Voice Direct™ 364
Data Book

SENSORY

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Voice Direct™ 364

Introduction

Sensory's Voice Direct™ 364 delivers state-of-the-art speech recognition technology in a cost-effective, flexible IC format that is ideally suited for a variety of consumer products. Voice Direct™ 364 is quickly and easily embedded into existing products or new designs because it can operate in stand alone mode or as a slave IC to external host processors. This flexibility makes Sensory's Voice Direct™ 364 the value-added choice for countless applications. With a minimum of external memory and hardware, you can incorporate Voice Direct™ 364 into electrical switches, desktop appliances, consumer electronics, and practically any consumer product that can be controlled using voice-activated technology. Voice Direct™ 364 can be used as a direct replacement of Voice Direct™ with the added continuous-listening (CL) feature.

This data book describes the end-user voice recognition features, training approach, and command set, as well as the design, interface, and protocol parameters you need to implement Voice Direct™ 364 technology.

Feature Overview

Voice Direct™ 364 is a speaker-dependent speech recognition IC. It maps spoken commands to system control functions using sophisticated speech recognition technology. Using easy-to-learn, intuitive techniques, end users train Voice Direct™ 364, which performs speech and sound prompting and speaker-dependent (SD) speech recognition. Voice Direct™ 364 can also be controlled by an external host processor (slave mode) or operate in a pin-configurable stand-alone mode. Voice Direct™ 364 product line includes: the Voice Direct™ 364 IC, the Voice Direct™ 364 Module, and the Voice Direct™ 364 Speech Recognition Kit.

Voice Direct™ 364 incorporates and includes an analog-to-digital signal converter, analog control signals, fully-automated speech prompting and recognition (neural network recognition engine and speech/sound generator), DAC output for the speech synthesis, external serial EEPROM and parallel ROM, and Digital I/O interfaces. Among Voice Direct™ 364's capabilities are:

- Speaker-dependent recognition, works in any language
- Support for language localization and custom prompts (English and German prompts available)

- Full support for speech and sound prompts.
- Recognition of up to 60 words/phrases in slave mode, 15 in stand-alone mode
- Phrase recognition up to 2.5 seconds
- Real time responsiveness: response time typically less than 500 msec.
- Minimal memory: 128 bytes per word of external memory
- Two operating modes: external host-controlled (slave mode) or pin-configurable stand alone mode
- A full command set for external host-driven programs

Voice Direct™ 364 employs a sophisticated neural network to recognize trained words or phrases with greater than 99% accuracy. The Voice Direct™ 364 IC's highly integrated design reduces the external parts count, so you can configure a complete recognition system with little more than a battery, speaker, external memory, microphone, and crystal. Or you can use the Voice Direct™ 364 Module -- a complete, pin-configurable pre-assembled board, ready to connect to your application.

Voice Direct™ 364 records and accesses trained speech in voice recognition templates. It has private access to these voice recognition templates via external serial EEPROM memory (8 Kbytes). You can also configure an optional language/extended speech ROM.

Sensory's Voice Direct™ 364 is designed to operate as a stand-alone device or as a slave device. As a slave device, it receives and processes the commands from a host controller or CPU and returns the status information and data. Communication with the host CPU is through a 3-wire serial bus. Voice Direct™ 364 uses a rich command set, so application programmers can implement complex voice recognition functions with a minimum of CPU overhead. This allows the application software to focus on providing an intuitive and efficient user interface.

Implementation Overview

Implementing Voice Direct™ 364 technology involves selecting a slave or stand-alone mode:

Slave Mode: Writing the application control software for a host CPU and physically embedding a Voice Direct™ 364 IC into your product.
Stand Alone Mode: Configuring Voice Direct™ 364 pins to switches that you use to implement your program and physically embedding a Voice Direct™ 364 IC into your product.

What follows is an overview of Voice Direct™ 364 concepts and capabilities, its command set and serial interface, and its hardware requirements and features. Subsequent sections describe these topics in detail.

Voice Direct™ 364 maintains a template directory with the following information for each entry:

- A speaker-dependent speech template – a digitally constructed synthesis of a spoken name

- A control function
- An attribute byte – to identify the kind or type of entry during searches

Users can execute control functions associated with a name entry by voice recognition. One or more users can organize multiple directories or word groups – these capabilities make use of the attribute byte. The attribute byte is combined with a search mask during recognition and directory functions. This makes it possible to more effectively scan templates assigned by multiple users or searching by categories

Slave Mode

In slave mode, all operations are controlled by the host CPU through the master/slave bus. You can program Voice Direct™ 364 to provide system control functions. An extensive, easy-to-implement command set helps you write the host CPU application control software. Your program can incorporate speech from a long list of pre-recorded prompts to creatively guide the end user through the user interface. Commands are conveyed in data packets via the 3-wire serial interface that connects the host processor to Voice Direct™ 364.

In slave mode, Voice Direct™ 364 requires minimal external circuitry. (See Section: Voice Direct™ 364 Module Schematic, page 63). The following components are required unless otherwise noted:

- Microphone
- Speaker
- A few passive components
- External Serial EEPROM (for external template storage memory)
- Oscillator Circuit
- Speaker Amplifier
- External ROM for customized speech or foreign language (optional)

Stand Alone Mode

In stand alone mode, the functional capability of the Voice Direct™ 364 IC is determined by configuration of specific I/O pins. The pin inputs (-TRAIN, -CL TRAIN, and -RECOG) generate specific chip outputs and actions. You can build a complete recognition system using only the Voice Direct™ 364 IC and the following items in addition to the components listed in the slave mode:

- A few passive components
- Decoder Circuit for I/O (optional)
- LED (optional)

Voice Direct™ 364 Product Line

A full line of Sensory Voice Direct™ 364 products is available to help you rapidly develop applications:

- *The Voice Direct™ 364 IC* - The Voice Direct™ 364 integrated circuit without the external components described above.
- *The Voice Direct™ 364 Module* - A pre-configured IC assembled on a module for prototype development and limited volume production.
- *The Voice Direct™ 364 Speech Recognition Kit* - A minimally configured Voice Direct™ 364 system that incorporates the Voice Direct™ 364 Module with speaker, microphone element, LED, switches, and a few passive components.

Voice Direct™ 364 Concepts and Functional Capabilities

The following sections describe core concepts and capabilities that are useful in creating the application control program that controls Voice Direct™ 364 capabilities. Differences between slave mode and stand-alone mode are noted. In the descriptions that follow, "user" refers to the end user of your application control program. The following topics are covered:

- Speech Recognition
- Voice Direct™ 364 Entry Structure
- Speech Templates
- Attribute Bytes
- Masks
- Current Pointer
- Standard Words and Phrases
- Custom Words and Phrases
- Development Parameters
- Stand Alone Mode
  - Standard SD Mode
  - Continuous Listening Mode
- Slave Mode

Speech Recognition

Voice Direct™ 364 performs speaker-dependent discrete word recognition by comparing a pattern that it generates in real time with previously trained word templates. The pattern Voice Direct™ 364 generates is based on a digital reconstruction of the voice command.

Each word to be recognized must first be *trained.* During training, Voice Direct™ 364 builds up a *template* representing the individual speaker's unique sound pattern for each specific word or phrase to be recognized. Templates are stored in serial EEPROM. During recognition a new pattern is produced and compared to the stored templates to determine which word was spoken.

Voice Direct™ 364 features integrated speech prompting for both training and recognition operations, allowing the development of sophisticated interactive products with little or no programming. As always, the focus of Voice Direct™ 364 control programs should be simplicity and ease-of-use.

In both stand-alone and slave modes, Voice Direct™ 364 performs the following operations when recognizing a word:

1. The audio signal (spoken word) is externally amplified and filtered and then supplied to the analog inputs to Voice Direct™ 364, which converts the analog waveforms to digital samples.

2. Voice Direct™ 364 analyzes the speech signal samples and generates a pattern of information representing significant speech elements.

3. Voice Direct™ 364 increases or decreases the gain of the internal amplifier as needed to maintain signal quality.

4. Using a neural network, the pattern is compared with previously stored template patterns; a small number of candidate templates is selected.

5. The candidate templates are further processed to determine the one template that provides the best match to the unknown pattern.

6. If the best match template gives a score above a pre-defined threshold, Voice Direct™ 364 chooses the word associated with that template. If no template provides a match above threshold, a special "no match" value is chosen.

Steps 1-3 above are repeated for each word during training. Voice Direct™ 364 stores the average of two training patterns for each word to improve accuracy. Before storing a new template it is selectively compared with the existing templates in the set. The new candidate word will not be accepted if it is too similar to an existing word (for example, "Bill Smith" and "Jill Smith").

Voice Direct™ 364, like other speech recognition systems, are necessarily subject to two types of errors: *rejects* (failure to recognize a word in the vocabulary) and *substitutions* (confusion of two vocabulary words, or recognition of a non-vocabulary word). The relative importance of each type of error may depend on the application.

Voice Direct™ 364 provides a *recognition selectivity* level that allows the user to optimize the tradeoff in these two types of recognition errors. When the selectivity level is set to its highest value, Voice Direct™ 364 minimizes substitution errors. That is, it rarely recognizes a non-vocabulary word, but it may occasionally reject a word in the vocabulary. When the recognition selectivity level is set to its lowest value, Voice Direct™ 364 minimizes rejects. That is, it rarely fails to recognize a vocabulary word, but may occasionally also recognize non-vocabulary words. Best results are obtained in most cases by using the default selectivity level (an intermediate value).

In slave mode the Recognition selectivity level should be set using the “Put Register + Register Number” (4Fh) command. A subset of these parameters is available for selection via resistor programming in stand-alone mode. See Stand Alone Mode (p. 14).

Voice Direct™ 364 Entry Structure

During training, Voice Direct™ 364 creates and stores entries in the serial EEPROM. Entries have the following elements:

A speaker-dependent speech template of the name
An attribute byte

These are described below.

Speaker-Dependent Speech Templates

Within the context of the product application, a user must train Voice Direct™ 364 to recognize each name in the directory. During this training process, speaker-dependent speech templates are created and then stored for comparison during the recognition process.

Training is simple, although it should be noted that there are differences in training the unit it Standard SD Mode vs. Continuous Listening mode. In general, it consists of speaking a name and then repeating it once for confirmation. Each time the name is spoken a template is created. The two templates thus created during the training process must closely match (the speech patterns should be similar). If the two templates match sufficiently, then a third template composed of the average of the first two templates is automatically created. This third average template is then stored in the external memory and used during the recognition process.

During the voice recognition process, a fresh template of the spoken word is produced. This new template is then compared to the stored templates to determine which name was spoken.

Attribute Bytes

When an entry is created, an attribute byte is associated with the voice template. Attribute bytes allow users to distinguish between different groups or kinds of entries.

This method of dividing trained names into categories requires no extra memory or buffering because Voice Direct™ 364 dynamically allocates memory rather than using fixed blocks. Consider an application that supports two different users. Rather than dividing the memory in half, it can be allocated according to actual usage. The user with more numbers to call can train templates as needed, while the other user fills up the remainder. This avoids leaving empty memory slots in one user’s directory, while the second directory is needlessly and inconveniently restricted to fewer slots.

This method also allows two different types of templates to be stored. One is a Speaker Dependent (SD) template, and other is a Continuous Listening Speaker Dependent (CL) template.

Mask

During searches, the host CPU application program (slave mode) or Voice Direct™ 364 (stand-alone mode) generates a mask. The mask is logically 'ANDed 'or 'Compared' (CP) against each attribute byte depending on how the register *opMode* is configured. Mask supports flexible applications with multiple directories or word lists. In fact, mask helps such applications perform more responsively by reducing search times. During recognition and directory functions, a mask is constructed to select and/or exclude words in specific groups.

> *During the training process, the mask is used to determine which existing word groups should be included when testing for similar words. The mask also has an effect on how other directory commands such as "Increment Current Pointer," "Decrement Current pointer," and "Query Lexicon Status" will function. For more information, see the command summary.*

Current Pointer

The Current Pointer points to the physical slot for the current entry in the group and is used to select and operate on entries within a group. The entry selected by the Current Pointer is referred to as the Current Entry. Many of Voice Direct™ 364 commands operate on the Current Entry.

Synthesizing Standard Words and Phrases

Voice Direct™ 364 comes with 32K bytes of general-purpose Standard English or German words and phrases onboard. Two word lists, a mandatory Prompt List and an optional Speech list, are available. Each list has its own set of indices.

The mandatory Prompt List contains speech that is accessed directly by the chip during the training and recognition process. Speech in this list is also accessed to issue specific error messages (such as "Please talk louder"), thereby providing user feedback during training and voice recognition. Words and phrases in this list cannot be accessed via the Say Prompt command.

The optional Speech List contains speech that can be accessed via the Say Prompt Command. These are standard prompts useful in creating the user interface for applications. Examples include prompting to review operations, and to play error messages (such as "memory full" or "memory empty") at the application level.

Custom Words and Phrases

You can replace the onboard standard word list with a customized word list for English or foreign (German or other) languages via an external ROM chip. This external ROM can contain either 32K or 64K of speech synthesis. The only limitation on the external synthesis is that it must be divided into two lists -- the Prompt and Speech lists described above. The Prompt List in the external ROM must contain the same number of indices as that of the onboard Prompt List,

and the synthesis at each index must have a meaning (in the new language) identical to that of the onboard Prompt List (in North American English or German). This discipline is required because the Prompt List indices reflect functionality that is hard-coded into Voice Direct™ 364. For example, sentence 0 of the Prompt List Table ("Say Name" -- see below) could be replaced with a custom voice synthesis equivalent in a different language, or with an extended prompt such as "Please say the name of the person to be added to the directory."

Since the Speech List is accessed solely by the application control code, there are no requirements to either the number of indices, or the semantic meaning of any index. Your are free to create a Speech List of any desired synthesis required by your application – you are limited only by the available memory. For more information on creating a custom Speech List, contact Sensory.

> *A rule of thumb: about 800 bytes of memory per word are required for good quality synthesis, and about 400 bytes per word for acceptable quality synthesis. This rule of thumb varies by language and the characteristics of the voice talent.*

Stand Alone Mode

At power-up, or when Voice Direct™ 364 is hard-reset, it checks the following hardware configurations.

Slave and Stand Alone Modes
If the MODE pin is resistively pulled to Ground, the Voice Direct™ 364 will operate in the stand-alone mode. This allows the chip to work in an environment with completely non-slave elements. Pin inputs will generate specific chip outputs and actions. The functionality is fixed and will be a limited set that is primarily determined by the number of I/O pins.

