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PROX BY HID

eProx MCM ™

User Manual & Specification

Part No. 4025A Rev K
August 2, 2006

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1 Product Description

1.1 Scope

This document describes the physical characteristics, functional requirements and software features contained in the HID eProx MCM. It lists the product specifications, as well as environmental and operational criteria.

1.2 Purpose

The purpose of this document is to describe the HID eProx MCM features and functions. This document will also cover how to make an HID FSK tag reader using the HID MCM. Included in this will be details on the additional components required, antenna design and any other special considerations necessary to make a HID card reader.

CAUTION!

The MCM is a multiple part assembly that uses a conventional soldering process. When the MCM is introduced into an OEM assembly, care must be taken to limit the temperature of the body and top portion of the MCM so it does not exceed 255°C. Some assemblers may not accurately control the upper limit during the reflow process, so adjustments to their standard process may be necessary to ensure that the temperature profile is not too high for the MCM as measured on the body. See the "Assembly Guidelines" section, below.

1.3 Summary

The purpose of this product is to provide as much of the function of a HID Reader as is practical on a single module. The customer can easily integrate HID Prox Technology into an existing design without having to do a full Proximity Reader design. This design concept takes advantage of the fact that most electronic modules already include functions such as regulators, beepers, LEDs and transient surge protection. If these devices already exist in an electronic design and the regulator is capable of sourcing the required power, then adding Prox is as simple as adding the MCM, a few discrete components and an antenna. The exact requirements will be further detailed later in this document.

The MCM offers the following output features:

- Wiegand interface: Data 1, Data 0 Signal Return with external LED, Beeper and Hold inputs optional.
- Clock and Data Format, optional
- Green and Red Bicolor LED output
- Beeper output

2 Hardware Description

CAUTION!

The HID eProx MCM is a static sensitive device. Care should be taken at all times when handling the eProx MCM to avoid static discharge that can damage the device. When handling, grounded wrist straps should be used. Also, when a eProx MCM is not attached to a circuit board, it should always be stored in an anti-static container or bag.

2.1 Product Identification

The HID eProx MCM base part number is 4025A. The shipping label is marked with the complete model part number and final assembly number.

4025A 01 XX

- XX: Current firmware revision# (May change with product improvements)
- 01: Firmware module #
  - 01= Generic Module (firmware revision is –05 as of this update)
  - 02= Clock and Data Configuration
  - 04= Configurable fast startup option - 210mS (firmware revision is –01 as of this update)
- 4025A: Model Base Number

Notes

Some older MCMs have the part number 4025ANN00 – These are compatible with 4025A0102. 4025A0105 is an upgrade from 4025A0102.

2.2 Hardware functions

The MCM hardware consists of the following basic functions:

- 30 Pin DIP assembly, contains
- Micro controller
- 8 MHz ceramic resonator
- 128 byte EEPROM
- FSK base-band receiver circuitry
- Antenna exciter drive circuitry
- Automatic bicolor LED and Beeper control
- External bicolor LED and Beeper control
- Wiegand data outputs (Output driver transistors not included)

2.2.1 Dimensional Specifications

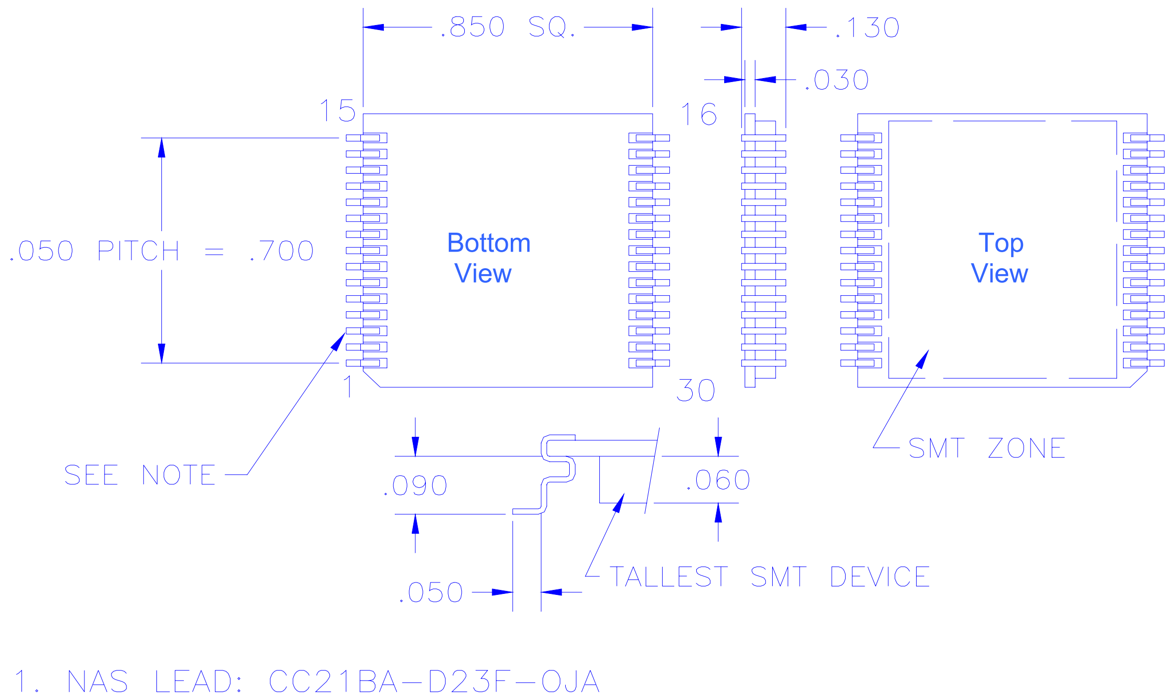


Figure 1 Dimension Drawing of eProx MCM

2.2.2 Pinout Description

The eProx MCM Pinout and pin function description is given below: IO directions are referenced to the MCM. Unused inputs should be terminated before power is applied unless otherwise specified.

Pin #	Pin Name	Direction	Standard Firmware (4025-501-XX)	Description
1	MCLR	Input	Active Low	Resets MCM Micro controller, internal pull-up provided
2	Data 0	Output	Active High	Wiegand format Data 0, or Active High Clock and Data format Data
3	Data 1	Output	Active High	Wiegand format Data 1 output, or Active High Clock and Data format Strobe
4	Card Present	Output	Active High	Clock & Data format message envelope
5	Red LED	Output	Active High	Red LED drive
6	Green LED	Output	Active High	Green LED drive
7	D1	Output	Reserved	Leave circuit open
8	D4	Output	Reserved	Leave circuit open
9	MDATA	Output	N/A	Digitized data from MCM amplifier
10	AMP	Output	N/A	Analog data from MCM amplifier
11	Beeper 1	Output	Active High	DC Beeper or AC Beeper drive (TTL square wave)
12	D3	Output	N/A	AC Beeper drive (inverted Beeper 1)
13	C5	Output	Reserved	Leave circuit open
14	B1	Output	Reserved	Leave circuit open
15	Input	Input	N/A	Connect to Antenna/ Peak detector circuit
16	Transmit	Output	N/A	**Not Used**, Reserved for UART output from MCM (Mark = HI), Leave circuit open
17	D5	Output	Reserved	Leave circuit open
18	Receive	Input	N/A	**Not Used**, Reserved for UART input to MCM (Mark = HI), pulled up internally.
19	D6	Output	Reserved	Leave circuit open
20	B3	Output	Reserved	Leave circuit open
21	B2	Output	Reserved	Leave circuit open
22	B0	Output	Reserved	Leave circuit open
23	Beeper Control In	Input	Active Low	Tells MCM to sound beeper while asserted, pulled up internally
24	Green LED Control In	Input	Active Low	Tells MCM to light Green LED while asserted, pulled up internally
25	Red LED Control In	Input	Active Low	Tells MCM to light Red LED while asserted, pulled up internally
26	Hold Control In	Input	Active Low	Tells MCM to Hold card data, pulled up internally
27	VDD	Input	N/A	Power supply
28	GND	-	N/A	Ground
29	ANT-	Output	N/A	To tuning capacitor for antenna
30	ANT+	Output	N/A	To antenna

