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Emic Text-To-Speech Module (#30006)

General Description

The Emic Text-to-Speech (TTS) Platform is a modular hardware design for text-to-speech applications. The Emic Platform is a fully integrated module that converts a stream of digital text into a high-quality English-speaking voice. It provides a simple way to speech-enable any embedded application. Requiring a simple 2-wire serial interface and two optional I/O lines for status notification, the Emic Platform can easily be integrated into nearly any new or existing design.
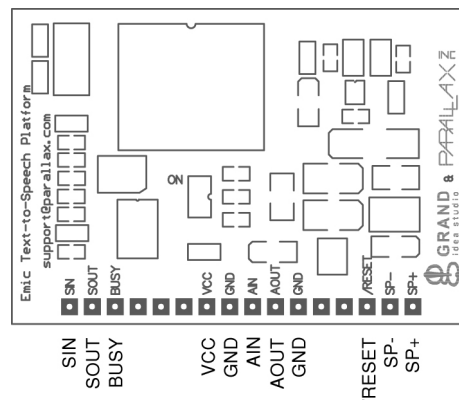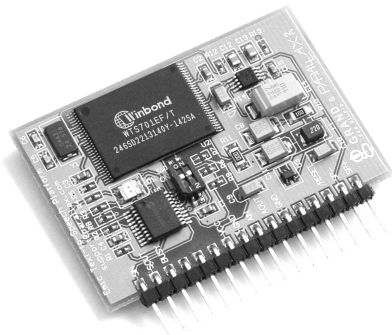
The Emic Platform is controlled through a simple set of commands and off-loads most of the computational overhead required for TTS from the host controller. The Emic Platform command set consists of a number of functions for core TTS functionality and abstracts the low-level hardware from the end-user application, making it extremely simple to add TTS capabilities to any product.

Features

- Fully-integrated, high-quality speech synthesis on a single module
- Elegant platform provides for unlimited text-to-speech applications
- Simple interface to BASIC Stamp® and Javelin Stamp™

Module Highlights

- Serial TTL interface (2-wire, 2400 baud)
- Requires single +5VDC supply
- Compact size: 2.0" L x 1.375" W
- On-board 8 Ω, 300 mW speaker driver
- Easy-to-use ASCII or hexadecimal command sequences
- Bi-color LED for visual indication of activity
- 0.100" pin spacing for easy prototyping and integration
- -40 ºC to +85 ºC operating temperature

Pin Description

Pin (OEM[1])	Pin (SIP)	Pin Name	Type	Function
1	7	VCC	P	System power, +5V DC input.
2	3	BUSY	O	Busy notification line. Digital logic HIGH when Emic Platform is in-use (e.g., receiving characters, converting text-to-speech, etc.) or when a system error has occurred. Logic LOW when the Emic Platform is idle and ready to receive new commands or text. The visible LED on the Emic Platform is red when BUSY is HIGH and green when BUSY is LOW.
3	1	SIN	I	Serial In. TTL-level interface, 2400bps, 8 data bits, no parity, 1 stop bit.
4	2	SOUT	O	Serial Out. TTL-level interface, 2400bps, 8 data bits, no parity, 1 stop bit.
5	8, 11	GND	G	System ground. Connect to power supply's ground (GND) terminal.
6	14	/RESET	I	External system reset pin. Active LOW digital input. Bring this pin LOW to reset the Emic Platform. Recommended use is after the host controller power-up or an Emic Platform system error. This pin should be left floating if it is not used.
7	10	AOUT (ANA)	O	Audio output buffer pin provides a single-ended analog output of the synthesized speech for external amplification. Drives a minimum load of 5k Ω up to a maximum of 1Vp-p. The AC signal is superimposed on approximately 1.2VDC bias and must be capacitively coupled to the load.
8	15	SP-	O	Differential negative speaker driver output. Designed to drive an 8 Ω speaker up to a maximum of 23.5mW for the OEM version and 300mW for the SIP version. Do NOT connect this pin if using SP+ as single-ended output (OEM version only).
9	16	SP+	O	Differential positive speaker driver output. Designed to drive an 8 Ω speaker up to a maximum of 23.5mW for the OEM version and 300mW for the SIP version. On the OEM version, this pin is biased to approximately 1.2VDC and can be used as a single-ended output if capacitively coupled to the load.
---	9	AIN	I	Analog input pin for SIP version only. Allows an audio signal to be fed through the Emic Platform to either the AOUT or SP+/SP- pins. The input has a nominal 694mVp-p level. There is no gain control on this signal. The audio signal must be AC coupled to the AIN pin. No signal should be active on the AIN pin when it is not in use, or else the signal may bleed through to the Emic Platform's audio output at undesirable times. This pin should be left floating if it is not implemented.

1. For information only; the OEM version is no longer in production.

Note: Type: I = Input, O = Output, I/O = Bidirectional, P = Power, G = Ground

NOTE: All unspecified pins should be left floating. They should not be connected at any time. Connecting unspecified pins to any signal, ground, or VCC may result in improper device behavior or cause damage to the device.

Block Diagram
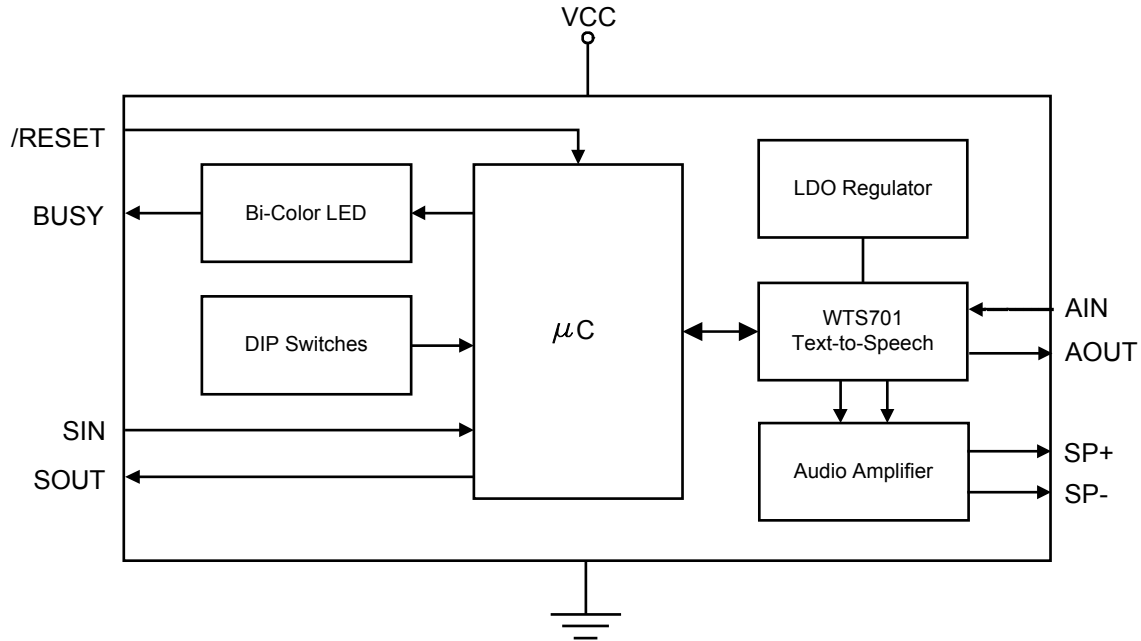
Note: The AIN pin is not available on the OEM version.

