PageCenter Technical Manual
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Sonik Technologies Corporation

1 Technical Description

1.1 Overview

The **PAGE CENTER** is a desk top system that provides paging and wireless two-way communications. With an Intel 32 bit processor at its core, and 4 megabytes of FLASH memory, the **PAGE CENTER** can handle the wireless communications needs of the small office or a large plant. It is designed to be form and function compatible with Mororola's discontinued "PeopleFinder" paging system.

Internally, it has two distinct circuits, a "Main Board" that controls the unit, and an "RF Board" that contains the transmitting and receiving circuits. The RF Board is enclosed within a metal shield on the Main Board.

PAGE CENTER features:

Stand-alone operation with built-in keypad and LCD display.

Build-in RS-232 serial port for advanced paging applications.

Built-in telephone interface for remote access.

Internal two-way radio for monitoring the channel and two-way voice communication.

POCSAG paging encoder at 512, 1200, and 2400 baud

1000 pager database

Group paging

8 external alarm inputs for automatic generation of pre-programmed pages.

Pages may be initiated from DTMF equipped two-way radios.

Built-in speaker and microphone, with provisions for external connections.

Operation on either wide or narrow band channels.

Internal time-out-timer

Automatic disconnect of telco on no-activity.

Busy channel lock-out to avoid transmitting on an active channel.

The **PAGE CENTER** operates in one of two basic modes. They are the *Page Mode* and the *Program Mode*. The *Page Mode* is used to send digital pages to a selected pager or group of pagers. It may also be used to communicate with a two-way radio. For the **PAGE CENTER** to send pages to a pager, it must first be programmed with the pager's CAP code. This is done, one time, using the *Program Mode*. The *Program Mode* is used to set up the individual pager's information, group information, automatic paging information, and some system-level features.

Although the operator may send pages using the built-in keypad, pages may also be generated in a variety of other ways. Pages may be initiated through the RS-232 serial port on the rear of the unit. Another way is to use the built-in telephone interface. When connected to a telephone line, pages may be entered using a touch-tone phone by dialing

into the unit. The **PAGE CENTER** may also be configured to automatically generate a page, based upon an electrical input to special input pins on the rear of the unit. A busy-channel detect circuit disables transmitting if the channel is busy.

The **PAGE CENTER** has an internal database, which stores the CAP code for every pager in your system. The CAP code is the special 7 digit code that identifies an individual pager or paging receiver device. To make paging simpler, you need only configure the CAP codes once by assigning an easy-to-remember number or name to it. For instance, you may have 3 pagers with the following CAP codes: 1924589, 0029111, 0935199. You can program them into the database as pager names 1, 2, and 3 as follows:

Pager CAP Code	Pager Name
1924589	1
0029111	2
0935199	3

Internal to the PageCenter, there is a motherboard (part number 5A296) and a radio transceiver module (part number 5A204). The radio transceiver module is enclosed in a metal shield on the motherboard.

The service manual for the 5A204 transceiver is available separate from this Technical Manual.

2 Types of Emissions

The PageCenter uses FM modulation for all communications. It has four modulation modes, wide/narrow bandwidth and voice/data modes. They are:

Mode	***Designator***
Voice from mic or telco, 5kHz deviation limiter	16K0F3E
Voice from mic or telco, 2.5kHz deviation limiter	11K0F3E
POCSAG paging data, +/- 4.5kHz deviation	16K0F1D
POCSAG paging data, +/- 2.25kHz deviation	11K0F1D

The mode of operation is automatically switched by the PageCenter, depending upon how the unit is being used. It switches to voice mode when audio is being transmitted, and to data mode when POCSAG data is being transmitted.

The PageCenter's transmitter is configured at the factory, or at a service shop, to be either a wide-band or a narrow-band transmitter. This is configured via software as well as the frequency of operation and any sub-audible signaling. Wide mode is provided for operation on older 25kHz spaced systems, and narrow mode is provided for operation on 12.5kHz spaced channels.

