



ANTI-PINCH WINDOW LIFT CONTROL MODULE USER'S GUIDE

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Preface

NOTICE TO CUSTOMERS

All documentation becomes dated, and this manual is no exception. Microchip tools and documentation are constantly evolving to meet customer needs, so some actual dialogs and/or tool descriptions may differ from those in this document. Please refer to our web site (www.microchip.com) to obtain the latest documentation available.

Documents are identified with a “DS” number. This number is located on the bottom of each page, in front of the page number. The numbering convention for the DS number is “DSXXXXXA”, where “XXXXX” is the document number and “A” is the revision level of the document.

For the most up-to-date information on development tools, see the MPLAB® IDE on-line help. Select the Help menu, and then Topics to open a list of available on-line help files.

INTRODUCTION

This chapter contains general information that will be useful to know before using the Anti-Pinch Window Lift Control Module. Items discussed in this chapter include:

- Document Layout
- Conventions Used in this Guide
- Recommended Reading
- The Microchip Web Site
- Customer Support

DOCUMENT LAYOUT

This document describes how to use the Anti-Pinch Window Lift Control Module. The manual layout is as follows:

- **Chapter 1. “Getting Started – Quick Setup”**
- **Chapter 2. “Window Lift Control Module Hardware”**
- **Chapter 3. “Window Lift Control Module Software”**

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CONVENTIONS USED IN THIS GUIDE

This manual uses the following documentation conventions:

DOCUMENTATION CONVENTIONS

Description	Represents	Examples
Arial font:		
Italic characters	Referenced books	<i>MPLAB[®] IDE User's Guide</i>
	Emphasized text	...is the <i>only</i> compiler...
Initial caps	A window	the Output window
	A dialog	the Settings dialog
	A menu selection	select Enable Programmer
Quotes	A field name in a window or dialog	"Save project before build"
Underlined, italic text with right angle bracket	A menu path	<u><i>File>Save</i></u>
Bold characters	A dialog button	Click OK
	A tab	Click the Power tab
N'Rnnnn	A number in verilog format, where N is the total number of digits, R is the radix and n is a digit.	4'b0010, 2'hF1
Text in angle brackets < >	A key on the keyboard	Press <Enter>, <F1>
Courier New font:		
Plain Courier New	Sample source code	#define START
	Filenames	autoexec.bat
	File paths	c:\mcc18\h
	Keywords	_asm, _endasm, static
	Command-line options	-Opa+, -Opa-
	Bit values	0, 1
	Constants	0xFF, 'A'
Italic Courier New	A variable argument	<i>file.o</i> , where <i>file</i> can be any valid filename
Square brackets []	Optional arguments	mcc18 [options] <i>file</i> [options]
Curly brackets and pipe character: { }	Choice of mutually exclusive arguments; an OR selection	errorlevel {0 1}
Ellipses...	Replaces repeated text	var_name [, var_name...]
	Represents code supplied by user	void main (void) { ... }

RECOMMENDED READING

This user's guide describes how to use the Anti-Pinch Window Lift Control Module. Other useful documents are listed below. The following Microchip documents are available and recommended as supplemental reference resources.

It is recommended that you become familiar with the documents listed below, prior to using the Anti-Pinch Reference Design.

PICkit™ 2 Microcontroller Programmer User's Guide (DS51553)

Consult this document for instructions on how to use the PICkit 2 Microcontroller Programmer hardware and software.

PIC16F688 Data Sheet (DS41203)

Data sheet for the PIC16F688 14-pin, Flash-based, 8-bit CMOS microcontrollers with nanoWatt Technology.

MCP201 LIN Transceiver with Voltage Regulator Data Sheet (DS21730)

Data sheet for the MCP201 LIN transceiver. Gives an overview of the device including modes of operation and electrical characteristics.

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- **Product Support** – Data sheets and errata, application notes and sample programs, design resources, user's guides and hardware support documents, latest software releases and archived software
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- Distributor or Representative
- Local Sales Office
- Field Application Engineer (FAE)
- Technical Support
- Development Systems Information Line

Customers should contact their distributor, representative or field application engineer (FAE) for support. Local sales offices are also available to help customers. A listing of sales offices and locations is included in the back of this document.