Stand-alone operating mode is designed to provide a complete recognition system using only the Voice Direct, external template storage memory, an audio preamplifier, and passive components. Switches can be connected to the -TRAIN, -CL TRAIN and -RECOG pins to control operation. The descriptions below describe this configuration and refer to these switches as the TRAIN, CL TRAIN, and RECOGNITION switches.

At power-on Voice Direct™ 364 checks the level on the MODE pin. An external 100K resistor pulls this pin to either Vdd or GND. When the pin is pulled to GND, the Voice Direct™ 364 begins operation in Stand Alone mode. The chip continues to operate in Stand Alone mode as long as the power remains on. After this power-on check, the MODE pin is automatically configured for use as a speaker output driver pin.

At the beginning of its Stand Alone Standard SD mode power-on tests, the Voice Direct™ 364 activates all of the OUTx signals, the HIGH signal, and the ERROR signal. Then Voice Direct™ 364 performs its power-on configuration operations. These configurations remain in effect until power is turned off.

Please refer to Section *Voice Direct™ 364 Module Schematic starting on page 63* for configuration schematics for each mode.

Standard Speaker-Dependent (SD) and Continuous Listening Recognition (CL) Modes
There are two recognition modes in the Stand Alone mode: Standard Speaker-Dependent Mode (SD), and Continuous Listening Mode (CL).

To select Standard SD mode, leave the -CL TRAIN pin open.

To select CL mode, connect a resistor at the -CL TRAIN pin to the ground. For slow CL performance, use a 680 K-Ohm resistor. For fast CL performance, select a 47 K-Ohm resistor.

Training and Recognition Selectivity Level Configuration Pins
The –RECOG, -TRAIN, and -CL TRAIN pins are checked at power-up. These bits determine the selectivity level to be used for training and recognition.

- **-TRAIN high** selects minimum selectivity level in SD training. In this case, Voice Direct™ 364 will accept words that are similar sounding to each other, possibly degrading recognition accuracy.
- **-TRAIN low** selects maximum selectivity level in SD training. In this case, Voice Direct™ 364 will reject words that are too similar sounding to each other, potentially increasing recognition accuracy.
- **-CL TRAIN high** selects minimum selectivity level in CL training. In this case, Voice Direct™ 364 will accept words that are similar sounding to each other, possibly degrading recognition accuracy.
- **-CL TRAIN low** selects maximum selectivity level in CL training. In this case, Voice Direct™ 364 will reject words that are too similar sounding to each other, potentially increasing recognition accuracy.
- **-RECOG high** selects minimum selectivity level in SD and CL recognition. In this case, Voice Direct™ 364 will produce less rejection errors of words in the list, but more substitution errors of correct words.
- **-RECOG low** selects maximum selectivity level in SD and CL recognition. In this case, Voice Direct™ 364 will produce less substitution errors of correct words, and will produce more rejection errors of words in the list.

After some further internal checking, Voice Direct™ 364 is ready to begin operation. It de-activates all output signals and serves notice that it is ready with one or two short audible "beeps". If the unit is in stand-alone mode, a single beep will be generated, if it is in slave mode, two beeps will be generated. It then begins monitoring for commands to train, recognize, or erase.

Standard SD Mode

Training

Pressing the TRAIN switch for at least 1/10 second initiates automatic training of up to 15 individual words or phrases. A word or phrase must be shorter than 2.5 seconds and may not contain silences longer than 0.5 seconds. For example, the name "John Smith" would be an acceptable phrase as long as the two words are not spoken in isolation. Training terminates when no word is spoken in response to a prompt, when either switch is pressed a second time during training, *or after all words have been trained.*

Pressing the TRAIN switch at a later time resumes training. New words are added to the end of the set already recorded. New words may be added to the set at any time, up to a maximum of 15 words. Individual words from the set may not be deleted or overwritten, but the entire set can be erased (see "Erasing" below).

Recognition

Recognition is initiated when the RECOGNITION button is pressed. A prompt is spoken and the Voice Direct™ 364 listens to the word being spoken. If the spoken word matches a stored template, one (or two) of 8 category pins is activated (pulled high for approximately one second) and a voice message indicates the matching category number. If the set contains 8 or fewer elements, these pins may be used to control actions directly. If the set contains more than 8 elements, decoding is necessary. If the spoken word is not recognized for any reason, none of the category pins is activated and an appropriate voice message is synthesized. Since this can occur if Voice Direct™ 364 has not been trained on the word, the "no category" output is not considered an error condition, and the ERROR bit remains inactive.

Voice Direct™ 364 monitors the background noise level and gives a voice warning if the noise is too high for recognition. Voice Direct™ 364 works well with high (above 80 dB) levels of *steady* background noise (such as a fan), but it may make errors at lower levels if the background noise is not steady (for example, a TV set). Best results will be obtained in a relatively quiet location.

Warnings may also appear if the word is spoken too softly, too loudly, or too quickly after the prompt. The ERROR signal goes high when these conditions occur.

Erasing

Users can erase all stored templates by pressing the TRAIN and RECOG buttons together for at least one second. A voice message confirms the operation.

Errors

Any error occurring during training or recognition produces a spoken message. The ERROR signal is also activated (for approximately 1 second) to indicate an error.

Continuous Listening Recognition (CL) Modes

CL Recognition Sets

When the Voice Direct™ 364 operation mode is set for the CL, it can be used in either 'Single-CL triggering' or 'Multi-CL triggering' mode.

Selecting 'Single-CL triggering' or 'Multi-CL triggering' Mode

The selection for the 'Single-CL triggering' or 'Multi-CL triggering' mode will be set by the TALK / CL CFG port.

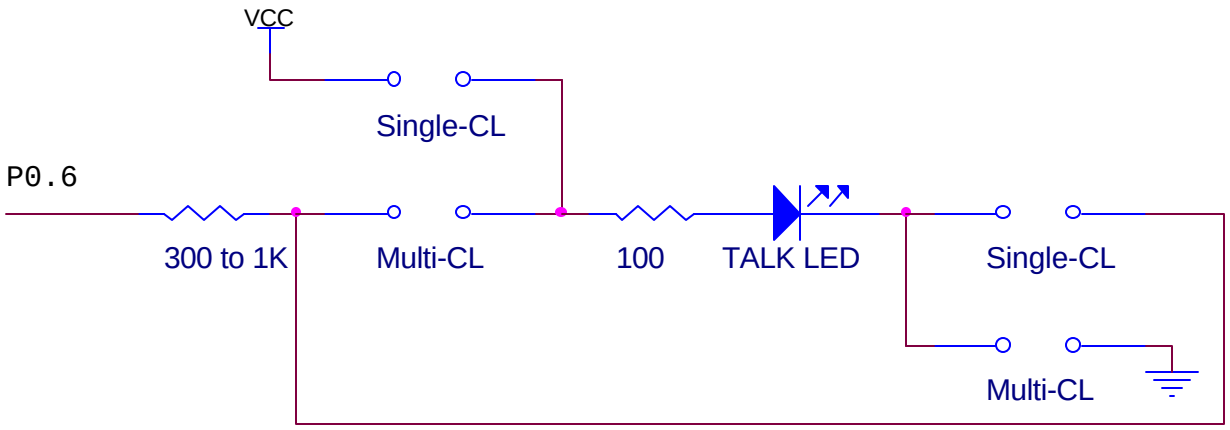


Figure 1: CL Hardware Configuration

To select 'Single-CL triggering', place shorting blocks on 'Single-CL' jumpers.

To select 'Multi-CL triggering', place shorting blocks on 'Multi-CL' jumpers.

Note: At power-up, a check will be performed for the 'Single-CL triggering' or 'Multi-CL triggering'. If it is set for the 'Single-CL triggering', TALK / CL CFG is active low. If it is set for the 'Multi-CL triggering', TALK / CL CFG is active high.

Single-CL Triggering Mode

CL word	Up to 15 SD words
CL Word A	01: SD Word = output-01 02: SD Word = output-02 03: SD Word = output-03 04: SD Word = output-04 05: SD Word = output-05 06: SD Word = output-06 07: SD Word = output-07 08: SD Word = output-08 09: SD Word = output-09 10: SD Word = output-10 11: SD Word = output-11 12: SD Word = output-12 13: SD Word = output-13 14: SD Word = output-14 15: SD Word = output-15

Multi-CL Triggering Mode

CL word A	Up to 5 SD words
CL word B	**Up to 5 SD words**
CL word C	**Up to 5 SD words**
CL Word A	SD Word 1 = output-01 SD Word 2 = output-02 SD Word 3 = output-03 SD Word 4 = output-04 SD Word 5 = output-05
CL Word B	SD Word 6 = output-06 SD Word 7 = output-07 SD Word 8 = output-08 SD Word 9 = output-09 SD Word 10 = output-10
CL Word C	SD Word 11 = output-11 SD Word 12 = output-12 SD Word 13 = output-13 SD Word 14 = output-14 SD Word 15 = output-15

The word (SD) following the triggering word (CL) will be matched only against the templates in the corresponding set.

For example, if the trigger word (CL) is recognized as Set-B, the word for SD will be matched only against the SD templates (06, 07, 08, 09, and 10).

> *The 'Multi-CL triggering' can be used for a single user using multiple continuous words for triggering, or for multiple users using a single word for triggering.*

When it is used for multiple users, the data would be organized as:

User-1: "Sound System"	User-1: "on" User-1: "off" User-1: "up" User-1: "down" - empty -
User-2: "Sound System"	User-2: "on" User-2: "off" User-2: "up" User-2: "down" - empty -
User-3: "Sound System"	User-3: "on" User-3: "off" User-3: "up" User-3: "down" - empty -

The outputs for the 'Multi-CL triggering' mode must be decoded with external circuitry. The sequence number of the SD word corresponds to the sequence number of the output. Here is a sample of the external logic for multiple users with a common set of outputs:

Gated Output-1 = (1^{st} SD word of 'A') + (1^{st} SD word of 'B') + (1^{st} SD word of 'C')

Gated Output-2 = (2^{nd} SD word of 'A') + (2^{nd} SD word of 'B') + (2^{nd} SD word of 'C')

Gated Output-3 = (3^{rd} SD word of 'A') + (3^{rd} SD word of 'B') + (3^{rd} SD word of 'C')

Gated Output-4 = (4th SD word of 'A') + (4th SD word of 'B') + (4th SD word of 'C')

Gated Output-5 = (5th SD word of 'A') + (5th SD word of 'B') + (5th SD word of 'C')

In the above example, this mode can be used for applications such as remote controls or home automation. The CL trigger word could be "Sound System", and the corresponding SD words

could be “ON’, “OFF”, “UP”, “DOWN”, etc. In this case, each user trains the set the same way as others.

The outputs are re-mapped and are different than SD or Single-CL Triggering Modes.

- 3 lines to select the CL word: Word 1, 2 or 3
- 5 lines to select the SD set: Word 1, 2, 3, 4, or 5

P1.0 Set 1
P1.1 Set 2
P1.2 Set 3

P1.3 Word 1
P1.4 Word 2
P1.5 Word 3
P1.6 Word 4
P1.7 Word 5

Training Words in CL Mode

A separate switch is required for the CL training and the SD training modes. However, the SD words must be trained right after the CL trigger words. Each set is trained separately.

Training can be aborted before training any SD words. If the trigger words are trained without any SD words in its set, when the CL word is triggered, it will act as if the first word in its set was recognized.

Example:

Press CL Training SW		***User-1***
Voice Direct 364:	“Say word one”	*Training first CL word*
User-1:	“Sound System”	
Voice Direct 364:	“Repeat”	
User-1:	“Sound System”	
Press SD Training SW		
Voice Direct 364:	“Say word one - one”	*Training first SD word in first set*
User-1:	“On”	
Voice Direct 364:	“Repeat”	
User-1:	“On”	
Press SD Training SW		
Voice Direct 364:	“Say word one - two”	*Training second SD word in first set*
User-1:	“Shutdown”	
Voice Direct 364:	“Repeat”	
User-1:	“Shutdown”	

Press CL Training SW		***User-2***
Voice Direct 364:	"Say word two"	*Training second CL word*
User-2:	"Sound System"	
Voice Direct 364:	"Repeat"	
User-2:	"Sound System"	
Press SD Training SW		
Voice Direct 364:	"Say word two - one"	*Training first SD word in second set*
User-2:	"On"	
Voice Direct 364:	"Repeat"	
User-2:	"On"	
Press SD Training SW		
Voice Direct 364:	"Say word two - two"	*Training second SD word in second set*
User-2:	"Shutdown"	
Voice Direct 364:	"Repeat"	
User-2:	"Shutdown"	

Slave Mode

If the -TE signal is resistively pulled to Vdd, Voice Direct™ 364 will operate in the slave mode, which requires an external control device (MCPU). The host CPU is programmed to issue commands that control the Voice Direct™ 364 IC. No custom programming is allowed on the ASSP chip via external ROM.

The slave operating mode is designed to provide a full-featured, multiple-set recognition system combined with high quality phrase synthesis in a chip that can easily be controlled by an external host. Recognition templates are stored in non-volatile serial EEPROM accessed by Voice Direct™ 364. While providing a powerful high-level control interface, the slave mode Voice Direct™ 364 allows the host CPU to control the flow of operations and to initiate training, recognition, or synthesis as appropriate. This contrasts with Stand Alone mode, which requires a fixed sequence.

Slave mode supports up to 60 words organized in flexible recognition sets. During recognition and directory functions, a mask is applied against each attribute byte to select and/or exclude words in specific groups.

Slave mode operation uses certain pins for functions that differ from stand alone mode functions. Alias names are given below for these pins to clarify their use in slave mode.

The Voice Direct™ 364 Command Set

Command Set Overview

This section describes the set of Voice Direct™ 364 commands and command responses. The commands are sent to Voice Direct™ 364 by the host CPU via the serial interface (see p. 35).

