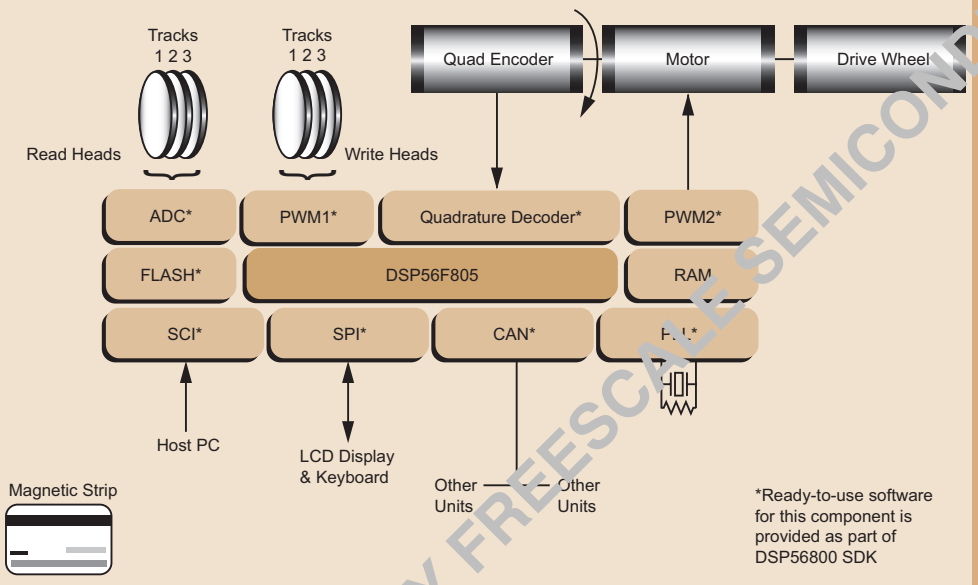
Applying the DSP56F801, 803, and 805 in Magnetic Card Strip Encoders and Readers

Overview

In addition to the common credit card, magnetic strip card use has rapidly spread to student IDs, grocery store discount cards, copy machine user ID cards, vending machine debit cards, library cards, etc. The DSP56F80x family offers the processing power and peripherals for a cost-effective solution.

DSP56F805 SUPERIOR CARD ENCODING ELEMENTS



Key Benefits

> Combines processing power of a DSP, functionality of a microcontroller, and flexible set of peripherals on a single chip

> ADC peripherals can work with varied inputs, allowing maximum flexibility on the type of preamplifier used with system's read heads

> SCI ports connect easily to host processing system; SPI ports support stand-alone system

> CAN bus networking groups together high-volume encoder applications

> Out-of-the-box software components designed to expedite time-to-market and reduce development costs

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Freescale Ordering Information

Part Number	Product Highlights	Additional Information
DSP56F801	80MHz, 40 MIPS, SCI, SPI, ADC, PWM, Quad Timer and > 8K Program Flash > 1K Program RAM > 2K Data Flash > 1K Data RAM	MCU-friendly instruction set, OnCE for debug, on-chip relaxation oscillator, 2K BootFLASH and up to 11 GPIO available in a 48-pin LQFP.
DSP56F803	80MHz, 40 MIPS, CAN, SCI, SPI, ADC, PWMs, Quadrature Decoder, Quad Timer and > 31.5K Program Flash > 512K Program RAM > 4K Data Flash > 2K Data RAM	MCU-friendly instruction set, OnCE for debug, on-chip relaxation oscillator, 2K BootFLASH, external memory expansion, and up to 16 GPIO available in a 100-pin LQFP.
DSP56F805	80MHz, 40 MIPS, CAN, SCIs, SPI, ADC, PWMs, Quadrature Decoder, Quad Timer and > 31.5K Program Flash > 512K Program RAM > 4K Data Flash > 2K Data RAM	MCU-friendly instruction set, OnCE for debug, on-chip relaxation oscillator, 2K BootFLASH, external memory expansion, and up to 32 GPIO available in a 144-pin LQFP
MC56F834x	Quad Timers, FlexCAN, Off-Chip Memory Expansion, an MCU-friendly instruction set, Enhanced OnCE for debug, and temperature sensor with > 144KB Flash > 12KB RAM	Industrial (-40°C to 105°C) and Extended (-40°C to 125°C) Temperature Ranges with up to 76 GPIOs in a 128, 144 or 160-pin LQFP
MC56F835x	Quad Timers, FlexCAN, Off-Chip Memory Expansion, an MCU-friendly instruction set, Enhanced OnCE for debug, and temperature sensor with > 280KB Flash > 20KB RAM	Industrial (-40°C to 105°C) and Extended (-40°C to 125°C) Temperature Ranges with up to 76 GPIOs in a 128, 144 or 160-pin LQFP
MC56F836x	Quad Timers, FlexCAN, Off-Chip Memory Expansion, an MCU-friendly instruction set, Enhanced OnCE for debug, and temperature sensor with > 576KB Flash > 64KB RAM	Industrial (-40°C to 105°C) and Extended (-40°C to 125°C) Temperature Ranges with up to 76 GPIOs in a 128, 144 or 160-pin LQFP

Design Challenges

With the increasing deployment of magnetic strip cards, the demand for less expensive and more robust card encoding and issuing equipment has also grown. Multifunctional components are needed to deliver sophisticated technical solutions efficiently and at a reasonable cost.