Technical support is available through the web site at: <http://support.microchip.com>

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NOTES:



1.1 INTRODUCTION

1.2 HARDWARE

- PLUG HOUSING 6-POSITION MINI UNIV-MATE, PN# 172168-1, one per connector
- SOCKET TERMINALS 16-20AWG TIN CRIMP, PN# 171637-1, 6 per connector

Before applying power, make sure that jumpers E1 and E2 are connected to pins 1 and 2 (see Figure 1-2).

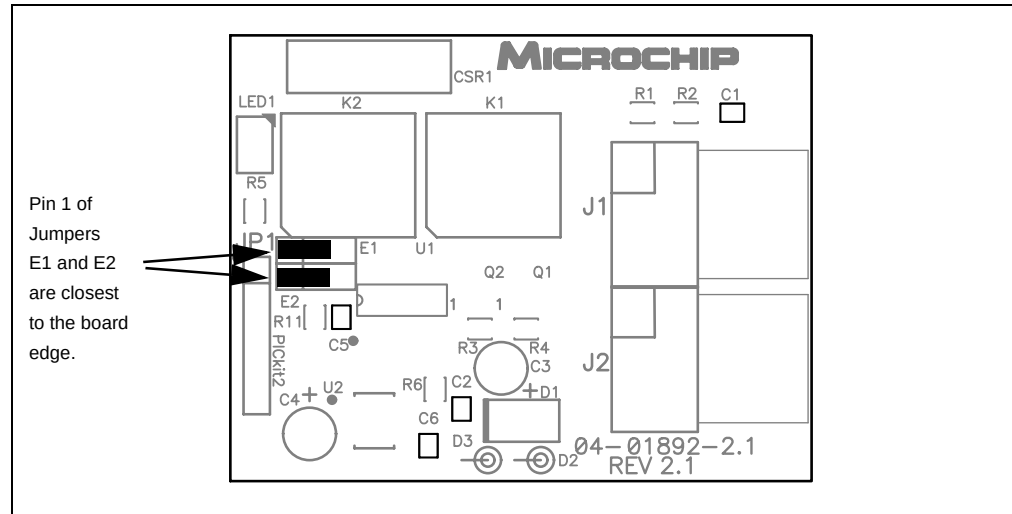
The schematic diagram illustrates the internal components and connections of the Microchip CSR1 module. Key components include a motor (M) connected to J1-1, a DOWN button connected to J2-4, and an UP button connected to J2-3. The module is powered by +12 VDC and GND, and has a LIN input. The diagram also shows various other components like resistors (R1, R2, R3, R4), capacitors (C1, C3), and diodes (D1, D2, D3) connected to the module's pins.

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LIN commands are sent via the LIN bus connected to J2-5.

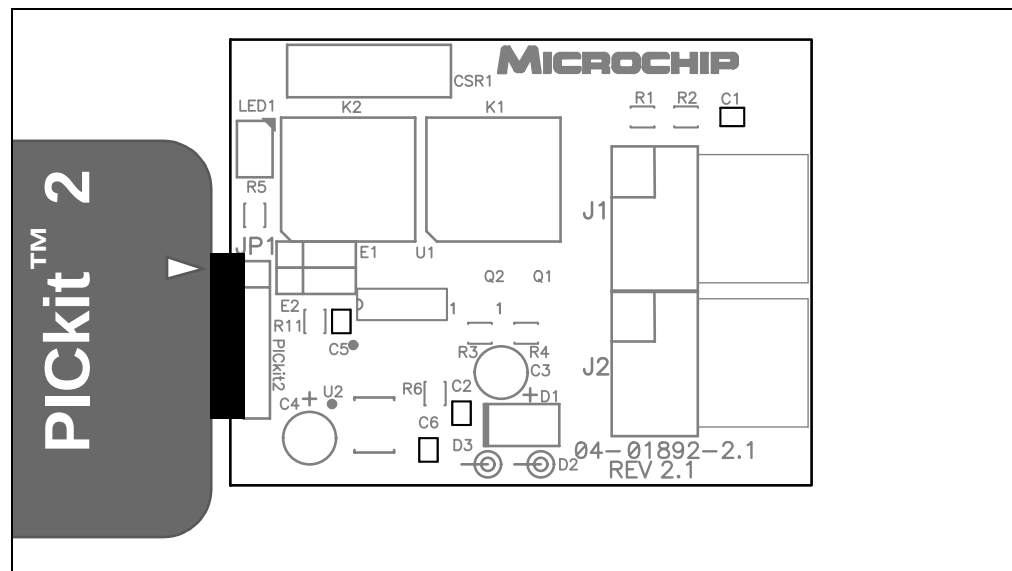
Programmed with the standard firmware, the module responds to LIN 2.0 message frame of two data bytes and classic checksum (checksum only includes data). The identifier is **0x05**. **Bit 2** of the first databyte signals '**down**' and **bit 1** signals '**up**'. The second databyte is not used.