3 Function of Active Devices

Active devices on main board

Reference Designator	Function
HY1	Telephone interface hybrid
OSC1	48MHz clock for the CPU.
Q1	Serial ID ROM

Q9	Mic AGC adjustment
U10, U105	RS232 transceiver for serial I/O
U101	Inverter for memory timing
U104	CMOS audio switch to connect audio paths for the various modes
U104D	CMOS switch that changes the gain of the post-limiter mixer. It changes gain by 50% when the radoi is on a narrow-band channel.
U105	Inverter for AT type keyboard interface.
U106	Digital pot to adjust volume
U107	Audio switch to connect various audio paths
U108A	Mixes DTMF encode audio with speech synthesizer.
U108B	Buffer/mixer for local speaker audio
U11	FLASH memory for data and program storage
U13A	Comparator for channel busy detect circuit.
U14,U7, U19	Voltage regulators
U15A	Post-limiter mixer. Combines pre-emphaisezed audio with digital paging and sub-audible signaling. Reduces input signals to 1.7V p-p.
U15B	Splatter filter. 3kHz low-pass filter to meet emission mask and filter requirements.
U15C	Audio pre-emphasis and limiter. Power rails are used to limit output signal.
U15D	Mixer. Combines mic, DTMF, telephone, and speech synthsizer audio.
U2, U102	RAM memory
U20A	Mic amp
U20B	300Hz high pass filter, unity gain
U20C	Buffer/mixer for audio going to telephone interface.
U20D	Noise-amp ofr channel busy detector.
U22	DTMF encoder and decoder
U23	Voice synthesizer D/A converter.
U24	1 watt audio amplifier
U25C	Mixer/buffer for audio to telephone interface.
U25D	Data recovery circuit to receive DPL sub-audible signaling.
U26A	Telephone signal amplifier
U26C	Telephone audio voice detector.
U26D	Mic voice detector for VOX.
U27, U28, U29	Digital I/O expansion port
U30	CTCSS encoder and decoder. Generates and decodes sub-audible signaling tones.
U4	EEPROM
U7	EEPROM and watchdog timer.
U99	386EX microporcessor

4 Main-Board Tune-up Procedures

4.1 Adjustments

The following table lists the internal adjustments. These may only be adjusted by qualified electronic service personnel using calibrated test equipment.

Reference Designator	Function
R9	Squelch/carrier detect threshold level. Set so that busy LED comes on at 12dB SINAD point.
R20	Receive audio level.
R16	RX audio bias. Adjust it for a 2.5V DC reading at TP8.
R32	CTCSS encode level. Adjust for 10% of full-system deviation w/CTCSS encoder on.
R34	Paging data level. Adjust for 90% full system deviation w/POCSAG data being transmitted.
R41	Voice limiter. Adjust for 90% full system deviation with loud audio into the microphone or 0dBm into the telco interface.
R60	Mic gain. Adjust for proper mic audio level.
R52	Telco audio to transmitter level. Adjust for proper voice deviaiton of the transmitter with signal from the telco interface.
R69	Telco line driver level. Adjust for proper level to the telco from the received audio.

4.2 Alignement Procedure

4.2.1 Radio Interface

This procedure assumes a properly tuned 5A204 VHF transceiver is installed in the unit. See section 8 on how to align the RF Board if it has not already been done.

You will need a DC power source, service monitor, oscilloscope, and DVM. Full System Deviation =5.0kHz for wide-band versions, and FSD=2.5kHz for narrow-band versions.