3 Standalone Reader Design

This section describes how to make a complete RFID Reader using the HID eProx MCM. In the partitioning of the Reader system, there are several functions that are best partitioned outside of the MCM. This is partly because existing electronic modules (i.e. Alarm system keypads) already incorporate these features. Other features are not practical to include in the MCM due to their size or power dissipation requirements. These features are listed below and described in subsequent sections of this document:

- Voltage Regulator
- Series Resonant Antenna Circuit
- Peak Detection Circuit
- Transient Surge Protection
- Beeper
- LED's for User feedback
- Reset Circuitry

3.1 Antenna Design Notes

Obtaining good read-range performance from an antenna requires careful attention to several factors. All of these factors are affected by the near proximity of electrically conducting (metal) surfaces, which are almost always present in electronic systems. The most important characteristics of the antenna are:

3.1.1 Antenna Circuit Inductance

The antenna must be reasonably close to an inductance of 675uH, which is perfectly resonant at 125KHz with the series 2400ρF 2% capacitor that is present on the Proximity Reader circuit. The effective inductance seen by the circuit is reduced by the proximity of the antenna to metal. For some antenna geometry's, this effect can easily be as much as 30% of total inductance.

3.1.2 Eddy Current Field Cancellation

When the antenna is located near metal, the effective range of the antenna may be reduced even after the inductance of the antenna is adjusted to obtain resonance at 125KHz. The range reduction is due to the eddy currents present in the metal, which create a magnetic field opposing the antenna magnetic field. The effect is more pronounced when the majority of the field produced by the antenna is perpendicular to the nearby metal surface. This means a large reduction of range for loop antenna placed parallel to a metal surface, since the field produced by eddy currents in the metal cancels much of the magnetic field.

3.1.3 Antenna Circuit Q

The resistive load caused by eddy currents in the housing may reduce the Q of the antenna circuit. Ferrous materials are much worse in this respect than non-ferrous materials. Antenna Q is also dependent on antenna wire diameter, and whether or not a ferrite core is used in the antenna construction. A high Q antenna circuit is desirable.

3.1.4 Antenna-Transponder Mutual Inductance

The antenna must be a size, which will have good mutual inductive coupling to HID transponders. If the antenna is too large, it will not couple well to key fobs. If it is too small, it will not couple well to ProxCard II transponders.

3.1.5 Example Antenna Configuration and Design Hints

This example utilizes a simple freestanding, air-core coil and orients the antenna so that most of the magnetic field produced runs perpendicular to the metal surface. This type antenna is inexpensive and can fit into a low profile housing. However, it is the type most adversely affected by a metal surface parallel to the antenna. The minimum recommended distance from coil to metal surface is 0.40 inches for a 1-inch (inside diameter) coil.

3.1.6 Antenna Material

Magnet wire, 30 AWG approximately 140 turns x 5"/turn

3.1.7 Antenna Dimensions

For a circular antenna winding, a coil of approximately 1.2" diameter gives acceptable results. Larger antenna will give more distance with ProxCard, but may not couple well to ProxKey (fobs). Smaller antenna diameters may not couple strongly enough to the ProxCard II antenna.

3.1.8 Antenna Winding

Adjust total number of turns to 675µH @ 125KHz while antenna is in proximity to the Reader housing, in the same relative position and orientation, which will apply in the production unit. Note that the housing material composition, thickness, and shape will all affect the measured inductance to some extent. To obtain best results, perform the experiments carefully to faithfully reproduce the desired product environment. This is illustrated in Figure 2 Tuning the Antenna for the Product Environment.

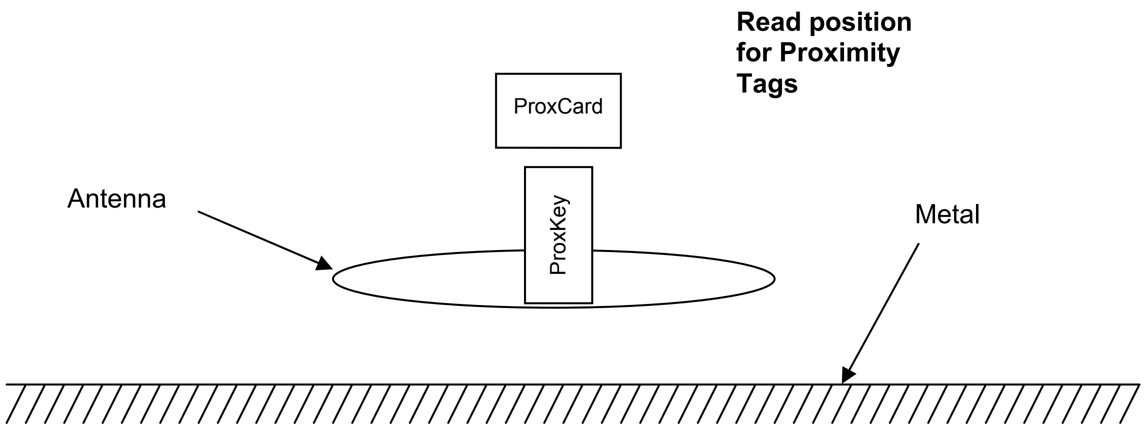


Figure 2 Tuning the Antenna for the Product Environment

3.1.9 Peak Detection Circuit

The HID eProx MCM is designed to work with a peak detection circuit. Since the HID tag data is FSK/8/10 and digitally encoded, it can be seen as amplitude modulated signal on the Reader carrier signal. The function of the peak detection circuit is to follow the maximum envelope voltage present on the antenna. This results in extraction of the digital data in the form of an AC waveform of less than 10 volts in peak-peak amplitude riding on a DC offset of approximately one-half the peak-peak voltage present on the antenna. By removing the DC component of this output signal and amplifying the areas of interest, the tag data is extracted for decoding by the micro controller.

The components that comprise the peak detection circuit are a diode, capacitor and resistor. The diode must be sized so that its breakdown voltage is large enough to withstand the voltage generated on the antenna. Although this is a function of the antenna design, a diode such as a 10BF40 will be sufficient to cover most antenna designs. The capacitor* should be a 390pF, 5% COG or NPO part. Its voltage rating should also be selected based on the resulting peak-peak voltage on the antenna. The resistor should be a 100K, 5% part with a power rating that also depends on the peak-peak voltage on the antenna.
*390pFd, 200V cap - We use a Murata Erie - GRM42-6COG391J200BB or Mepco - C391J1206CKLT.

The antenna, the peak detection circuit, and their connection to the MCM are in Figure 3 Connection of Antenna and Peak Detector to eProx MCM.

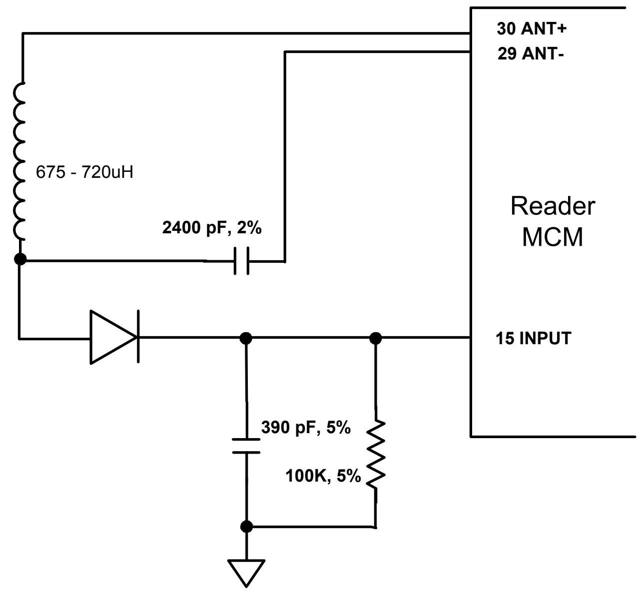


Figure 3 Connection of Antenna and Peak Detector to eProx MCM

3.1.10 PCB Layout for the Peak Detector Circuit

- To reduce EMI problems, keep the traces short in the Peak detector circuit.
- Avoid routing digital signals near the antenna or near the Pin 15 input.

