# AN728

# Remote Keyless Entry and Convenience Center Reference Design with LIN Bus Interface

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## OVERVIEW

This Application Note describes the working of a KEELOQ® code hopping decoder implemented on a Microchip mid-range MCU (PIC16F873). The software implements a stand-alone decoder integrated with a convenience center master microcontroller. The decoder supports the Microchip's HCS200, HCS201, HCS300, HCS301, HCS360, and HCS361 KEELOQ hopping code encoders. The decoder supports normal and secure learning. Two manufacturer's codes allow different manufacturers to share a public key, but retain their own private keys.

This design has been optimized to integrate into either an existing model platform without modification to the wiring harness (piggybacks onto original), or can be used with a new model with multiplexed wiring using the LIN standard. Operational flexibility is key to overall concept with many scalable features that can be customer, dealer, or factory end-of-line programmable.

This system has, additionally, been presently installed in a vehicle that has been completely retrofitted with Remote Keyless Entry (RKE) and power seat memory modules. This platform will also be used to test the future lighting control and engine immobilizer modules.

## FEATURES

- Supports two manufacturer's codes
- Compatible with Microchip's HCS200, HCS201, HCS300, HCS301, HCS360 and HCS361 encoders.
- Automatic baud rate detection
- Automatic Normal or Secure learn detection
- Six learnable transmitters
- LIN Network Functions
  - Operates boot (trunk) lock remotely
  - LIN master node
  - Flash parking lights upon lock or unlock command
  - Flash headlamps (*n*-times to forever)
- Can be added to existing wiring harness without modification

The LIN (Local Interconnect Network) protocol was devised to address low cost automotive networks. The LIN standard is meant to replace the myriad of low-end multiplex wiring solutions in current use.

The LIN standard includes the specification of the transmission protocol, the transmission medium, the interface between, development tools, and the interfaces for software programming.
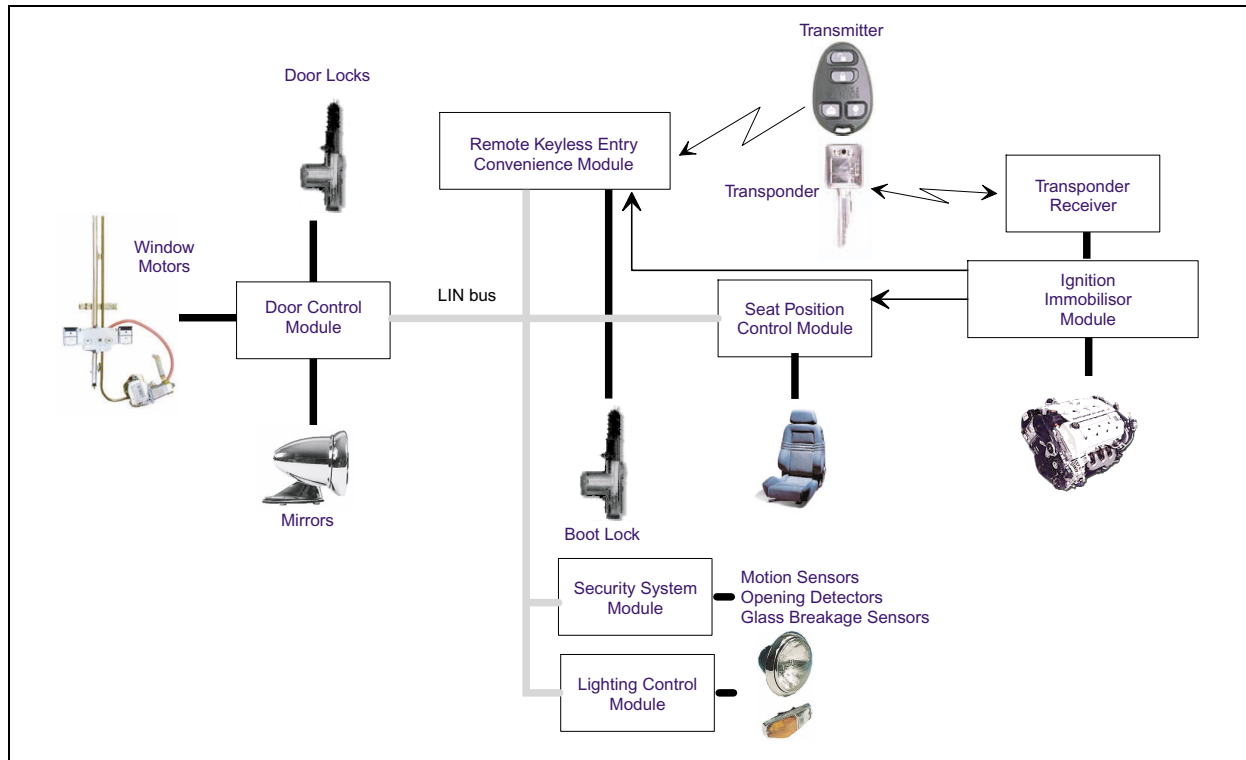
**FIGURE 1:** RKE SYSTEM
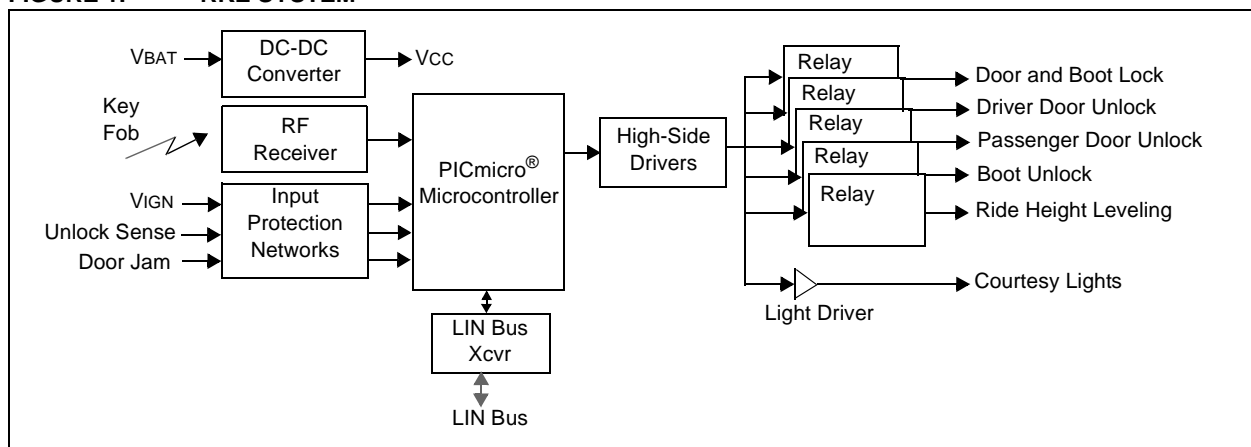


**Notice:** This is a non-restricted version of Application Note AN728 which is available under the KEELOQ License Agreement. The license agreement can be ordered from the Microchip Literature Center as DS40149.