1. Apply DC power to the unit. Connect the service monitor to the ANT port.
2. Put a jumper across JP3 pins 1&2 for 2 watt operation, or JP3 pins 2&3 for 4 watt operation. The power output setting depends upon system requirements and the maximum power output allowed by the station license.
3. Program the unit's transmit and receive frequencies. Disable sub-audible signaling. Set the TX bandwidth to "wide band".
4. Generate an RF carrier on the receive frequency, 1kHz tone, 60% FSD. RF level 10uV.
5. Adjust R16 for a 1.5V p-p (530mV RMS) signal on TP8.
6. Adjust the RF generator to .35uV. Adjust R9 so that the carrier detect LED is on, and so that it goes off when the RF level is below .25uV.
7. Set the speaker volume level to normal level (about 25% full volume).
8. Key the transmitter using the F3 key.
9. Speak into the mic and adjust R41 (limiter) for 4.0-4.5kHz deviation and R60 (mic gain) for good audio level when speaking into the mic.
10. Generate a 600Hz square wave to the transmitter using Test Function 4. Adjust R34 for 4.0kHz deviation.
11. Unkey the unit.
12. Enable a 100Hz CTCSS encoder on the transmit frequency.
13. Key the transmitter with the F3 key. Adjust R32 for +/-500Hz deviation of the CTCSS tone.

4.2.2 Telco Interface

1. Generate an RF carrier on the receive frequency, 1kHz tone, 60% FSD. RF level 10uV.
2. Connect the TELCO line to the RX audio. (hold the 2 button down on power up to bring-up the audio-path functions)
3. Adjust R69 (telco line level) for a level of –9dBm on the line.
4. Disable the RX audio. And generate a DTMF tone from the PageCenter.
5. Verify that the line level is between –15 and -12dBm.

6. Generate a –9dBm 1000Hz tone onto the TELCO line from an external test instrument.
7. Using the internal audio-path connect routines, connect the TELCO to the transmitter.
8. Measure the p-p waveform at TP10 on an oscilloscope. Adjust R52 so that the 1000Hz sine wave is just below the clipping level.

4.2.3 Final Test

Once the unit is assembled and ready to ship, the following checks should be performed.

1. Program any customer-specific frequencies and databases into the unit.
2. Verify the LCD and keypad are working properly with Test Function 5 and 6.
3. Verify the backlight on the LCD is on.
4. Verify the TX LED works when pressing F3.
5. Verify the busy LED comes on when a carrier is on the channel.
6. Key the transmitter with the F3 key, speak into the mic and verify the audio level is set correctly.
7. Verify that PORT1 and PORT can be used to send a page in the TAP manual mode.
8. Verify all 8 alarm inputs work using Test Function 7.
9. Verify that the Wide/narrow setting in the TX Setup menu is set to match the type of radio that is installed in the unit.
10. Verify that a voice telephone call can be made from a two-way radio.
11. Send a numeric page from the keypad to a pager and verify that it is received and properly decoded by a pager.

5 Main-Board Circuit Description

5.1 Microprocessor (Page 1 of the schematic)

When the unit first powers up, a 386EX processor(U99) executes a program out of the internal EPROM (U4). Once the self-test is passed, it passes control to the application program that resides in the FLASH memory (U11).

U2 and U102 are 8 bit X 128K RAM chips, forming a 16 bit wide X 128K deep RAM for scratchpad use by the processor.

U27-29 expand the I/O capabilities of the processor, allowing it to control or read up to 72 digital signals.

U7 is a watch-dog timer, that provides a clean reset for the CPU, and holds some security information in it. Q1 holds the electronic serial number of the unit.

The processor performs all of the main control tasks, user interface, and paging encoding. It runs at 24MHz, and can process input from the keypad, two serial ports, and either the radio or the telephone port, all at the same time.

5.2 I/O (Page 2 of the schematic)

The internal transceiver is connected to the PageCenter's motherboard via P3, a 14 pin header. It is located inside of the shielded radio area.

U14 proves a clean, regulated 5V for the transceiver.

JP3 selects the B+ voltage to the transceiver. A jumper on pins 1&2 set it to 8V, and pins 2&3 set it to 12V.

The transceiver is switched between TX and RX mode by pin 4 of P3. It is labeled +5RX, and switched to ground when in the TX mode.