> *This section applies only to Voice Direct™ 364 in slave mode.*

Table 1 - Command Set

Command	Parameters	Data returned	Description	Class
00h	~	~	No Operation	6
01h	~	Version String	Get Version String	6
02h	Prompt, Source, Tries	~	Train A Name	1
10h	Prompt, Source, Tries	~	Recognize Word	2
20h	~	~	Clear Current Pointer	3
21h	~	~	Increment Current Pointer	3
22h	~	~	Decrement Current Pointer	3
23h	~	~	Save Current Pointer	3
24h	~	~	Restore Current Pointer	3
25h	~	~	Swap Current Pointer	3
26h	~	Current Pointer	Get Current Pointer	3
27h	~	~	Delete Current Entry	3
28h	0x55	~	Delete All Stored Words	3
29h	Mask, Attribute	~	Set Mask and Attribute	3
2Ah	~	Attribute, Status	Get Entry Status	3
2Bh	~	Capacity, Free, Matching	Query Lexicon A Status	3
30h	Prompt, Source	~	Say A Prompt	4
40h	~	~	Power Down	5
41h	Index, Parameter	~	Store Parameter	5
42h	Index	Parameter	Fetch Parameter	5
43h	5 bits of data[1]	~	Configure I/O Expansion	5
44h	~	5 bits of data[1]	Read I/O Expansion	
45h	5 bits of data[1]	~	Write I/O Expansion	5
4Ah	Mask	~	Promptless CL Recognition	2
4Bh	Mask	Capacity, Free, Matching	Query Lexicon B Status	3
4Ch	Mask	~	Promptless SD Recognition	2
4Dh	CL Performance		Set CL Performance	5
4Eh	Reg Number	Reg	Get Register *(See Table 2)*	5
4Fh	Reg Number, Reg	~	Put Register *(See Table 2)*	5
50h	Addr H, Addr L	Byte	Get SEEPROM Byte	5
51h	Addr H, Addr L, Byte	~	Write SEEPROM Byte	5
52h	0x49	~	Write All FF to SEEPROM	6
80h	~	Step ID	Continue (single step mode)	6

Class definitions:

1 – Training	4 – Synthesis
2 – Recognition	5 – Control function
3 – Directory function	6 – Debug

[1]Data is sent as a single byte, with Data[4:0] corresponding to Expansion IO[4:0].

Register Information

Table 2 - Register Table

Reg #	Register Description	Reg #	Register Description
00	-	01	-
02	-	03	-
04	-	05	-
06	Mode	07	Mode2
08	Status	09	Ask-count
0A	Current pointer	0B	Auxiliary pointer
0C	Temporary pointer	0D	Current attribute
0E	Mask	0F	Message 1
10	Next template	11	-
12	Counter	13	Ask counter
14	Max classes	15	Training delta
16	Recognition threshold 1	17	Recognition threshold 2
18	Self match	19	-
1A	-	1B	-
1C	-	1D	-
1E	-	1F	-
20	-	21	-
22	-	23	-
24	-	25	-
26	-	27	-
28	-	29	Operation mode
2A	-	2B	-
2C	-	2D	-
2E	CL performance	2F	-

Command Responses

Table 3 - Command Responses

Response	Class	Description
00h	All	Command successfully executed to completion
01h	1,2	Time out
02h	1,2	Reserved
03h	1,2	Background too noisy
04h	1,2	Spoke too soft
05h	1,2	Spoke too loud
06h	1,2	Spoke too soon
07h	1,2	No match found
08h	2	Uncertain match found
09h	1	Entry too similar
0Ah- 0Fh		Reserved
10h	2,3	Memory empty
11h	1	Memory full
12h	3	Invalid pointer (No matching Attributes)
13h	3	No matching Attributes
14h – 17h		Reserved
18h	1,2	Spoke too long
19h – 1Fh		Reserved
20h	All	Unknown command
21h	All	Invalid parameter (value, digit, or index)
FFh	1,2,4	Command interrupted

Functional Description

What follows is a functional description of each command. The invalid parameter response (21h) is always a possible command response, even when not explicitly cited in the descriptions that follow.

Command – 00h (No Operation)
Arguments: ~
Returns: ~
Responses: 00, 21

This command returns a response code of 00h (Success). It is provided primarily for testing the communications interface.

Command 01h - (Get Version)
Arguments: ~
Returns: Version String (56h, 44h, 53h, 01h, 00h)
Responses: 00, 21

This command returns a five-byte sequence indicating the Sensory product model and software version number. The first three bytes will always be 56h, 44h, and 53h (ASCII 'VDS') for the Voice Direct™ 364 System. The last two bytes are, respectively, the major and minor version numbers in binary format.

Command 02h - (Train A Name)
Arguments: Prompt, Source, Tries
Returns: ~
Responses: 00, 01, 02, 03, 04, 05, 06, 08, 09, 11, 21, FF

This command allocates directory space and launches a training session for new entries. The training session generates a speaker-dependent speech template. This command requires three parameters: an index indicating which spoken prompt is to be used, a byte indicating the source synthesis table to use (00=Mandatory Table, 01= Optional Table, see Prompt Lists, p.43) and the number of retries allowed. This command may be aborted by the host.

The user is prompted using the prompt index supplied, then asked again to "Repeat". The new word is tested for similarity with existing words selected by the current mask. When the entry is saved to permanent memory, the current attribute is also saved (see Attribute Bytes p. 12).

After Voice Direct™ 364 saves the entry, the Current Pointer points to the newly created entry. Any command that changes the Current Pointer will cause this new entry to be destroyed. These commands include: Increment, Decrement, Restore, and Swap Current Pointer.

If the training process is unsuccessful after the specified number of retries, the command response will reflect the last attempt (i.e., the reported failure will be that of the final try) and returned to the host. If the trained name is too similar to an existing entry name, then the Current Pointer points to the entry that caused the error, but no spoken error is output to the speaker.

Table 4 - Training Response Codes

Command Response	Current Pointer
Success	Index of new entry
Too similar	Index of entry which is too similar
Any other error	Invalid

Command 10h - (Recognize Word)	
Arguments:	**Prompt, Source, Tries**
Returns:	**~**
Responses:	**00, 01, 02, 03, 04, 05, 06, 07, 10, 21, FF**

This command prompts the user for a name, creates a temporary word template and compares it against stored templates for a match. Specific word sets may be selected using Command 29h (Set Mask and Attribute.) If recognition is successful, the Current Pointer will be set to the index of the entry that matches the word. If the recognition is unsuccessful after the specified number of retries, the Current Pointer will be invalid and the command response will reflect the last recognition attempt and returned to the host. This command requires three parameters: a prompt number to be used, a byte indicating the source synthesis table to use (00= Mandatory Table, 01=Optional Table, see Prompt Lists, p.43) and the number of retries allowed. This command may be aborted by the host.

Table 5 - Recognize Word Response Code

Command Response	Current Pointer
Success	Index of new entry
Confused	Best matching entry (Use Command 0Dh – Swap Current Pointer to select 2nd best matching entry)
Any other error	Invalid

Command 20h - (Clear Current Pointer)	
Arguments:	**~**
Returns:	**~**
Responses:	**00, 10, 13, 21**

This command resets the Current Pointer to “0” regardless of mask and attribute.

Command 21h - (Increment Current Pointer)	
Arguments:	**~**
Returns:	**~**
Responses:	**00, 07, 10, 14, 21**

This command causes Voice Direct™ 364 to increment (move forward) the Current Pointer to the next matching directory entry based on the mask. This command can be used in routines that

browse the directory. If the current pointer is incremented from the end of entries, it will return "No match found".

> **Increment Current Pointer** *and* **Decrement Current Pointer** *are not necessarily linear functions – when used in conjunction with a mask byte they will skip over names that the mask does not match.*

Command 22h - (Decrement Current Pointer)	
Arguments:	**~**
Returns:	**~**
Responses:	**00, 07, 10, 14, 21**

This command causes Voice Direct™ 364 to decrement (move backward) the Current Pointer to the previous matching directory entry based on the mask. This command can be used in routines that browse the directory. If the current pointer is decremented from the first entry, it will return "No match found".

Command 23h - (Save Current Pointer)	
Arguments:	**~**
Returns:	**~**
Responses:	**00, 21**

This command saves the Current Pointer in a temporary memory location. The saved Current Pointer value can be restored by Command 24h (Restore Current Pointer). This command requires no parameters.

> *Note that the saved Current Pointer is lost if power is removed from the Voice Direct™ 364.*

Command 24h - (Restore Current Pointer)	
Arguments:	**~**
Returns:	**~**
Responses:	**00, 12, 21**

This command restores the Current Pointer to its last saved value – the value saved by a Command 23h (Save Current Pointer). Note that if directory entry associated with the Current Pointer has been deleted, then the restored Current Pointer will no longer point to a valid directory entry. There are no parameters required for this command.

Command 25h - (Swap Current Pointer)	
Arguments:	**~**
Returns:	**~**
Responses:	**00, 21**

This command is valid only if the "Auto-Retry" parameter is disabled. If, after a recognition attempt, there are two possible recognition candidates in the speaker-dependent templates, then the Current Pointer points to the best matching entry. This command switches the Current Pointer to point to the second-best matching entry. Issuing this command again switches the Current Pointer back to the best matching entry. There are no parameters required for this command.

Command 26h - (Get Current Pointer)	
Arguments:	**~**
Returns:	**~**
Responses:	**00, 12, 21**

This command returns the current pointer.

Command 27h - (Delete Current Entry)	
Arguments:	**~**
Returns:	**~**
Responses:	**00, 12, 21**

This command deletes the name, phone numbers, and attribute byte of the entry that is associated with the Current Pointer. If the Current Pointer is not valid, then this command does not delete an entry and instead returns a Command Response of 12h (Invalid Pointer). There are no parameters required for this command.

Command 28h - (Delete All Stored Words)	
Arguments:	**0x55**
Returns:	**~**
Responses:	**00, 21**

This command deletes all stored names and returns to the initial state. This command requires a one-byte parameter of the value 055h.

Command 29h - (Set Mask and Attribute)	
Arguments:	**Mask, Attribute**
Returns:	**~**
Responses:	**00, 21**

This command is used to set the internal variables mask and attribute when using multiple word sets. Mask and attribute have power up defaults of FFh and 01h, respectively. This allows a single directory of words to be managed without concern for this command. See the sections on Attribute Bytes (p. 12) and Mask (p. 13).

Command 2Ah - (Get Entry Status)	
Arguments:	**~**
Returns:	**Attribute, Environment**
Responses:	**00, 12, 21**

This command returns the attribute and status of the entry associated with the Current Pointer. The first byte sent is the attribute byte for the entry and the next byte indicates the Environment used for training the template. However, if the Current Pointer is not valid, this command does not return an entry status and instead returns a Command Response of 12h (Invalid Pointer). There are no parameters required for this command. Currently, the Environment byte is inactive.

Command 2Bh - (Query Lexicon Status)	
Arguments:	**~**
Returns:	**Capacity, Free, Entries**
Responses:	**00, 21**

This command is used to return information about the lexicon. Three bytes are returned: Total word Capacity, Number of Free slots available, and Number of directory Entries selected by the current mask byte.

The current attribute bit will be checked against the current mask byte.

Command 30h - (Say A Prompt)	
Arguments:	**Prompt, Source**
Returns:	**~**
Responses:	**00, 12, 21**

This command plays a predefined voice prompt. A prompt index is required. Speech prompts are spoken from the optional Speech List. See Prompt List (p. 43). This command may be aborted by the host.

Command 40h - (Power Down)	
Arguments:	**~**
Returns:	**~**
Responses:	**00, 21**

This command causes Voice Direct™ 364 to enter a low power sleep state. This command returns a “successful” response just before entering low power mode.

Command 41h - (Store Parameter)	
Arguments:	**Index, Parameter**
Returns:	**~**
Responses:	**00, 21**

This command stores a new value for a single parameter in the Serial EEPROM parameter block. The required parameters are an index and value. The flash parameter block provides a number of user configurable options, as well as 32 bytes of general-purpose storage.

Table 6 – Parameter Table

Parameter	Index	Default Value
Environment	00h	00h
Auto-retry	05h	01h
Single step	06h	00h
Train speech out	07h	00h
Startup beep	08h	01h
Train recognition threshold 1	26h	8Ah
Train recognition threshold 2	28h	7Fh

Command 42h - (Fetch Parameter)	
Arguments:	**Index**
Returns:	**Parameter**
Responses:	**00, 21**

This command returns a single parameter value from the flash parameter block. This command requires an index and returns a value. The flash parameter block provides a number of user configurable options, as well as 32 bytes of general-purpose storage.

Command 43h - (Configure I/O Expansion)	
Arguments:	**5 bits of I/O data**
Returns:	**~**

This command configures the Expansion I/O pins. IO[4:0] is addressed as Data[4:0]. To configure an I/O as an output, set the bit to "1". To configure an I/O as input, set the bit to "0".

Command 44h - (Read I/O Expansion)	
Arguments:	**~**
Returns:	**5 bits of I/O data**

This command returns the values on the Expansion I/O pins that have been configured as inputs. IO[4:0] is returned as Data[4:0]. A high level returns "1", a low level returns "0". Bits programmed as outputs return the output values.

Command 45h - (Write I/O Expansion)	
Arguments:	**5 bits of I/O data**
Returns:	**~**

This command sets the I/O pins programmed as outputs to the values supplied by Data. Data[4:0] are written as IO[4:0]. Each output pin is set to a high level if the corresponding bit is "1"; the output pin is set to a low level if the corresponding bit is "0". Pins programmed as inputs are unaffected.

Command 4Ah - (Promptless CL recognition)	
Arguments:	**mask**
Returns:	**~**

Specific word sets may be selected using Command 29h (Set Mask and Attribute.) If recognition is successful, the Current Pointer will be set to the index of the entry that matches the word. If the recognition is unsuccessful after the specified number of retries, the Current Pointer will be invalid and the command response will reflect the last recognition attempt and returned to the host. This command requires one parameter: mask. This command may be aborted by the host.

In CL mode, Voice Direct™ 364 continues to listen and to do the recognition until the word is recognized or interrupted by the host.

Command 4Bh - (Query Lexicon B Status)	
Arguments:	
Returns:	**~**

This command is used to return information about the lexicon. Three bytes are returned: Total word Capacity, Number of Free slots available, and Number of directory Entries selected by the current mask byte.

The current attribute byte will be logic-ANDed against the current mask byte.

Command 4Ch - (Promptless SD recognition)	
Arguments:	**Mask**
Returns:	**~**

Specific word sets may be selected using Command 29h (Set Mask and Attribute.) If recognition is successful, the Current Pointer will be set to the index of the entry that matches the word. If the recognition is unsuccessful after the specified number of retries, the Current Pointer will be invalid and the command response will reflect the last recognition attempt and returned to the host. This command requires one parameter: mask. This command may be aborted by the host.