Freescale Semiconductor Solution

The Freescale Semiconductor DSP56F805 has all the processing circuitry required to build a complete card-encoding system. As shown in the figure on page 1, the DSP56F805 offers all the elements required to build a completely capable card-encoding system with little need for additional circuitry.

A visual inspection of a credit card may leave the impression the credit card has but a single magnetic strip. In actuality, the International Organization of Standardization (ISO) dictates the locations of three strips, a standard observed by nearly every type of card. Each of these strips, or tracks, is recorded at different bit densities using the character-encoding standards shown in the following table.

Common Card Formats

Track	Encoding	Density	Format	Characters	Use
1	IATA	210 BPI	Alpha	79	Name
2	ABA	75 BPI	BCD	40	Account
3	THRIFT	210 BPI	BCD	107	Uncommon

Airline customers are often greeted by name after their credit card is swiped by the ticket agent. That's because the International Air Transport Association (IATA) standard for placing the customer's name and account information is assigned to track one of a credit card. A quick swipe of the card and the customer's name becomes instantly available, with no database query required.

Track two is written in the lingua franca of the credit card processing world as set forth by the American Banking Association (ABA). Nearly all credit cards and credit card equipment around the world use track two, though there is currently a movement to relocate their data to track one because it holds more information.

Track three was originally intended to support offline automated teller machine (ATM) transactions. Once deployed, ATMs were quickly networked. The need to support offline transactions quickly diminished, and with it the use of track three.

The following list explains some of the basic components of a magnetic strip encoder system and how the DSP56F805 peripherals can be efficiently applied:

> **The Read Head.** Very low-level currents in the read head coils are induced when the card's track, containing regions of flux transition, is swiped. In order to interface effectively to the DSP56F805's analog-to-digital converter (ADC) peripherals, some preamplifier circuitry is required. The DSP56F805's ADCs can be configured to work with differential or single-ended inputs, so there is no practical restriction on the type of preamplifier used.

> **The Write Heads.** The DSP56F805 has two sets, six pairs total, of high-current pulse width modulation (PWM) outputs. These complementary-pair outputs are well suited to directly drive the write heads of a magnetic strip encoder.

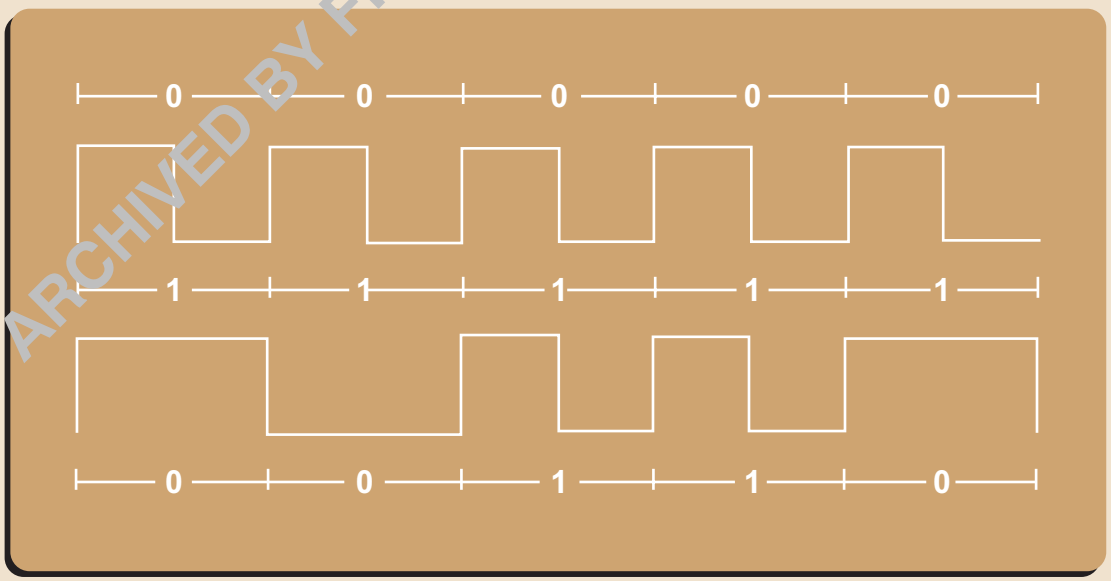
> **The Drive System.** Most card readers use the user's arm as the motor to drive the cards past the read heads. The data decoding is accomplished by discriminating the relative widths of pulses. The data is encoded on the card using two-frequency coherent phase encoding, also known as Aiken Biphase (see figure below).