3.2 Voltage Regulator

The MCM works in a voltage range from 4.5V to 5.5V. The current required to operate it and the antenna depends on the antenna design. For most antennas, the average current required will be less than 20mA with peak currents less than 150mA.

3.3 Beeper/Sounder

The MCM is designed to be configurable for driving either an AC Beeper (Sounder) or a DC beeper. In the case of the Sounder, the default drive frequency is 2.7Khz at a level of VDD on pin 11. If a DC beeper is desired, the MCM will drive the signal on pin 11 to VDD for the configured amount of time. The recommended method for driving the DC beeper is by using the MCM to bias the base of an open-collector transistor arrangement.

3.4 Wiegand Data Interface / Transient Surge Protection

The eProx MCM provides digital outputs D0, D1, and Card Present, which are suitable for driving the simple bipolar-transistor line-drive interface circuits traditionally used in Access Control applications. (Therefore, the data sense appearing on the MCM pins is the logical inverse of the signals, which are required at the inputs of most Access Control Panels.)

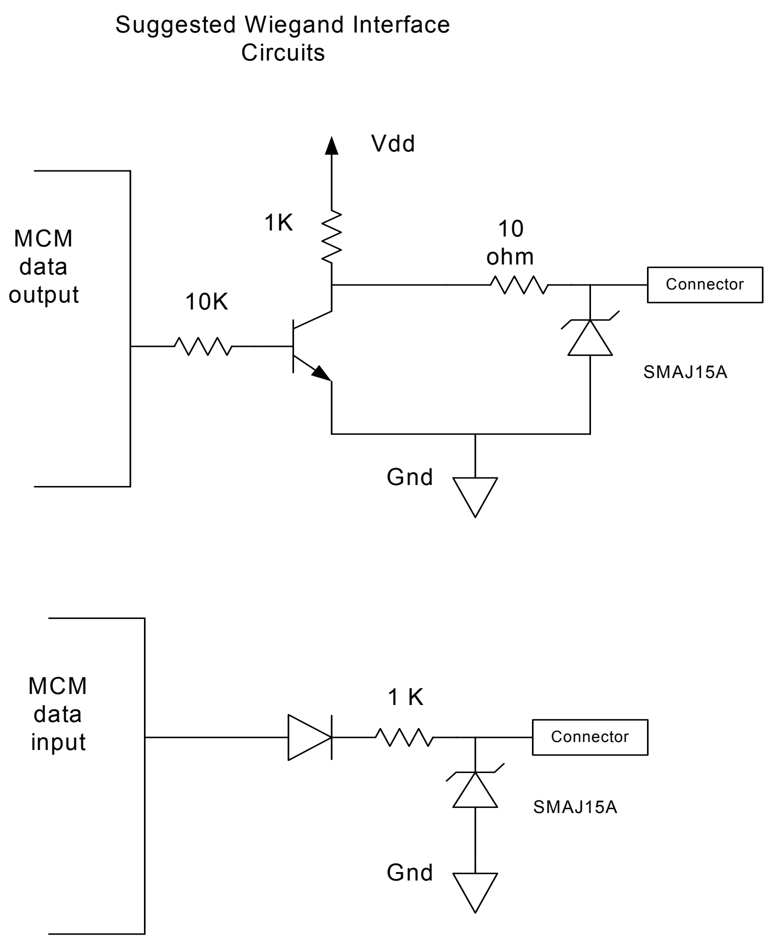


Figure 4: Typical Wiegand Line Circuits

The eProx MCM does not provide transient surge protection internally. Any MCM line that interfaces to external hardware must be protected against transient surges. One means of protection is to use a unidirectional transzorb on each line connecting to an external device. The transzorbs should be sized such that they allow the designed signal level to pass unaffected while filtering out high voltage spikes above and below VDD and ground respectively.

3.5 LEDs for User feedback

The MCM is also designed to provide drive to both a Red and Green LED. For HID Readers, the default operation is that the LED is normally Red and turns Green when a tag is successfully read. The Red and Green LED lines are on pins 5 and 6 respectively. It should also be noted that the Host "controller" to which the MCM is connected has the capability to control the LEDs. This can be done by asserting the appropriate line to a logic low level. While these lines are held low, the LED will light and remain lit until the line is brought back to a logic high level. The three configuration options for LED control are:

- Single Line LED Control: In this mode, the Host can control the Green LED only, while the eProx MCM controls the red.
- Dual Line LED Control: In this mode, the Host can control both the Green and Red LEDs.
- No Host Control: In this mode the Host has no control over the LEDs.

The LED mode control is configurable via a Command Card.

3.6 Hardware Power-On-Reset

To take advantage of the Power-On-Reset function of the eProx MCM, a few discrete components should be added to pin 1 (MCLR) of the module **if slow power-on (>200mS) is expected.** The suggested circuit is shown below. Usually the internal pull-up (provided on the eProx MCM) is sufficient.

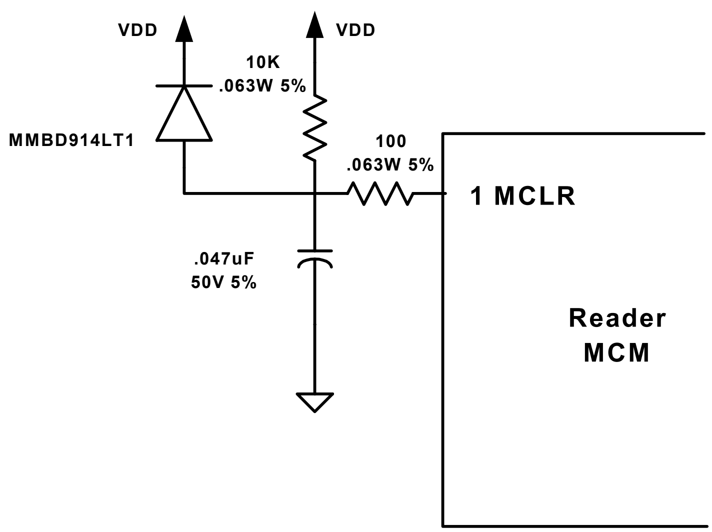


Figure 4 Connection of External Reset Circuit to eProx MCM

4 Module Integrated Configuration

Integrating the MCM into an existing electronic module is simpler than building a standalone reader. This is because existing modules most likely already include voltage regulators and transient surge protection. Some probably also include LED's and beepers. If this is the case, then integrating Prox technology is as simple as adding the peak detector, antenna, tuning capacitor and the appropriate external power on reset circuitry.

4.1 Power Budget

It is recommended that a power budget be done on the module to consider both the power requirements of the existing module functions as well as the function of the Prox Reader system. This could in some case, require the module voltage regulator to be up-scaled to handle the total power requirements.

4.2 Power-On-Reset

The Power-On-Reset function can also be achieved in the Module Integrated configuration. In this case, a free I/O line on the host device or an existing POR chip can be used to accomplish the Power-On-Reset. In this case, the idea is to assure that the VDD level at pin 27 with respect to pin 28 has reached 4V or greater before bringing the MCLR line high. To assure POR, the rise rate of this signal must be greater than 50mV/s.

5 Software Description

5.1 HID Related Processing Firmware

The Reader will acquire and output tag data from cards and tags. Firmware in the Reader will be programmed to output data in either the standard Wiegand output format or the optional Clock and Data output format (output feature is EEPROM selectable via command card).