FIGURE 1-2: DEFAULT JUMPER POSITIONS



The board may be re-programmed through JP1 with a Microchip PICKit™ 2 Development Programmer (not included).

FIGURE 1-3: PROGRAMMING BY PICKit™ 2 PROGRAMMER VIA JP1



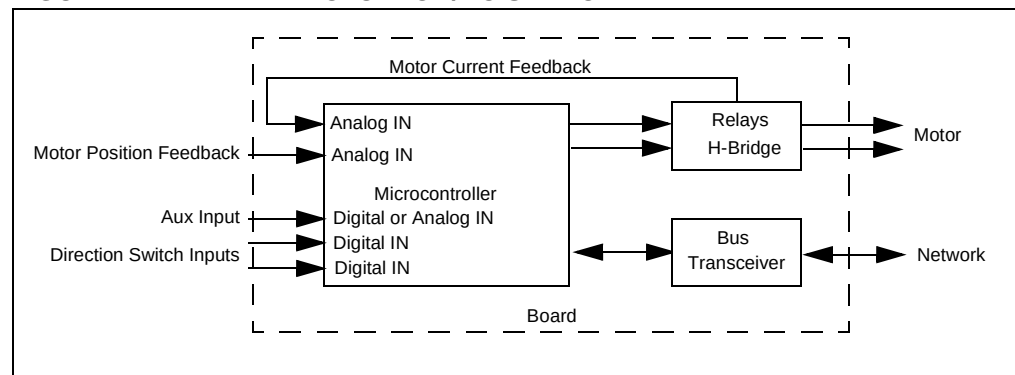
Chapter 2. Window Lift Control Module Hardware

2.1 INTRODUCTION

The Anti-Pinch Window Lift Control module is implemented using a Microchip generic LIN Actuator and DC Servo board. Hard-wired switch inputs, as well as LIN commands, can be used to control the two output relays.

This module consists of a microcontroller, power supply, relays with their associated drivers, input conditioning circuits and network physical interface.

FIGURE 2-1: LIN ACTUATOR/DC SERVO



2.2 HARDWARE

2.2.1 Inputs

The CW (Clockwise) and CCW (Counterclockwise) inputs from connector J2 (see Figure 2-3) can be routed either to the microcontroller or directly to the motor relay drivers as selected by E1 and E2. In this application, the microcontroller has full control over the motor so the switch inputs are routed to the microcontroller as direction requests (see Figure 2-5).

The current across the motor is measured by a current-sensing resistor at location CSR1 on the circuit board.

An auxiliary input signal, such as Ignition or Accessory-On, can be sent through J1-4 (see Figure 2-2). A resistor-capacitor-diode network can be installed in positions R7 through R10. These are component footprint placeholders and accept standard 0805 parts. This input is not used at this time.

2.2.2 Outputs

The two relays are driven by two logic-input MOSFETs. The relays are configured in an H-bridge arrangement to apply reversible voltage to the controlled motor. These relays can supply up to 20A of continuous current.

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2.2.3 Microcontroller

The microcontroller can be any one of the 14-pin PIC[®] device family members, but in this instance, it is a PIC16F688. The PIC16F688 has an Enhanced Addressable USART that supports the Local Interconnect Network (LIN) and SAE J2602 protocol. The following table shows the I/O port connections.