As the figure below demonstrates, the high pulse width of a "1" is always one half that of a "0," regardless of data density or swipe speed. (Constant data density and reasonably constant swipe speed are usually assumed to simplify processing.) A "0" can be a high or a low pulse. A card filled with all "0"s or all "1"s thus represents a decoding problem, but this extreme case never happens in the real world.

In a card writer, you'll want to ensure data encoding is as accurate as possible. This allows *slop* with the less expensive, motorless (manual swipe) readers. As shown in the figure on page 1, the second PWM peripheral is used to drive the card drive wheel at a known speed. The DSP56F805 is well suited to drive all popular motor types. The quadrature decoder peripheral of the DSP56F805 can be employed if even the more accurate closed loop speed control is desired.

In a more sophisticated but mechanically simpler version of a writer system, the encoder/motor/drive wheel combination may be replaced with an encoder/idler wheel pair. In such a configuration, the user would manually swipe the card, with the idler wheel picking up speed and location information. The encoder would then serve to generate the reference clock used to write out the data at a rate appropriate to the current swipe speed and card location.

WAVEFORM DENSITY SWIPE SPEED



- **The Processing System.** The DSP56F80x family has all the on-board Flash and RAM required for such an application. If an even more ambitious system dictates a larger memory footprint, the DSP56F803 and DSP56F805 provide external memory interfaces with generous addressing space.

  The DSP56F80x DSP core is a tremendously versatile processor with many functions experienced designers of microcontroller-based embedded systems will appreciate. The DSP portions of the core are well suited to running algorithms to drive motors and cleanse the noisy real-world signals of read heads.
- **RS-232 Communications.** All members of the DSP56F80x family have serial communications interface (SCI) ports designed for direct interfacing to an RS-232 transceiver. This port allows for easy connection to a host processing system.
- **Serial Peripheral Interface (SPI) Communications.** The DSP56F80x is effective when implemented in card encoder systems designed to be stand-alone (away from any host PC). An SPI port permits painless connection to many output enabler (original equipment manufacturer) smart keypads and LCD displays. The DSP56F805 offers a second SCI port as well.
- **Networking.** For high-volume encoder applications, grouped together by multiple high-throughput sites, controller area network (CAN) bus networking is available to link units together. The designer need only apply a small CAN physical transceiver. The programmer need only use CAN routines out of the extensive library of functions contained within the Software Development Kit (SDK) offered with all Freescale Semiconductor DSPs.
- **Software**. Out-of-the-box software components for all on-chip peripherals, in combination with software libraries for motor control, communication, and signal processing, make it easy to develop the most demanding real-time embedded applications.

Putting It All Together

The DSP56F80x series of Freescale Semiconductor DSPs have more than ample processing power and many micro controller like features, making them well suited to general embedded processing and control tasks. Though explicitly designed with motor control in mind, this family's extensive collection of peripherals, combined with your ingenuity, can be applied to solve a wide range of design problems. In this instance, we've shown how a DSP56F805 can be used to form the heart of magnetic card strip encoder equipment without additional processing power requirements and with only minimal additional circuitry.

Development Tools

Tool Type	Product Name	Vendor	Description
Software	Processor Expert	Freescale Semiconductor	Software infrastructure that allows development of efficient, high-level software applications that are fully portable and reusable across all 56800/E family of processors.
Software	CWDSP56800	Freescale Semiconductor	CodeWarrior Software Development Tools for DSP56800 (Metrowerks)
Hardware	DSP56F801EVM	Freescale Semiconductor	Evaluation Module for the DSP56F801and DSP56F802
Hardware	DSP56F803EVM	Freescale Semiconductor	Evaluation Module for the DSP56F803
Hardware	DSP56F805EVM	Freescale Semiconductor	Evaluation Module for the DSP56F805
Hardware	MC56F8367EVM	Freescale Semiconductor	Evaluation Module for the 56F834x, 56F835x, 56F836x
Development Kit	DSPOSRTOS	Freescale Semiconductor	Emulation Support for DSP56F80x Processors (Requires Ethernet Network)

Disclaimer

This document may not include all the details necessary to completely develop this design. It is provided as a reference only and is intended to demonstrate the variety of applications for the device.

Learn More: Contact the Technical Information Center at +1-800-521-6274 or +1-480-768-2130.
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