Functional Description

Overview

The Emic Platform is a fully integrated module that converts a stream of digital text into a high-quality English-speaking voice. The Emic Platform performs text-to-speech synthesis and host processor communications. The system architecture consists of the following functions:

- Serial interface to interpret commands and data using a simple command structure and menuing system
- Text normalization module to pre-process incoming text into pronounceable words
- Word-to-phoneme translator which converts incoming words into their phonetic representation
- Phoneme mapping to match incoming phonemes into their corresponding pre-recorded audio sample
- Volume, pitch, and speed adjustments
- On-board audio amplifier (300 mW)

The Emic Platform ships with a standard American English-speaking female voice with a San Francisco Bay Area dialect. The Emic Platform is designed to support different languages or voices as they become available.

Physical Connections

The Emic Platform can be integrated into any design using a minimum of five connections (VCC, GND, SIN, SOUT, and AOUT). Optional status and control pins are also available if desired. Though many configurations are possible, a typical connection diagram to a microprocessor uses eight connections (VCC, GND, SIN, SOUT, BUSY, /RESET, SP-, SP+).

Basic Connection Diagram: Emic Platform with Microprocessor Host Control
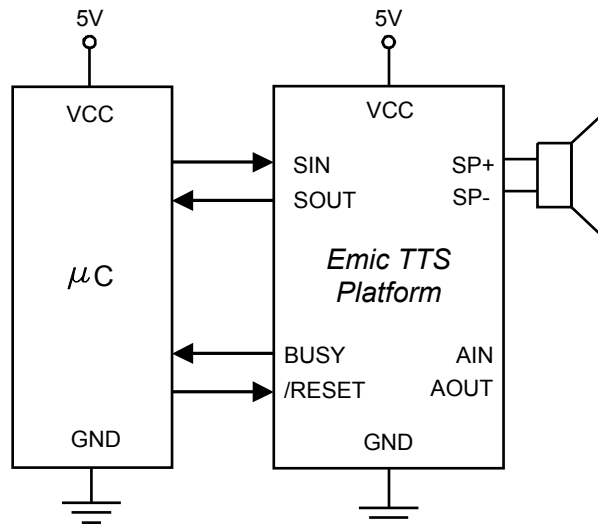
Communication Protocol

The Emic Platform is controlled by the host via an easy-to-use, TTL-level, asynchronous, two-wire serial communications interface. The SIN (Serial Input) pin receives data and commands from the host controller to the Emic Platform. The SOUT (Serial Output) pin transmits data and responses to the host controller from the Emic Platform.

The Emic Platform can connect directly to any TTL-compatible UART or to an RS232-compatible interface by using an external level shifter.

All communication is 8 data bits, no parity, 1 stop bit, non-inverted, least significant bit first (8N1). The baud rate is configured in the Emic Platform firmware for 2400 baud, a standard communications speed supported by the BASIC Stamp microcontroller, the Javelin Stamp microcontroller, and most any other microcontroller or PC. The host controller must initiate all communication. The Emic Platform does not initiate any communication. Refer to the section on Command Structure for a list of available commands.

Configuration Switches

The two-position DIP switch located on the Emic Platform is used to configure the communications properties of the device to fit a wide range of applications.

If SW1 is set to ON, the Emic Platform will accept and respond to commands in an ASCII (printable text) format. If SW1 is set to OFF, the Emic Platform will accept and respond to commands in a hexadecimal format. Refer to the section on Command Structure for details.

If SW2 is set to ON, each byte sent to the Emic Platform will be echoed back to the host processor. If SW2 is set to OFF, the Emic Platform will not echo each byte to the host processor and will only transmit the command response (such as "OK", "ERROR", or other information) This switch is useful for applications where the user needs to ensure the data is being properly received by the Emic Platform or to verify that the correct data is being typed, such as when the Emic Platform is hooked up to a PC and simple terminal program.

Control Lines

In addition to the serial communications interface, the Emic Platform has two control lines. The BUSY pin is used by the Emic Platform to notify the host controller that it is busy and cannot accept new commands or data (such as during a text-to-speech conversion). The BUSY pin is set HIGH when the Emic Platform is in use. The BUSY pin is set LOW when the Emic Platform is in the idle state and ready to receive a new command.

A visual indication of the state of the Emic Platform is given with the on-board LED (Light Emitting Diode). When BUSY is HIGH, the LED is red. When BUSY is LOW, the LED is green. On initial power-up and during device reset, the on-board LED will be both red and green while the Emic Platform is initializing.

The /RESET pin is an active LOW digital input used to "hard reset" the Emic Platform, which reinitializes the module's control firmware and resets the volume, speed, and pitch settings to their default values. This pin should be left floating if it is not used, or else it should remain in a logic HIGH state until a system reset is desired.

Command Structure

The Emic Platform can accept commands in either an ASCII (printable text) or hexadecimal format depending on the configuration DIP switch setting (refer to Configuration Switches section). The hexadecimal format is essentially an abbreviated form of the longer ASCII command structure. Both command formats result in the same operation.

Available Command Set

Command	ASCII	Hexadecimal
Convert text to speech	`say=text;`	0x00, text, 0xAA
Set volume	`volume=n;`	0x01, n, 0xAA
Set speed	`speed=n;`	0x02, n, 0xAA
Set pitch	`pitch=n;`	0x03, n, 0xAA
Add abbreviation	`addabbr=abbr,text;`	0x04, abbr, 0x2C, text, 0xAA
Delete abbreviation	`delabbr=abbr;`	0x05, abbr, 0xAA
List abbreviations	`listabbr;`	0x06, 0xAA
Emic version numbers	`version;`	0x07, 0xAA
Device soft reset	`reset;`	0x08, 0xAA
Analog audio input (SIP only)	`audio;`	0x09, 0xAA
Emic help	`help;` or `?;`	0xFE, 0xAA

The Emic Platform has a 128-byte circular receive buffer, meaning that any combination of command and data must be less than 128 bytes in order to be properly handled. If this limit is exceeded, the pointer in the buffer will reset to the beginning and overwrite previously received characters. A single word may have a maximum length of 53 characters. Any words longer than 53 characters will be truncated.

