Automotive HVAC Control
System with LCD Interface

Quick Start Guide

Devices Supported:

MC9S12HY
1. Introduction

This document describes startup guide for an automotive HVAC (Heating, Ventilation and Air Conditioning) control system based on MC9S12HY64 with LCD, touch pads and IR remote interface.

![S12HY based HVAC reference design PCB – LCD side](image1)

![S12HY based HVAC reference design PCB – MCU side](image2)

<table>
<thead>
<tr>
<th>Jumper</th>
<th>Functionality</th>
<th>Connection</th>
</tr>
</thead>
<tbody>
<tr>
<td>P1</td>
<td>Power Jack</td>
<td></td>
</tr>
</tbody>
</table>
| SW1    | Ignition emulation switch      | 2-3: ignition ON
1-2: ignition OFF |
| J1     | Power connector                | 1: +12V
2: GND                  |
| J2     | VLCD                           |                             |
| J3     | SCI connector                  |                             |
| J4     | S12 BDM Connector              |                             |
### Table 1: Headers and connectors list

<table>
<thead>
<tr>
<th>J5</th>
<th>HVAC unit 18 pin connector</th>
</tr>
</thead>
<tbody>
<tr>
<td>J8</td>
<td>MC33984 Sense back</td>
</tr>
<tr>
<td></td>
<td>HS0 Blower motor feedback</td>
</tr>
<tr>
<td></td>
<td>connected to ADC channel</td>
</tr>
<tr>
<td>J9</td>
<td>CAN termination connector</td>
</tr>
<tr>
<td>J10</td>
<td>CAN connector</td>
</tr>
<tr>
<td>J11</td>
<td>PT60 Reset Connector</td>
</tr>
<tr>
<td>J12</td>
<td>GPIO Connector</td>
</tr>
<tr>
<td>J13</td>
<td>PT60 BDM connector</td>
</tr>
<tr>
<td>J14</td>
<td>PT60 Power Selection Pin</td>
</tr>
<tr>
<td></td>
<td>2-3</td>
</tr>
</tbody>
</table>

#### 2. Steps for startup

1. Before powering up, ensure following header settings:
   a. J2 is connected
   b. HVAC unit is connected on J5, if required
   c. J8 is connected
   d. J11 is connected
   e. J14 is connected between pin 2&3
2. Now the board can be powered up by either inserting a 12V adapter in P1 or by connecting a 12V battery in J1. When using J1, ensure that +ve node of battery is connected in pin 1 and –ve node in pin 2.
3. After the board is powered up, check SW1 status. If SW1 is connected between pins 1&2, it emulates ignition off and the MCU is in low power and LCD backlight is off. If SW1 is connected between pins 2&3, it emulates ignition on and the MCU is in run mode, LCD backlight is on and system is working correctly.
4. Now, you can control the system using touch pads and remote.

![Figure 3: design with HVAC unit](image-url)
3. **LCD Details**

![LCD Diagram](image)

Figure 3: LCD major blocks

The existing HVAC units use mechanical knobs, which in the present design have been shown on LCD. Major blocks of LCD are shown in Figure 3, which include:

- **Date display** – shows the date in DD/MM/YY format.
- **Time display** – shows the Time in HH:MM format. User can select between 24H/12H display format.
- **Cabin temperature display** – displays the car’s real time cabin temperature.
- **Fan position** – A fan is made up of 4 spokes/blades, as is shown in figure 4. L1 shows the position 1 of all the 4 spokes of the fan, L2 - position 2 and L3 - position 3. Rotation of the fan is a function of blower motor speed, higher the blower motor speed faster the fan will rotate.
- **Blower speed** – shows the speed of the blower motor at which it is currently running.
- **AC display** – shows AC on/off position.
- **Defogger** – it is shown when the defogger is switched on.
- **Cooling control display** – it is a 9-level display for showing the level of cooling/heating. Any level indicates the mixing of hot/cold air through the vents using the flap control. The flap will be positioned to one extreme, for level 1 display, allowing only the cold air to flow, while it will be positioned on the other extreme, level 9 allowing only the hot air to flow.
- **Air flow position** – shows the vent position for the air flow. There are total of 5 possible positions as per the HVAC units used
  - Face
  - Foot
Face & Foot
Defrost
Foot & defrost
In each of the above case the corresponding text will be displayed

Recirculation display – shows whether the air circulation is fresh-air or recirculation-air. All the above displays, except temperature display can be controlled by user interface. The temperature display shows the cabin’s temperature which is not modifiable by any user interface.

4. Control interface
The reference design has two types of control interfaces

1. IR remote control
2. Capacitive touch pads

4.1. IR Remote Control

Figure 5: IR remote control along with key descriptions

NEC protocol based IR Remote control is used for the reference design. Each key press updates its corresponding section on the LCD and is shown in figure 5. Unmarked keys are kept for future enhancements. The functionality of each key block is as below:

- AC ON/OFF – AC can be switched ON/OFF with this key, and the corresponding AC status will be display on LCD.
- Air flow positions – AF +/- keys are used to change the vent positions. Each key press will drive the vent position actuator motor and the corresponding text and position on the LCD will be displayed.
**Defogger** – defogger can be switched ON/OFF with this key. If the defogger is switched on the icon will be displayed on LCD.

**Recirculation** – CIRC is used to select between fresh-air and recirculation-air, which will drive the fresh air actuator motor and the corresponding arrow on the recirculation section of the LCD will be displayed.

**Cooling Control** – COLD/HOT key are used to change the degree of coldness/hotness in the vehicle. Pressing this key will drive the cooling actuator motor in the background, while the COLD/HOT level will be updated on the LCD.

**Blower Speed Control** – F+/ - keys are used to update the blower speed by increasing the duty cycle of the PWM used to drive the PMDC blower motor. This will also update the blower speed on the LCD.

**Date/Time display** – Time Menu is used to select between the Date and Time display on the LCD. When date display is selected, then the ‘Mode’ key is used to select between date/month/year, while in time display, it is used to select between hours/minutes/time-format (AM/PM/24H). ‘Set’ key increments the selected digit, and once the limit is reached, digit is reset to zero.

4.2. **Capacitive touch pads**

Proximity Capacitive Touch Sensor Controller PT60 is interfaced to the MCU via SPI bus, through which it communicates the various touch pad pressed. Each touch pad updates its corresponding section on the
LCD and is shown in figure 7. ON/OFF, DEFG, CIRC, AF+/ have the same functionality as the corresponding IR remote key, which have already been explained in the above section.

As the numbers of keys are limited, an innovative way of menu selection has been implemented using the 3 keys:

- MENU SELECT
- MODE /-
- SET /+

When the AC is switched on, the MENU SELECT key, selects between 4 menu states as shown below in figure 27, starting from Blower Motor Menu. Table 4 shows the functionality of touch pads MODE/- and SET/+ in each mode. The functionalities mentioned in the table are same as those for the IR keys.

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Menu Mode</th>
<th>‘Mode/-’ Key Function</th>
<th>‘Set/+’ Key Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Blower Speed</td>
<td>F -</td>
<td>F+</td>
</tr>
<tr>
<td>2</td>
<td>Cooling Control</td>
<td>Cold</td>
<td>Hot</td>
</tr>
<tr>
<td>3</td>
<td>Date</td>
<td>Mode</td>
<td>Set</td>
</tr>
<tr>
<td>4</td>
<td>Time</td>
<td>Mode</td>
<td>Set</td>
</tr>
</tbody>
</table>

Table 2: Functionality of Mode/Set keys when Menu key is active