5.2 Main Processing Loop

The main processing loop consists of the following steps:

1. On power-up, the firmware checks to see if it is connected to a self-test fixture. If the fixture is detected, self-test is performed.

2. The firmware then runs an initialization sequence by configurable information stored in EEPROM. The flow of initialization is as follows:

    - Micro controller
    - MCM Hardware ports

3. Run audio-visual power up sequence based on configuration information.

4. Enable the appropriate interrupts based on configuration information. Possible interrupt sources are:

    - External beeper control line
    - External green LED control line
    - External red LED line
    - External Hold line
    - Keypad (i.e. key pressed)
    - **Not Used**, COMM (external communication module) noted for future use

5. If no interrupt is being serviced, turn on exciter and attempt to read a tag.

6. If tag read,

    - Turn off exciter
    - Process data
    - Beep & flash as configured
    - Output data as configured

7. If tag read failed, increment power level (if applicable) and go to 3. If only one power level selected, turn off exciter and go to 3.

8. If an interrupt occurs, it will be serviced and if a tag read is in process, it will be aborted. After completion of the interrupt service, the Reader will resume where it left off

6 Product Specifications

6.1 Environmental Characteristics

Operating Temperature Range	-30°C to 65°C (-22°F to 150°F)
Storage Temperature Range	-40°C to 85°C (-40°F to 185°F)
Operating Humidity Range	5% to 95% non-condensing
Operating Vibration Limit	.04 g^2/Hz 20-2000Hz
Operating Shock Limit	30g, 11mS, Half Sine

6.2 Power Requirements

Power supply	Linear type recommended
Operating Voltage Range	4.5VDC – 5.5VDC
Absolute Maximum	6.0VDC
Peak Current	<150mA

6.3 Operating Parameters

Reader LED Control	Red & Green External
Input Wiegand Data Pulse Widths	20µSec - 100µSec
Input Wiegand Data Interval	200µSec – 20mSec
Frequency of Operation	125Khz +/- 1Khz

7 Functional Descriptions

7.1 Operating Cycle

The unit will operate in two states:

- Idle/Ready
- Busy/Transmitting

Idle/Ready is the normal Reader state waiting for a card to be presented. When a card is presented and is being read, the Reader is in the Busy/Transmitting state.

7.2 Accuracy

The unit will not have more than 1 misread (resulting in transmitting an error) per 10 million.

7.3 Factory Configurable Options

The eProx MCM will be configurable via Command Cards

OPTION	DESCRIPTION
00	beep 'on', reader flashes green LED on card reads, LED normally 'red'
01	beep 'off'[1], reader flashes green LED on card reads, LED normally 'red'
02	beep 'on', reader flashes green LED on card reads, LED normally 'off'
03	beep 'off'[1], reader flashes green LED on card reads, LED normally 'off'
04	beep 'on', host must flash green LED (single mode), LED normally 'red'
05	beep 'off'[1], host must flash green LED (single mode), LED normally 'red'
06	beep 'on', host must flash green and/or red, LED normally 'off'
07	beep 'off'[1], host must flash green and/or red, LED normally 'off'

NOTE

[1] "Beep Off" setting disables the default internal beeper control. External control of the beeper, green and red LED are always active. Dual mode refers to an external mode that will control both LEDs, so both LED's are normally off. Single mode refers to an external mode that can control the green LED only, so the red LED is normally on. The LED will appear amber if toggled between red and green (50Hz to 20KHz).

7.4 Mounting

CAUTION!

The MCM is a multiple part assembly that uses a conventional soldering process. When the MCM is introduced into an OEM assembly, care must be taken to limit the temperature of the body and top portion of the MCM so it does not exceed 255°C. Some assemblers may not accurately control the upper limit during the reflow process, so adjustments to their standard process may be necessary to ensure that the temperature profile is not too high for the MCM as measured on the body. See the "Assembly Guidelines" section, below.

The eProx MCM is designed to be a surface mount part in a sequential soldering process. By adding mounting pads to a circuit board as per the package specification drawing (Figure 1 Dimension Drawing of eProx MCM, page 6), the part can be assembled like any other surface mount IC. See Assembly Guidelines, page 23 for more information.

7.5 Product Shipping Preparation

The eProx MCM should be shipped in static resistant packaging. The MCM will be marked with:

- Product name
- Product Model Number
- Final Assembly Number
- Lot Number
- Serial Number
- HID Corporate Identity (Logo)

7.6 Clock & Data Output - Data Timing

The outputs, Card Present, Data and Strobe are low going signals and the following timing chart describes the timing.

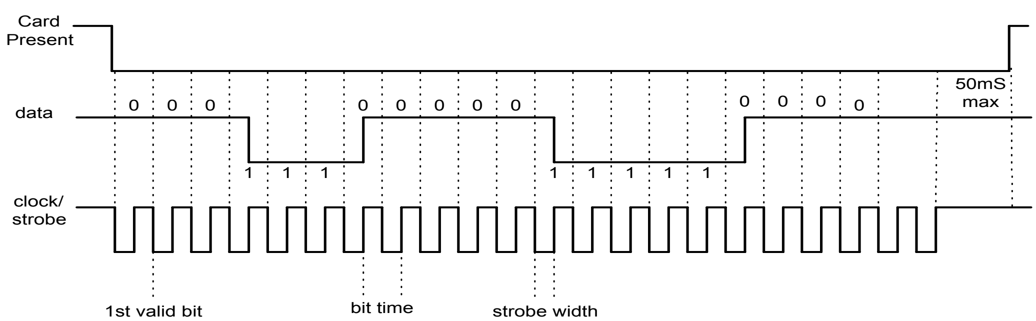


Figure 5 Timing

- bit time = 1.5mSec (default)
- strobe width = bit time/3 (33% of bit time), default = 500µSec
- clock/strobe is valid 1.5mSec (one clock cycle, min) after card present is asserted
- data is valid 10µSec (min) before the negative edge of clock/strobe card present returns to the high level 50mSec (max.) after the last clock/strobe.

> **NOTE:**
>
> The above timing is representative of a magnetic stripe card traveling at 8.9" per second. The timing is to be adjustable for cards traveling at 4" per second to 20" per second. This relates to bit times of 3.3mSec and 666µSec, respectively. There are 75 bits per inch on Track 2. The first 25 bits and trailing bits are zeros, not shown above.

7.6.1 Bit Structure

The data will be packed into the ABA/ISO Track-2 message format in accordance with the following rules based on customer codes.

7.6.2 Case 1:

Customer Code will have the data output as follows. The output is in the Track-2 character format but the bits are packed in sets of three bits (octal)

40 bits of card info:

0cccCCCCabcdefghijklmnopqrstuvwxyzABCDEF

0 – command card flag

cccCCCC -- the customer code

abc.....DEF -- the programmed data on the card (32-bits)

The leading 0 is discarded, leaving 39 bits to output.

1248p 1248p 1248p 1248p 1248p 1248p 1248p 1248p 1248p 1248p 1248p 1248p 1248p 1248p 1248p 1248p

<B> ccc0p CCC0p baC0p edc0p hgf0p kji0p nml0p qpo0p tsr0p wvu0p zyx0p CBA0p FED0p <F> <LRC>

7.6.3 Bit Stream

The bit stream will consist of 25 leading zeros, the message and fill with zeros until the end of the message. The message will consist of a minimum of 210 bits.

0000000000000000000000000	11010	10000	01000	11001	11111	00100	0000000000000...000000
	B	1	2	3	F	LRC	

7.6.4 Output Specification - Requirement

- Vol............0.5VDC max.
- Voh............3.5VDC min.
- Sink............25mA
- Source.........5.0mA

7.6.5 Definitions and Glossary

Word	Description
Reader	A device that decodes data from a portable data carrying media (card).
Control Panel	A device that accepts and process data from a Reader and controls any or all input devices contained in a Reader
Data	A signal line that stays low throughout the decoding process and for 7mSec after the last read flux reversal is read from the media.
Card Present	A signal line that is designated as the output that delivers the pulses that is interpreted as binary ones and zeroes
Strobe/Clock	A signal line whose outputted narrow pulses are used to indicate the read data output is valid.