The Emic Platform will process the buffer when it receives the termination character. In ASCII mode, the termination character is a ";" (semicolon) or 0x0D byte (carriage return). In hexadecimal mode, it is a 0xAA byte. In order to clear the receive buffer, such as in the case of a typo or error, a single termination character should be sent, depending on the ASCII or hexadecimal mode of the Emic Platform.

In ASCII mode, if a valid command is entered and the operation is successful, the Emic Platform will respond with "OK". If an incorrect command or data format is entered or if the operation has failed, the Emic Platform will respond with "ERROR".

In hexadecimal mode, if a valid command is entered and the operation is successful, the Emic Platform returns a single 0x55 byte. If an incorrect command or data format is entered or if the operation has failed, the Emic Platform returns a single 0xFF byte.

Convert text to speech:

This command begins the text-to-speech conversion process using the passed text string. The audio will be output on both the single-ended AOUT pin and the differential SP+/SP- speaker driver output. Refer to the sections on Allowable ASCII Characters and Phonetic Alphabet for more details.

During this operation, the visible LED will remain RED and the BUSY line will be set HIGH until all passed text has been converted to speech. Once the text-to-speech conversion begins, it will continue until the process is complete. There is no way to interrupt the process, other than pulling the /RESET pin LOW to reinitialize the Emic Platform. When the text-to-speech conversion is complete, the LED will return to GREEN and the BUSY line will be set LOW.

Command example: Convert the text "hello" to audible speech

	ASCII	Hexadecimal
To Emic Platform	say=hello;	0x00, 0x68, 0x65, 0x6C, 0x6C, 0x6F, 0xAA
From Emic Platform	OK	0x55

Set volume:

This command sets the audio output volume of the Emic Platform. A single byte, n, is passed along with the command to specify the desired volume. A digitally controlled attenuator on the Emic Platform provides volume control in 8 steps of 4 dB, referenced to the output. Total volume range is from -28 dB (softest, n = 0) to 0 dB (loudest, n = 7). Default volume is set to -12 dB (n = 4).

In addition to the range of decimal numbers, "+" or "-" can also be passed to increment or decrement the current volume by 1 step. This will have no effect if an increment command is sent when the volume is already at the loudest setting or if a decrement command is sent when the volume is already at the softest setting. When the Emic Platform is reset or when power is removed, the volume setting will revert to its default value.

Command example: Set volume to n = 3 (-16dB)

	ASCII	Hexadecimal
To Emic Platform	volume=3;	0x01, 0x33, 0xAA
From Emic Platform	OK	0x55

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Set speed:

This command sets the speed at which the converted speech is spoken. A single byte, *n*, is passed along with the command to specify the desired speed. Total speed range is from *n* = 0 (slowest) to *n* = 4 (fastest). Default speed is set to *n* = 2.

In addition to the range of decimal numbers, "+" or "-" can also be passed to increment or decrement the current speed by 1 step. This will have no effect if an increment command is sent when the speed is already at the fastest setting or if a decrement command is sent when the speed is already at the slowest.

When using concatenative speech synthesis systems such as the Emic Platform, speech speed and pitch are often adjusted together to maintain an audible and understandable output. However, it is not required, and each may be adjusted separately if desired. When the Emic Platform is reset or when power is removed, the speed setting will revert to its default value.

Command example: Increment speed setting by one step

	ASCII	Hexadecimal
To Emic Platform	speed=+;	0x02, 0x2B, 0xAA
From Emic Platform	OK	0x55

Set pitch:

This command sets the pitch of the converted speech. A single byte, *n*, is passed along with the command to specify the desired pitch. Total pitch range is from *n* = 0 (lowest) to *n* = 6 (highest). Default pitch is set to *n* = 1.

In addition to the range of decimal numbers, "+" or "-" can also be passed to increment or decrement the current pitch by 1 step. This will have no effect if an increment command is sent when the pitch is already at the highest setting or if a decrement command is sent when the pitch is already at the lowest.

When using concatenative speech synthesis systems such as the Emic Platform, speech speed and pitch are often adjusted together to maintain an audible and understandable output. However, it is not required, and each may be adjusted separately if desired. When the Emic Platform is reset or when power is removed, the pitch setting will revert to its default value.

Command example: Decrement pitch setting by one step

	ASCII	Hexadecimal
To Emic Platform	pitch=-;	0x03, 0x2D, 0xAA
From Emic Platform	OK	0x55

Add abbreviation:

This command adds a user-specified abbreviation to the abbreviation table stored on the Emic Platform. The abbreviation, *abbr*, and its corresponding full word or sentence, *text*, are passed along with the command. Once an abbreviation is loaded into the Emic Platform, the full text will replace the abbreviation any time the abbreviation is used during a text-to-speech conversion.

If multiple abbreviations are added with the same abbreviation string, the Emic Platform will use the first instance. The expanded text for the abbreviation cannot contain any numerals (such as "Basic Stamp 2"), only alphabetic characters (such as "Basic Stamp Two").

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When an abbreviation is successfully added, the Emic Platform performs a "soft reset", which resets the volume, speed, and pitch settings to their default values. Refer to the section on Abbreviations for details.

Command example: Convert SMS/Instant Message abbreviation into understandable word, ":)" into "happy"

	ASCII	Hexadecimal
To Emic Platform	`addabbr=:),happy;`	0x04, 0x3A, 0x29, 0x2C, 0x68, 0x61, 0x70, 0x70, 0x79, 0xAA
From Emic Platform	`OK`	0x55

Delete abbreviation:

This command deletes a user-specified abbreviation from the abbreviation table stored on the Emic Platform. The abbreviation to be deleted, *abbr*, is passed along with the command. Even if a non-existent abbreviation is passed with the command, the Emic Platform will respond with "OK" or a single 0x55 byte depending on the ASCII or hexadecimal mode of the Emic Platform. After an abbreviation entry is deleted, the entry is removed from the abbreviation table and not used. *However, the entry still takes up space in the internal memory of the Emic Platform.* When an abbreviation is successfully deleted, the Emic Platform performs a "soft reset", which resets the volume, speed, and pitch settings to their default values. Refer to the section on Abbreviations for details.

Command example: Delete the ":)" abbreviation from the abbreviation list

	ASCII	Hexadecimal
To Emic Platform	`delabbr=:);`	0x05, 0x3A, 0x29, 0xAA
From Emic Platform	`OK`	0x55

List abbreviations:

This command returns the valid abbreviation table stored on the Emic Platform. Refer to the section on Abbreviations for details. Example response from the Emic Platform:

```
Abbreviation List =
:)
happy
TTS
text to speech
```

If the Emic Platform is in hexadecimal mode, the "Abbreviation List =" header will not be transmitted and a single 0x0A byte will be used to separate all table entries instead of a new line and carriage return. At the end of the table listing or if no abbreviation entries exist, the Emic Platform will respond with "OK" or a single 0x55 byte depending on the ASCII or hexadecimal mode of the Emic Platform.