Command 4Dh - (Set CL Performance)	
Arguments:	
Returns:	**~**

Some applications of Continuous Listening require maximum accuracy with the fewest false triggers. This configuration is appropriate for an application such as a light switch, where a false trigger may be more than a minor inconvenience. Further, the CL recognizer in such an application hears a great many phrases that are *not* trigger phrases, so there are many opportunities for false triggers and a high level of accuracy is desired. A consequence of this high accuracy is relatively slow responsiveness.

Other applications – games, for example – can accept occasional false triggers, but need fast response. In these applications the relative frequency of trigger phrases may be quite high, so false triggering accuracy is less of a concern.

The tradeoff between CL accuracy and responsiveness is controlled by the system parameter, CL_PERFORMANCE. This parameter may be set from 1 to 3 (inclusive), with the default value of 3 giving the highest accuracy, but the most sluggish response.

Command 4Eh - (Get Register)	
Arguments:	**Register Number**
Returns:	**Register Content**

This command reads and returns the register.

Command 4Fh - (Put Register)	
Arguments:	**Register Number, Register Content**
Returns:	**Register**

This command writes to the register.

Command 50h - (Get a Byte from Serial EPROM)	
Arguments:	**Address Hi, Address Low**
Returns:	**Byte**

This command reads the byte from serial EEPROM, and returns the byte to the host.

Command 51h - (Write a Byte to Serial EPROM)	
Arguments:	**Address Hi, Address Low, Byte**
Returns:	**~**

This command writes the byte to the serial EEPROM.

Command 52h - (Write All “FF” in Serial EEPROM)	
Arguments:	**Address Hi, Address Low**
Returns:	**Byte**

This command writes “FF” to all the byte in the serial EEPROM.

Command 80h - (Continue)	
Arguments:	~
Returns:	~

This command is used in Single Step Mode to cause instruction execution to continue to the next major processing step. If the Public Parameter “Single Step” is set to YES, than major functions, such as Training and Recognition, will stop at major macro elements and the status code returned will be set to STOPPED. Issuing this command resumes operation and proceeds to the next major block.

Functional Description

20h – Train Average Parameter This parameter is used during training. It controls the similarity required between two successive training passes of the same name. This parameter can range between 45h and 7Fh. The default is 6Eh. A lower number, like 45h, requires both trained templates to be very similar in order to pass. A higher number, like 7Fh, allows for a looser match between the two (trained) templates.

21h – Train Delta Match Parameter This parameter is used during training. It controls the similarity between the new template and existing templates. This parameter can range between 00h and 20h; 0Ch is the default. A lower number allows new templates to be stored that are closer in similarity to existing templates (for example, "Jim" and "Tim"). This allows similar templates to be stored, but may affect accuracy in large sets. A higher number requires a new template to be more distinct from an existing template.

24h - Accuracy Parameter This parameter is used when recognizing a name. It has a default of 5Fh and can range between 45h (close match) and 7Fh (loose match). The actual results of recognition accuracy for these different values will vary depending on the person, the template, and the word being spoken. A general overview of the range limits is as follows:

Loose Match - The closer the constant is to the “Loose Match” value, the more likely the Voice Direct™ 364 will find a match between any spoken word and a trained template. Thus, a spoken word (previously trained) will be identified correctly more often, but an untrained word is more likely to be falsely identified as matching a trained template.

Close Match - The closer the constant is to the “Close Match” value, the more likely the Voice Direct™ 364 will not find a match between any spoken word and a trained template. The lower the value, the closer a spoken word must match a trained template to get valid speech recognition identification. This will reduce the likelihood that an untrained spoken word will match a trained one. But it will be more difficult

for a correctly spoken word to match an existing template.

Serial Interface

> *This section applies only to Voice Direct™ 364 in slave mode.*

Communications

Data communication and control are accomplished using a 3 wire synchronous serial interface. Since the serial interface lines are open-collector (open-drain), pull-up resistors should be attached to all signals. If application requirements call for Voice Direct™ 364 to be powered down while the rest of the system is still powered up, take care to ensure that the external pull-up resistors are also powered down. Doing so will prevent current leakage into the Voice Direct™ 364 I/O ports. The following table describes the 3 lines used for data and handshaking between the Voice Direct™ 364 and the MCPU. In the table and the timing diagrams, VDR refers to the Voice Direct™ 364 IC.

Table 7 - Data Transfer Signal Description: Slave Mode

Signal	Pin	Description	VDR=>MCPU	MCPU=>VDR
DATA	22	Bi-directional Data line	Data valid when SHS = 0	Data valid when MHS = 0
-MHS	37	Master Handshake (Host => VoiceDir)	0 = Data bit valid	0 = Data bit accepted
-SHS	23	Slave Handshake (VoiceDir => Host)	0 = Data bit accepted	0 = Data bit valid

Miscellaneous I/O

Signal	QFP Pin	Description	Use
-TALK	29	Indicates that the Voice Direct™ 364 is generating speech output	Switching audio paths when synthesizing speech

Data is transferred one bit at a time with full handshaking as described below.

1. When the host CPU has data to transmit to the VDR, the host CPU sets DATA to the data value, verifies that -SHS (Slave Handshake) is in the *high* state, then sets -MHS (Master Handshake) to the *low* state to request a transfer.

2. The VDR senses the *low* state of -MHS and reads DATA, which then sets SHS to the *low* state to acknowledge the DATA.

3. The host CPU senses the *low* state of -SHS, and sets -MHS to the *high* state to indicate that DATA is no longer valid, and at the same time sets DATA high (releasing it).

4. The VDR then sets -SHS to the *high* state to indicate that the cycle is complete. Both devices are now ready to transfer the next data bit.

Voice Direct™ 364 remains busy (-SHS = low state) after receiving the final bit of a command packet, until after that command has been completed and Voice Direct™ 364 is ready to send a response. During this time, a time-consuming command can be interrupted by the master CPU with a low pulse on the -MSH line. When Voice Direct™ 364 has data to transmit to the MCPU, it follows the same procedure by setting -SHS to the low state. (See Figures 2, 3, and 4.) The protocol is completely symmetrical. The first processor to set its HS signal to the low state is the transmitter; the other processor is the receiver.

Data is always transferred in 8 bit bytes, with the most significant bit transferred first.

Note: By convention, the slave (Voice Direct™ 364) never transmits data unless requested to by the master (MCPU), thus avoiding the possibility of a collision (both processors setting their HS signals low simultaneously).

Figure 2 - Data Transfer – (Command to Response)

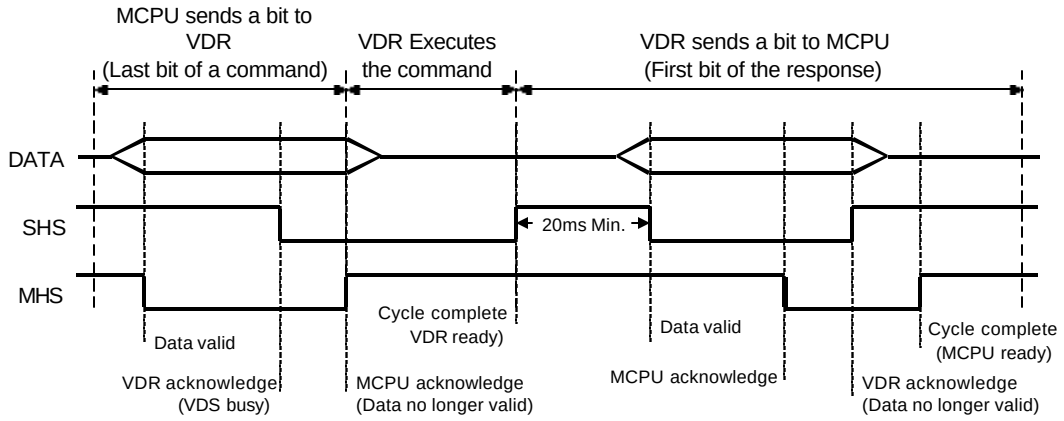


Figure 3 - Interrupt Timing Diagram

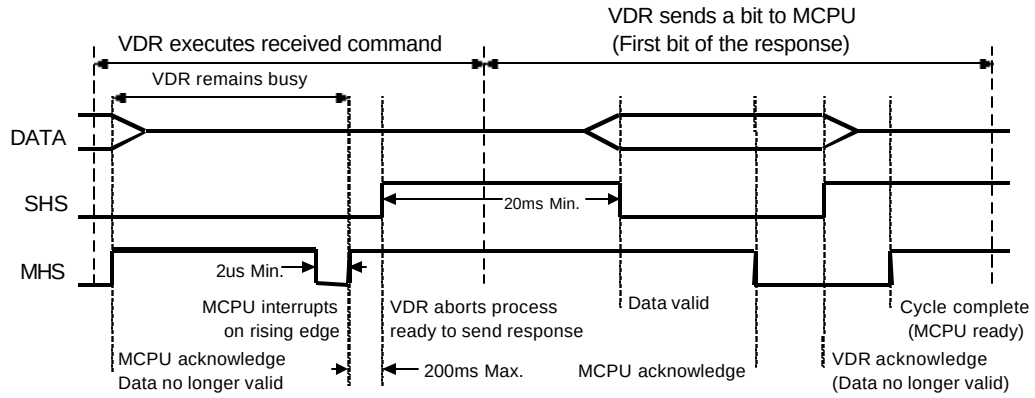
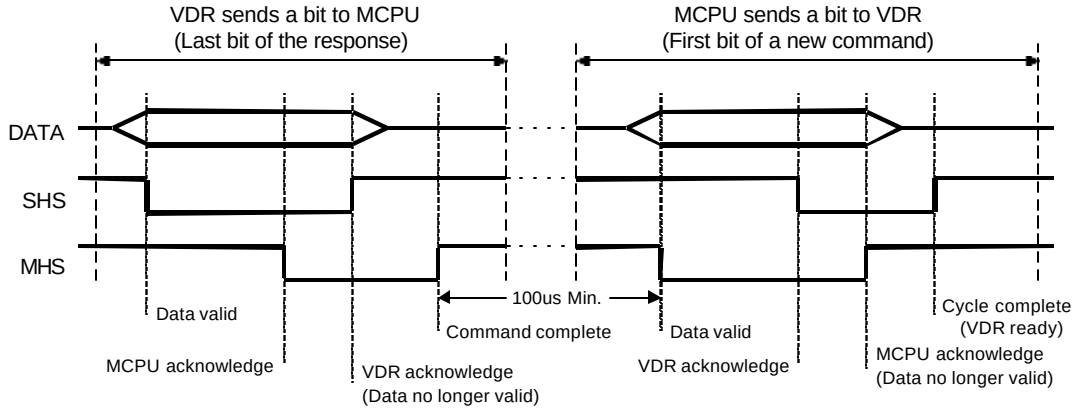


Figure 4 - Data Transfer (Response to Next Command)



Data Packets

> *This section applies only to Voice Direct™ 364 in slave mode.*

Overview

All data is transmitted in 8-bit bytes, and all messages are sent in packets. The packet format conveys error checking and byte synchronization information. A packet always starts with a "sync field" of FFh (8 or more 1 bits) followed by a length byte, then one or more data bytes, then a checksum byte. The length byte specifies the number of bytes to follow including the checksum. The checksum is the 8-bit additive, modulo-256 sum of all the data bytes and the length byte added together. For example the data 01, 02, 03, 04 would be sent as follows:

Table 8 - Sample Data Packet

Byte	Value	Notes
0	FFh	Sync Field, 8 or more consecutive 1 bits
1	05h	Packet length, count of bytes to follow
2	01h	First data byte
3	02h	Second data byte
4	03h	Third data byte
5	04h	Fourth data byte
6	0Fh	Checksum, (5+1+2+3+4)

Implementation

Packet/byte synchronization is accomplished as follows:

1. The receiver shifts in bits until the accumulated byte value is equal to FFh (all bits are zero).
2. The receiver then continues shifting in data until the most significant bit resets to zero. This indicates that the currently accumulated byte is a valid length byte and the start of a packet.

For synchronization to work properly, the receiver must first initialize its shift register to all zeroes. Once a valid packet is found the receiver accepts (length) bytes and performs the checksum calculation (ascertains that the sum of all the data bytes plus the length byte

is equal to the checksum byte). Note that modulo-256 arithmetic is used; the carry is discarded during the checksum calculation.

It is worth recalling that all communication is initiated by the MCPU; the Voice Direct™ 364 never sends data unless requested by the MCPU. Accordingly, all commands are in one of the following formats:

A request from the host CPU to Voice Direct™ 364. A request consists of a command byte and possible parameters or data.
A response from Voice Direct™ 364 to the MCPU. A response consists of a status byte and possible data.

After a command is issued to Voice Direct™ 364, the host CPU must wait until the VDS is ready (-SHS = high) before receiving the command response. The host CPU can interrupt a command by pulsing the -MHS line to the low state. This causes Voice Direct™ 364 to abort the task and return appropriate status. For more on this, see Figure 2 - Data Transfer – (Command to Response), Figure 3 - Interrupt Timing Diagram, and Figure 4 - Data Transfer (Response to Next Command).

External Component Specifications

This section includes a brief description and schematic of the external components needed to fully characterize a Voice Direct™ 364 IC. You can acquire these components and then use the schematic to build the circuit. Or Sensory, Inc. can supply you with everything you need:

- *The Voice Direct™ 364 Module* - A pre-configured circuit for prototype development and limited volume production.
- *The Voice Direct™ 364 Speech Recognition Kit* - The Voice Direct™ 364 Speech Recognition Kit includes a Voice Direct™ 364 Module, a speaker, a microphone element, and other passive components for the minimum hardware configuration.

For more information on these products, contact Sensory.

Voice Direct™ 364 needs very little external circuitry to operate. In either mode, the chip requires external circuitry as described and illustrated below.

Audio Output

The Voice Direct™ 364 IC provides a high-impedance (22kOhm) analog audio output DAC. This signal must be power amplified to drive a speaker, and should be low-pass filtered with a corner frequency around 20 kHz. See the Section Voice Direct™ 364 Module Schematics starting on page 63. *Included in the Voice Direct™ 364 Module and the Voice Direct™ 364 Speech Recognition Kit.*

Microphone

The microphone is used for speech inputs. It is an inexpensive omni-directional electret model with a minimum sensitivity of -60dB. Required for both stand-alone and slave modes. *Included in the Voice Direct™ 364 Speech Recognition Kit*.