In the RX mode, receive audio comes from P3 pin 13, and is buffered by U13C. R16 sets the level at TP8 to a standard value of around 1.5V for a signal with 60% deviation. The buffered signal is split into two path. One path is via U30 pin 23 (which strips off the CTCSS signals from the audio) and then to U21D. U21D is the mute gate, and it turns the audio to the speaker on and off. The other receive path is through U13B, a 300Hz low-pass filter. It strips off the voice, and passes the CTCSS signals to U30 pin 24 for decoding.

In the TX mode, audio from the microphone is leveled by an AGC circuit at U20A. U18C is a switch to turn the mic audio on and off. The mic audio is mixed with various other audio sources by U15D. The other transmit audio sources are the telephone audio via U18A and the speech synthesizer via U21C. The combined TX audio is high-pass filtered to get rid on any low-frequency energy, by U20B. C115 and R51 are the pre-emphasis time constant, and the power supply rails of U15C are used to hard-limit the audio level. The limited audio is the low-pass filtered by U15A and U15B, wich also reduce its amplitude for proper deviation. U15A has a gain-switch on it, formed by U104D and R113. When U15A is closed, the gain of U15A is cut in half. This is done on narrow-band channels. R122 and C122 further filter the TX audio, and then it is sent to the transceiver's modulator. When POCSAG paging data is to be sent, the TX audio path is disabled by opening up U18C, U21C, and U18A, and then closing U104B. Digital data from the CPU is sent to the modulator through U104B, being level adjusted by R34 and low-pass filtered by both the splatter filter and RC filter(R35 and C45). If CTCSS is used, U30 generates the CTCSS signal, U104A is closed, and U15A mixes the CTCSS signal with the transmitted audio. CTCSS is not used with POCSAG transmission. The DC voltage on P3 pin 6 is proportional to the frequency of the transmitted signal. To adjust for any frequency error in the radio or in the modulator, R160 is used to trim the unit exactly on frequency.

5.3 Audio Interface (page 3 of schematic)

The telephone interface is an RJ-11 jack on the rear of the unit. It is JP6 on the schematic. The telephone line is RF decoupled by L1, L2, C71 and C72. F3 and F4 are poly fuses to protect the line when the transient protection devices (D4) short out. The telco line goes into HY1, which is a monolythic hybrid designed to meet FCC part 68 regulations.

Audio to the telco enters HY1 at pin 11. It comes from a buffer/mixer, U20C. Audio to the telco can be either RX audio from the radio via U18D, microphone audio via U107B, or DTMF tones via U107C.

U22 is an integrated DTMF encoder/decoder. It is shared by both the telephone circuits and the radio circuits.

U23 is a D/A converter. Speech waveforms are output by the processor via this D/A converter, and low-pass filtered by U25B. The speech can either be sent to the telco or to the radio transmitter.

U24 is a 1 watt audio amplifier. It drives the internal speaker, or an external spaker plugged into J2. The speaker audio signals are buffered by U106B. The output of U106B is level adjusted by a digital potentiometer, U106. The value of the digital pot is set by up/down buttons on the front panel of the unit.

U26B is a high-gain amplifier, that amplifies the mic audio to a level of about 3V p-p. D6 rectifies this, and U26D is a level comparator. When the rectified signal exceeds the voltage on pin 13, the MIC_VOX signal is asserted, signaling that someone is talking into the mic. The MIC_AGC signal also goes to the AGC circuit on the mic pre-amp.

U26A and U26C form an TELCO VOX circuit, similar to the MIC VOX circuit in operation.

5.4 Serial I/O and Power Supply (page 4)

U10 and U105 form the two serial port buffers. Signals from and to the CPU are buffered and then connected to the DB-9 serial connectors. These ports are used to enter pages and for uploading new firmware into the unit.

U16, U17, U19, and U12 are voltage regulators, providing clean regulated voltage to the various circuits in the unit.

The alarm inputs come in via P4, the AUX I/O connector. The pins of this connector are RF decoupled by C116 and C117. R48 and R54 are ESD current limits. K1 and K2 are spare relays for future features.