Emic and WTS701 version numbers:

This command returns the hardware and firmware version numbers of the Emic Platform and the core Winbond WTS701 Single-Chip Text-to-Speech Processor. For diagnostics and troubleshooting only. Example response from the Emic Platform:

```
Emic HWREV = 1A
Emic SWREV = 12
WTS701 HWVER = 02
WTS701 SWVER = 68
```

If the Emic Platform is in hexadecimal mode, the headers will not be transmitted and only the four byte values will be sent. At the end of the version listing, the Emic Platform will respond with "OK" or a single 0x55 byte depending on the ASCII or hexadecimal mode of the Emic Platform.

Device reset:

This command performs a "soft reset" of the Emic Platform, which resets the volume, speed, and pitch settings to their default values. All abbreviations stored on the device will remain intact. The "Device reset" command is different than using the external /RESET pin, which is a "hard reset" that completely restarts the Emic Platform and reinitializes the module's control firmware.

Upon initial power-up of the Emic Platform and when the "Device reset" command is successful, the Emic Platform will respond with "OK" or a single 0x55 byte, depending on the ASCII or hexadecimal mode of the Emic Platform. The visible LED will be both red and green while the Emic Platform is initializing.

Analog audio input:

This command is for the SIP version only and enables the analog audio signal on the AIN pin to be fed through the Emic Platform to either the AOUT or SP+/SP- pins. During this operation, the visible LED will remain RED and the BUSY line will be set HIGH. This command will remain active until the Emic Platform receives a single termination character. In ASCII mode, the termination character is a ";" (semicolon) or 0x0D byte (carriage return). In hexadecimal mode, it is a 0xAA byte.

When the command is successful and the feed through is disabled, the Emic Platform will respond with "OK" or a single 0x55 byte, depending on the ASCII or hexadecimal mode of the Emic Platform. The BUSY line will then be set LOW and the visible LED will turn green.

No signal should be active on the AIN pin when it is not in use, or else the signal may bleed through to the Emic Platform's audio output at undesirable times. The input has a nominal 694mVp-p level. No on-board gain control is available. The audio signal must be AC coupled to the AIN pin. This pin should be left floating if it is not implemented.

Emic help:

This command prints a table of available commands. The menu will vary slightly between the OEM and SIP versions. Example response from the Emic Platform:

```
Emic Text-to-Speech Platform
Copyright (c) 2004 Grand Idea Studio, Inc. (www.grandideastudio.com)
Distributed by Parallax, Inc. (www.parallax.com)
For support, contact support@parallax.com or call 916-624-8333

Command                 | ASCII                 | Hexadecimal
------------------------+-----------------------+-------------------------
Convert text to speech  | say=text;             | $00, text, $AA
Set volume (0-7, -, +)  | volume=n;             | $01, n, $AA
Set speed (0-4, -, +)   | speed=n;              | $02, n, $AA
Set pitch (0-6, -, +)   | pitch=n;              | $03, n, $AA
Add abbreviation        | addabbr=abbr,text;    | $04, abbr, $2C, text, $AA
Delete abbreviation     | delabbr=abbr;         | $05, abbr, $AA
List abbreviations      | listabbr;             | $06, $AA
Emic version numbers    | version;              | $07, $AA
Device reset            | reset;                | $08, $AA
Analog audio input      | audio;                | $09, $AA
Emic help (this is it)  | help; or ?;           | $FE, $AA
```

Allowable ASCII Characters

The following table lists the ASCII characters that are accepted and understood by the Emic Platform. Unexpected behavior may occur if the input text contains characters that are not defined in this ASCII table.

Hex	Symbol	Hex	Symbol	Hex	Symbol	Hex	Symbol
0x00		0x20	(space)	0x40	@	0x60	
0x01		0x21	!	0x41	A	0x61	a
0x02		0x22		0x42	B	0x62	b
0x03		0x23	#	0x43	C	0x63	c
0x04		0x24	$	0x44	D	0x64	d
0x05		0x25	%	0x45	E	0x65	e
0x06		0x26	&	0x46	F	0x66	f
0x07		0x27	' (apostrophe)	0x47	G	0x67	g
0x08		0x28	(	0x48	H	0x68	h
0x09		0x29	)	0x49	I	0x69	i
0x0A		0x2A	*	0x4A	J	0x6A	j
0x0B		0x2B	+	0x4B	K	0x6B	k
0x0C		0x2C	, (comma)	0x4C	L	0x6C	l
0x0D		0x2D	- (dash)	0x4D	M	0x6D	m
0x0E		0x2E	. (period)	0x4E	N	0x6E	n
0x0F		0x2F	/ (slash)	0x4F	O	0x6F	o
0x10	^P (enable phonetic alphabet)	0x30	0	0x50	P	0x70	p
0x11	^Q	0x31	1	0x51	Q	0x71	q
0x12		0x32	2	0x52	R	0x72	r
0x13	^S	0x33	3	0x53	S	0x73	s
0x14		0x34	4	0x54	T	0x74	t
0x15	^U	0x35	5	0x55	U	0x75	u
0x16	^V	0x36	6	0x56	V	0x76	v
0x17		0x37	7	0x57	W	0x77	w
0x18		0x38	8	0x58	X	0x78	x
0x19		0x39	9	0x59	Y	0x79	y
0x1A	EOT	0x3A	: (colon)	0x5A	Z	0x7A	z
0x1B		0x3B		0x5B	[(left bracket)	0x7B	
0x1C		0x3C		0x5C	\ (backslash)	0x7C	
0x1D		0x3D	=	0x5D	] (right bracket)	0x7D	
0x1E		0x3E		0x5E		0x7E	
0x1F		0x3F	?	0x5F	_ (underscore)	0x7F	

Phonetic Alphabet

The Emic Platform uses concatenative speech synthesis to generate its spoken words. The TTS conversion is achieved by processing incoming text into a phonetic representation that is mapped to a corpus of naturally spoken word parts.

The Emic Platform uses an intermediate phonetic translation, which represents an alphabet of phonemes and stress for each input word. This feature allows the text sent to the Emic Platform to consist of ASCII characters as well as specific phonemes. This capability offers the flexibility to send words already processed for phonetic representation, achieving the desired pronunciation.

The following table lists the phoneme symbols that are accepted by the Emic Platform.