TABLE 2-1: I/O CONNECTIONS

PORT Pin	Function	Notes
Inputs		
RA0	Not used	ICSP [™] Data
RA1	Motor current sense feedback input	ICSP Clock
RA4	Clockwise switch input	
RA5	Counterclockwise switch input	
RC3	Auxiliary input	
Outputs		
RC0	Clockwise motor driver output	
RC1	Counterclockwise motor driver output	
Network Transceiver Interface		
RC2	CS output	
RC4	TX output	
RC5	RX input	
Unused pins		
RA2	Not used	
RA3	Not used	ICSP $\overline{\text{MCLR}}$

The microcontroller Flash program and E2 data memory may be programmed through JP1. This connector is pinout compatible with PICKit 1 and 2 programmers. Microchip's MPLAB[®] ICD 2 may also be used with an appropriately pinned cable (not supplied). (See "**PIC16F688 Data Sheet**" (DS-41203), for additional information.)

2.2.4 Network Interface

A MCP201 LIN Bus Transceiver is used for the physical slave bus driver to connect to a LIN- or J2602-compatible network. A Zener diode protects the LIN bus pin from transient voltages. The capacitor between the LIN bus pin and ground should have its value adjusted for the particular network topology. A large pull-up resistor on the FAULT/SLPS pin ensures that a MCP201 device resets to a standard slope control profile. (See "**MCP201 Data Sheet**" (DS-21430), for more information.)

2.2.5 Power Supply

Power is supplied to the board through a J2 system connector (AMP 770969-1) (see Figure 2-2). The voltage should be in the range of 8-18 VDC. The voltage regulator is reverse-battery, transient and load-dump protected.

To reduce power consumption in key-off situations, the 'power-on' LED may be removed.

2.2.6 Connectors

FIGURE 2-2: J1 MOTOR CONNECTOR

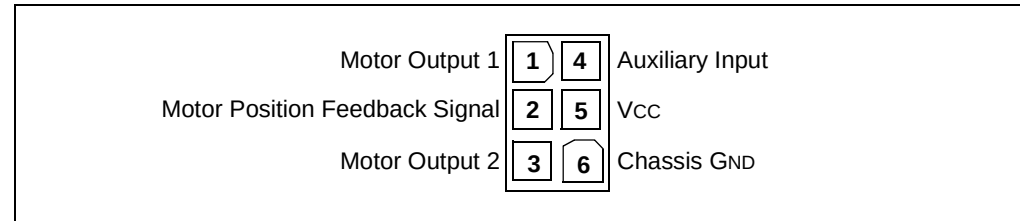


FIGURE 2-3: J2 SYSTEM CONNECTOR

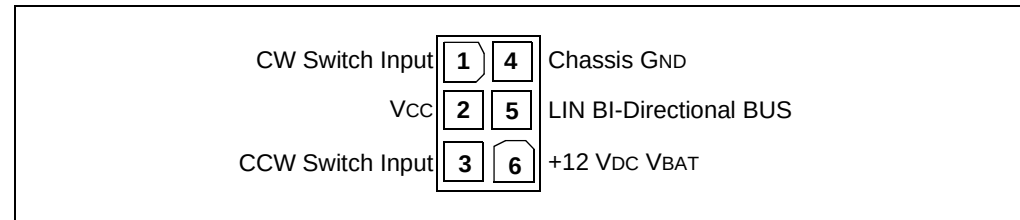
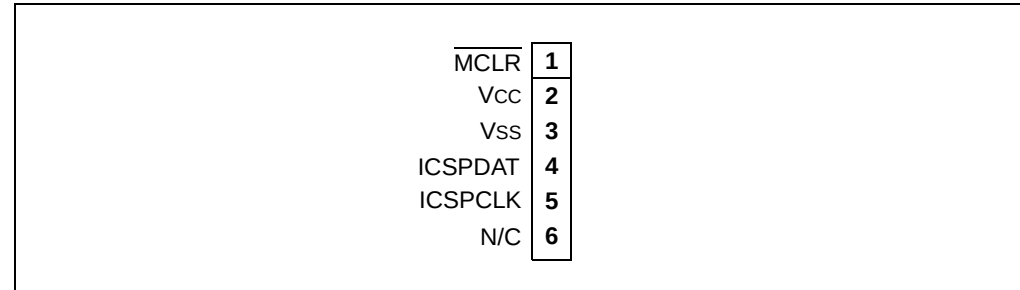