Preamplifier

Voice Direct™ 364 IC incorporates the microphone preamplifier, which amplifies and filters the microphone signal to a level suitable for Voice Direct, requiring minimal parts. *Included in the Voice Direct™ 364 Module and the Voice Direct™ 364 Speech Recognition Kit.*

Serial EEPROM

Voice Direct™ 364 IC uses an 8 Kbyte serial EEPROM to store speech template. Voice Direct™ 364 Module includes the serial EEPROM on board. *Included in the Voice Direct™ 364 Module and the Voice Direct™ 364 Speech Recognition Kit.*

Oscillator

The oscillator provides a high frequency clock (14.318 MHz) for the Voice Direct™ 364 IC. It must be a crystal ceramic resonator or LC circuit. Required for both stand-alone and slave modes. *Included in the Voice Direct™ 364 Module and the Voice Direct™ 364 Speech Recognition Kit.*

Speaker

The speaker is used to output audio prompts from the Voice Direct™ 364. The IC requires an amplified speaker with high input impedance. The module includes an on-board power amplifier that can be used to directly drive an 8-ohm speaker. Please refer to Application Note 80-0105 *DAC Output* for recommended amplifier designs if you are designing your own application circuit. This document is available for download from Sensory's website at www.voiceactivation.com. *Included in the Voice Direct™ 364 Speech Recognition Kit.*

External ROM (Optional)

The external ROM is optional. It is required for customized speech or non-Standard English language applications. For more information, contact Sensory. *External ROM is intended for applications using the Voice Direct™ 364 IC and a custom PCB. The Voice Direct™ 364 Module and the Voice Direct™ 364 Speech Recognition Kit are not designed for use with external ROM.*

User Interface

Prompt List

While running training and recognition processes, Voice Direct™ 364 has direct and exclusive access to speech in the mandatory Prompt List. The Prompt List is actually a set of pointers to speech elements listed in the table below.

> *The spoken prompts in the Prompt List can be duplicated in the Speech list with little memory penalty.*

Table 9 - Prompt List

Prompt #	Spoken Prompt (English)	Spoken Prompt (German)
1	“one”	“eins”
2	“two”	“zwei”
3	“three”	“drei”
4	“four”	“vier”
5	“five”	“fünf”
6	“six”	“sechs”
7	“seven”	“sieben”
8	“eight”	“acht”
9	“nine”	“neun”
10	“ten”	“zehn”
11	“eleven”	“elf”
12	“twelve”	“zwölf”
13	“thirteen”	“dreizehn”
14	“fourteen”	“vierzehn”
15	“fifteen”	“fünfzehn”
16	“sixteen”	“sechszehn”
17	“seventeen”	“siebzehn”
18	“eighteen”	“achtzehn”
19	“nineteen”	“neunzehn”
20	“twenty”	“zwanzig”
21	“twenty one”	“einundzwanzig”
22	“twenty two”	“zweiundzwanzig”
23	“twenty three”	“dreiundzwanzig”
24	“twenty four”	“vierundzwanzig”
25	“twenty five”	“fünfundzwanzig”
26	“twenty six”	“sechsundzwanzig”
27	“twenty seven”	“siebenundzwanzig”
28	“twenty eight”	“achtundzwanzig”
29	“twenty nine”	“neunundzwanzig”
30	“thirty”	“dreißig”
31	“thirty one”	“einunddreißig”
32	“thirty two”	“zweiunddreißig”

33	“thirty three”	“dreiunddreißig”
34	“thirty four”	“vierunddreißig”
35	“thirty five”	“fünfunddreißig”
36	“thirty six”	“sechsunddreißig”
37	“thirty seven”	“siebenunddreißig”
38	“thirty eight”	“achtunddreißig”
39	“thirty nine”	“neununddreißig”
40	“forty”	“vierzig”
41	“forty one”	“einundvierzig”
42	“forty two”	“zweiundvierzig”
43	“forty three”	“dreiundvierzig”
44	“forty four”	“vierundvierzig”
45	“forty five”	“fünfundvierzig”
46	“forty six”	“sechsundvierzig”
47	“forty seven”	“siebenundvierzig”
48	“forty eight”	“achtundvierzig”
49	“forty nine”	“neunundvierzig”
50	“fifty”	“fünfzig”
51	“fifty one”	“einundfünfzig”
52	“fifty two”	“zweiundfünfzig”
53	“fifty three”	“dreiundfünfzig”
54	“fifty four”	“vierundfünfzig”
54	“fifty five”	“fünfundfünfzig”
56	“fifty six”	“sechsundfünfzig”
57	“fifty seven”	“siebenundfünfzig”
58	“fifty eight”	“achtundfünfzig”
59	“fifty nine”	“neunundfünfzig”
60	“sixty”	“sechzig”
61	“say word one”	“Sagen Sie Wort eins”
62	“say word two”	“Sagen Sie Wort zwei”
63	“say word three”	“Sagen Sie Wort drei”
64	“say word four”	“Sagen Sie Wort vier”
65	“say word five”	“Sagen Sie Wort fünf”
66	“say word six”	“Sagen Sie Wort sechs”
67	“say word seven”	“Sagen Sie Wort sieben”
68	“say word eight”	“Sagen Sie Wort acht”
69	“say word nine”	“Sagen Sie Wort neun”
70	“say word ten”	“Sagen Sie Wort zehn”
71	“say word eleven”	“Sagen Sie Wort elf”
72	“say word twelve”	“Sagen Sie Wort zwölf”
73	“say word thirteen”	“Sagen Sie Wort dreizehn”
74	“say word fourteen”	“Sagen Sie Wort vierzehn”
75	“say word fifteen”	“Sagen Sie Wort fünfzehn”
76	“say word sixteen”	“Sagen Sie Wort sechzehn”
77	“say word seventeen”	“Sagen Sie Wort siebzehn”
78	“say word eighteen”	“Sagen Sie Wort achtzehn”
79	“say word nineteen”	“Sagen Sie Wort neunzehn”
80	“say word twenty”	“Sagen Sie Wort zwanzig”
81	“say word twenty-one”	“Sagen Sie Wort einundzwanzig”

82	“say word twenty-two”	“Sagen Sie Wort zweiundzwanzig”
83	“say word twenty-three”	“Sagen Sie Wort dreiundzwanzig”
84	“say word twenty-four”	“Sagen Sie Wort vierundzwanzig”
85	“say word twenty-five”	“Sagen Sie Wort fünfundzwanzig”
86	“say word twenty-six”	“Sagen Sie Wort sechsundzwanzig”
87	“say word twenty-seven”	“Sagen Sie Wort siebenundzwanzig”
88	“say word twenty-eight”	“Sagen Sie Wort achtundzwanzig”
89	“say word twenty-nine”	“Sagen Sie Wort neunundzwanzig”
90	“say word thirty”	“Sagen Sie Wort dreißig”
91	“say word thirty-one”	“Sagen Sie Wort einunddreißig”
92	“say word thirty-two”	“Sagen Sie Wort zweiunddreißig”
93	“say word thirty-three”	“Sagen Sie Wort dreiunddreißig”
94	“say word thirty-four”	“Sagen Sie Wort vierunddreißig”
95	“say word thirty-five”	“Sagen Sie Wort fünfunddreißig”
96	“say word thirty-six”	“Sagen Sie Wort sechsunddreißig”
97	“say word thirty-seven”	“Sagen Sie Wort siebenunddreißig”
98	“say word thirty-eight”	“Sagen Sie Wort achtunddreißig”
99	“say word thirty-nine”	“Sagen Sie Wort neununddreißig”
100	“say word forty”	“Sagen Sie Wort vierzig”
101	“say word forty-one”	“Sagen Sie Wort einundvierzig”
102	“say word forty-two”	“Sagen Sie Wort zweiundvierzig”
103	“say word forty-three”	“Sagen Sie Wort dreiundvierzig”
104	“say word forty-four”	“Sagen Sie Wort vierundvierzig”
105	“say word forty-five”	“Sagen Sie Wort fünfundvierzig”
106	“say word forty-six”	“Sagen Sie Wort sechsundvierzig”
107	“say word forty-seven”	“Sagen Sie Wort siebenundvierzig”
108	“say word forty-eight”	“Sagen Sie Wort achtundvierzig”
109	“say word forty-nine”	“Sagen Sie Wort neunundvierzig”
110	“say word fifty”	“Sagen Sie Wort fünfzig”
111	“say word fifty-one”	“Sagen Sie Wort einundfünfzig”
112	“say word fifty-two”	“Sagen Sie Wort zweiundfünfzig”
113	“say word fifty-three”	“Sagen Sie Wort dreiundfünfzig”
114	“say word fifty-four”	“Sagen Sie Wort vierundfünfzig”
115	“say word fifty-five”	“Sagen Sie Wort fünfundfünfzig”
116	“say word fifty-six”	“Sagen Sie Wort sechsundfünfzig”
117	“say word fifty-seven”	“Sagen Sie Wort siebenundfünfzig”
118	“say word fifty-eight”	“Sagen Sie Wort achtundfünfzig”
119	“say word fifty-nine”	“Sagen Sie Wort neunundfünfzig”
120	“say word sixty”	“Sagen Sie Wort sechzig”
121	“say a word”	“Sagen Sie ein Wort”
122	“repeat”	“Wiederholen Sie”
123	“repeat to confirm”	“Wiederholen Sie zur Bestätigung”
124	“training complete”	“Training beendet”
125	“reconfigure or erase”	“Abändern oder löschen”
126	“memory”	“Speicher”
127	“memory empty”	“Der Speicher ist leer”
128	“memory full”	“Der Speicher ist voll”
129	“memory erased”	“Speicher gelöscht”

130	“word not recognized”	“Wort nicht erkannt”
131	“error”	“Fehler”
132	“training error”	“Fehler beim Training”
133	“try again”	“Versuchen Sie es noch einmal”
134	“please talk louder”	“Bitte, sprechen Sie lauter”
135	“please talk softer”	“Bitte, sprechen Sie leiser”
136	“spoke too soon”	“Sie haben zu früh gesprochen”
137	“accepted”	“akzeptiert”
137	“rejected”	“abgelehnt”
139	“similar to a prior word”	“Ähnlich zu einem bestehenden Eintrag”
140	“similar to word one”	“Ähnlich zu Wort eins”
141	“similar to word two”	“Ähnlich zu Wort zwei”
142	“similar to word three”	“Ähnlich zu Wort drei”
143	“similar to word four”	“Ähnlich zu Wort vier”
144	“similar to word five”	“Ähnlich zu Wort fünf”
145	“similar to word six”	“Ähnlich zu Wort sechs”
146	“similar to word seven”	“Ähnlich zu Wort sieben”
147	“similar to word eight”	“Ähnlich zu Wort acht”
148	“similar to word nine”	“Ähnlich zu Wort neun”
149	“similar to word ten”	“Ähnlich zu Wort zehn”
150	“similar to word eleven”	“Ähnlich zu Wort elf”
151	“similar to word twelve”	“Ähnlich zu Wort zwölf”
152	“similar to word thirteen”	“Ähnlich zu Wort dreizehn”
153	“similar to word fourteen”	“Ähnlich zu Wort vierzehn”
154	“similar to word fifteen”	“Ähnlich zu Wort fünfzehn”
155	“similar to word sixteen”	“Ähnlich zu Wort sechzehn”
156	“similar to word seventeen”	“Ähnlich zu Wort siebzehn”
157	“similar to word eighteen”	“Ähnlich zu Wort achtzehn”
158	“similar to word nineteen”	“Ähnlich zu Wort neunzehn”
159	“similar to word twenty”	“Ähnlich zu Wort zwanzig”
160	“similar to word twenty-one”	“Ähnlich zu Wort einundzwanzig”
161	“similar to word twenty-two”	“Ähnlich zu Wort zweiundzwanzig”
162	“similar to word twenty-three”	“Ähnlich zu Wort dreiundzwanzig”
163	“similar to word twenty-four”	“Ähnlich zu Wort vierundzwanzig”
164	“similar to word twenty-five”	“Ähnlich zu Wort fünfundzwanzig”
165	“similar to word twenty-six”	“Ähnlich zu Wort sechsundzwanzig”
166	“similar to word twenty-seven”	“Ähnlich zu Wort siebenundzwanzig”
167	“similar to word twenty-eight”	“Ähnlich zu Wort achtundzwanzig”
168	“similar to word twenty-nine”	“Ähnlich zu Wort neunundzwanzig”
169	“similar to word thirty”	“Ähnlich zu Wort dreißig”
170	“similar to word thirty-one”	“Ähnlich zu Wort einunddreißig”
171	“similar to word thirty-two”	“Ähnlich zu Wort zweiunddreißig”
172	“similar to word thirty-three”	“Ähnlich zu Wort dreiunddreißig”
173	“similar to word thirty-four”	“Ähnlich zu Wort vierunddreißig”
174	“similar to word thirty-five”	“Ähnlich zu Wort fünfunddreißig”
175	“similar to word thirty-six”	“Ähnlich zu Wort sechsunddreißig”
176	“similar to word thirty-seven”	“Ähnlich zu Wort siebenunddreißig”
177	“similar to word thirty-eight”	“Ähnlich zu Wort achtunddreißig”
178	“similar to word thirty-nine”	“Ähnlich zu Wort neununddreißig”

179	“similar to word forty”	“Ähnlich zu Wort vierzig”
180	“similar to word forty-one”	“Ähnlich zu Wort einundvierzig”
181	“similar to word forty-two”	“Ähnlich zu Wort zweiundvierzig”
182	“similar to word forty-three”	“Ähnlich zu Wort dreiundvierzig”
183	“similar to word forty-four”	“Ähnlich zu Wort vierundvierzig”
184	“similar to word forty-five”	“Ähnlich zu Wort fünfundvierzig”
185	“similar to word forty-six”	“Ähnlich zu Wort sechsundvierzig”
186	“similar to word forty-seven”	“Ähnlich zu Wort siebenundvierzig”
187	“similar to word forty-eight”	“Ähnlich zu Wort achtundvierzig”
188	“similar to word forty-nine”	“Ähnlich zu Wort neunundvierzig”
189	“similar to word fifty”	“Ähnlich zu Wort fünfzig”
190	“similar to word fifty-one”	“Ähnlich zu Wort einundfünfzig”
191	“similar to word fifty-two”	“Ähnlich zu Wort zweiundfünfzig”
192	“similar to word fifty-three”	“Ähnlich zu Wort dreiundfünfzig”
193	“similar to word fifty-four”	“Ähnlich zu Wort vierundfünfzig”
194	“similar to word fifty-five”	“Ähnlich zu Wort fünfundfünfzig”
195	“similar to word fifty-six”	“Ähnlich zu Wort sechsundfünfzig”
196	“similar to word fifty-seven”	“Ähnlich zu Wort siebenundfünfzig”
197	“similar to word fifty-eight”	“Ähnlich zu Wort achtundfünfzig”
198	“similar to word fifty-nine”	“Ähnlich zu Wort neunundfünfzig”
199	“similar to word sixty”	“Ähnlich zu Wort sechzig.”
200	low beep	low beep
201	double low beep	double low beep
202	high beep	high beep
203	double high beep	double high beep
204	low beep high beep (rising)	low beep high beep (rising)
205	high beep low beep (falling)	high beep low beep (falling)
206	long beep	long beep
207	high beep m$	high beep m$
208	double high beep	double high beep

Optional Prompt List

The speech list contains optional prompts that may be used to create the application’s user interface. The Optional Prompt List is accessed via the Say A Prompt Command. Phrases can be substituted or added to this list based on memory availability.