Vowels			Consonants		
Phoneme	Hex Value	Example	Phoneme	Hex Value	Example
i	0x69	b*ea*t	p	0x70	*p*et
I	0x49	b*i*t	t	0x74	*t*en
e	0x65	b*ai*t	k	0x6B	*k*it
E	0x45	b*e*t	b	0x62	*b*et
@	0x40	b*a*t	d	0x64	*d*ebt
u	0x75	b*oo*t	g	0x67	*g*et
U	0x55	b*oo*k	h	0x68	*h*at
o	0x6F	b*oa*t	f	0x66	*f*at
c	0x63	b*ou*ght	T	0x54	*th*ing
a	0x61	B*o*b	D	0x44	*th*at
A	0x41	b*u*t	s	0x73	*s*at
R	0x52	b*urr*	S	0x53	*sh*ut
O	0x4F	b*o*y	v	0x76	*v*at
Y	0x59	b*uy*	z	0x7A	*z*oo
W	0x57	d*ow*n	Z	0x5A	a*z*ure
x	0x78	ab*o*ut	y	0x79	*y*ou
X	0x58	ros*e*s	w	0x77	*w*it
			r	0x72	*r*ent
			l	0x6C	*l*et
			m	0x6D	*m*et
			n	0x6E	*n*et
			G	0x47	si*ng*
			C	0x43	*ch*urch
			J	0x4A	*j*u*dg*e
			P	0x50	bu*tt*er
			Q	0x51	wri*tt*en

Each phoneme is represented by exactly one character and each vowel is preceded by a pitch symbol (represented by a number 1 or 0). Each word has a single "1" stress which represents the main stress of the word. All other syllables in the word have "0" stress. For example, the phonetic translation of "testing" would be "t1Est0IG".

Phonetic strings can be sent directly to the Emic Platform by embedding phoneme strings into the text stream that is desired for conversion. To embed a phoneme string, the string must be preceded by a Control-P character (^P, 0x10) and terminated by a space character (0x20). For example, "The quick ^Pbw1Wn fox."

The phonetic alphabet can be used to specify particular pronunciations for greater control. For example, many English words, even common ones, have multiple valid phoneme transcriptions. In some cases, one transcription may sound better than others. Exploring variant phonetic transcriptions can solve many output problems. Developers of TTS applications are often tempted to fix pronunciation problems by using aberrant spellings of words, but phonetic transcriptions should be used instead as they provide a more detailed control.

Abbreviations

The Emic Platform has support for entering and using custom abbreviations. 2kB of internal Flash memory is reserved specifically for this purpose. The Abbreviations feature of the Emic Platform is used to convert frequently used abbreviations or symbols (such as SMS messages or stock tickers) into an expanded text string. Commands exist on the Emic Platform to add, delete, or list the user-defined abbreviations. Refer to the section on Command Structure for details.

Once a user-defined abbreviation is loaded into the Emic Platform, the full text will replace the abbreviation any time the abbreviation is used during a text-to-speech conversion. If multiple abbreviations are added with the same abbreviation string, the Emic Platform will use the first instance. The expanded text for the abbreviation cannot contain any numerals (such as "Basic Stamp 2"), only alphabetic characters (such as "Basic Stamp Two").

When an abbreviation is successfully added or deleted the Emic Platform will soft-reset, which returns the volume, speed, and pitch settings to their default values. The abbreviations remain stored on the Emic Platform after both soft- and hard-resets.

After a user-defined abbreviation entry is deleted, the entry is removed from the abbreviation table and not used. However, the entry still takes up space in the Flash memory. The only way to free all memory is to reprogram the Emic Platform control firmware. Contact Parallax technical support for additional details.

The Emic Platform also contains a default set of frequently used abbreviations. These abbreviations are case-sensitive. The following table lists these built-in abbreviations.

Abbreviation	Expanded Text	Abbreviation	Expanded Text	Abbreviation	Expanded Text
Sen	Senator	AL	Alabama	Bldg	Building
Rep	Representative	AK	Alaska	asap	A S A P
Jan	January	AZ	Arizona	cc	C C
Feb	February	AR	Arkansas	cm	Centimeters
Mar	March	CA	California	mm	Millimeters
Apr	April	Cal	California	ft	Feet
Jun	June	Calif	California	yd	Yards
Jul	July	DE	Delaware	yds	Yards
Aug	August	FL	Florida	pt	Pints
Sep	September	Fla	Florida	pts	Pints
Sept	September	GA	Georgia	qt	Quarts
Oct	October	IEEE	I Triple E	qts	Quarts
Nov	November	ID	Idaho	km	Kilometers
Dec	December	IL	Illinois	mi	Miles
Mon	Monday	IN	Indiana	deg	Degrees
Tue	Tuesday	IA	Iowa	cu	Cubic
Wed	Wednesday	KS	Kansas	diam	Diameter
Thu	Thursday	KY	Kentucky	FAX	Fax
Fri	Friday	MA	Massachusetts	Geog	Geography
Sat	Saturday	MI	Michigan	govt	Government
Sun	Sunday	MS	Mississippi	min	Minute
A.M	A M	MN	Minnesota	mins	Minutes
P.M	P M	MO	Missouri	hr	Hour
a.m	A M	MT	Montana	hrs	Hours
p.m	P M	NV	Nevada	yr	Year
pm	P M	NH	New Hampshire	yrs	Years
PM	P M	NM	New Mexico	doz	Dozen
PhD	P H D	NY	New York	Inc	Incorporated
Mr	Mister	NJ	New Jersey	KW	Kilowatt
Mrs	Missus	NC	North Carolina	lb	Pound
Ms	Miz	ND	North Dakota	lbs	Pounds
Dr	Doctor	OH	Ohio	mngr	Manager

Jr	Junior	PA	Pennsylvania	Nat	National
Esq	Esquire	RI	Rhode Island	NASDAQ	Nasdaq
Pres	President	SC	South Carolina	ok	O K
Prof	Professor	SD	South Dakota	oz	Ounces
Sgt	Sargeant	TN	Tennessee	Pl	Place
Lt	Lieutenant	TX	Texas	rcvd	Received
Lieut	Lieutenant	Tex	Texas	rpm	R P M
Maj	Major	UT	Utah	tel	Telephone
MPH	Miles per hour	VT	Vermont	tv	T V
Col	Colonel	VA	Virginia	vs	Versus
Gen	General	WA	Washington	U.S.	U S
Sr	Senior	WV	West Virginia	U.S.A	U S A
St	Street	WI	Wisconsin	VISA	Veeza
Av	Avenue	WY	Wyoming	w	With
Ave	Avenue	N	North	wrt	With respect to
Rd	Road	S	South	wk	Week
Rt	Route	E	East	Xmas	Christmas
Rte	Route	W	West	etc	Etcetra
Blvd	Boulevard	LA	Los Angeles	c/o	Care of
Terr	Terrace	SF	San Francisco	w/o	Without
Exwy	Expressway	SJ	San Jose	III	The third
Expwy	Expressway	Ans	Answer	WYSIWYG	Whisywig
Drwy	Driveway	Q	Question	THE	The
Dept	Department	Asst	Assistant		
Ct	Court	Atty	Attorney		

Electrical Characteristics

Absolute Maximum Ratings

Condition	Value
Operating Temperature	-40ºC to +85ºC
Storage Temperature	-55ºC to +125ºC
Supply Voltage (V_{CC})	+4.5V to +5.5V
Ground Voltage (V_{SS})	0V
Voltage on any pin with respect to V_{SS}	-0.3V to +7.0V

NOTICE: Stresses above those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress rating only and functional operation of the device at those or any other conditions above those indicated in the operation listings of this specification is not implied. Exposure to maximum rating conditions for extended periods may affect device reliability.