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**FIGURE 2:** **SYSTEM BLOCK DIAGRAM**



## OPERATIONAL FEATURES

For optional features refer to Section "Customer Option Programming"

### Locks

LOCK AND UNLOCK WITH DOOR SWITCHES

- One UNLOCK push of driver's door switch unlocks passenger doors, second push within 4 seconds unlocks driver's side. (Option: UNLOCK operates all doors, simultaneously)
- Push of passenger's UNLOCK switch only unlocks passenger doors. (Option: if above option is selected, passenger's UNLOCK operate all doors)
- Push of any LOCK switch locks all doors and boot.

LOCK AND UNLOCK WITH RKE FOB

- One push of RKE UNLOCK switch unlocks driver's door, second push within 4 seconds unlocks passenger doors. (Option: RKE UNLOCK operates all doors, simultaneously)
- One push of RKE LOCK switch locks all doors and boot.
- One push of RKE BOOT switch unlocks and opens boot lid.

## AUTO-LOCK/UNLOCK (OPTIONALLY ENABLED)

- All doors unlock when ignition is turned off. (Option: when ignition key is removed)
- All doors lock when transmission has DRIVE selected. (Option: when vehicle speed reaches 20 mph (32 kph) and DRIVE selected)
- All doors and boot lock after 0-100 seconds (programmable) after ignition key is removed and all doors have been closed. (Option: disabled)
- If above Auto-lock mode is selected, then if any windows are not fully closed, close all windows. (Option: disabled)
- Boot is automatically locked whenever closed. (Option: disabled)

## Lighting

### COURTESY LIGHTS

- On whenever a door is open.
- On half intensity for 0-30 seconds (programmable) or until a door is opened, when ignition is switched off. (Option: disabled)
- Dimming to off (0-30 seconds, programmable) when all doors closed. (Option: off immediately, no dimming)
- Off immediately when ignition is switched on.
- On for 0-30 seconds (programmable) or until a door is opened when RKE unlocks any doors.
- Off immediately when RKE locks all doors.

### HEADLIGHTS

- If headlights are on, keep on for 0-90 seconds (settable by instrument panel control) after ignition is switched off.
- If ambient light is low, and RKE unlocks any doors, headlights on for 0-30 seconds (programmable) or until ignition is switched on. (Option: disabled or sidelights only)

### SIDELIGHTS

- Flash for 1 second whenever RKE locks or unlocks doors. (Option: disabled)

## Seats and Mirrors

Whenever the driver's door is unlocked by the RKE, the driver's seat positioning system and the rearview mirrors will be commanded to assume a position stored in their respective nonvolatile memories. The position number is selected by decoding the serial number of the RKE transmitter. Thus several different transmitter fobs can command their own unique settings. (Option: disabled)

A given seat/mirror setting can be associated to a specific transmitter, by the following sequence.

1. Adjust seat and mirrors to desired position.
2. With the ignition switch on, press the LOCK and UNLOCK switches on the selected RKE fob simultaneously.

These settings are now associated with this transmitter.

## Remote Transmitter LEARN Function

Learning is a feature that allows the addition of new transmitters to the system without the need to reprogram the system. During the learning process, the decoder identifies the transmitter and stores its parameters (cryptographic key and synchronization information) in EEPROM for future use. If the transmitter is activated again, the decoder will recognize the transmitter and respond to it normally.

The decoder's learning capabilities simplify replacement of lost transmitters. When a transmitter is lost, the user can "teach" the decoder the crypto-key of a new transmitter bought off the shelf. When a transmitter is lost, it is advisable to erase and relearn all existing transmitters to ensure that the lost transmitter is denied access to the system.

Learning a transmitter by a decoder is a two-phase process. During the learn process, a cryptographic key is generated by the decoder. The crypto-key is stored with the serial number and synchronization information after the crypto-key has been verified.

The crypto-key generation process has three inputs. The first is the source of the crypto-key generation. The source can be the encoder's serial number (normal learn) or the encoder's seed (secure learn). The next input is the crypto-key generation algorithm. The third input to the system is a manufacturer's crypto-key. The manufacturer's crypto-key tailors the crypto-key generation algorithm to a specific manufacturer. This customizing of the crypto-key generation algorithm means competitors can not clone transmitters for a system.

Two transmissions are needed by the decoder during learn; one is used to generate a crypto-key and the second, to validate the generated crypto-key. If the user uses the serial number as the crypto-key generation source, then both transmissions will be normal hopping code transmissions. If the user chooses to use secure learn (seed as the crypto-key generation source), the first transmission should be a hopping code transmission, and the second transmission a seed transmission. The HCS360 and HCS361 encoders are ideally suited for secure learn. These encoders transmit the seed if S0 and S1 are activated for longer than 3 seconds. This means that secure learn can be performed with a single extended press of a button assuming the button is tied to S0 and S1.

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## LEARNING PROCEDURE

Learning a transmitter is accomplished as follows:

1.  Press and release the LEARN button. The LEARN LED will turn on to indicate that the decoder has entered Learn mode.
2.  Press transmitter button. The LEARN LED will turn off, indicating a transmission has been received.
3.  Press transmitter a second time. The LEARN LED will flash to indicate that the transmitter was learned successfully.
4.  Repeat steps 1-3 to learn up to the maximum number of transmitters. Additional transmitters will overwrite transmitters already in the system.

Learning will be terminated if two non-sequential codes are received or if two acceptable codes were not received within about 30 seconds. An unsuccessful learning attempt will be indicated by the LEARN LED turning on for 1 second.

| Note: | The second transmission must be a SEED transmission when secure learn is used. |
|---|---|

## TRANSMITTER ERASING

Erasing of all the transmitters is accomplished by pressing and holding the LEARN button for 8 seconds. The LED will turn off at the end of the 8 seconds to indicate that the transmitters were erased.

## Network Operation

The unit is connected to a LIN interface bus as a secondary master node. Six command frames are encoded by the firmware.

-   Unlock boot
-   Flash sidelamps upon lock or unlock
-   Lock all doors and boot
-   Flash headlamps on 'PANIC' push
-   Stop flashing headlamps on second 'PANIC' push

The LIN identifiers selected for this application are '0Bh' and '11h'. The six commands are selected by the first data byte following the identifier.

**TABLE 1:      LIN IDENTIFIERS**

| ID | 1st data byte | 2nd data byte | Action |
|---|---|---|---|
| 0Bh | 00h | x | Reserved |
| 0Bh | 01h | 03h | Flash Park |
| 11h | 10 | x | Unlock Boot |
| 11h | 17 | x | All Lock |
| 0Bh | 02 | FF | Flash Head |
| 0Bh | 02 | 00 | Stop Flash |

## Currently Implemented Features

For functions lighting and seat/mirror position control, the RKE module communicates command and transmitter identification data over the LIN bus interface to the appropriate submodule. These submodules are normally autonomous in operation, but can be commanded externally. They perform the requested function without further supervision of the RKE module. If an error should occur during execution of a command, a diagnostic trouble code will be stored for later retrieval through a service data link.

| Note: | For safety reasons, whenever the ignition switch is in the 'on' position, all output functions are inhibited. |
|---|---|

**TABLE 2:     FEATURE STATUS**

| Feature | Currently Implemented | Comments |
|---|---|---|
| Lock/Unlock w/ switch | Yes | |
| Lock/Unlock w/ RKE | Yes | |
| Auto Lock/ Unlock | Partial | Needs V$_{SS}$ and/or DRIVE input |
| Courtesy Lights | Yes | |
| HeadLights | Yes | Communicates to Lighting Control Module |
| SideLights | Yes | Communicates to Lighting Control Module |
| Seat and mirror position | No | Communicates to Seat Position Module and Mirror Position Module |

## CUSTOMER OPTION PROGRAMMING

Some functional options can be selected from the RKE transmitter key fob. These options are available to any transmitter that has already been learned by the system. Pressing any button, with the exception of Panic, for longer than four seconds will enter the Programming mode. A second button pressed, simultaneously, within the four to ten second period will toggle an option on or off. The programming sequence can be cancelled by releasing the first button, then pushing any button.