7.6.6 Physical Interface

For an HID Reader, the following cable conductor assignments and specified wire colors are listed below:

Name	Description
+DC (Power)	Red conductor wire, provides power from the power supply or panel to the Reader. The voltage on this conductor will be 5VDC. The actual operating range is 4.75VDC to 14VDC. Reader Power is either supplied by the control panel or by a separate power supply. Linear supplies are recommended for RF Reader devices.
Ground	Black conductor wire, provides electrical common between the Reader and the panel. All other voltage levels are referenced to this conductor.
Data	Green conductor wire, a signal from the Reader to the panel. A pulse on this conductor indicates a data bit with the binary value of one or zero. A HI level data bit has a value of ONE and a LO level data bit has a value of Zero. The data level is true and stable at both the falling and rising edges of the clocking strobe.
Card Present	Orange conductor wire, a signal from the Reader to the panel. A steady pulse on this conductor indicates the start and end of a media swipe and may be used as an interrupt signal to alert firmware of the read/decoding operation in process.
Strobe/Clock	White conductor wire, a signal from the Reader to the panel. A signal line whose outputted narrow pulses are used to indicate the read data output is valid. The strobe output can be used as an interrupt or storage register (SIO) clocking signal.

7.7 Wiegand Output Specification

The specifications of voltage, current, power and timing are from the perspective of the Reader. A common signal ground is defined as a voltage reference that is common to both the Reader and the control panel. The voltages for the data outputs are referenced from the power supply ground located at the Reader. The voltage measured for the power to the Reader is referenced from the power-supply-return-connection location at the Reader, not at the source of the power. The voltage, current, and timing of the data pulses are measured at the Reader in reference to the power supply/signal ground at the Reader. The voltage, current and timing of a signal driving an auxiliary input device on a Reader are measured at the control panel that is controlling the input device (with reference to the signal ground at the panel).

This does not eliminate interdependence of the wiring between the Reader and control panel, but gives rise to guidelines for the specification of wiring between the Reader and control panel.

7.7.1 Definitions and Glossary

Word	Description
Reader	A device that decodes data from a portable data carrying media (card).
Control Panel	A device that accepts and processes data from a Reader and controls any or all input devices contained in a Reader.
Data Zero	The signal line that is designated as the output that delivers the pulses that is interpreted as binary zeroes.
Data One	Signal line that is designated as the output that delivers the pulses that is interpreted as binary ones.
Signal Ground	Voltage reference used to determine all signal/data voltage measurements.

7.7.2 Output Specification - Requirement

The Data One and Data Zero control conductors connect signals between the Reader and the panel. The logic levels are defined as follows:

- Vol..............0.5VDC max.
- Voh..............3.5VDC min.
- Sink..............25mA
- Source..........5.0mA

7.7.3 Data Pulses

The Data One and Data Zero signals are normally held at a logic high level until the Reader is ready to send a data stream. The Reader places asynchronous low pulses on the appropriate data lines to transmit the data stream to the panel. The following timing parameters shall be observed:

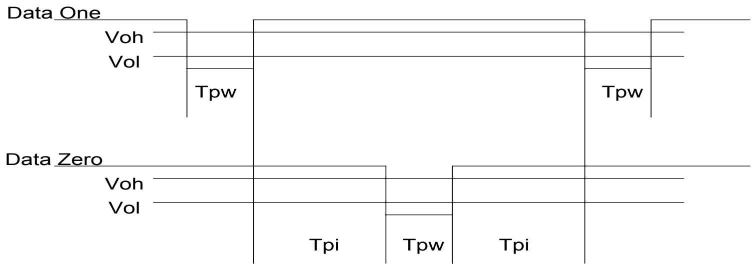


Figure 6 Data Pulses - Timing

- Tpw Pulse Width Time -- 20µSec (minimum) to 100µSec (maximum)
- Tpi Pulse Interval Time -- 200µSec (minimum) to 20mSec (maximum)

7.7.4 Special Wiegand Configuration

- Wiegand Data Pulse Widths………………..25µSec to 1mSec in 4µSec steps
- Wiegand Data Pulse Interval……………….50µSec to 6mSec in 25µSec steps
- Anti-PassBack Delay………………………..1 to 6 seconds in 25mSec steps

8 Application Notes

8.1 Assembly Guidelines

The MCM is a multiple part assembly that uses a conventional soldering process. When the MCM is introduced into an OEM assembly, care must be taken to limit the temperature of the body and top portion of the MCM so it does not exceed 255°C. Some assemblers may not accurately control the upper limit during the reflow process, so adjustments to their standard process may be necessary to ensure that the temperature profile is not too high for the MCM as measured on the body.

The MCM is supplied to the customers as a functional component and ready for their assembly process. The temperature profile used in the assembly process is critical to the board assembly and the attachment of the MCM. **HID recommends that the assembler considers the process carefully and further recommends that the assembler starts with a small sample batch, where yield can be determined and the process can be adjusted for the subsequent prototype runs.**

Pre-bake instructions:

Refer to MSL label on packaging and IPC/JEDEC J-STD-033B for pre-bake instructions.

Temperature profile:

The temperature profile for the assembly containing an MCM is dependant on the type of soldering process, but here are some guidelines. Use a thermal gradient not to exceed 2 degrees per second. Reflow with Vapor Phase or IR heat to required temperature and hold for required time. Use clean dry air or nitrogen atmosphere. To cool down the assembly, it should be allowed to cool gradually, do not exceed 2 degrees per second until room temperature.

Solder Reflow Profile:

The Pb-Free solder alloy tested in design and manufacturing consists of 96.5Sn/3.0Ag/0.5Cu (tin, copper, silver). A solder liquidous melting range of 215-218°C (419-424°F) is required. Figure 7 Temperature Reflow Profile outlines the desired temperature reflow profile for proper utilization. The MCM is assembled with an RoHS compliant lead free temperature solder that is liquidous at 245°C, therefore the peak of the temperature measured internally, on the body, and the printed circuit board of the MCM should be closely controlled and not exceed 240°C to avoid damaging the components inside the MCM assembly.