Table 10 – Optional Prompt List

Prompt #	Spoken Prompt Description
1	one
2	two
3	three
4	four
5	five
6	six

7	seven
8	eight
9	nine
10	ten
11	eleven
12	twelve
13	thirteen
14	fourteen
15	fifteen
16	sixteen
17	seventeen
18	eighteen
19	nineteen
20	twenty
21	twenty one
22	twenty two
23	twenty three
24	twenty four
25	twenty five
26	twenty six
27	twenty seven
28	twenty eight
29	twenty nine
30	thirty
31	thirty one
32	thirty two
33	thirty three
34	thirty four
35	thirty five
36	thirty six
37	thirty seven
38	thirty eight
39	thirty nine
40	forty
41	forty one
42	forty two
43	forty three
44	forty four
45	forty five
46	forty six
47	forty seven
48	forty eight
49	forty nine
50	fifty
51	fifty one
52	fifty two
53	fifty three
54	fifty four
55	fifty five
56	fifty six

57	fifty seven
58	fifty eight
59	fifty nine
60	sixty
61	user one
62	user two
63	user three
64	user four
65	accepted
66	rejected
67	a
68	b
69	c
70	d
71	directory a
72	directory b
73	directory c
74	directory d
75	memory set a
76	memory set b
77	memory set c
78	memory set d
79	reconfigure or erase
80	memory
81	memory empty
82	memory full
83	memory erased
84	memory set a erased
85	memory set b erased
86	memory set c erased
87	memory set d erased
88	repeat
89	repeat to confirm
90	training complete
91	you said word one
92	you said word two
93	you said word three
94	you said word four
95	you said word five
96	you said word six
97	you said word seven
98	you said word eight
99	you said word nine
100	you said word ten
101	you said word eleven
102	you said word twelve
103	you said word thirteen
104	you said word fourteen
105	you said word fifteen

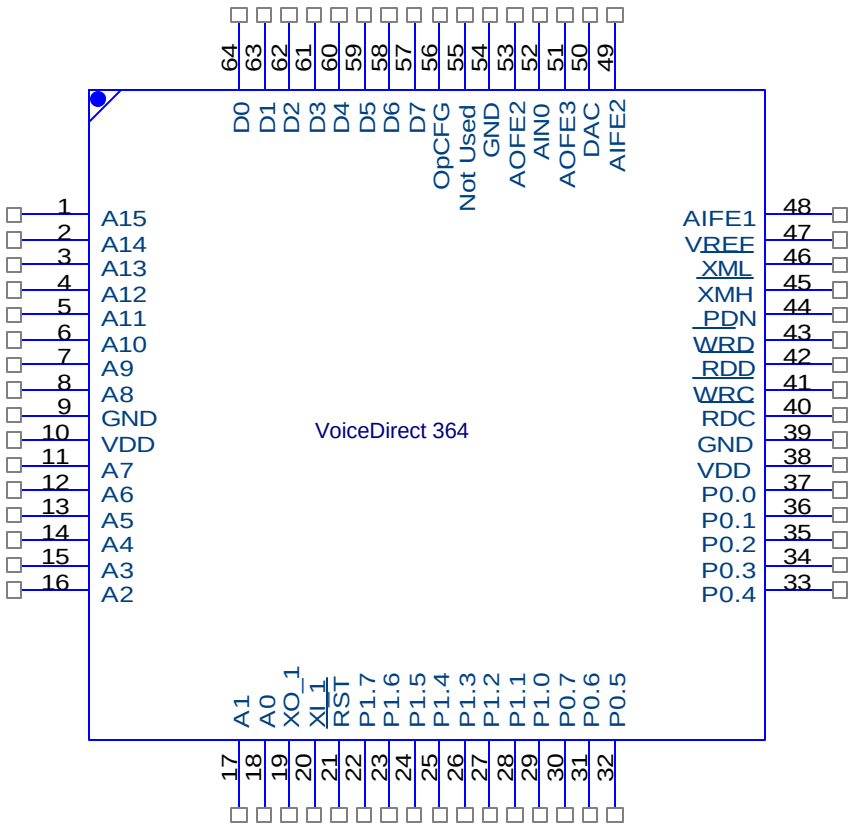
106	you said word sixteen
107	you said word seventeen
108	you said word eighteen
109	you said word nineteen
110	you said word twenty
111	you said word twenty-one
112	you said word twenty-two
113	you said word twenty-three
114	you said word twenty-four
115	you said word twenty-five
116	you said word twenty-six
117	you said word twenty-seven
118	you said word twenty-eight
119	you said word twenty-nine
120	you said word thirty
121	you said word thirty-one
122	you said word thirty-two
123	you said word thirty-three
124	you said word thirty-four
125	you said word thirty-five
126	you said word thirty-six
127	you said word thirty-seven
128	you said word thirty-eight
129	you said word thirty-nine
130	you said word forty
131	you said word forty-one
132	you said word forty-two
133	you said word forty-three
134	you said word forty-four
135	you said word forty-five
136	you said word forty-six
137	you said word forty-seven
138	you said word forty-eight
139	you said word forty-nine
140	you said word fifty
141	you said word fifty-one
142	you said word fifty-two
143	you said word fifty-three
144	you said word fifty-four
145	you said word fifty-five
146	you said word fifty-six
147	you said word fifty-seven
148	you said word fifty-seven
149	you said word fifty-eight
150	you said word fifty-nine
151	you said word sixty
152	word not recognized
153	error
154	training error
155	try again

156	please talk louder
157	please talk softer
158	spoke too soon
159	similar to a prior word
160	similar to word one
161	similar to word two
162	similar to word three
163	similar to word four
164	similar to word five
165	similar to word six
166	similar to word seven
167	similar to word eight
168	similar to word nine
169	similar to word ten
170	similar to word eleven
171	similar to word twelve
172	similar to word thirteen
173	similar to word fourteen
174	similar to word fifteen
175	similar to word sixteen
176	similar to word seventeen
177	similar to word eighteen
178	similar to word nineteen
179	similar to word twenty
180	similar to word twenty-one
181	similar to word twenty-two
182	similar to word twenty-three
183	similar to word twenty-four
184	similar to word twenty-five
185	similar to word twenty-six
186	similar to word twenty-seven
187	similar to word twenty-eight
188	similar to word twenty-nine
189	similar to word thirty
190	similar to word thirty-one
191	similar to word thirty-two
192	similar to word thirty-three
193	similar to word thirty-four
194	similar to word thirty-five
195	similar to word thirty-six
196	similar to word thirty-seven
197	similar to word thirty-eight
198	similar to word thirty-nine
199	similar to word forty
200	similar to word forty-one
201	similar to word forty-two
202	similar to word forty-three
203	similar to word forty-four
204	similar to word forty-five

205	similar to word forty-six
206	similar to word forty-seven
207	similar to word forty-eight
208	similar to word forty-nine
209	similar to word fifty
210	similar to word fifty-one
211	similar to word fifty-two
212	similar to word fifty-three
213	similar to word fifty-four
214	similar to word fifty-five
215	similar to word fifty-six
216	similar to word fifty-seven
217	similar to word fifty-eight
218	similar to word fifty-nine
219	similar to word sixty
220	*low beep*
221	*double low beep*
222	*high beep*
223	*double high beep*
224	*low beep high beep (rising)*
225	*high beep low beep (falling)*
226	*long beep*
227	*high beep*
228	*double high beep*
229	*0 msec silence*
230	*20 msec silence*
231	*40 msec silence*
232	*50 msec silence*
233	*75 msec silence*
234	*100 msec silence*
235	*160 msec silence*
236	*320 msec silence*
237	*500 msec silence*
238	*1000 msec silence*
239	*2000 msec silence*
240	*4000 msec silence*

Voice Direct™ 364 IC Specifications

IC Pin Descriptions



Pin Identification

Name	QFP Pin	Description	I/O
A[15:0]	1-8, 11-18	External Memory Address Bus	O
AIN0	52	Analog In, low gain. (range AGND to AVDD/2.)	I
AOFE2	53	Output of 2nd stage of preamplifier	O
AOFE3	51	Output of 3rd stage of preamplifier	O
AIFE1	48	Input of 1st stage of preamplifier	I
AIFE2	49	Input of 2nd stage of preamplifier	I
Not Used	55	-	O
MODE	56	Stand Alone / Slave Mode Select	I
DACOUT	50	Analog Output (not buffered)	O
D[7:0]	57-64	External Data Bus	I/O
GND	9, 39,54	Ground	-
PDN	44	Power Down. Active high when powered down.	O
P00	37	Stand Alone: Not Used	-
		Slave: Serial Interface Master Handshake (MFS)	I
P01	36	Stand Alone: Recognition	I
		Slave: Not Used	-
P02	35	Stand Alone: Training	I
		Slave: Not Used	-
P03	34	Stand Alone: Error LED	O
		Slave: Low when processing a command	O
P04	33	CLOCK for Serial EEPROM	O
P05	32	DATA for Serial EEPROM	I/O
P06	31	Stand Alone: CL Talk LED / CL Configuration	I/O
		Slave: Not Used	-
P07	30	Stand Alone: CL Training	I/O
		Slave: Not Used	-
P10	29	Stand Alone: Output Set 1 or 9	O
		Slave: TALK	O
P11	28	Stand Alone: Output Set 2 or 10	O
		Slave: Configurable I/O - 0	I/O
P12	27	Stand Alone: Output Set 3 or 11	O
		Slave: Configurable I/O - 1	I/O
P13	26	Stand Alone: Output Set 4 or 12	O
		Slave: Configurable I/O - 2	I/O
P14	25	Stand Alone: Output Set 5 or 13	O
		Slave: Configurable I/O - 3	I/O
P15	24	Stand Alone: Output Set 6 or 14	O
		Slave: Configurable I/O - 4	I/O

P16	23	Stand Alone: Output Set 7 or 15 Slave: Serial Interface Handshake (SHS)	O I/O
P17	22	Stand Alone: Output Set 8 Slave: Serial Interface Data (DATA)	O I/O
/RDC	40	Code Read Strobe	O
/RDD	42	Data Read Strobe	O
/RESET	21	Reset	I
VREF	47	Reference Voltage = Vdd/2	-
V_{DD}	10,38	Supply Voltage	-
/WRC	41	Code Write Strobe	O
/WRD	43	Data Write Strobe	O
/XMH	45	External Hi-memory enable (low active)	I
/XML	46	External Low-memory enable (low active)	I
XO1	19	Oscillator 1 output (high frequency)	O
XI1	20	Oscillator 1 input	I
XO2	NA	Oscillator 2 output (32768 Hz)	O
XI2	NA	Oscillator 2 input	I

Note: Substrate should be connected to VSS

ABSOLUTE MAXIMUM RATINGS

Any pin to GND	-0.1V to +6.5V
Operating temperature(T_O)	-20°C to +70°C
Soldering temperature	260°C for 10 sec
Power dissipation	1 W
Operating Conditions	-20°C to +70°C; V_{DD}=2.4 - 5.25V V_{SS}=0V

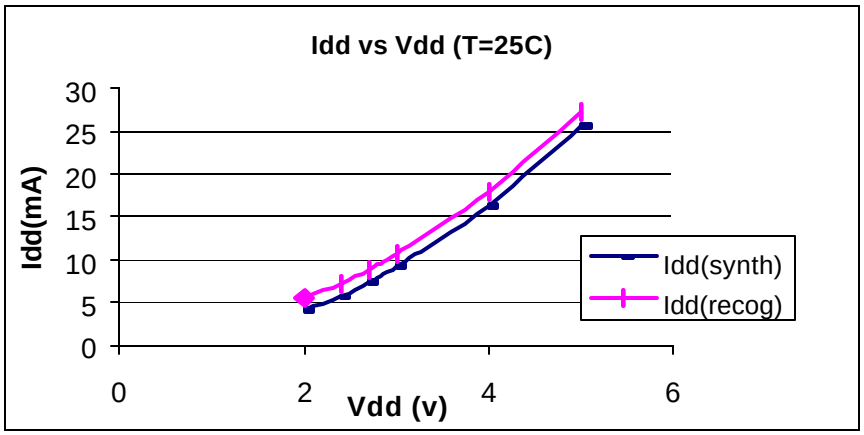
WARNING: *Stressing the RSC-364 beyond the "Absolute Maximum Ratings" may cause permanent damage. These are stress ratings only. Operation beyond the "Operating Conditions" is not recommended and extended exposure beyond the "Operating Conditions" may affect device reliability.*

D.C. CHARACTERISTICS

(T_O = -20°C to +70°C, V_{DD} = 2.4V – 5.25V)

SYMBOL	PARAMETER	MIN	TYP	MAX	UNITS	TEST CONDITIONS
V_{IL}	Input Low Voltage	-0.1		0.75	V	
V_{IH}(Vcc<3.6)	Input High Voltage	0.8*Vdd		Vdd+0.3	V	
V_{IH}(Vcc>3.6)	Input High Voltage	3.0		Vdd+0.3	V	
V_{OL}	Output Low Voltage		0.3	0.1*Vdd	V	I_{OL}= 2 mA
V_{OH}	Output High Voltage (I/O Pins)	0.8*Vdd	0.9*Vdd		V	I_{OL}= -2 mA
I_{IL}	Logical 0 Input Current		<1	10	uA	$V_{ss}<V_{pin}<V_{dd}$
I_{DD1}(Vcc=3.3V)	Supply Current, Active		10	20	mA	Hi-Z Outputs
I_{DD3}(Vcc=3.3V)	Supply Current, Powerdown		1	10	uA	Hi-Z Outputs
Rpu	Pull-up resistance P0.0-P1.7					
	I/O Pins	5,80, Hi-Z	6.5,200, Hi-Z		kΩ	Selected with software
	/XML,/XMH		200		kΩ	Fixed