**TABLE 3: OPTIONAL FUNCTIONS**

| First Button | Second Button | Action | Option |
|---|---|---|---|
| Unlock | | | |
| | Lock | Toggle Config1.6 | RKEUNL: RKE Door Lock Option |
| | Boot[1] | | |
| | Panic | Enter LEARN Mode | Set receiver to learn new transmitter fobs (up to a total of eight) |
| Lock | | | |
| | Unlock | Toggle Config4.5 | CHRP: Audible Feedback on RKE Lock/ Unlock Events |
| | Boot[1] | Toggle Config1.0 | BOOTLK: Boot Lock Option |
| | Panic | Toggle Config4.7 | RKEFSH: Flash Sidelights on RKE Activity |
| Boot[1] | | | |
| | Unlock[1] | | |
| | Lock[1] | | |
| | Panic[1] | | |
| **Note 1:** Not available on three-button RKE fobs. | | | |

## CIRCUIT DESCRIPTION

### Voltage Regulator

The regulator is an automotive-grade, low dropout linear device capable of supplying up to 500 mA of current. It contains reverse battery polarity and over-voltage protection, and can handle load dump transients of +60V / -50V. It also has internal short circuit detection and thermal overload protection.

The input to the board is further protected by a reverse polarity blocking diode (D2) and over-voltage control by a zener diode (D3).

Battery voltage is current limited to the LIN transceiver by resistor, R6.

### Inputs and Outputs

#### PROTECTED SYSTEM INPUTS

All inputs that are exposed to the vehicle system are clamped by back-to-back Schottky diodes to the internal $V_{CC}$ and $V_{SS}$ power planes.

All inputs are assumed to switch between chassis ground and 14.4V $V_{BAT}$. A resistor divider is provided to attenuate the input to a $V_{CC}$-$V_{SS}$ voltage range.

To use the J1-2 and J1-5 inputs, the respective input protection circuitry must be installed and the traces between E1 and E2 cut.

#### RELAY OUTPUTS

The relays are rated at 14$V_{DC}$, 20 A with a maximum switching power of 400 W.

The coils are driven from the PICmicro MCU through an octal high-side driver array. Each driver is capable of +500 mA and a total package load of not more than 2.5 W. The normally open (NO) contacts of relays K1 through K4 are tied together and supplied by J2, pin 10. All other contacts are kept separate and available on J1, J2, or discreet pads.

To use the alternative TP1 and/or TP2 outputs of the high-side driver, the input signal conditioning circuits associated with J1-2 and J1-5 must be removed and the jumpers E1 and E2 installed.

#### PULSE-WIDTH MODULATED OUTPUT

A high current (5 A, 80V) Darlington-pair transistor drives pin 14 of J2. The transistor can be installed in either the Q1 or the Q2 position on the board. Q1 configures the output to be a high-side drive. Q2 is for low-side drive. The output transistor is protected by blocking diode, D4.

### RADIO FREQUENCY RECEIVER INPUT

The output of the radio receiver module U1 is connected to pin 25 (RB4) of the PICmicro MCU, U2. A wire of suitable length is connected to the pad labeled ANT1 as an antenna.

### LEARN CONTROL INTERFACE

Connector JP2 is used to connect to a remote switch and LED to implement the 'Learn' request function and status display. The switch input is pulled up to $V_{CC}$ by an onboard 10 kΩ resistor. The LED is driven through an onboard 1 kΩ current-limiting resistor.

### IN-CIRCUIT DEBUG AND SERIAL PROGRAMMING INTERFACE

The resident PICmicro MCU software can be debugged or reprogrammed through an MPLAB® ICD or ICSP™ module connected to JP3. This is normally a RJ11, 6-pin telecom connector, but for the automotive environment this has been replaced with a 6-pin mini DIN. This connector and its associated cabling are much more robust than the typical telecom-type hardware.
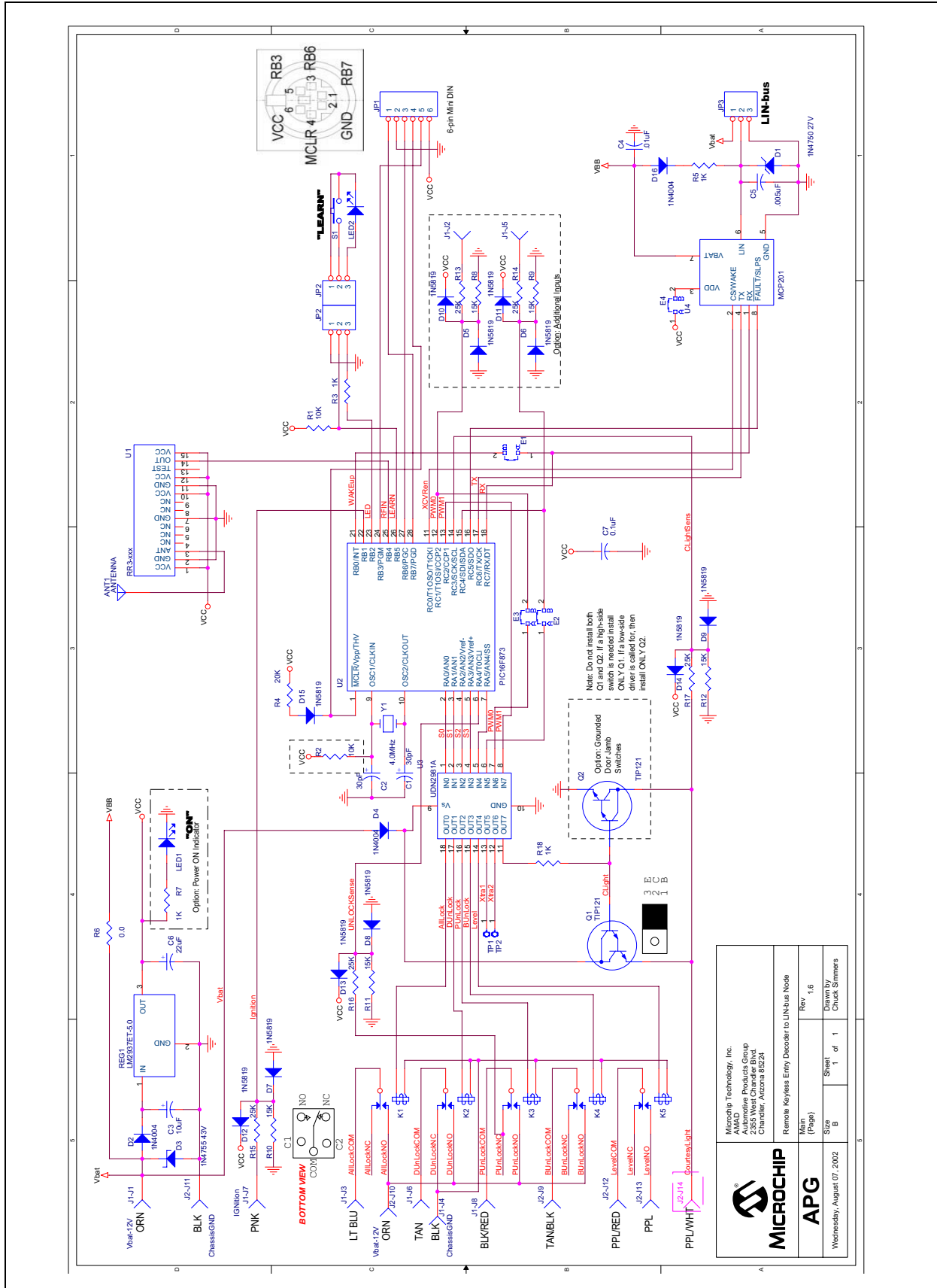
### Local Interconnect Network (LIN) Interface