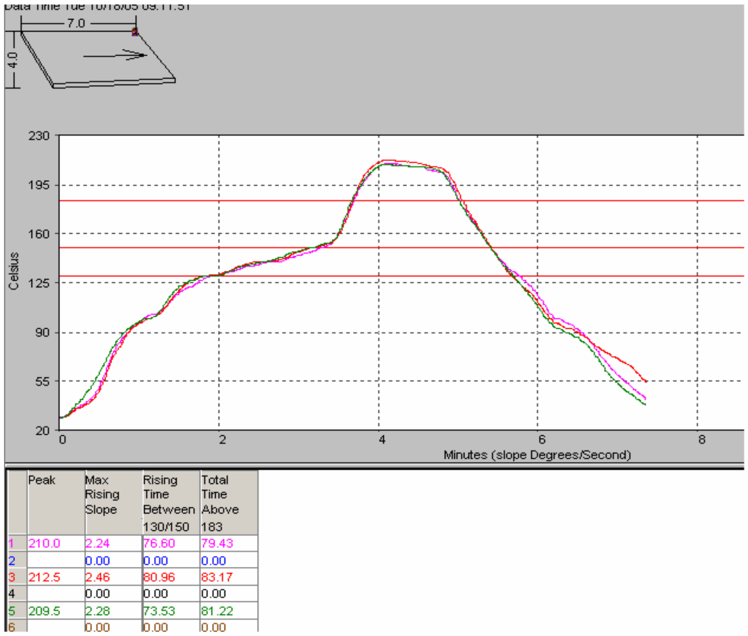
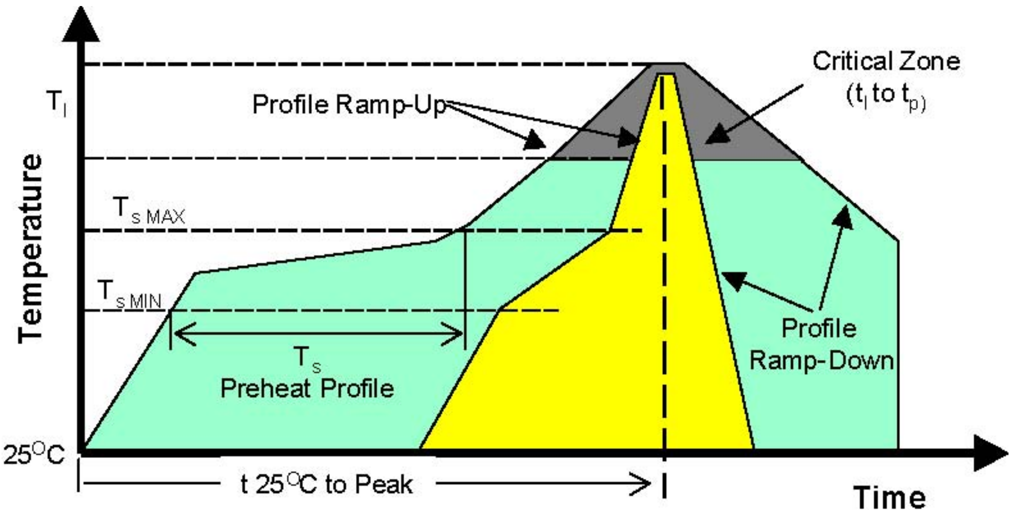


Figure 7 Temperature Reflow Profile

Note: The solders used in the description above are not a requirement but used as a guide and are example only.



Symbol	Description
$T_{s\ MIN}$	Minimum Temperature
$T_{s\ MAX}$	Maximum Temperature
T_s	Time From Minimum to Maximum
T_l	Temperature At Liquid State
T_p	Preheat Temperature
t_p	Ramp-Down Temperature
t_l	Time Above Liquid State

Preheat Zone Temperature

Alloy Liquidous Zone

Part Temperature

Pb-FREE REFLOW PROFILES (Pb-Free Product Compliance Table)		
Feature	**Large Body**	**Small Body**
Avg. ramp-up rate (Tl to Tp)	3°C/sec. max.	3°C/sec. max.
Preheat:		
Temperature Min. (Tsmin)	150°C	150°C
Temperature Max. (Tsmax)	200°C	200°C
Time (min to max) (Ts)	60-180sec.	60-180sec.
Tsmax to Tl:		
Ramp-up rate	3°C/sec. max	3°C/sec. max
Time above:		
Temperature (Tl)	217°C	217°C
Time (tl)	60-150 sec.	60-150 sec.

Pb-FREE REFLOW PROFILES (Pb-Free Product Compliance Table)		
Feature	**Large Body**	**Small Body**
Pre Temperature (Tp)	240 (-5)°C	245 (-5)°C
Time within 5C of actual Peak	10-30 sec.	20-40 sec.
Temperature (tp)		
Ramp-down Rate	6°C/sec. max.	6°C/sec. max.
Time 25C to Peak Temperature	8 minutes max.	8 minutes max.

Special condition components:

If the assembly has components that also need higher temperature profile because of the mass of the part or other reasons, it is suggested that those parts be assembled in a 2-step process:

1) Attach all high temperature components on the first pass through the manufacturing process, and
2) Use a reflow profile designed to peak between 235 to 240°C (as measured on the body of the MCM) for the attachment of the MCM and other standard parts.

Some assemblies may use a manual assembly process, for through-hole or other parts, as a second or third step. The MCM can be manually soldered in this step also. Care must be taken to not exceed the temperature specification (240°C as measured on the body) regardless of the step in which the MCM is installed.

8.2 Coils

The following is a description of two types of HID coils used on existing products. Coils similar to these can be ordered from Magnelab at (303) 772-9100 or (888) 442-6700

8.2.1 Dimensions

ProxPro type coil				
Length	Height	Thickness	Width	Radius
4.00" (ID)	4.00" (ID)	.125” (Max)	.250” (Max)	.300” (4x)
Number of turns-48 Inductance (uH)-634 ± 16 @ 1Khz DC Resistance at 25°C (ohms): 2.65 ± .07 Resonant Frequency (Khz): 500 ± 50 Material: 26 AWG copper wire with polyurethane insulation and a 105°C softening temperature polyvinyl butyral bonding layer.				
ProxPro Plus type coil				
6.89" (ID)	6.89" (ID)	.080” (Max)	.225” (Max)	.115” (4x)
Number of turns-33 Inductance (uH)-625 ±2% @ 1Khz DC Resistance at 25°C (ohms): 3.9 ± 20% Resonant Frequency (Khz): 410 ± 35 Material: 26 AWG copper wire with polyurethane insulation and a 105°C softening temperature polyvinyl butyral bonding layer.				

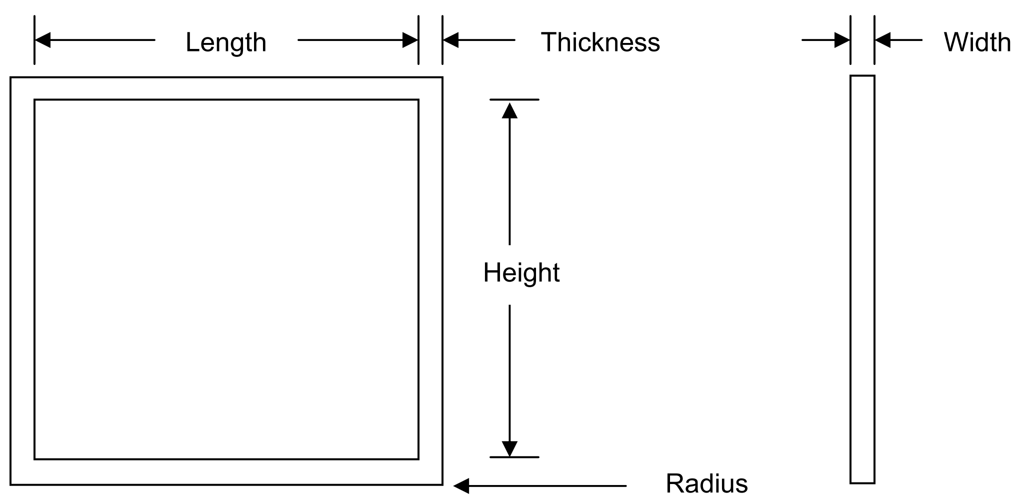


Figure 8 Typical Coil

Note: As the coil size is increased the read range also increases although as the coil size increases some areas within the excitation field may have trouble reading cards. The coil size increases to a point where the coupling between the coil and the card is not great enough to energize the card sufficiently. At this point the coil current/voltage can be increased to compensate for the loss in coupling.

8.3 Peak detection diode – more information

The diode to be used is an International Rectifier, ultra fast recovery diode, 400(Vrwm) Part No.-10BF40, SMB/DO-214AA type package, HID Part No.-23-0009-01. The voltage of the diode must be great enough to withstand the peak-to-peak voltage of the coil. As the voltage is increased a diode with a greater working voltage may have to be used. An example of this diode is a Vishay (Telefunken), surface mount, ultra-fast rectifier, 75ns(trr), 1000(Vrwm), Part No.-BYG23M, HID Part No.23-0019-01 or Vishay (Litteon power semiconductor), surface mount, ultra-fast rectifier, 1000(Vrwm), 75ns(trr), Part No.-US1M,. The reverse recovery time must be 75ns or less.