VDD vs. IDD

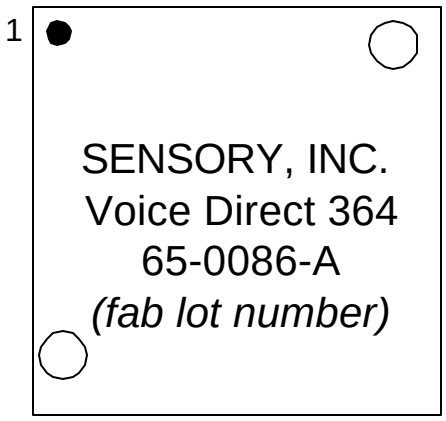


A.C. Characteristics (External memory accesses)

(T_O = -20°C to +70°C, V_{DD} = 3.3V; load capacitance for outputs = 80 pF; Osc=14.32 MHz)

SYMBOL	PARAMETER	CPU=osc/1, 1 WS MIN	CPU=osc/1, 1 WS MAX	CPU=osc/2, 0WS MIN	CPU=osc/2, 0WS MAX	
1/TCL1	Processor Clock frequency		14.32		7.16	MHz
TRLRH	-RDC (-RDD) Pulse Width		140		140	ns
TRLAV	-RDC (-RDD) Low to Address valid		5		5	ns
TALRAX	Address hold after -RDC (-RDD)		0		0	ns
TRAVDV	Address valid to Valid Data In		135		135	ns
TRHDX	Data Hold after -RDC (-RDD)	0		0		ns
TWLWH	-WRC (-WRD) Pulse Width		140		140	ns
TAVWL	Address Valid to -WRC (-WRD)	35		70		ns
TALWAX	Address Hold after -WRC (-WRD)	35		70		ns
TWDVAV	Write Data Valid to Address Valid		5		5	ns
TWHQX	Data Hold after -WRC (-WRD)	35		70		ns

IC Marking

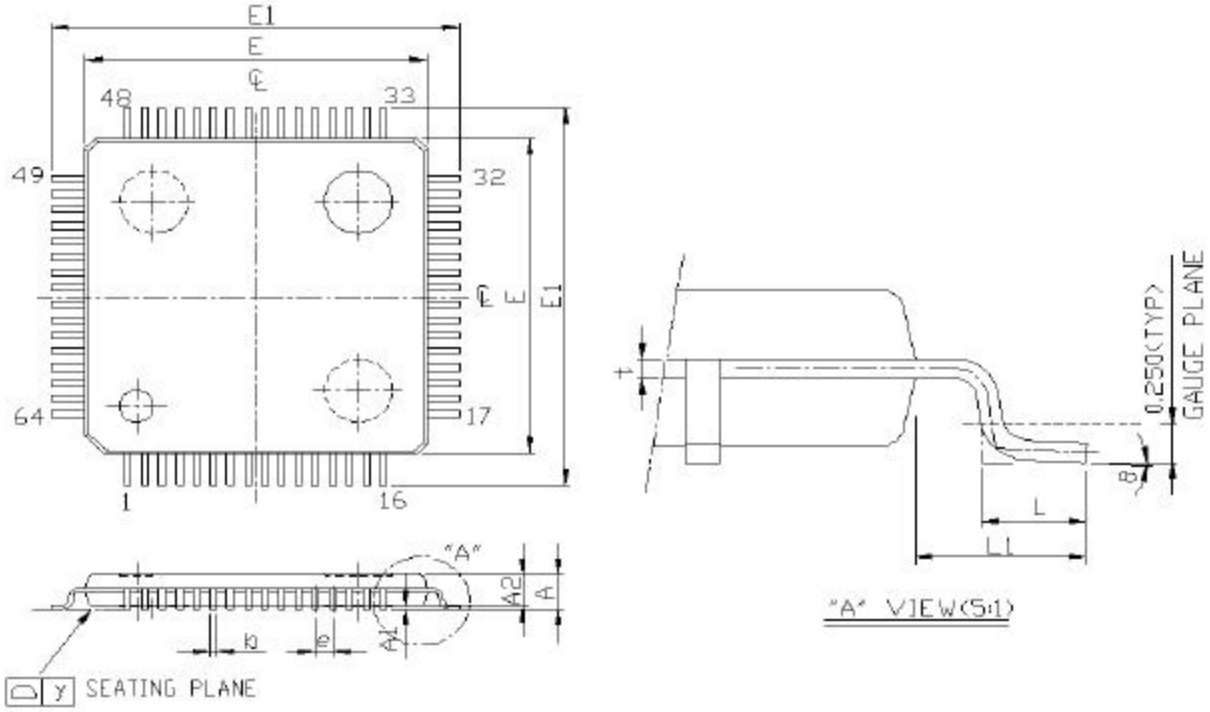


Pin #1 of Top Mark:	*Top Left*
Height of Character:	*Please scale to fit*
Fab Lot Number:	*Lot and wafer number provided by wafer fab*

IC Packaging Specification

Package:	64L QFP (10x10x1.4mm)
Tray:	KOSTAT Thin Bakeable, Black, Static Dissipative 160 positions. Max Bake Temperature: 150° C.
Bundle (Typical):	10 + 1 (1600 parts)

-Cu L/F, Footprint 1.0mm



UNIT/ SYMBOL	MM (BASE)	INCH (REF)
A	1.200 (MAX)	0.047 (MAX)
A1	0.100±0.05	0.004±0.002
A2	1.00±0.05	0.039±0.002
b	0.170~0.270	0.007~0.011
E1	12.000±0.100	0.472±0.004
E	10.000±0.100	0.394±0.004
e	0.500 (TYP)	0.020 (TYP)
t	0.127 (TYP)	0.005 (TYP)
y	0.076 (MAX)	0.003 (MAX)
¶	0~7°	0~7°
L	0.006±0.150	0.024±0.006
L1	1.000 (REF)	0.039 (REF)

Packaging Description

Each bundle consists of 10 full trays plus 1 empty tray. Each bundle is strapped with 3 nylon straps. After the trays are bundled, each bundle is placed in a conductive bag with silica gel. The bag is then sealed after air is evacuated from the bag.

The sealed bundle is put into a cardboard box in the following order: cardboard sheet, two sheets of bubble wrap, the bundle, two more sheets of bubble wrap and lastly another piece of cardboard. The cardboard box is then sealed.

On one of the short ends of the box, a label is affixed that contains the same information listed on the bag label.

Dry Bag Recommendations

This device has been qualified to meet JEDEC Moisture Sensitivity Level 3 requirements. Level 3 specifies that the exposure time at the customer site after opening the units is 168 hours in an environment less than 30C and 60% RH.

Manufacturing Information

Manufacturer: Taiwan Semiconductor Manufacturing Corporation (TSMC)
Country of Origin: Taiwan

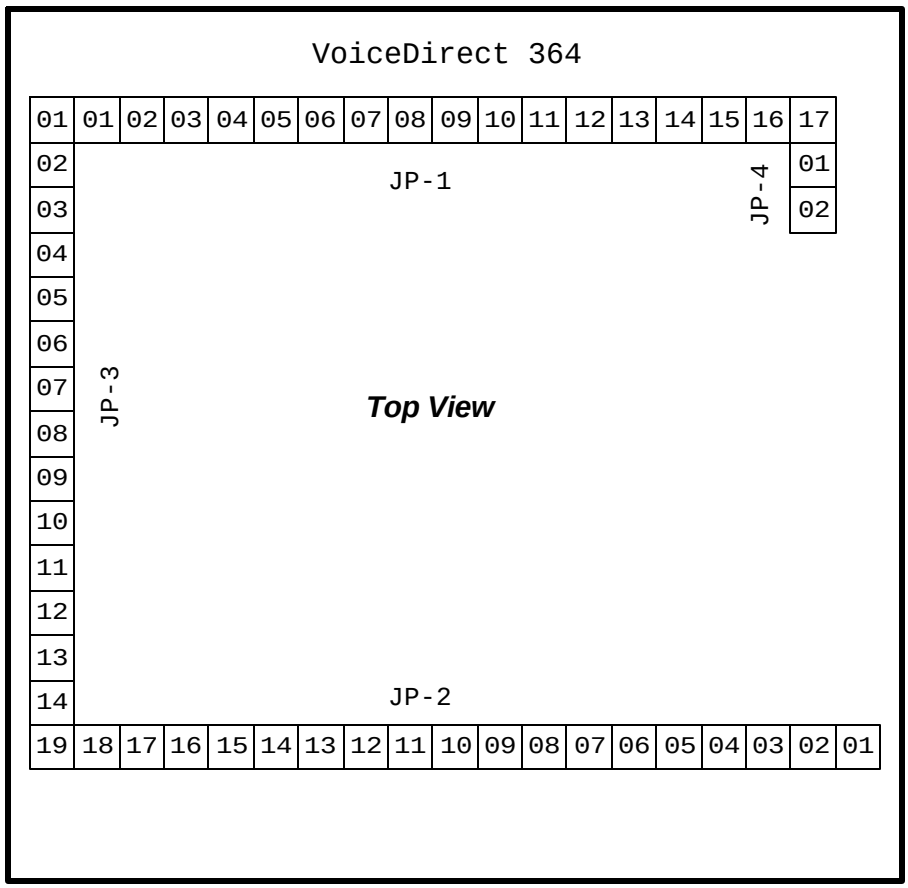
Voice Direct™ 364 Module Specifications

The Voice Direct™ 364 Module is a pre-configured circuit that integrates required external components for prototype development and lower volume production runs. The Voice Direct™ 364 Module comes with all of the required external components except for a microphone and speaker. The Voice Direct™ 364 Module integrates the following:

- Audio power amplifier
- Atmel AT27C512R (512 Kbit)
- Oscillator (14.31818 MHz)

The Voice Direct™ 364 Module is approximately 2 inches x 2 inches.

Voice Direct™ 364 Module Port Layout



Module Pin Descriptions

Pin #	Name	Description	I/O
JP1:			
01 ~ 17	-	Not Used	I
JP2:			
01	MIC IN	Microphone Input Connection	I
02	MIC BIAS	Microphone Bias (Electret microphone)	O
03	MIC RETURN	Analog Ground. For noise reasons, analog and digital grounds should connect together only at the Voice Direct 364	-
04	+5V	5 Volt (+) power supply connection	I
05	GND	Ground connection	I
06	SPEAKER (+)	Speaker connection (positive)	O
07	SPEAKER (-)	Speaker connection (internally connected to ground)	O
08	DACOUT	Analog output (unbuffered)	O
09	MHS (P0.0)	Stand Alone Mode: Not Used Slave Mode: Serial Interface Master Handshake (MHS)	- I
10	-RECOG (P0.1)	Stand Alone Mode: Recognition Sensitivity (see below) Slave Mode: Not Used	I -
11	-TRAIN (P0.2)	Stand Alone Mode: Training Sensitivity (see below) Slave Mode: Not Used	I -
12	OUT1 (P1.0)	Stand Alone Mode: Output 1 or 9 (Active high) Slave Mode: Talk	O O
13	OUT2 (P1.1)	Stand Alone Mode: Output 2 or 10 (Active high) Slave Mode: Configurable I/O #0	O I/O
14	OUT3 (P1.2)	Stand Alone Mode: Output 3 or 11 (Active high) Slave Mode: Configurable I/O #1	O I/O
15	OUT4 (P1.3)	Stand Alone Mode: Output 4 or 12 (Active high) Slave Mode: Configurable I/O #2	O I/O
16	OUT5 (P1.4)	Stand Alone Mode: Output 5 or 13 (Active high) Slave Mode: Configurable I/O #3	O I/O
17	OUT6 (P1.5)	Stand Alone Mode: Output 6 or 14 (Active high) Slave Mode: Configurable I/O #4	O I/O
18	OUT7 / SHS (P1.6)	Stand Alone Mode: Output 7 or 15 (Active high) Slave Mode: Serial Interface Slave Handshake (SHS)	O I/O
19	OUT8 / DATA (P1.7)	Stand Alone Mode: Output 8 (Active high) Slave Mode: Serial Interface Data (DATA)	O I/O
JP3:			
01 ~ 08	-	Not Used	-
09	WRC	External Code Write Strobe (Active low).	O
10	ERROR / PROCESS (P0.3)	Stand Alone Mode: Error LED Slave Mode: Low when processing a command	O O
11	GND	Ground	I
12	GND	Ground	I
13	MODE	Slave/Stand-alone mode selection	I
14	-RESET	Reset (Active low)	I
JP4:			
01	TALK / CL CFG (P0.6)	Stand Alone Mode: TALK LED, Single-/Multi-CL config. port Slave Mode: Not Used	I/O -
02	-CL TRAIN (P0.7)	Stand Alone Mode: CL Training, CL performance config. port Slave Mode: Not Used	I -

Voice Direct™ 364 Module Schematics

This section contains schematics detailing the internal circuitry of the Voice Direct™ 364 module, as well as system configuration schematics describing how to power-up the module in different modes of operation.