DC Characteristics

Emic Platform SIP

At V_{CC} = +5.0V and T_A = 25ºC unless otherwise noted

Parameter	Symbol	Test Conditions	Specification			Unit
			Min.	Typ.	Max.	
Supply Voltage	V_{CC}	---	4.5	5.0	5.5	V
Vcc Rise Time (1)	S_{VCC}	---	0.05	---	---	V/ms
Supply Current, Idle	I_{IDLE}	---	32.9	---	---	mA
Supply Current, Active Conversion	I_{CC}	---	38.8	73	---	mA
Supply Current, /RESET Low	I_{MCLR}	---	26.5	---	---	mA
Input LOW voltage (except /RESET)	V_{IL}	+4.5V <= V_{CC} <= +5.5V	---	---	0.8	V
Input LOW voltage (/RESET)	V_{ILRST}	---	---	---	0.2 * V_{CC}	V
Input HIGH voltage (except /RESET)	V_{IH}	+4.5V <= V_{CC} <= +5.5V	2.0	---	---	V
Input HIGH voltage (/RESET)	V_{IHRST}	---	0.8 * V_{CC}	---	---	V
Output LOW voltage	V_{OL}	V_{CC} = +4.5V	---	---	0.6	V
Output HIGH voltage	V_{OH}	V_{CC} = +4.5V	V_{CC} - 0.7	---	---	V
BUSY Pin Output Current	I_{BUSY}	---	---	---	20	mA

Note 1: Rise time to ensure internal reset of the Emic Platform. Failure to meet this specification may result in an unknown start-up state and unintended operation of the Emic Platform.

At V_{CC} = +5.0V and T_A = 25ºC unless otherwise noted

Parameter	Symbol	Test Conditions	Specification			Unit
			Min.	Typ.	Max.	
Supply Voltage	V_{CC}	---	4.5	5.0	5.5	V
Vcc Rise Time	S_{VCC}	---	0.05	---	---	V/ms
Supply Current, Idle	I_{IDLE}	---	32.4	---	---	mA
Supply Current, Active Conversion	I_{CC}	---	35.7	---	---	mA
Supply Current, /RESET Low	I_{MCLR}	---	23.8	---	---	mA
Input LOW voltage (except /RESET)	V_{IL}	+4.5V <= V_{CC} <= +5.5V	---	---	0.8	V
Input LOW voltage (/RESET)	V_{ILRST}	---	---	---	0.2 * V_{CC}	V
Input HIGH voltage (except /RESET)	V_{IH}	+4.5V <= V_{CC} <= +5.5V	2.0	---	---	V
Input HIGH voltage (/RESET)	V_{IHRST}	---	0.8 * V_{CC}	---	---	V
Output LOW voltage	V_{OL}	V_{CC} = +4.5V	---	---	0.6	V
Output HIGH voltage	V_{OH}	V_{CC} = +4.5V	V_{CC} - 0.7	---	---	V
BUSY Pin Output Current	I_{BUSY}	---	---	---	20	mA

Note: For information only; the OEM version is no longer in production.

AC Characteristics

At V_{CC} = +5.0V and T_A = 25ºC unless otherwise noted

Parameter	Symbol	Test Conditions	Specification			Unit
			Min.	Typ.	Max.	
Emic Platform Power-On Time	T_{PWR}	---	---	200	---	mS
/RESET Pulse Width (LOW)	T_{RST}	---	2	---	---	uS
Serial Communication Bit Period (1)	T_{BIT}	2400 bits/second	---	416	---	uS

Note 1: The bit period is determined by an on-board RC oscillator and is temperature sensitive.

Speaker Driver Specifications

Emic Platform SIP

Parameter	Symbol	Test Conditions	Specification			Unit
			Min.	Typ.	Max.	
Power Output	P_{OUT}	Differential load @ 8 Ω	---	300	---	mW_{RMS}

| Parameter	Symbol	Test Conditions	Specification			Unit
			Min.	Typ.	Max.	
SP+/- Output Load Impedance	R_{SPLG}	---	8	---	---	Ω
SP+/- Output Load Capacitance	C_{SPLG}	---	---	---	100	pF
SP+/- Output Bias Voltage	V_{SPBIAS}	---	---	1.2	---	V_{DC}
Power Output	P_{OUT}	Differential load @ 8 Ω	---	23.5	---	mW_{RMS}

Note 1: For information only; the OEM version is no longer in production.

Analog Output Specifications (AOUT pin)

| Parameter	Symbol	Test Conditions	Specification			Unit
			Min.	Typ.	Max.	
AOUT Maximum Output Swing	V_{AOUT}	5k Ω load (AC coupled)	---	---	1.0	V
Minimum Load Impedance	R_L	---	5	---	---	k Ω
Maximum Load Capacitance	C_L	---	---	---	100	pF
AOUT Output Bias Voltage	V_{BIAS}	---	---	1.2	---	V_{DC}

Timing Waveforms

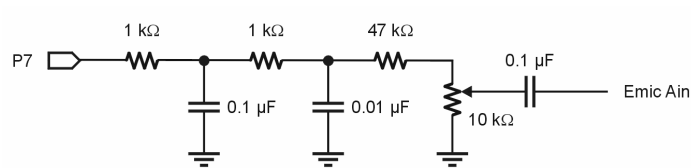### *Emic Platform Power-On Sequence*
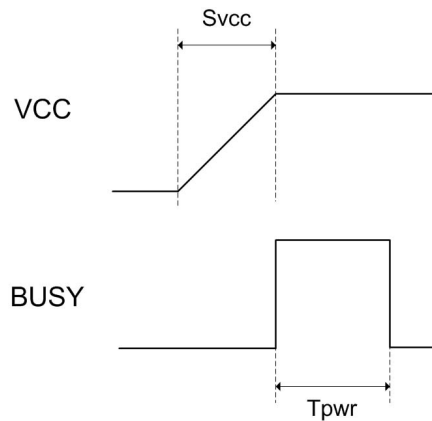
Circuit Connections