The LIN bus interface is through a Microchip MCP201 LIN transceiver. The internal PICmicro UART pins (RC6/TX and RC7/RX) are connected to the respective pins on the transceiver. The transceiver's Chip Select input is driven from RC0. A high level on this output turns the transmitter on. The $\overline{FAULT}$ output of the transceiver is brought to the RC5 for software fault detection and correction.

The RX pin of the LIN receiver can, alternatively, be connected to RB0 by installing jumper E1. This allows the PICmicro MCU to be setup to wake on a transition of the LIN bus.

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## APPENDIX A:    SCHEMATICS

## Schematic Revision History

| Revision Number | Description | Matching PCB |
|---|---|---|
| RKE001 Revision 1.3 | First release, replaced 2mm double-row connector with.156 single row, added two auxiliary inputs conditioning circuits, added optional low-side courtesy light driver, replaced RJ11 6-pin ICD connector with a 6-pin mini DIN. | Hand-wired prototype |
| RKE001 Revision 1.4 | Added D15 diode to $\overline{\text{MCLR}}$ pin. | RKE001 Rev 1.2 |
| RKE001 Revision 1.5 | Not released | None |
| RKE001 Revision 1.6 | Released K-line transceiver with MCP201. Changed Jx connectors for higher current. | RKE001 Rev 1.6 |
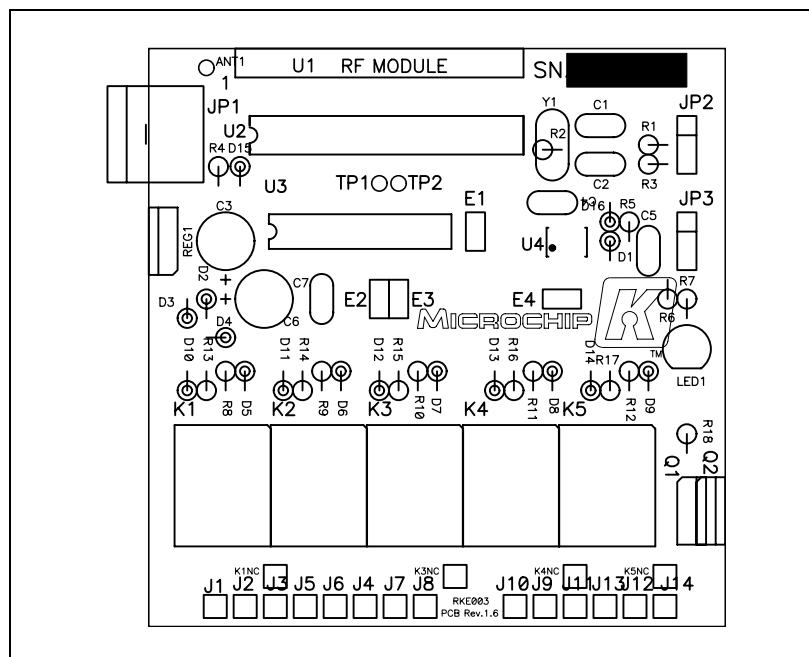


## PCB Revision History

| Revision Number | Description | Matching Schematic |
|---|---|---|
| RKE001 Revision 1.2 | Relay footprints are backwards. Fully functional. | RKE001 Rev. 1.4 |
| RKE001 Revision 1.3 | Fixed relay footprints. No change to J1-J14. | RKE001 Rev. 1.4 |
| RKE001 Revision 1.4 | Not released | RKE001 Rev 1.5 |
| RKE001 Revision 1.5 | Not released | RKE001 Rev 1.5 |
| RKE001 Revision 1.6 | Re-oriented parts placement to quiet LIN area and for more current carrying capability. | RKE001 Rev 1.6 |

**TABLE 4: CONNECTOR DESCRIPTIONS**

| | JP1 ICD/ICSP Interface | | |
| --- | --- | --- | --- |
| **Pin Number** | **Pin Name** | **Description** | **PICmicro MCU Signal** |
| 1 | $\overline{\text{MCLR}}$ | Master Clear Input / Program Mode Select | Pin 1 $\overline{\text{MLCR}}$ |
| 2 | VCC | +5VDC Power | Pin 20 VDD |
| 3 | GND | Ground Power | Pin 8,19 VSS |
| 4 | RB7 | Data Input/Output | Pin 28 RB7/PGD |
| 5 | RB6 | Clock Input | Pin 27 RB6/PGC |
| 6 | RB3 | Low Voltage ICSP Programming Input | Pin 24 RB3/PGM |

| | JP2 Learn Interface | | |
| --- | --- | --- | --- |
| **Pin Number** | **Pin Name** | **Description** | **PICmicro MCU Signal** |
| 1 | GND | Ground Power | Pin 8,19 VSS |
| 2 | SW | Learn Switch Input | Pin 26 RB5 |
| 3 | LED | Learn LED Output | Pin 23 RB2 |

| | JP3 LIN Interface | | |
| --- | --- | --- | --- |
| **Pin Number** | **Pin Name** | **Description** | **PICmicro MCU Signal** |
| 1 | VBAT | +12VDC Battery Power | No connection |
| 2 | LIN | LIN bus Input/Output | Pin 17 and 18 RC6/TX and RC7/RX |
| 3 | GND | Bus Ground Power | Pin 8,19 VSS |