8.4 Longer read range

The driver being used on the MCM module with the ProxPro type coil can be expected to drive 300-350mApeak-to-peak AC coil current at resonance (125Khz). The MCM typically uses a regulator that regulates the voltage on the driver to 5.2Vdc. The coils shown above can be resonant at 125Khz using a series capacitor 2400pF, COG, 500v, 2%, 1812 or 1808 package, HID Part No.21-0005-03 or 286-0242-32. Further an external driver may be used to increase the drive current but may have to be operated off of a separate supply. Using a greater voltage would increase the drive current capability of the circuit. For an example of the driver try the Teledyne MOSFET driver Part No.TC4420OEA, HID Part No.- 11-0001-03. A supply voltage from 4.5v to 18v can be used for the 4420 driver.

8.5 Testing for read range

In the explanation and following pictures an MCM module with universal board and a Prox Pro coil were used for the testing. A clamshell style ProxCard II was used for the read distance measurements.
First: Find the size of coil being used. Measure and record the size of your antenna. Sometimes using a larger antenna alone will increase read range.

Second: Find the peak to peak coil current when the exciter is on. Measure and record the peak to peak coil current. The driver being used on the MCM module with the ProxPro type coil can be expected to drive 300-350mApeak-to-peak AC coil current at resonance (125Khz). See Picture 1.0.

Together with a low noise system the ProxPro coil can be expected to deliver about 25cm read range <u>at best</u>. The MCM **Universal board** has an on board regulator it regulates the voltage to the MCM module to 5.2Vdc. Find your regulator, measure and record the output voltage and insure this voltage is 5.2vdc plus or minus .25vdc. It maybe possible to increase the regulator voltage slightly to increase read range but care must be taken <u>not</u> to exceed the maximum voltage rating of parts on the MCM module specifically the EEPROM and Microprocessor (5.5VDC)

Third: Find out whether your MCM Reader is exciter limited or receive limited. By using a card - open the card (Clamp shell style card is recommended) and place wires on Antenna+ and Antenna- of the coil. Connect a scope across the coil from Antenna+ to Antenna- and slowly present the card to your Reader monitoring the signal coming from the card (see Pictures 4.0 and 5.0). The signal seen on the scope will be an FSK signal dividing the carrier (125Khz) by 8 and by 10 for the data frequencies. Once the exciter is turned-on the card is held in reset for about 2.0ms after which time the card starts repeatedly sending the data until the exciter is turned off. Monitor the scope for when the card first turns on and sends good data. Measure and record the distance that the card is first sending good data. If the Reader does not read the card within 6-7mm of when it is turned on, this condition is called receive limited. If the card turns on and is sending good data and the Reader reads the card right when the card turns on this condition is called exciter limited. If the Reader is receive limited then there must be noise in the environment and care has to be taken to attenuate all noise in the pass band (8Khz to 20Khz) or side bands (108Khz to 120Khz and 132Khz to 144Khz).

Noise could be created from the surrounding circuitry of the Reader, it could be radiated in by CRT's close by, it could be conducted in on the power supply lines or radiated in by a near by sources. To insure there is no interference from a source near-by, turn off all none essential equipment and any computers within 10 feet of the Reader. For conducted noise, ensure the power supply being used to power the Reader is a clean linear supply. For circuitry noise issues insure good design practices/techniques are being used when laying out the PCB (see PCB Layout for the Peak Detector Circuit, page 11).

Take a second scope probe and monitor the signal returned by the card at the MCM pin 10 (Amp) see Figure 10 MCM Pin 10 (Amp) – Receiver and Figure 11 Receive Signal Expanded Resolution - Exciter Enabled. Monitor the noise floor while the exciter is on (**Note**: The exciter is turned on and off creating a duty cycle of 10 percent on-time and 90 percent off-time. Figure 10) the noise at this test point should be less than 100mv peak to peak (Figure 10). Most of the noise will be 125Khz. Other noise may occur at the band pass or side bands but should never exceed 10mv peak to peak and is preferably much less than this. If your reader is excite limited then you can try increasing the current in the coil to greater than 300-350ma peak to peak this will increase the excite field and cause the card to be read further away. The output into the excite coil is being achieved by differentially driving the coil and may be difficult to add an external driver that is differentially driven. It may be possible to use only half of the driver or a single side of the differential driver with an external driver to increase the excite field. If an external driver can be used to increase the drive current it will most likely have to be operated from a separate supply this supply should also be linear and clean.

Special precautions must be taken to eliminate any noise (band pass or side bands) getting into the Reader from new components added for the purpose of increasing current in the coil. Otherwise any extra read range achieved from increased current may be nullified by the extra noise being created in the system. The two main points here are to decrease noise and increase coil current to be successful in achieving an increased read range. The regulator being used may be inherently noisy and may need to be change to a quieter regulator. Sufficient filtering of the power supply and regulator are needed.

8.5.1 Exciter Current

Note: The AC current probe is set for measuring 10mA/mV so the peak to peak current shown here is approximately 340mAp-p.

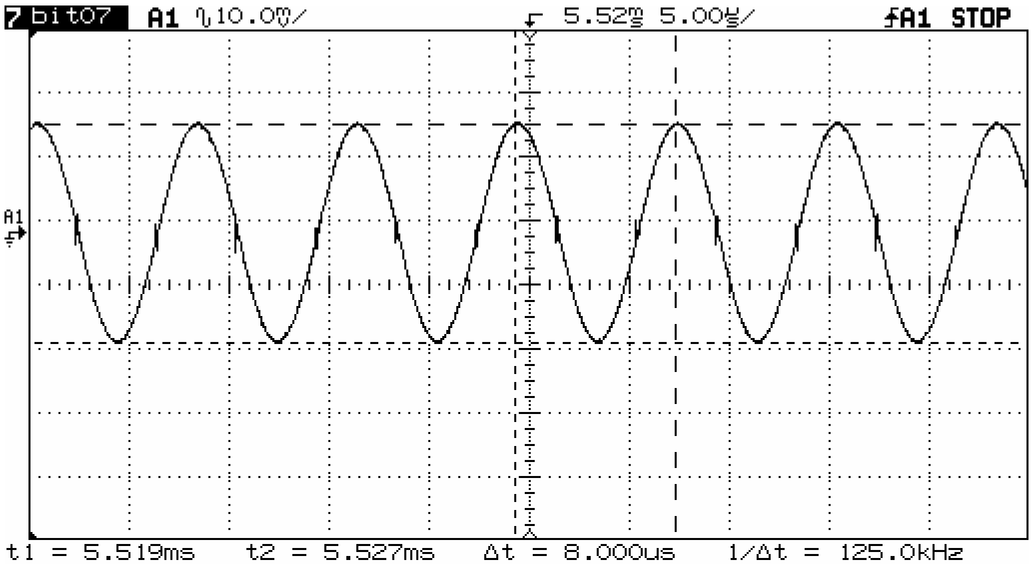


Figure 9 Exciter Current

8.5.2 MCM Pin 10 (Amp) – Receiver

Note: The exciter is being enable with approximately 10% duty so the receiver is only on for about 8.8ms then off for 93ms.

