ESP Hardware Specification

Revision 1, Jan. 30, 2012

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Overview

Developing an ESP accessory entails conforming to VRI modular-cable conventions/precautions, ensuring the accessory has acceptable operating and off-state current consumption, and designing a data interface compatible with the ESP bus.

The Extended Serial Protocol (ESP) interface is a serial protocol that allows accessories to communicate with a Valentine One Radar Locator and other accessories present on the ESP interface. Employing a "time-slicing" protocol, ESP uses a time-multiplexed single wire (plus ground) to accommodate bidirectional exchange amongst the connected devices. In general, signal levels are +5 Volts or ground. Each device has an assigned time slot in which it is allowed to transmit; when not transmitting, each device must be in a listen mode (i.e. transmit driver disabled) so that it can receive data from neighboring devices during their respective transmit time-slots. For details of timing and message format, refer to the "Extended Serial Protocol User's Guide"

For compatibility with older Radar Locators, all ESP devices manufactured by Valentine Research, Inc. also support Legacy Mode--- an older, open-collector output protocol that the Radar Locator used to generate the "Concealed Display Output Stream (CDOS)"

We prefer that third-party accessories support both ESP and Legacy modes.

RJ11 Cable Connectivity Precautions

To provide for easy retail availability of interface cables, VRI products historically employ 6-position, 4-conductor RJ11 telecom-style connecting cables. This modular-cord convention yields replacement convenience but necessitates a few design precautions.

Figure 1 illustrates important details in an example system featuring a V1 detector, connection to the car's 12 Volt supply (Lighter Adapter, Hardwire Power Adapter, or Savvy OBD interface), and a third-party accessory. As shown in Figure 1, standard (i.e. not "reversed") telephone cables swap connections end-to-end--- that is pin 2 connects to pin 5, and pin 3 connects to pin 4. Similarly, VRI accessories often feature two RJ-11 jacks so that devices may be daisy-chained. These products perform the same interchange of connections between receptacles.

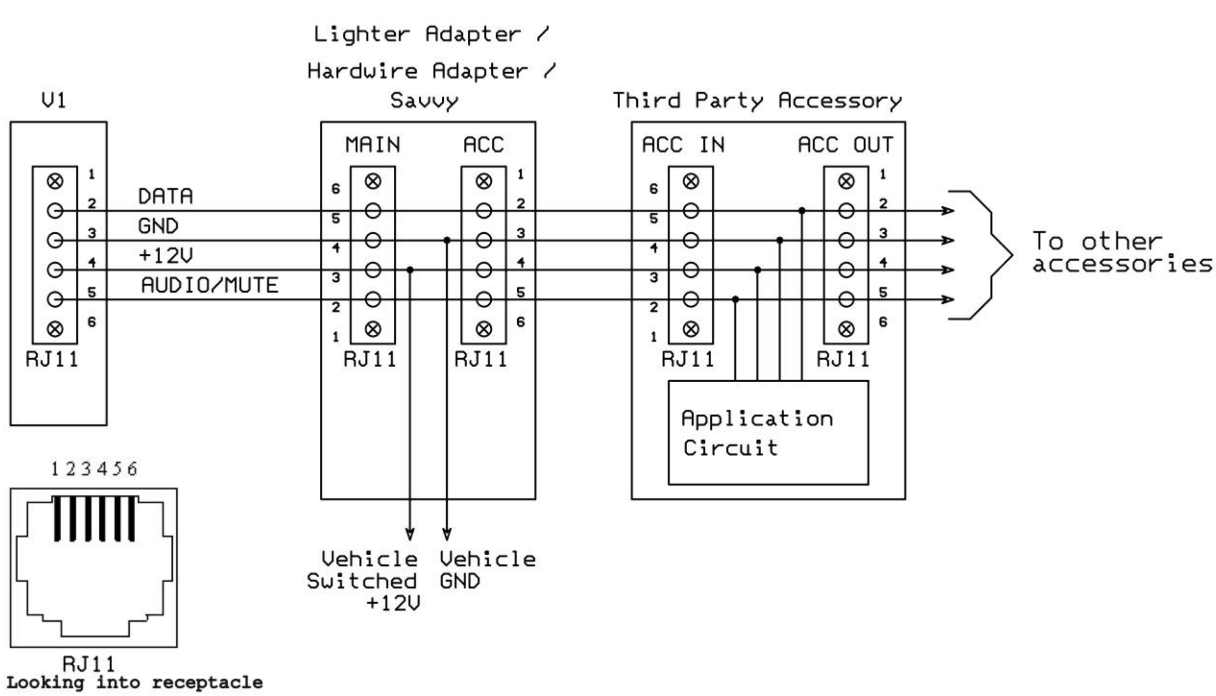

Figure 1. V1 System--- depicting V1, power adapter, Third-party device, modular cables

Note that if an owner mistakenly exchanges cable connections of an accessory device, the +12V and Ground conductors experience reverse battery polarity. Any circuitry within the device will likewise experience reverse battery polarity and any accessory devices daisy-chained “downstream” will also be exposed to reverse polarity. Further cautions: misconnection will place ground-connected metallic enclosures at battery potential and leave the enclosures vulnerable to shorting to chassis ground; any associated connection of an accessory’s ground bus to other car chassis device (e.g. auxiliary audio) faces a similar short-circuit path to the battery. Other fault paths of audio and display interfaces are also possible--- the cable swap will result in cross-connection of the DATA and AUDIO/MUTE signals. This exposition is intended to emphasize that ESP compatible hardware *must* incorporate appropriate circuit protection to preclude damage from misconnected devices.