Figure 5: Voice Direct™ 364 Module Schematic

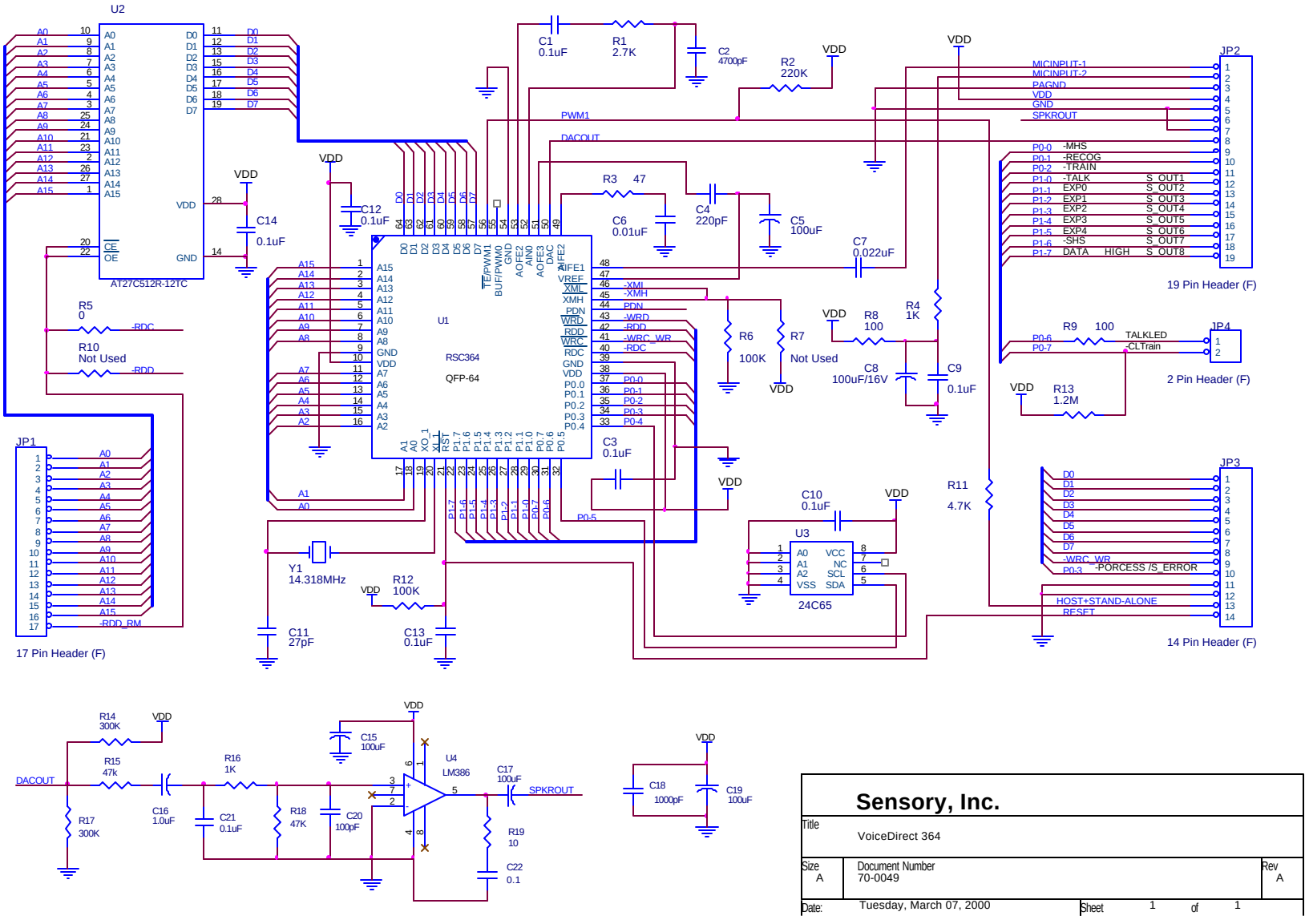


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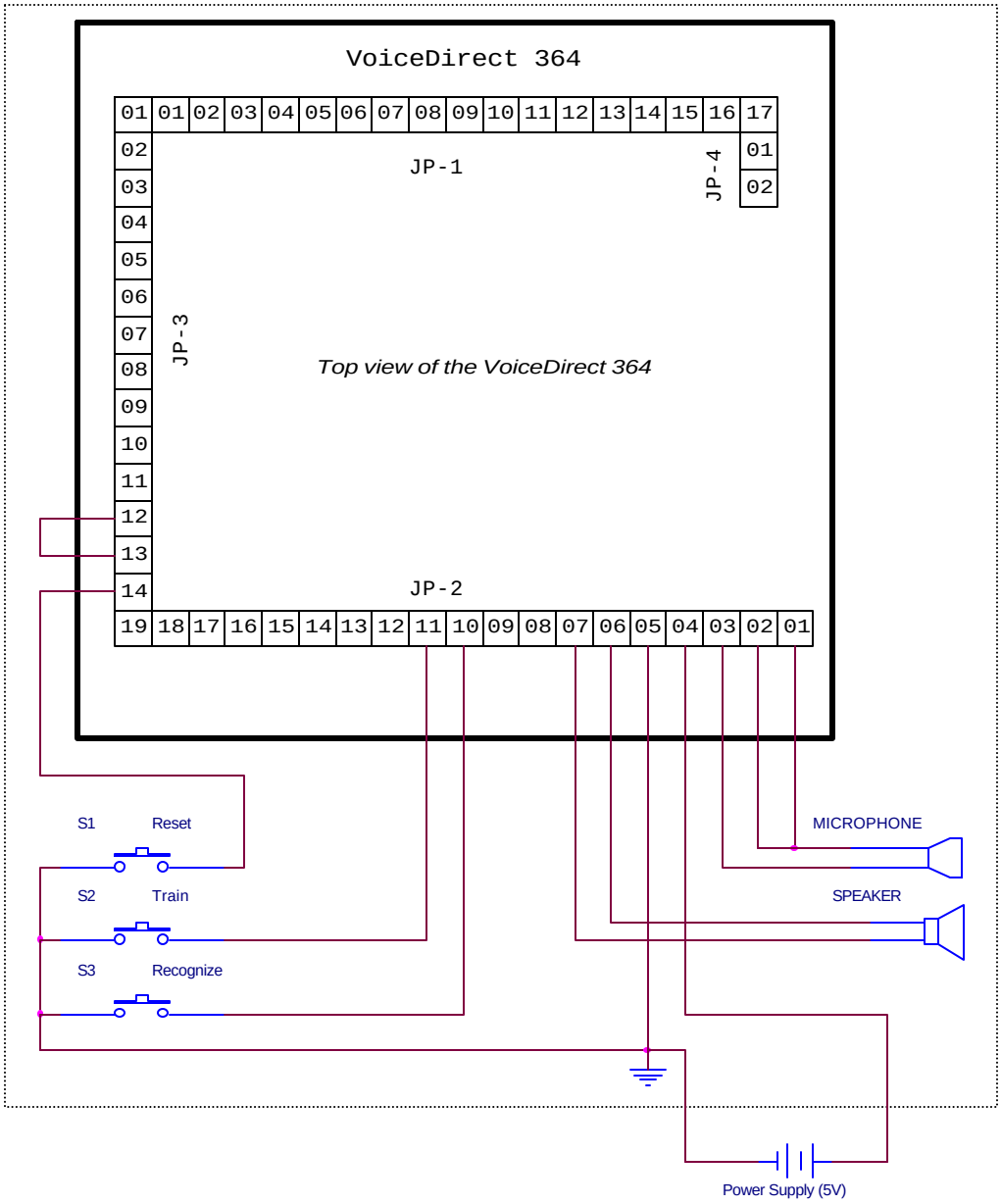
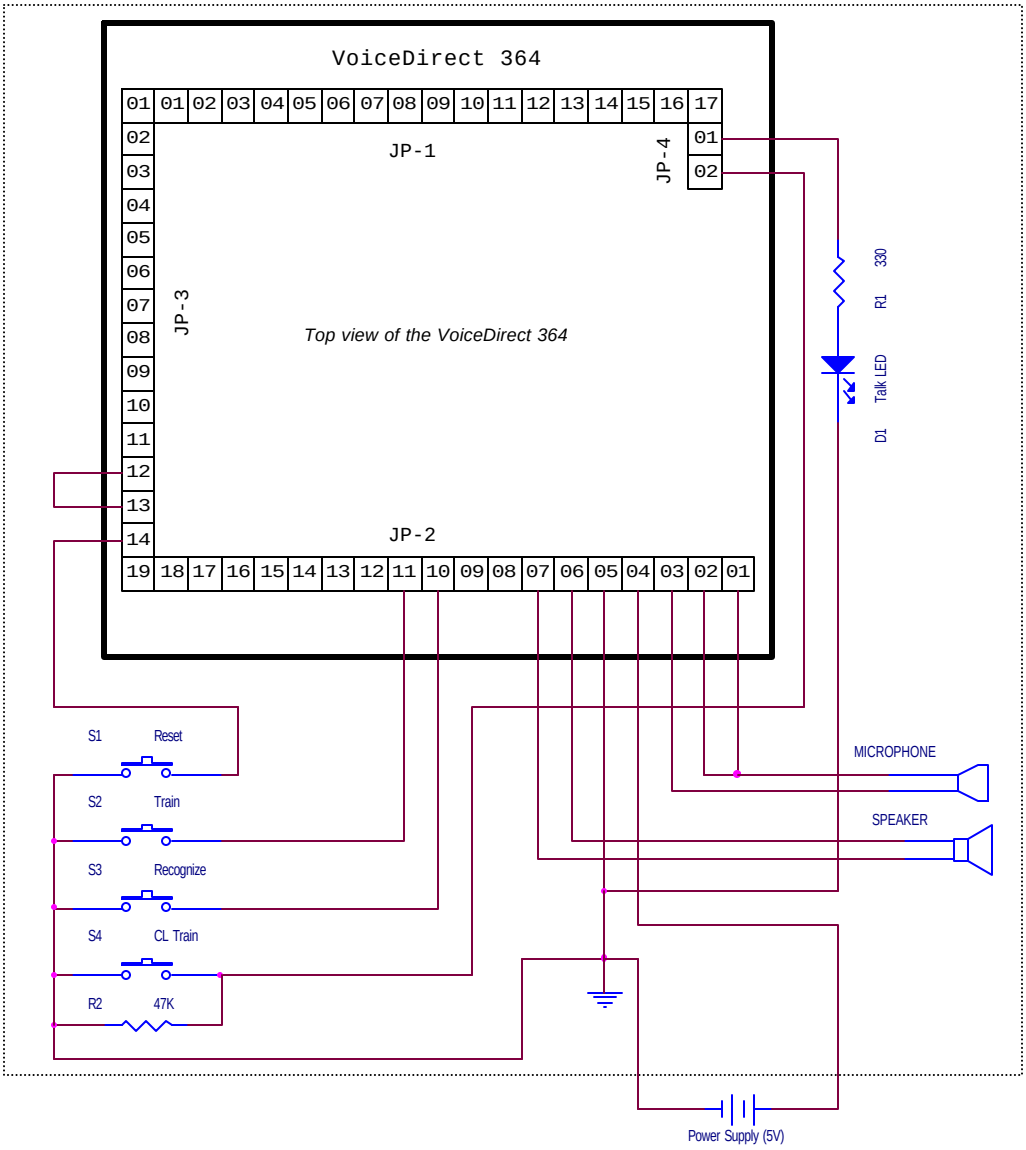
Figure 6: Module Stand Alone SD Mode Schematic



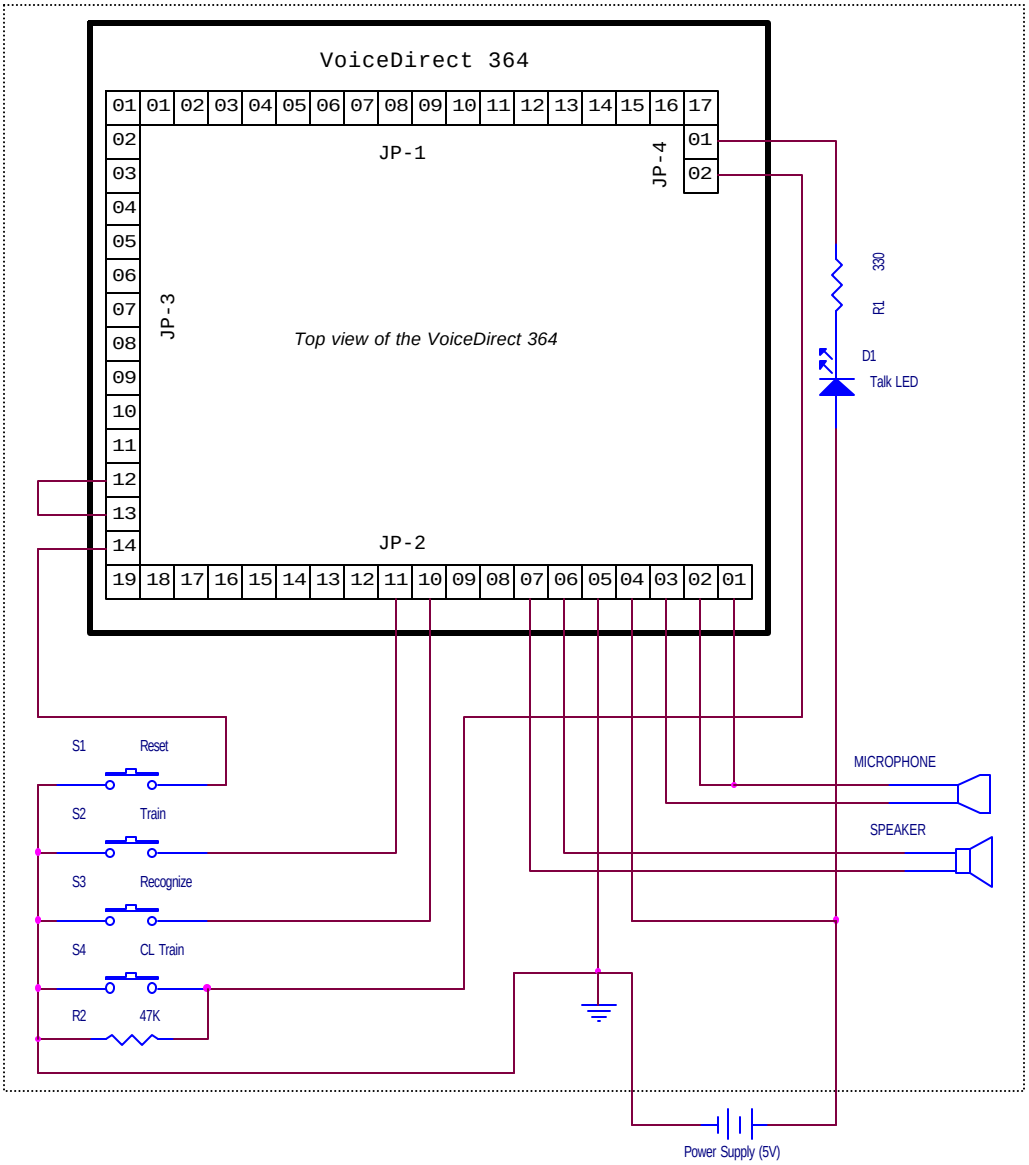
Note: Parts inside the dotted box are supplied with the Voice Direct™ 364 Speech Recognition Kit.

Figure 7: Module Stand Alone Single-CL Mode Schematic



Note: Parts inside the dotted box are supplied with the Voice Direct™ 364 Speech Recognition Kit.

Figure 8: Module Stand Alone Multi-CL Mode Schematic



Note: Parts inside the dotted box are supplied with the Voice Direct™ 364 Speech Recognition Kit.

Figure 9: Module Slave Mode Schematic