| | J1 System Interface | | |
| --- | --- | --- | --- |
| **Pin Number** | **Pin Name** | **Description** | **PICmicro MCU Signal** |
| 1 | VBAT | +12VDC Battery Power | No connection |
| 2 | IN1 | Input #1 | Pin 12 RC1 |
| 3 | K1COM | Relay #1 Common | Controlled by Pin 2 RA0 |
| 4 | K2NC | Relay #2 Normally Closed | Controlled by Pin 3 RA1 |
| 5 | IN2 | Input #2 | Pin 15 RC4 |
| 6 | K2COM | Relay #2 Common | Controlled by Pin 3 RA1 |
| 7 | Ignition / IN3 | Ignition Input #3 | Pin 22 RB1 |
| 8 | K3COM | Relay #3 Common | Controlled by Pin 4 RA2 |

| | J2 System Interface | | |
| --- | --- | --- | --- |
| **Pin Number** | **Pin Name** | **Description** | **PICmicro MCU Signal** |
| 9 | K4COM | Relay #4 Common | Controlled by Pin 5 RA3 |
| 10 | VBATRLY | Relays #1, #2, #3, and #4 Normally Open | — |
| 11 | GND | Chassis Ground Power | — |
| 12 | K5COM | Relay #5 Common | Controlled by Pin 7 RA5 |
| 13 | K5NO | Relay #5 Normally Open | Controlled by Pin 7 RA5 |
| 14 | PWM | 5.0 A High- or Low-side Output with Input #5 | Controlled by Pin 13 RC2, read by Pin 14 RC3 |

**Note:** J1 and J2 pin number are not sequential on board layout.

| Optional System Interface Signals | | | |
|---|---|---|---|
| **Pin Number** | **Pin Name** | **Description** | **PICmicro MCU Signal** |
| — | K1NC | Relay #1 Normally Closed | Controlled by Pin 2 RA0 |
| — | K3NC | Relay #3 Normally Closed and Input #4 | Controlled by Pin 4 RA2, read by Pin 6 RA4 |
| — | K4NC | Relay #4 Normally Closed | Controlled by Pin 5 RA3 |
| — | K5NC | Relay #5 Normally Closed | Controlled by Pin 7 RA5 |
| — | TP1 | 0.5 A High-side Output | Controlled by Pin 15 RC4 |
| — | TP2 | 0.5 A High-side Output | Controlled by Pin 12 RC1 |

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**FIGURE 3:** **VEHICLE SYSTEM**

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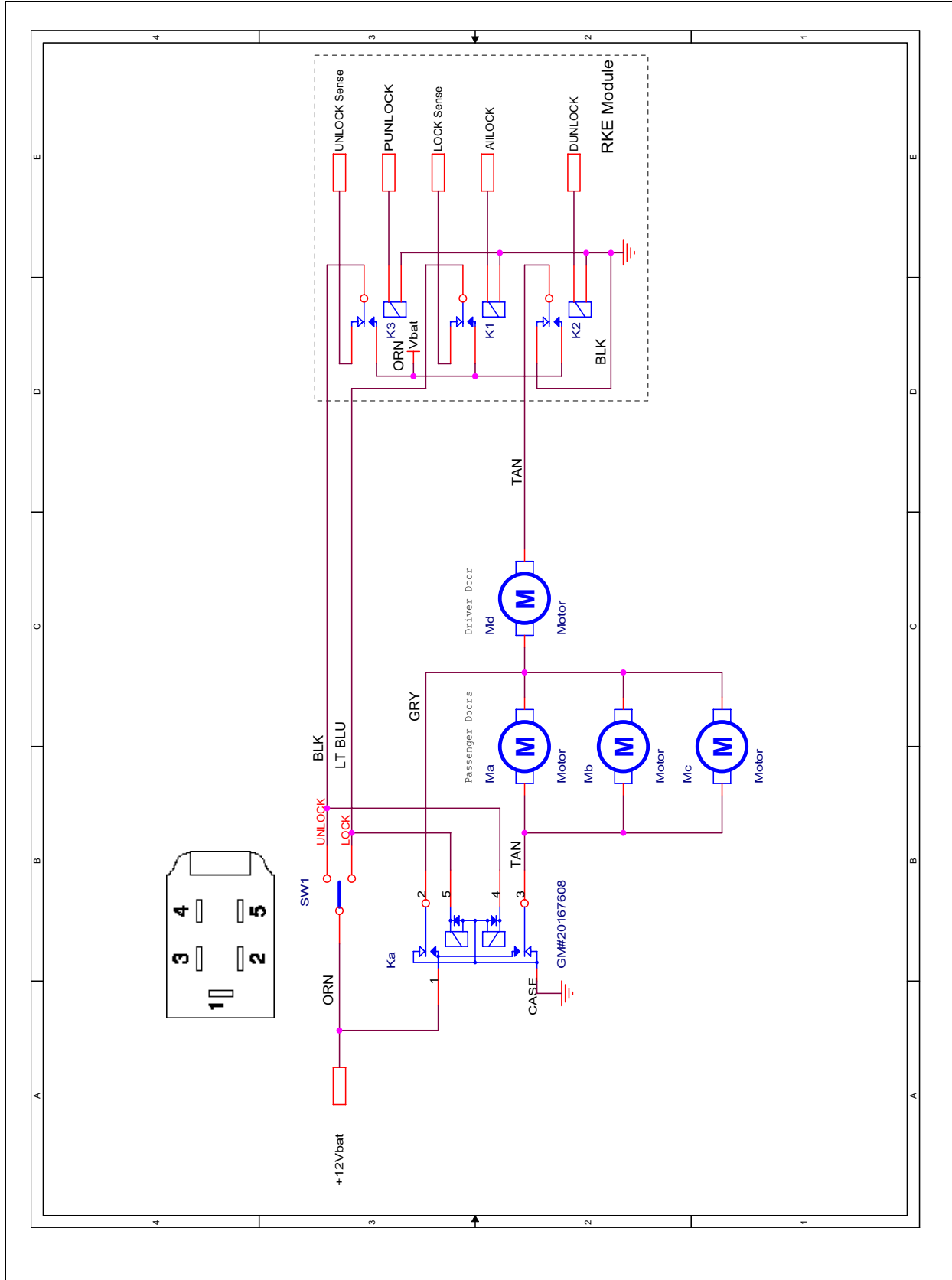
The present assignment of input and output circuits is as follows:

| Connector Number | Direction | Function | Signal Range |
|---|---|---|---|
| J1-1 | Power | +12V Battery | On always |
| J1-2 | — | Not assigned | |
| J1-3 | Out | Lock All | On = 12V Off = n.c. |
| J1-4 | Out | Driver Door Unlock NC | On = n.c. Off = 12V |
| J1-5 | — | Not assigned | |
| J1-6 | Out | Driver Door Unlock | On = 12V Off = n.c. |
| J1-7 | In | Ignition | On = 12V Off = n.c. |
| J1-8 | Out | Passenger Doors Unlock | On = 12V Off = n.c. |
| J2-9 | Out | Boot Unlock | On = 12V Off = n.c. |
| J2-10 | Power | +12V Battery | On always |
| J2-11 | Power | Chassis Ground | |
| J2-12 | Out | Load Leveler Solenoid | On = J2-12 shunted to J2-13 Off = n.c. |
| J2-13 | Out | Load Leveler Power | Switched on by Ignition |
| J2-14 | Out | Courtesy Lights | On = 12V Off = n.c. Continuously variable in 255 steps |
| K1NC | — | Not assigned | |
| K3NC | — | Not assigned | |
| K4NC | — | Not assigned | |
| K5NC | — | Not assigned | |

**Note:** Pins are not sequential on board.

## CONFIGURATION REGISTERS

Several features of the RKE system can be configured to suit the end user. These configuration bytes are located in EEPROM data memory and can be modified at software assembly time or by an external programmer such as PRO MATE® II. Refer to program listing for exact addresses.