Use the following circuit for connecting the Emic TTS Module to the BASIC Stamp microcontroller.
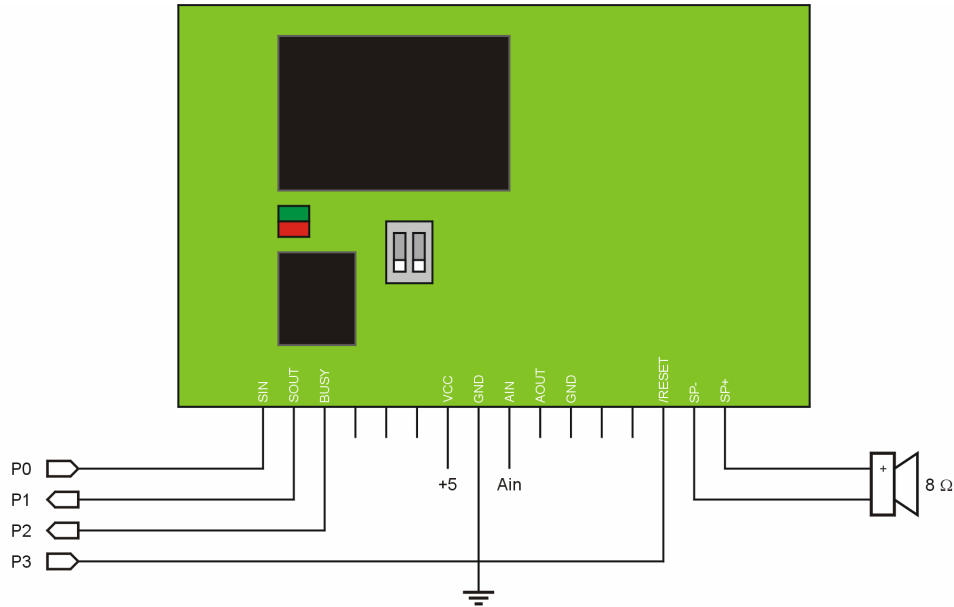
For programs that require amplifying the output from **FREQOUT** and **DTMFOUT**, use the following filter circuit to provide a clean sine wave to the Ain pin of the Emic TTS:

BASIC Stamp 2 Application

The following BASIC Stamp 2 (any) program demonstrates the features of the Emic TTS. This program uses the DEBUG window to provide a menu to Emic TTS features. Demonstrations that use **FREQOUT** and **DTMFOUT** will require the filter circuit/connections as illustrated on the previous page.

```
' ============================================================================
'
'   File...... Emic_TTS.BS2
'   Purpose... Demonstrates Features of the Emic TTS Platform
'   Author.... Parallax, Inc. (Copyright (c) 2004, All Rights Reserved)
'   E-mail.... support@parallax.com
'   Started...
'   Updated... 19 APR 2004
'
'   {$STAMP BS2}
'   {$PBASIC 2.5}
'
' ============================================================================



' -----[ Program Description ]------------------------------------------------
'
' This program demonstrates the TTS capabilities of the GIS Emic TTS
' module (SIP version).  Before running this demo make sure that both
' Emic DIP switches are set to OFF (Hex mode of Emic TTS).
'
' Adding Abbreviations CAUTION:
'
' If you use the AddAbbr command, do so only once.  By writing the same
' abbreviation over and over you are simply consuming flash space on the
' WTS701 -- flash that cannot be recovered without device reprogramming.



' -----[ Revision History ]---------------------------------------------------



' -----[ I/O Definitions ]----------------------------------------------------

Tx              PIN     0                       ' connects to Emic SIn
Rx              PIN     1                       ' connects to Emic SOut
Busy            PIN     2                       ' 1 = busy
Rst             PIN     3                       ' low to reset Emic TTS
AOut            PIN     7                       ' audio out from Stamp


' -----[ Constants ]----------------------------------------------------------
```

```
#SELECT $STAMP
  #CASE BS2, BS2E
    T2400        CON     396
    TmAdj        CON     $100                        ' x 1.0 (note time adjust)
    FrAdj        CON     $100                        ' x 1.0 (note freq adjust)

  #CASE BS2SX
    T2400        CON     1021
    TmAdj        CON     $280                        ' x 2.5
    FrAdj        CON     $066                        ' x 0.4

  #CASE BS2P
    T2400        CON     1021
    TmAdj        CON     $3C5                        ' x 3.77
    FrAdj        CON     $044                        ' x 0.265

  #CASE BS2PE
    T2400        CON     396
    TmAdj        CON     $100
    FrAdj        CON     $0AA                        ' x 0.665
#ENDSELECT

Baud           CON     T2400
Yes            CON     1
No             CON     0


' Emic Commands (Hex Mode)

Say            CON     $00                          ' say Engish text
Volume         CON     $01                          ' set volume, 0 - 7
Speed          CON     $02                          ' set speed, 0 - 4
Pitch          CON     $03                          ' set pitch, 0 - 6
AddAbbr        CON     $04                          ' add abbreviation
DelAbbr        CON     $05                          ' delete abbreviation
ListAbbr       CON     $06                          ' list abbreviations
Version        CON     $07                          ' get version
Reset          CON     $08                          ' soft reset
Audio          CON     $09                          ' enable audio in
PhT            CON     $10                          ' start of phonetic text
Help           CON     $FE                          ' display help
EOM            CON     $AA                          ' end of message


OK             CON     $55                          ' "okay" for hex mode



' -----[ Variables ]----------------------------------------------------

cmd            VAR     Byte                         ' menu command
```

```
response        VAR     cmd                         ' user response

vol             VAR     Nib                         ' current volume
spd             VAR     Nib                         ' current speed
ptch            VAR     Nib                         ' current pitch

eePntr          VAR     Word                        ' EEPROM pointer
char            VAR     Byte                        ' character from EE
verData         VAR     Byte(4)                     ' version data



' -----[ EEPROM Data ]--------------------------------------------------

Demo1           DATA    Say, "I love BASIC Stamps!", EOM
Demo2           DATA    Say, "The time is 12:45", EOM
UseAbbr         DATA    Say, "Your current speed is 65 MPH", EOM
Dial            DATA    Say, "Dialing", EOM
Phone           DATA    Say, "1-916-624-8333", EOM



' -----[ Initialization ]-----------------------------------------------

Setup:
  GOSUB Hard_Reset                                  ' restore defaults


' -----[ Program Code ]-------------------------------------------------

Main:
  DEBUG CLS,                                        ' display options menu
        "===========================", CR,
        "     Emic TTS Demo Menu     ", CR,
        "===========================", CR,
        CR,
        "[1] Demo 1", CR,
        "[2] Demo 2", CR,
        "[A] Abbreviation Demo", CR,
        "[F] Phonetic demo", CR,
        "[X] Sound Effects (uses Ain)", CR,
        CR,
        "[V] Set Volume (", DEC1 vol, ")", CR,
        "[S] Set Speed (", DEC1 spd, ")", CR,
        "[P] Set Pitch (", DEC1 ptch, ")", CR,
        CR,
        "[R] Revision data", CR,
        CR,
        ">> "
```

```
  DEBUGIN cmd                                         ' get command
  LOOKDOWN cmd, ["1122aAfFxXvVsSpPrR"], cmd           ' convert to number
  cmd = cmd / 2                                       ' allow for upper/lower
  IF (cmd > 8) THEN Main                              ' validate command

  BRANCH cmd, [Play_Msg, Play_Msg, Play_Msg,
               Ph_Demo, Play_SFX,
               Set_Volume, Set_Speed, Set_Pitch,
               Get_Rev]
  GOTO Main



' Process Menu command

Play_Msg:
  DEBUG CLS, "Saying: "
  LOOKUP cmd, [Demo1, Demo2, UseAbbr, UseAbbr], eePntr
  GOSUB Print_String
  LOOKUP cmd, [Demo1, Demo2, UseAbbr, UseAbbr], eePntr
  GOSUB Say_String
  GOSUB Check_Busy
  PAUSE 500
  GOTO Main



Play_SFX:
  DEBUG CLS, "Speech and Sound Effects"
  eePntr = Dial                                       ' say "Dialing..."
  GOSUB Say_String
  GOSUB Check_Busy
  eePntr = Phone                                      ' say phone number
  GOSUB Say_String
  GOSUB Check_Busy
  SEROUT Tx, Baud, [Audio, EOM]                       ' enable Emic Ain
  eePntr = Phone
  GOSUB Dial_Phone                                    ' play DTMF phone number
  PAUSE 1000
  ' ring tone
  FREQOUT AOut, 2000 */ TmAdj, 440 */ FrAdj, 480 */ FrAdj
  INPUT AOut                                          ' release
  SEROUT Tx, Baud, [EOM]
  GOSUB Check_Busy
  PAUSE 500
  GOTO Main



Ph_Demo:
  DEBUG CLS, "Standard: 'Parallax'", CR
  SEROUT Tx, Baud, [Say, "Parallax", EOM]
```

```
  GOSUB Check_Busy
  DEBUG "Phonetic: 'pErAl@ks'", CR
  SEROUT Tx, Baud, [Say, PhT, "pErAl@ks ", EOM]
  GOSUB Check_Busy
  PAUSE 500
  GOTO Main


Set_Volume:
  DEBUG CLS, "Enter Volume (0 - 7): "          ' prompt user
  DEBUGIN DEC1 response                         ' get single-digit input
  vol = response MAX 7                          ' validate
  SEROUT TX, Baud, [Volume, DEC1 vol, EOM]      ' send to Emic
  GOSUB Wait_OK
  GOTO Main


Set_Speed:
  DEBUG CLS, "Enter Speed (0 - 4): "
  DEBUGIN DEC1 response
  spd = response MAX 4
  SEROUT Tx, Baud, [Speed, DEC1 spd, EOM]
  GOSUB Wait_OK
  GOTO Main


Set_Pitch:
  DEBUG CLS, "Enter Pitch (0 - 6): "
  DEBUGIN DEC1 response
  ptch = response MAX 6
  SEROUT Tx, Baud, [Pitch, DEC1 ptch, EOM]
  GOSUB Wait_OK
  GOTO Main


Get_Rev:
  SEROUT Tx, Baud, [Version, EOM]
  SERIN  Rx, Baud, [STR verData\4]
  DEBUG CLS,
        "Emic HWVER = ", HEX2 verData(0), CR,
        "Emic SWVER = ", HEX2 verData(1), CR,
        "WTS701 HWVER = ", HEX2 verData(2), CR,
        "WTS701 SWVER = ", HEX2 verData(3)
  PAUSE 3000
  GOTO Main

  END
```

```
' -----[ Subroutines ]---------------------------------------------------

' Reset Emic through serial connection

Soft_Reset:
  GOSUB Check_Busy                            ' wait for busy to release
  SEROUT Tx, Baud, [Reset, EOM]               ' send soft reset
  GOSUB Wait_OK
  vol = 4                                     ' set pgm vars to defaults
  spd = 2
  ptch = 1
  RETURN


' Check status of Emic TTS module
' -- wait until Busy line released by Emic
' -- code as written does not timeout

Check_Busy:
  PAUSE 1                                     ' allow busy to activate
  DO WHILE (Busy = Yes) : LOOP                ' wait until not busy
  RETURN


' Wait for okay message
' -- will timeout after 1 second

Wait_OK:
  SERIN Rx, Baud, 1000, TO_Error, [WAIT(OK)]
  RETURN


' Hard reset
' -- good when comm link is lost

Hard_Reset:                                   ' reset to default values
  LOW Rst                                     ' pull reset line low
  PAUSE 0                                     ' ~100 uS pause
  INPUT Rst                                   ' let reset float
  GOSUB Wait_OK
  vol = 4                                     ' set pgm vars to defaults
  spd = 2
  ptch = 1
  RETURN


' Send text string to Emic
' -- put first char of EE string in eePntr
```

```
Say_String:
  DO
    READ eePntr, char                          ' get char from EEPROM
    SEROUT Tx, Baud, [char]                     ' send it to Emic
    eePntr = eePntr + 1                         ' point to next
  LOOP UNTIL (char = EOM)                       ' stop when EOM found
  RETURN


' Print text string in DEBUG window
' -- put first char of EE string in eePntr

Print_String:
  DO
    READ eePntr, char                          ' get char from EEPROM
    IF (char >= 32) AND (char < 127) THEN      ' print only ASCII chars
      DEBUG char
    ENDIF
    eePntr = eePntr + 1                         ' point to next
  LOOP UNTIL (char = EOM)                       ' stop when EOM found
  RETURN


' Process time-out error

TO_Error:
  DEBUG CLS, "No response from Emic TTS."       ' ruh-roh, Shaggy
  END


' Dials phone string that is saved in DATA statement

Dial_Phone:
  DO
    READ eePntr, char                          ' get char from EEPROM
    IF (char >= "0") AND (char <= "9") THEN     ' valid digit
      DTMFOUT AOut, 200 */ TmAdj, 50, [char - "0"]
    ENDIF
    eePntr = eePntr + 1                         ' point to next
  LOOP UNTIL (char = EOM)                       ' stop when EOM found
  RETURN
```