5.5 Other Assemblies

Internal to the page center there are 4 main assemblies. They are:

1. The motherboard, described above.

2. The radio transceiver module, described in a separate publication.

3. The keyboard, which is a rubber keypad matrix, scanned by the CPU to detect key closures.

4. The Liquid Crystal Display.

6 RF Board Theory of Operation and Circuit Description

6.1 Synthesizer

In transmit mode, Q12, D6 and L24 form a voltage controlled oscillator. In receive mode, Q7, D7 and L26 form a voltage controlled oscillator. The output of the VCO is buffered by Q11, and fed into the input of a programmable divider/phase comparator, U3.

U3 divides the RF from the VCO down to either 10KHz or 12.4KHz, and compares this divided down signal to a reference. The reference is derived by dividing down a 14.4MHz crystal reference oscillator. A separate modem board programs U3 with the appropriate data for each radio frequency.

6.2 Reference oscillator

Y4 along with Q8 and associated circuitry form a high-stability 14.4MHz reference oscillator. D5 provides DC modulation capability. D4, RT2 and RT1 form a temperature compensation circuit, adjusting the voltage on D4 as the temperature varies.

6.3 Antenna Input

The RF I/O is via the ANT1 connection. This is an OSX female connector. L3, L2, C6, C7, and C8 form a 174MHz low-pass filter.

In receive mode, RF from the low-pass filter passes through L1 and into the receiver front end.

In the transmit mode, the 7.5V is applied to L10, which biases on D2 and D3. When these diodes conduct, D1 passes the transmit signal out to the low-pass filter on the antenna. D3 shorts the transmit to ground at the receivers input, protecting the receiver's LNA from damage.

6.4 Receiver

In the receive mode, RF from the antenna enters the receiver's front-end filter, comprised of L4, L5 and associated components. Q1 amplifies the RF 20dB. L6, L7, and L8 along with their associated components form a band-pass filter, tuned to the receiver's frequency of operation.

Q2 mixes the receiver's RF from Q1 with a local oscillator signal from the PLL. The output of Q2 is tuned to 21.4MHz.

Y1 and Y2 form a 4 pole crystal filter, provided the receiver with its selectivity. Q3 amplifies the 21.4MHz IF signal. The 21.4MHz signal is down-converted to 455kHz, and demodulated by U1. The RX output is an FM detected analog signal.

6.5 Transmitter

The transmit modulation is applied to the VCO and to the reference crystal, providing flat FM modulation response from DC to 5kHz. An external Gaussian filter, located on the modem board provides the base-band filtering and wave shaping.

The VCO's output is amplified by Q11, Q10, Q4, Q5, and Q6, to a level of up to 5 watts of RF. The maximum power output is dependent upon the voltage applied to the B+ signal (pin 2 of the I/O connector). The modem in the SkyLine typically supplies a regulated 7.5V to pin 2, thus limiting the RF power output to around 2 watts.

7 Radio I/O Connections

Internal to the unit, the *SkyLine*'s modem board interfaces to a radio transceiver circuit board through a 14 pin single in-line connector. Table 1 lists the function of each pin.

Pin #	Function
1	System ground
2	B+ (usually 7.5V DC from the modem PCB)
3	+7.5V transmit, ±5%.
4	+5.0V receive, 0V transmit, ±5%.
5	+5.0V regulated input, ±5%.
6	Transmit modulation. 2.5V DC RX, 2.5V DC with 2V p-p Gaussian filtered 9600bps data during transmit.
7	Synthesizer lock detect.
8	PLL enable signal. Latch enable signal for serial interface to PLL.
9	PLL data signal. Data to PLL chip via three wire interface, pins 8,9, and 10.
10	PLL clock signal.
11	No connect
12	RSSI output from radio.
13	Receiver discriminator output from radio.
14	No connect

Table 1

8 RF Board Alignment

This test procedure assumes that the transceiver module is part of a Sonik SkyLine wireless modem and will be tested with a properly configured modem board or test fixture.