Reliable reception of serial data transmission can be complicated by varying amplitude of the serial data and by superimposed voltage-offset shifts that arise from device operating current flowing through cable resistance. To elaborate on the latter issue, assume the detector draws 300 mA and the cable has 2 ohms resistance between the ground pin of the detector’s RJ-11 receptacle and the Lighter Adapter ground. “Ground” at the detector’s enclosure will be elevated 0.6 Volts above the car’s chassis ground; further, this elevated voltage can be noisy if the current drawn is dynamic, as can be anticipated from varying audio alerts and associated display activity as well as receiver mode switching. Because of these issues, we recommend that VRI equipment be connected as depicted in Figure 1, i.e. that cable length between the V1 and the vehicle power source be minimized to minimize corrupting voltage drops. Similarly, accessory devices should be arranged on the “ACC” side of the power adapter, as depicted in Figure 1.

To ensure compatibility with VRI systems, DC supply current required by accessory device(s) should be limited to 100 mA or less. If the accessory requires current exceeding 100 mA, operating current for the accessory should be supplied via a separate connector from a different source. In these circumstances, use of the RJ11 connector should be restricted to connecting to data lines and only modest DC current should be drawn from the RJ11 connector to power the associated circuitry. Obviously, the design must also protect against misconnection of the accessory to preclude damage to any of the connected devices or the vehicle itself.

Finally, accessories must draw acceptably low current (10 mA max. suggested) when the vehicle is turned-off to avoid draining the vehicle’s battery. It is safe to assume that the V1 is powered off when the car is turned-off (e.g. via ignition switch, Savvy, or manually by driver), so an accessory can be switched appropriately from active to standby by merely monitoring for activity on the data line. Resumption of ESP or Legacy activity should wake the accessory’s processor from a low-power sleep state to resume normal operation.

Application Circuit

Figure 2 is a simplified schematic of an ESP compatible interface that serves to illustrate circuit concepts and may be used as a guide in developing accessories. It incorporates two daisy-chained RJ11 connectors. D1 provides reverse-polarity protection to a 5 Volt regulator that in turn powers a 5V microprocessor and attendant circuitry (and presumably, third-party application circuitry, not shown).

The Figure 2 interface supports both ESP and Legacy modes. For simplicity, the design assumes use of a comparator residing within the microcontroller but, for schematic clarity, this comparator is depicted externally. (If a separate, off-processor comparator is required, any general purpose comparator accommodating 0 to 5V inputs should suffice; optional R8 supports an outboard comparator with open-collector output.)

By way of explaining circuit operation, assume the Discovery process has found the ESP mode is operative, which leaves the Legacy/ESP line (GPIO1) at 0V. Consequently, Q1 is biased off and its base-emitter junction is reverse-biased, minimizing loading of the data line. Serial data flows bi-directionally through R9, which serves to define driver impedance and limits fault current in the event of misconnection. Similarly, resistors R1 through R4 limit fault current flow in Q1 and the comparator. Since the Data line is bi-directional, the TXD pin must be kept in input mode (i.e. high impedance) except during output data transmission. In transmit, “Idle” is +5V, “Active” is 0V.