**REGISTER 1:**      **CONFIGURATION BYTE 1**

| D = 1 | D = 1 | D = 1 | D = 1 | D = 1 | D = 0 | D = 0 | D = 1 |
|-------|-------|-------|-------|-------|---------|--------|--------|
| UNLOCK | RKEUNL | AUTOUN | OFF/RM | AUTOLK | DRV/SPD | WINDUP | BOOTLK |

bit 7                                                     bit 0

bit 7      **UNLOCK**: Inside Door Lock Option bit

1 = Unlock passenger, first push. Unlock driver, second push.
0 = Unlock all, one push

bit 6      **RKEUNL:** RKE Door Lock Option**(1)** bit

1 = Unlock driver, first press. Unlock passenger, second press.
0 = Unlock all, one press

bit 5      **AUTOUN**: Auto Unlock Option bit

1 = Enable auto unlock option
0 = Disable auto unlock option

bit 4      **OFF/RM**: Auto Unlock Select bit

If bit 5, AUTOUN is '1', else bit 4 has no effect
1 = Unlock all when ignition is switched off
0 = Unlock all when ignition key is removed

bit 3      **AUTOLK**: Auto Lock Option bit

1 = Enable auto lock option
0 = Disable auto lock option

bit 2      **DRV/SPD**: Auto Lock Select bit

If bit 3, AUTOLK is '1', else bit 2 has no effect
1 = Lock all when vehicle speed is greater than 20 kph
0 = Lock all when DRIVE gear is selected

bit 1      **WINDUP**: Windows Up Option bit

1 = If any window is not closed when a lock function is invoked, window will be raised
0 = Disabled, no action

bit 0      **BOOTLK**: Boot Lock Option bit

1 = Boot is locked whenever it is closed
0 = Disabled, no action

**Note 1:** Can be customer programmed from transmitter fob. Refer to Section "Customer Option Programming".

| Legend: | | |
|---|---|---|
| R = Readable bit | W = Writable bit | U = Unimplemented bit, read as '0' |
| -n = Value at POR | '1' = Bit is set | '0' = Bit is cleared    x = Bit is unknown |
| D = Default value | | |

**REGISTER 2:** **CONFIGURATION BYTE 2**

| D = 0 | D = 0 | D = 0 | D = 0 | D = 0 | D = 0 | D = 0 | D = 0 |
|-------|-------|-------|-------|-------|-------|-------|-------|
| LKDLY7 | LKDLY6 | LKDLY5 | LKDLY4 | LKDLY3 | LKDLY2 | LKDLY1 | LKDLY0 |
| bit 7 | | | | | | | bit 0 |

bit 7-0 **KDLY<7:0>** Lock Delay Time bits

0 = Disabled, no delay
n = Delay time 1 to 255 seconds after ignition key is removed and all doors have been closed, all doors lock

| Legend: | | |
|---|---|---|
| R = Readable bit | W = Writable bit | U = Unimplemented bit, read as '0' |
| -n = Value at POR | '1' = Bit is set | '0' = Bit is cleared    x = Bit is unknown |
| D = Default value | | |

**REGISTER 3:** **CONFIGURATION BYTE 3**

| D = 0 | D = 0 | D = 0 | D = 1 | D = 1 | D = 1 | D = 1 | D = 1 |
|-------|-------|-------|-------|-------|-------|-------|-------|
| WLKAWY | WLKUP | SIDEO | CLDLY4 | CLDLY3 | CLDLY2 | CLDLY1 | CLDLY0 |
| bit 7 | | | | | | | bit 0 |

bit 7 **WLKAWY**: Enable Walk Away Headlight On bit

1 = Enable lighting module to keep headlights on for a set period of time. Time controlled by lighting module.
0 = Disable

bit 6 **WLKUP**: Enable Walk Up Lights On bit

1 = Enable lighting module to turn on lights for a set period of time. Time controlled by lighting module.
0 = Disable

bit 5 **SIDEO**: Side Lights Only Select bit

1 = If bit 6, WLKUP is 1, turn on headlights
0 = If bit 6, WLKUP is 1, turn on only sidelights

bit 4-0 **CLDLY<4:0>** Courtesy Light Delay Time bits

0 = Disabled, no delay
n = Delay time 1 to 31 seconds after ignition is switched off, courtesy lights will stay on

| Legend: | | |
|---|---|---|
| R = Readable bit | W = Writable bit | U = Unimplemented bit, read as '0' |
| -n = Value at POR | '1' = Bit is set | '0' = Bit is cleared    x = Bit is unknown |
| D = Default value | | |

**REGISTER 4:** **CONFIGURATION BYTE 4**

| D = 1 | D = 0 | D = 0 | D = 1 | D = 1 | D = 1 | D = 1 | D = 1 |
|-------|-------|-------|--------|--------|--------|--------|--------|
| RKEFSH | SMPOS | CHRP | CLDIM4 | CLDIM3 | CLDIM2 | CLDIM1 | CLDIM0 |

bit 7                                                                      bit 0

bit 7     **RKEFSH:** Flash Sidelights on RKE Activity [1] bit

1 = Flash sidelights for 1 second whenever RKE activity detected
0 = Disabled

bit 6     **SMPOS**: Seat and Mirror Position Command bit

1 = Command seat and mirror control modules to assume pre-selected position
0 = Disabled

bit 5     **CHRP:** Audible Feedback on RKE Lock and Unlock Events[1] [2] bit

1 = Audio transducer is enabled whenever RKE Lock/UnLock detected
0 = Disabled

bit 4-0     **CLDLY<4:0>** Courtesy Light Dim Time bits

0 = Disabled, no dimming
n = Dimming time 1 to 31 seconds after all doors are closed

**Note 1:** Can be customer programmed from transmitter fob. Refer to Section "Customer Option Programming".

     **2:** Must be disabled in certain markets.

| Legend: | | |
|---------|---|---|
| R = Readable bit | W = Writable bit | U = Unimplemented bit, read as '0' |
| -n = Value at POR | '1' = Bit is set | '0' = Bit is cleared     x = Bit is unknown |
| D = Default value | | |

