP
1	0.15 μF	16V	C26	Cap. cer. X7R $\pm 10\%$	Garrett	Rohm	MCH315C154KP
4	4.7 μF	10V	C1, C3, C5, C7	Tant. chip cap. A 3216 $\pm 10\%$	Garrett	Philips	49MC475B010KOAS
Surface Mount Resistors							
3	0 Ω	50V	R5, R8, R25	Res. chip 1206 1/8W $\pm 5\%$	Garrett	Rohm	MCR18JW000E
3	18 Ω	50V	R14, R15, R16	Res. chip 1206 1/8W $\pm 5\%$	Garrett	Rohm	MCR18JW180E
1	27 Ω	50V	R11	Res. chip 1206 1/8W $\pm 5\%$	Garrett	Rohm	MCR18JW270E
1	51 Ω	50V	R13	Res. chip 1206 1/8W $\pm 5\%$	Garrett	Rohm	MCR18JW510E
1	560 Ω	50V	R20	Res. chip 1206 1/8W $\pm 5\%$	Garrett	Rohm	MCR18JW561E
3	3.3k Ω	50V	R1, R3, R6	Res. chip 1206 1/8W $\pm 5\%$	Garrett	Rohm	MCR18JW332E
2	4.3k Ω	50V	R4, R7	Res. chip 1206 1/8W $\pm 5\%$	Garrett	Rohm	MCR18JW432E
1	8.2k Ω	50V	R19	Res. chip 1206 1/8W $\pm 5\%$	Garrett	Rohm	MCR18JW822E
2	9.1k Ω	50V	R2, R18	Res. chip 1206 1/8W $\pm 5\%$	Garrett	Rohm	MCR18JW912E
5	10k Ω	50V	R10, R12, R17, R22, R23	Res. chip 1206 1/8W $\pm 5\%$	Garrett	Rohm	MCR18JW103E
1	18k Ω	50V	R24	Res. chip 1206 1/8W $\pm 5\%$	Garrett	Rohm	MCR18JW183E
1	36k Ω	50V	R21	Res. chip 1206 1/8W $\pm 5\%$	Garrett	Rohm	MCR18JW364E
1	130k Ω	50V	R9	Res. chip 1206 1/8W $\pm 5\%$	Garrett	Rohm	MCR18JW134E
Surface Mount Diodes							
1			VR1 (Varactor)	Variable capacitance SMD diode	Digikey	Philips	BB215
1			D1	SM Led	Digikey		
Surface Mount Inductors							
1	0.18 μH		L1	Chip inductor 1008 $\pm 10\%$	Coilcraft	Coilcraft	1008CS-181XKBB
1	0.75 μH		L2	Chip inductor 1008 $\pm 10\%$	Coilcraft	Coilcraft	1008CS-751XKBB
Voltage Regulators							
3	100mA		U1, U2, U3	Voltage regulator	Digikey	National	LM317LZ
TCXO							
1	19.2MHz		G1	Temp. controlled crystal osc.	TEW	TEW	TXS1034N-19.2MHz
VCO							
1	1667MHz		G2	Voltage controlled osc.	Murata	Murata Erie	MQE530-1667
Surface Mount Integrated Circuits							
1			U4	2GHz Fractional-N Synthesizer	Philips	Philips	SA8025ADK
1			U5	Double Balanced Mixer Oscillator	Philips	Philips	SA602A
Miscellaneous							
3			JP1, JP2, JP3	SMA right angle jack receptacle	Newark	EF Johnson	142-0701-301
1			J1	Male 6-pins connector	STOCKO	STOCKO	MKS1956-6-0-606
1			J2	Male 2-pins connector	STOCKO	STOCKO	MKS1851-6-0-202
1			T3	Test point	Digikey	3M	929647-36
1				Printed circuit board	Philips	Philips	SA7025/8025-M
75 Total Parts							