8.1 Test Setup

With both the modem PCB and the transceiver PCB must be removed from the enclosure to align them. Connect the two boards together with a ribbon cable, providing access to the adjustments on the transceiver board.

Connect a 12.5V DC source to the DC input of the modem board. Connect a service monitor to the RF I/O of the radio.

8.2 Transmitter

Program the modem so that it is on the correct operating frequency or in the middle of the operating range. Refer to the SkyLine technical manual for programming information.

Enter the programming mode as outlined in the SkyLine Technical Manual. (…// sequence).

With the service monitor in the receive mode, key the transmitter using the TX DATA command.

Adjust L25 so that there is 4.0V DC on C97.

Adjust C91 to set the carrier on the center of the channel. The RF carrier should be set to within 50Hz of the desired frequency.

Adjust C58, C60, C65 and C67 for maximum power output.

Set up an oscilloscope or the service monitor's scope to view the transmit "eye". The eye is monitored by connecting the demodulated output of the service monitor to the input of the scope. The demodulated output and the scope input must be DC coupled. Trigger the scope off of the rising edge of the waveform. Sweep the scope at 200uS per division.

Adjust R72 for optimal transmit eye opening. Set the transmit deviation pot on the modem PCB for 3kHz deviation. Repeat the adjustment of R72 and the TX deviation until the unit has 3kHz deviation with flat low frequency response, maximum eye opening, and minimum ripple between the top and bottom of the pattern..

8.3 Receiver

With the service monitor set to generate FM, modulate a carrier with a 1kHz tone and 3kHz deviation. Set the RF level to 1mV.

Connect the SINAD meter to J1 pin 13.

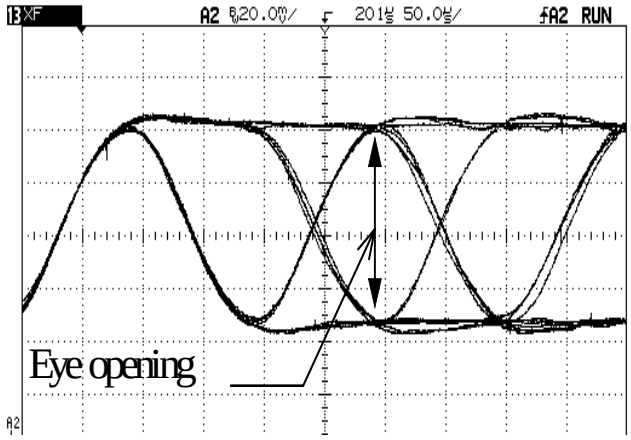
Program the modem so that the unit is on the correct operating frequency or in the middle of the operating frequency range.

Adjust the RX VCO using L26 so that there is 4.0V at C97.

Adjust L11 for a reading of 2.5VDC at pin 13 of J1.

Adjust L4, L5, L6,L7,and L8 for best SINAD. Lower the RF generator's source as the SINAD falls below 20dB, and readjust the inductors until the specified sensitivity is meet. Typically, 12dB SINAD will be obtained at the point where the modem will have a BER of $1X10^{-4}$. For this product, it is around .7uV.

Once the receiver has been tuned for best SINAD, adjust L11 for maximum "eye" opening. This is done by generating a 10uV RF carrier on the receive channel modulated by a 9600baud pseudorandom data stream with ±3kHz deviation. Ideally, the PN data should be gaussian filtered, but non-filtered will work. While monitoring the analog signal on J1 pin 13 with an oscilloscope, adjust L11 for maximum eye opening. The received base-band signal should look something like the following oscilloscope scope plot. The eye should be at least 75% open.



8.4 FCC Notice

It is the responsibility of the user of this equipment to obtain the proper FCC license to operate this product on the desired channel of operation.

This product complies with part 15 and 90 of the FCC rules and regulations. It may not be modified without the expressed consent of Sonik Technologies Corporation. Modification of this product could void the user's authorization to use the product.