Factory default values can be reestablished by cycling power off, then on, while pressing the LEARN button. After resetting back to the factory default, individual option selections can be reprogrammed into the configuration memory.
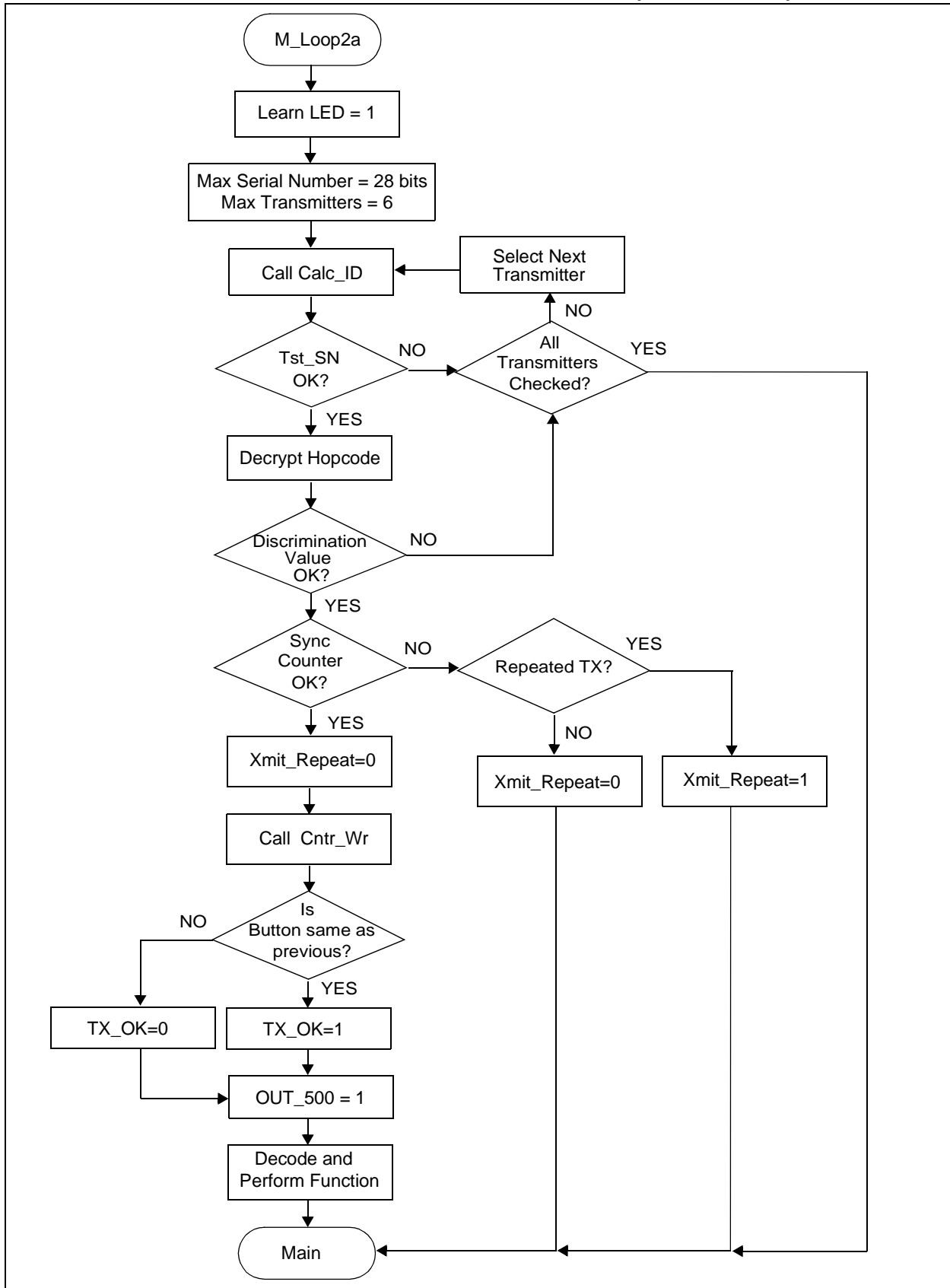
## Referenced Documents:

- "LIN Specification Package", Revision 1.2, November 17, 2000, www.lin-subbus.org
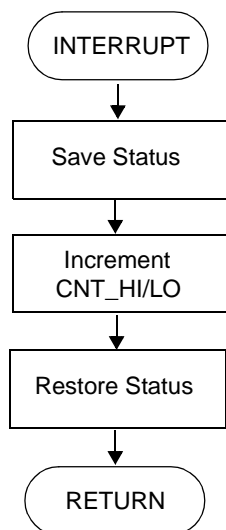- Microchip Applications Note AN729, "LIN Bus Implementation using PICmicros[®]", DS00729A