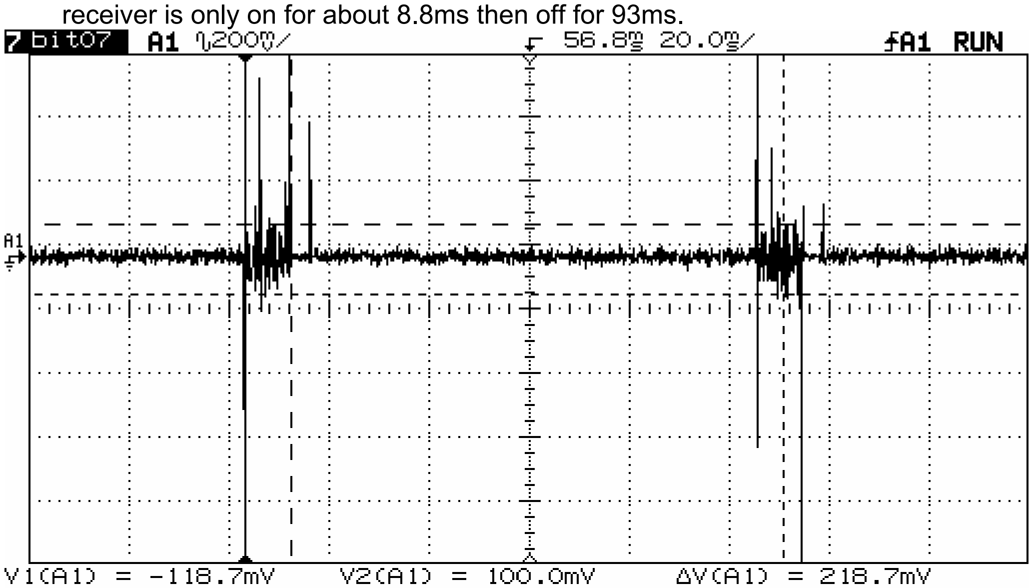


Figure 10 MCM Pin 10 (Amp) – Receiver

8.5.3 Receive Signal Expanded Resolution - Exciter Enabled

Note: The change in time base from Figure 10.

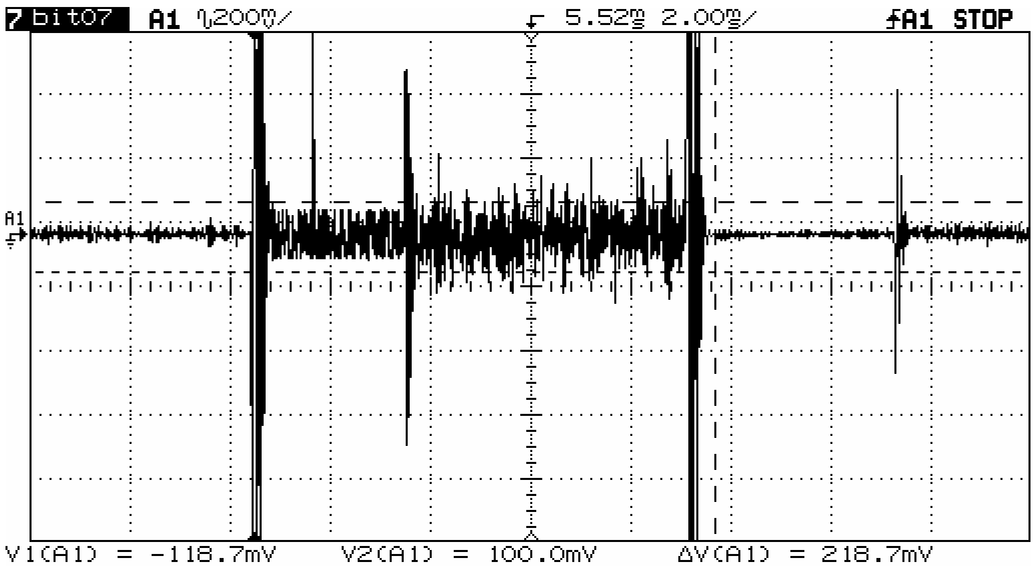


Figure 11 Receive Signal Expanded Resolution - Exciter Enabled

8.5.4 A1 = MCM pin 10 (Amp), A2 = Card Modulation

Note: In this picture the card has started to modulate good data also note the time base and that the picture shows the complete time the exciter is enabled. The exciter has extended its on time to approximately 83ms to facilitate capturing the data coming in from the card

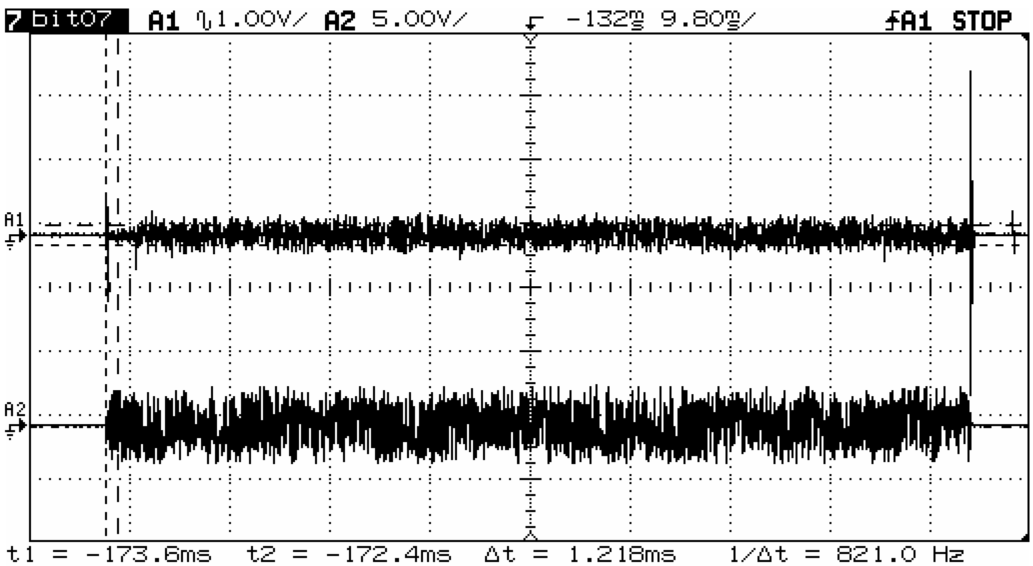


Figure 12 A1 = MCM pin 10 (Amp), A2 = Card Modulation

8.5.5 Expanded resolution of MCM Pin 10

A1 = MCM pin 10 (Amp), A2 = Card held in reset (POR) 1.218ms and data is being sent out after POR.

Note:The time base has changed from Figure 12 to show a more detailed picture of the card while being held in reset and after the card comes out of reset and starts modulating the data.

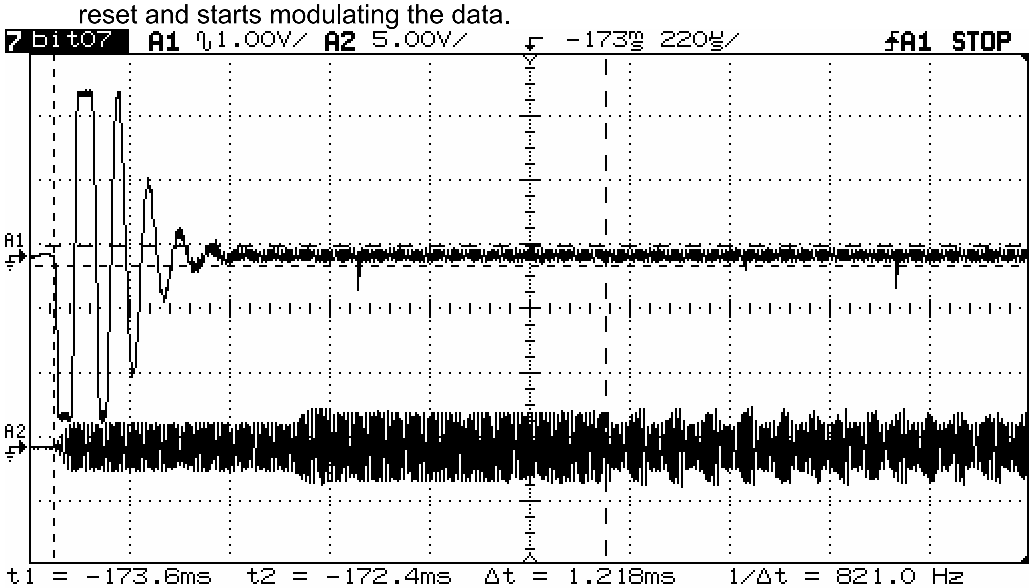


Figure 13 Expanded resolution of MCM Pin 10