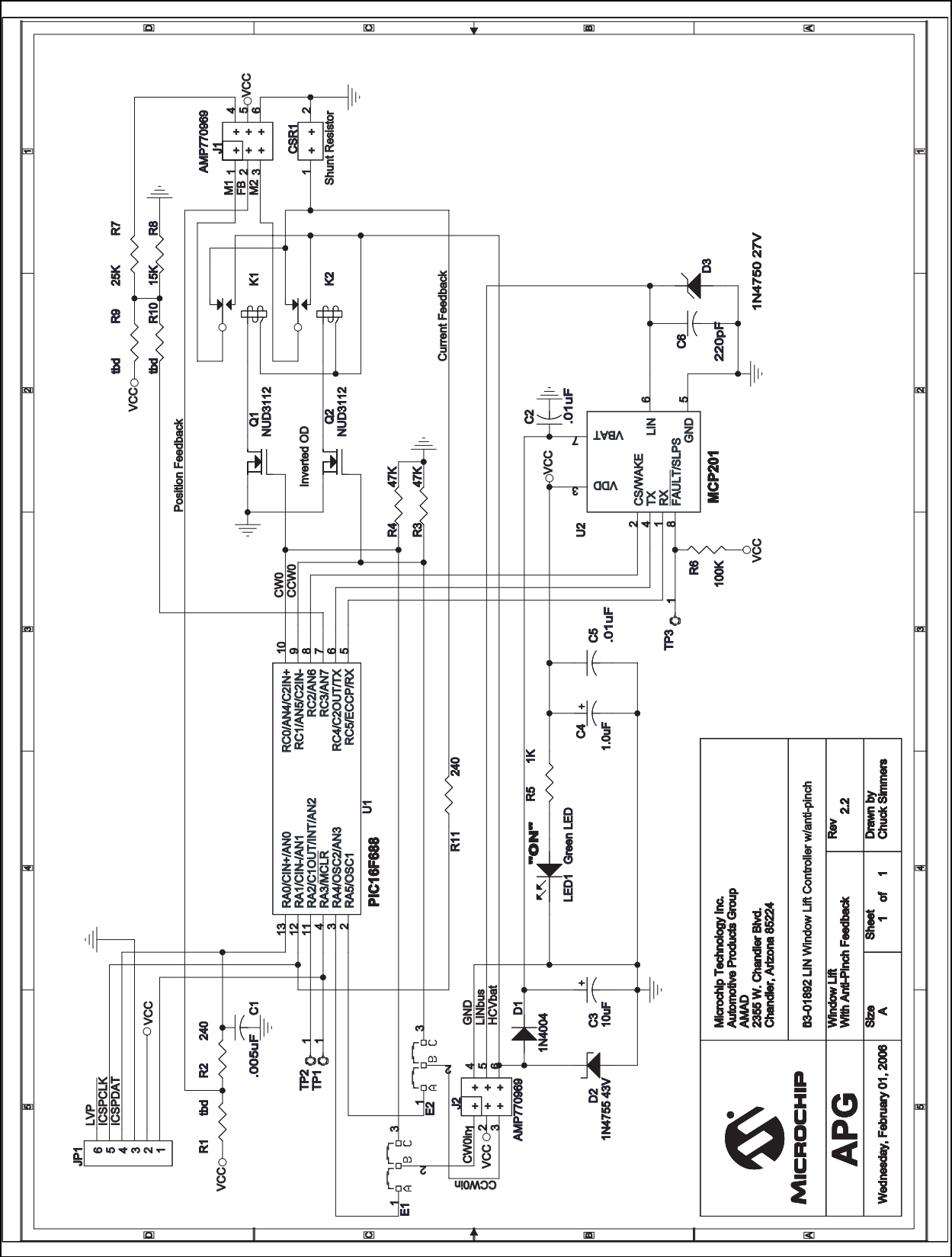
FIGURE 2-4: JP1 PROGRAMMING CONNECTOR



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2.3 SCHEMATICS

FIGURE 2-5: SCHEMATIC



Chapter 3. Window Lift Control Module Software

3.1 INTRODUCTION

The software supplied with this board is used as a basic guideline, or framework, rather than a production-ready program. The software includes all foundation routines to begin testing and evaluation, but final refinement and individual optimization is left to the user.