## APPENDIX B: MAIN PROGRAMMING FLOWCHARTS
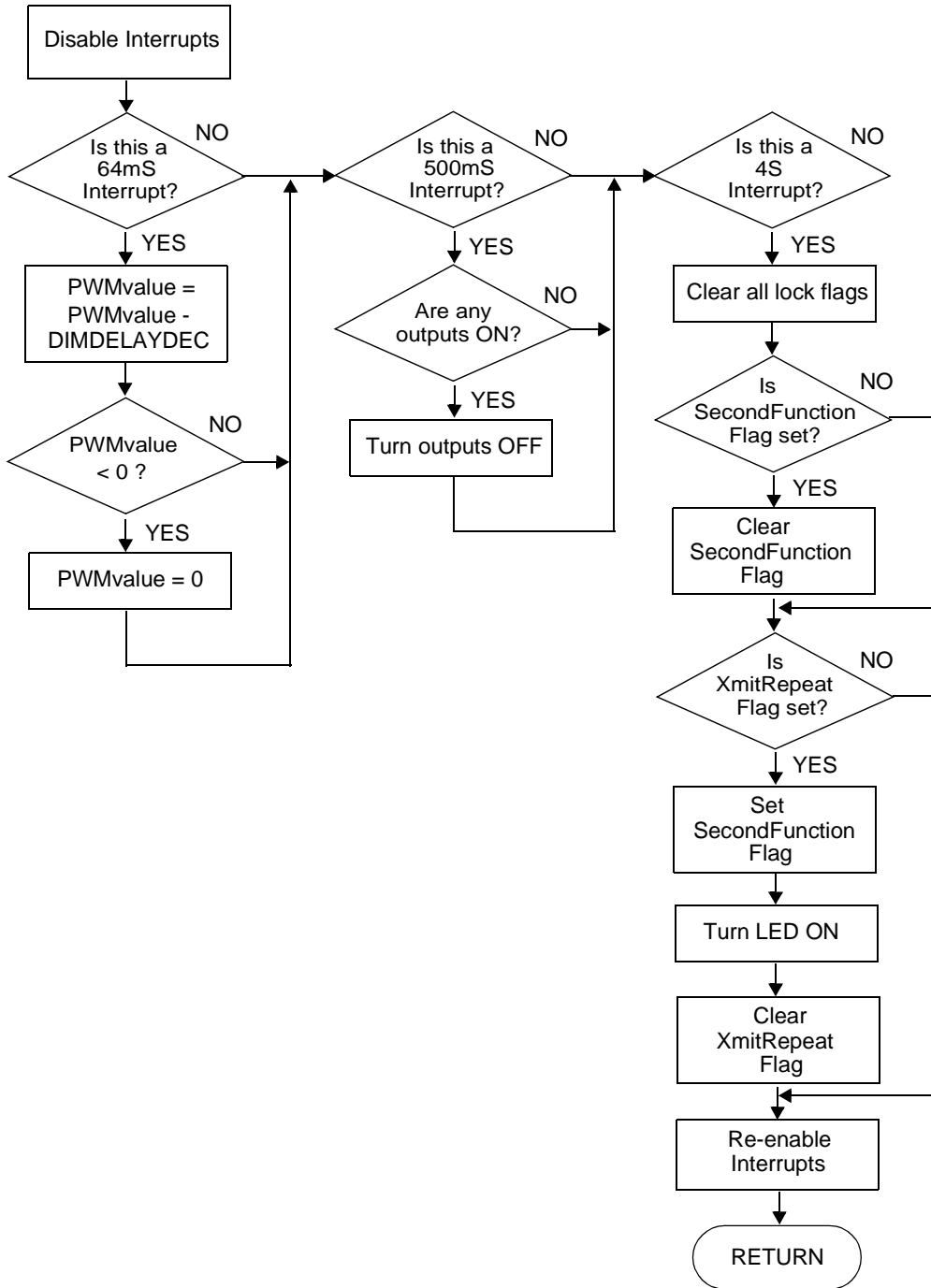
# AN728
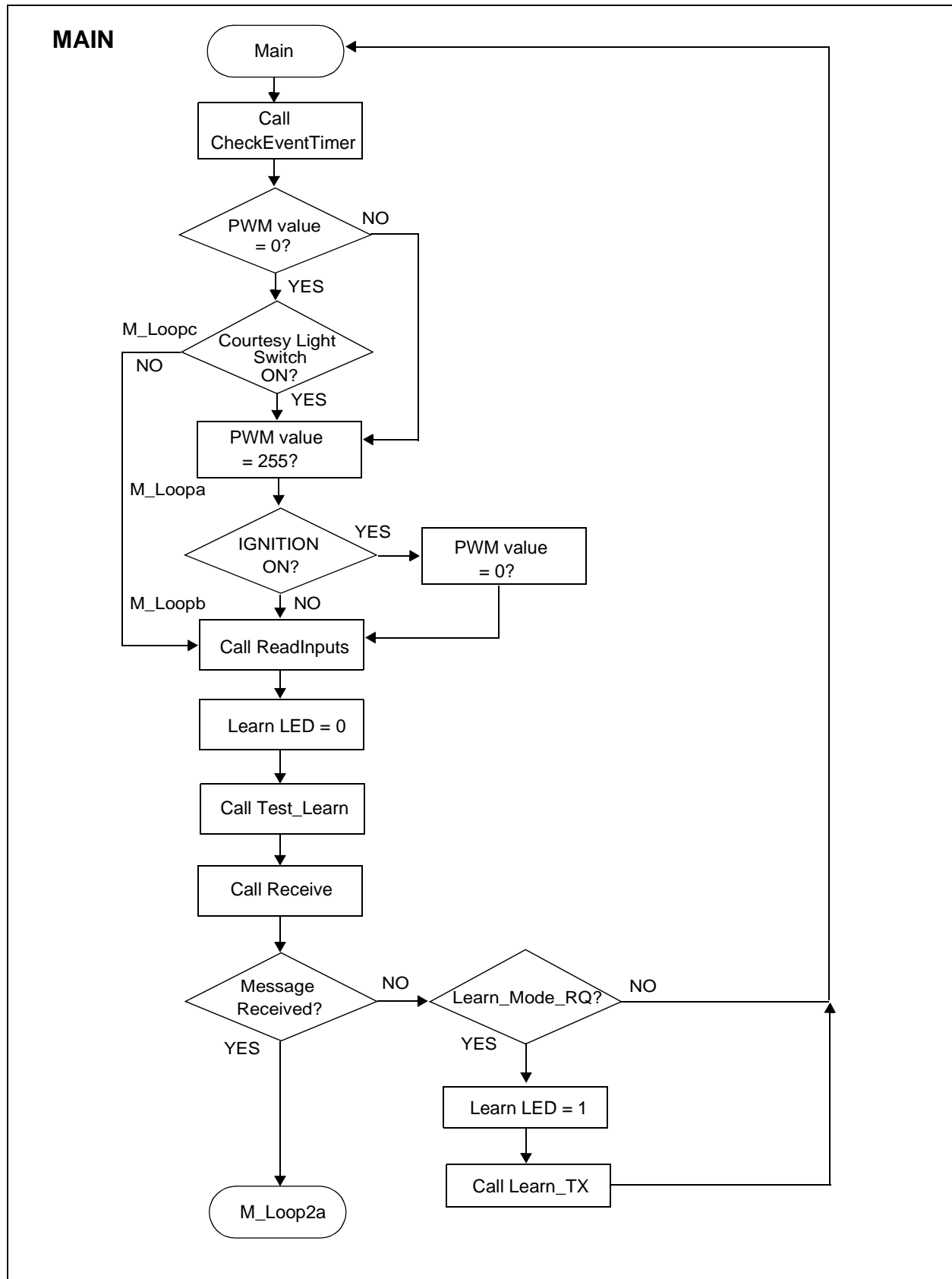
## APPENDIX B:    MAIN PROGRAMMING FLOWCHARTS (CONTINUED)

## APPENDIX B:   MAIN PROGRAMMING FLOWCHARTS (CONTINUED)

```
        ( INTERRUPT )
              │
              ▼
      ┌───────────────┐
      │  Save Status  │
      └───────────────┘
              │
              ▼
      ┌───────────────┐
      │   Increment   │
      │   CNT_HI/LO   │
      └───────────────┘
              │
              ▼
      ┌───────────────┐
      │ Restore Status│
      └───────────────┘
              │
              ▼
        (   RETURN   )
```

# AN728

**CHECKEVENTTIMER**

```
Disable Interrupts
        |
        v
  Is this a          NO
  64mS Interrupt? ---------------->
        |
       YES
        |
        v
  PWMvalue =
  PWMvalue -
  DIMDELAYDEC
        |
        v
  PWMvalue          NO
  < 0 ?        -------->
        |
       YES
        |
        v
  PWMvalue = 0

  Is this a          NO
  500mS Interrupt? --------------->
        |
       YES
        |
        v
  Are any            NO
  outputs ON?   -------->
        |
       YES
        |
        v
  Turn outputs OFF

  Is this a          NO
  4S Interrupt?  ---------------->
        |
       YES
        |
        v
  Clear all lock flags
        |
        v
  Is                 NO
  SecondFunction --------->
  Flag set?
        |
       YES
        |
        v
  Clear
  SecondFunction
  Flag
        |
        v
  Is                 NO
  XmitRepeat    --------->
  Flag set?
        |
       YES
        |
        v
  Set
  SecondFunction
  Flag
        |
        v
  Turn LED ON
        |
        v
  Clear
  XmitRepeat
  Flag
        |
        v
  Re-enable
  Interrupts
        |
        v
  RETURN
```

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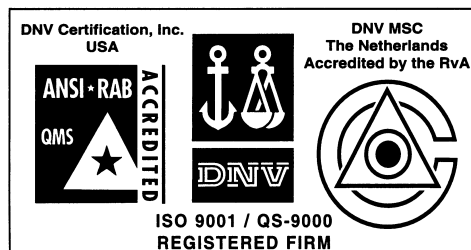
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