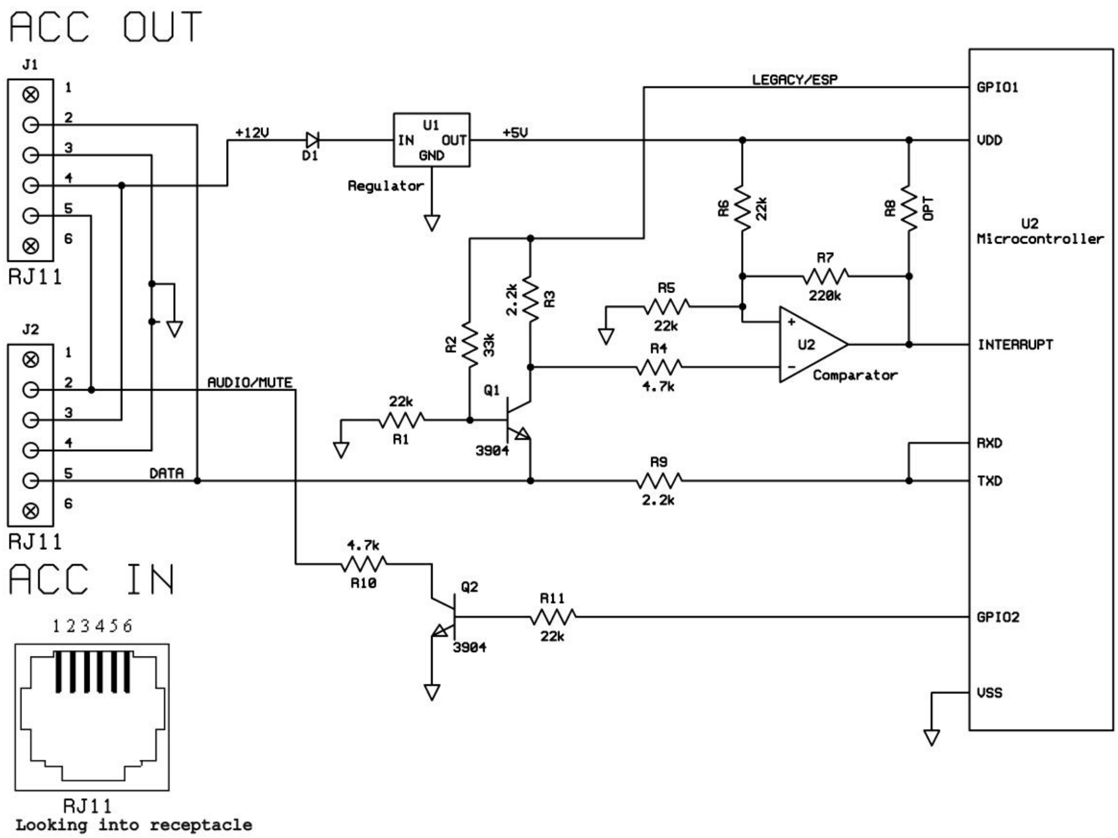

Figure 2. ESP Interface with Legacy support

Alternately, the Discovery process may find a Legacy system, so a few pertinent aspects of the Legacy protocol will be described to aid understanding.

Legacy V1 receivers feature an open-collector interface to provide serial data to Concealed Display (CD) modules. Presence of a pull-up (nominally, 5V) within the CD module is recognized by the host V1, causing it to blank its own display in favor of the CD. However, accessory devices needing to decode the CDOS when there is no CD present can do so by employing a 1.4V pull-up. The reduced pull-up voltage allows the CDOS data to be sensed without forcing the V1 display to extinguish. Thus, for an ESP accessory to also support Legacy Mode, the accessory must incorporate a switchable pull-up provision. [Note: Idle state pull-up voltage in the range of 1.66V to 3.3V is restricted for factory use; pull-up voltages within this range will activate protocols that will not comply with the CDOS format.] "Idle" is pull-up voltage, "Active" is open-collector conducting to ground.

Continuing description of the Figure 2 application circuit, assume Discovery software has found a Legacy system, consequently leaving the Legacy/ESP line set to 5V. Q1 and its bias resistors comprise an emitter-follower with output voltage of about 1.4 Volts. When the data line is driven low by an open-collector driver in the host V1 detector, Q1 saturates and current is limited to a couple of mA by R3. This circuit has the virtue of delivering the required pull-up voltage but requiring only modest standby current. Collector current in Q1 is sensed by the comparator, whose output is processed in software. For reception of Legacy data, the TXD pin must be held in input mode to avoid loading incoming data. Table 1 summarizes the appropriate states of the processor ports.

Mode	Legacy/ESP port	TXD port
Legacy	+5V	High Z
ESP receive	0V	High Z
ESP transmit	0V	Xmit
Sleep	+5V	High Z

Table 1. Mode Summary

As mentioned earlier, when the V1 is powered-off, accessories should likewise enter a standby mode to ensure low standby-current. Monitoring for activity on the data line is a convenient way to ascertain if the accessory should be active or in standby. To this end, Figure 2 also shows the receive comparator tied to a processor interrupt input. Cessation of data line activity would imply the accessory should enter standby configuration. Resumption of serial data activity would trigger the interrupt pin and wake the processor for normal operation. Figure 2 shows connection to an Interrupt to emphasize this concept. However, some processors may not require allocation of an additional processor input, but rather awake when data triggers an interrupt provided by the processor's on-board comparator. As indicated in Table 1, to prepare the accessory for sleep mode the Legacy/ESP line must be set to Legacy to ensure an active pull-up on the data line. Otherwise, the accessory may not recognize activity when a Legacy V1 is powered up.

Mute Processing

Figure 2 shows an optional method of asserting the "Mute" function via Q2, with R10 providing fault protection; this circuit function is the only method for an accessory to remotely mute a legacy V1 receiver.

The Audio/Mute line is quiescent in the high state (~5 V pull-up residing in the V1) and is pulled low by Q2 to assert Mute button functionality. The V1 will respond to Mute line manipulation via Q2 exactly as it would to pressing the front-panel Mute push-button. That is, the Mute line must be held low at least 200 ms to ensure recognition and activate muting; similarly, a low level persisting longer than 1 second will trigger V1 mode change (i.e. All bogies, logic, advanced logic). The Mute line should not be held low continuously, since continuous assertion would block mute attempts from the V1 front panel. Finally, the Mute line should be released when the accessory is placed in the sleep state; if the Mute line were held low during V1 power-up, the V1 would be forced into user programming mode.

Specification Revision History

File Revision	Date	Change Description
1.0000	01/30/12	Document Released