3.2 SOFTWARE

The set of modules presented in this user's guide implements the following features:

- Interrupt driven LIN 2.0 protocol state machine
- Error detection and accumulation (error reporting is not addressed).
- Motor current-sensing of a stall condition with auto-reverse.
- Internal 8 MHz oscillator (auto-baud rate detection for LIN messages).

3.2.1 MODULE OVERVIEW

The code presented in this user's guide is composed of the following basic modules:

TABLE 3-1:

File	Description
WindowLift20.asm	Main program
UART688i.inc	EAUSART variables and constants
UART688i.asm	LIN protocol handler
ID_table.inc	LIN Identifier information tables

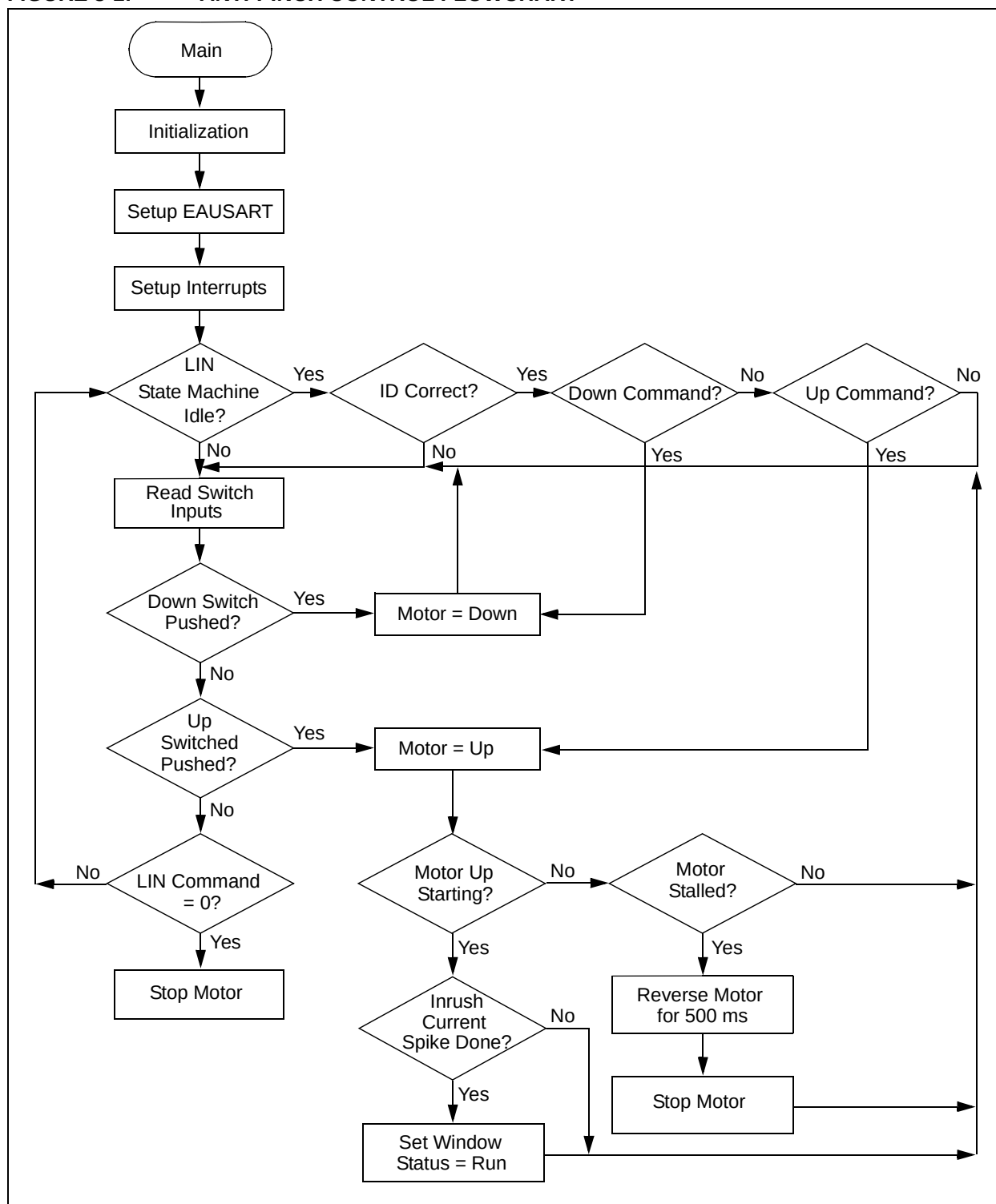
WindowLift20.asm contains a loop that reads the direction requests from the switches and from slave LIN message frames (see Figure 3-1). Window 'DOWN' requests, either from the switch or from a LIN command, are directed to the motor outputs without qualification. Window 'UP' requests are passed to the motor while monitoring the drawn current. There is an initial in-rush spike when the motor is first turned ON. This spike is monitored and once the current falls below a pre-determined threshold, the anti-pinch detection is armed. Any increase in current over the threshold will cause the motor to reverse for 500 mS and stop. This sequence is repeated as long as there is a pending 'DOWN' request.

Some refinements that could be added to the firmware are:

- Better in-rush spike detection
- Current threshold averaging for motor and transmission aging. This would also yield closer threshold anti-pinch tolerance.
- Filtering the motor current ripple to measure motor speed and travel
- Express UP/DOWN commands from the switches
- Anti-pinch override (UP button held down)

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FIGURE 3-1: ANTI-PINCH CONTROL FLOWCHART



3.2.2 LIN Protocol Handler

The LIN Handler routine is outlined in Figure 3-2. This code constitutes a LIN 2.0-compatible slave interface. The status of the state machine is based on the MESSAGE_COUNTER value and is serial port interrupt driven.

- Break characters are detected and validated for length
- Sync characters are checked to content (0x55) and speed (auto-baud overflow).

The identifier byte is passed through an ID look-up table and checked for validity for this slave, message length is extracted and whether this message data field is supplied or to be consumed.

If the Break or Sync characters cause an error, or the identifier is not listed in the table, the state machine is reset and returns to waiting for a valid Break.

Received data is stored in a buffer and the identifier parity bits and message frame checksum are checked.

Data to be transmitted is taken from the buffer and the appropriate checksum generated.

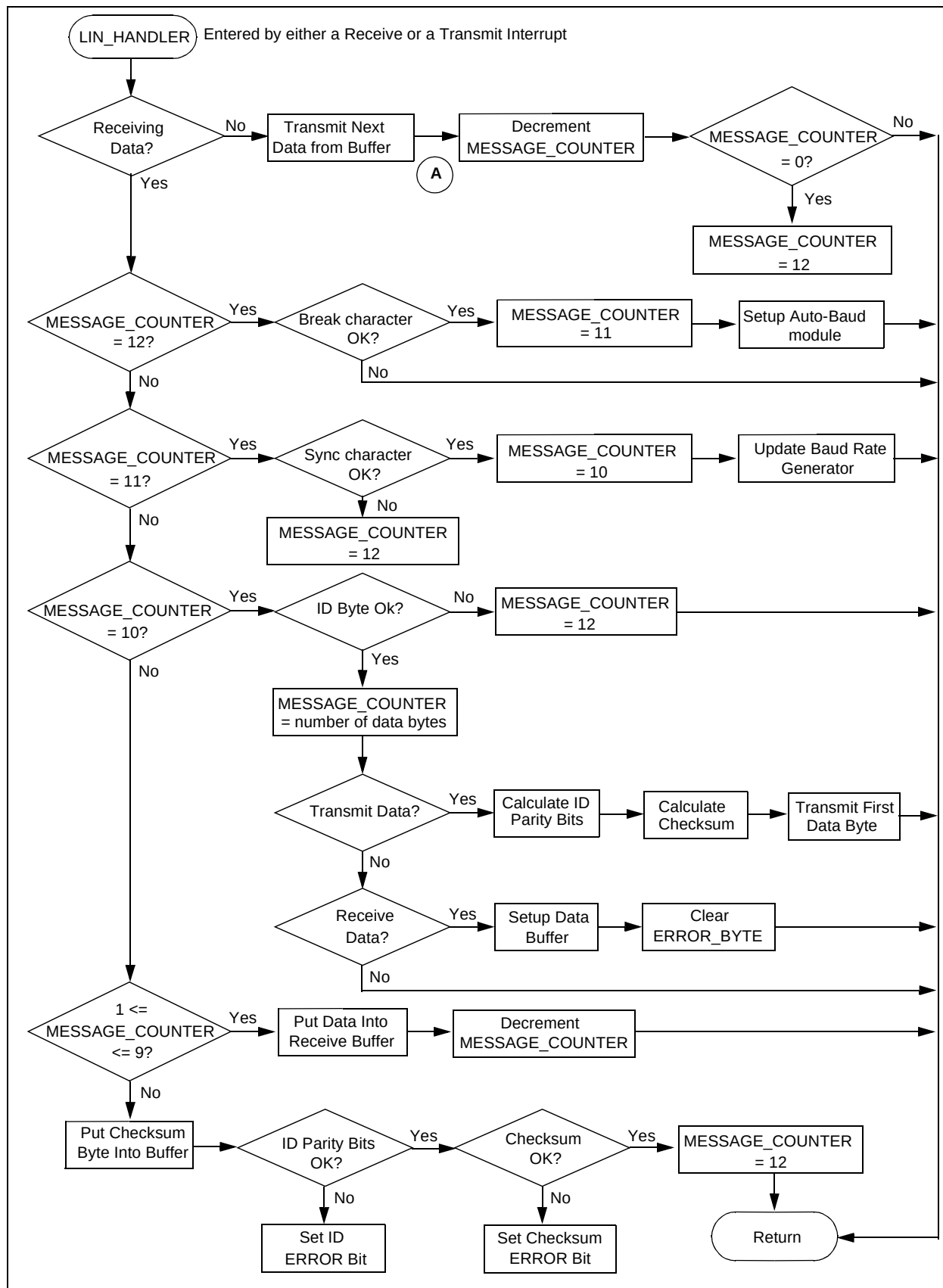
All the state machine activities are handled in the background in an interrupt service routine. An Idle state machine is signalled by the MESSAGE_COUNTER = 12, indicating a full/empty data buffer.

Some enhancements that can be easily made to the LIN handler:

- Although an ERROR_BYTE exists to accumulate parity and checksum errors, it is cleared on every incoming frame. Error counters could be added for additional error reporting.
- No transmitted data bit testing is done. This could be added at point 'A' marked in the flowchart. Bus errors thus detected can be accumulated and reported in the ERROR_BYTE.
- Bus time-out and Idle detections using and internal timer/counter.

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FIGURE 3-2: LIN HANDLER FLOWCHART



3.2.3 LIN Description File Information

Example 3-1 is an excerpt of a LDF file defining this module.

Note: The ID = 5, DOWN = databyte1 - bit 0, UP = databyte1 - bit 1, and the remaining bits of databyte1 and all of databyte2 are not used.

EXAMPLE 3-1: LDF FILE EXAMPLE

```
LIN_description_file;
LIN_protocol_version = "2.00";
LIN_language_version = "2.00";

LIN_speed = 10.40 kbps;

Nodes
  Master: Master, 10 ms, 0.10 ms;
  Slaves: Slavel;

Signals
  UP: 1, 0, Master, Slavel;
  DOWN: 1, 0, Master, Slavel;

Frames
  Window: 5, Master, 2
    DOWN, 0;
    UP, 1;

Node_attributes
  Slavel
    LIN_protocol = "2.0";
    configured_NAD = 127;
    product_id = 32767, 65535, 0;
    P2_min = 0 ms;
    ST_min = 0 ms;
```



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