User's Manual

RENESAS

PE-HMI1 v2.0

User's Manual: Hardware

RENESAS SYNERGY™ S7G2

Renesas Electronics
www.renesas.com

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(2012.4)

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FCC Part 15 Compliance

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

-- Reorient or relocate the receiving antenna.

-- Increase the separation between the equipment and receiver.

-- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.

-- Consult the dealer or an experienced radio/TV technician for help.

The FCC requires the user to be notified that any changes or modifications made to this device that are not expressly approved by Purple Communications, Inc, may void the user's authority to operate the equipment.

Industry Canada Compliance

This device complies with Industry Canada license-exempt RSS standard(s). Operation is subject to the following two conditions:

1. This device may not cause harmful interference;
2. This device must accept any interference received, including interference that may cause undesired operation of the device.

Cet appareil est conforme à Industrie Canada une licence standard RSS exonérés (s). Son fonctionnement est soumis aux deux conditions suivantes:

1. Cet appareil ne doit pas provoquer d'interférences
2. Cet appareil doit accepter toute interférence reçue, y compris les interférences pouvant provoquer un fonctionnement indésirable de l'appareil.

Precautions

This Renesas PE-HMI1 is only intended for use in a laboratory environment under ambient temperature and humidity conditions. A safe separation distance should be used between this and sensitive equipment. Its use outside the laboratory, classroom, study area or similar such area invalidates conformity with the protection requirements of the Electromagnetic Compatibility Directive and could lead to prosecution.

The product generates, uses, and can radiate radio frequency energy and may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment causes harmful interference to radio or television reception, which can be determined by turning the equipment off or on, you are encouraged to try to correct the interference by one or more of the following measures;

- Ensure attached cables do not lie across the equipment
- Reorient the receiving antenna
- Increase the distance between the equipment and the receiver
- Connect the equipment into an outlet on a circuit different from that which the receiver is connected
- Power down the equipment when not in use
- Consult the dealer or an experienced radio/TV technician for help NOTE: It is recommended that wherever possible shielded interface cables are used.

The product is potentially susceptible to certain EMC phenomena. To mitigate against them it is recommended that the following measures be undertaken;

- The user is advised that mobile phones should not be used within 10m of the product when in use.
- The user is advised to take ESD precautions when handling the equipment.

The Renesas PE-HMI1 does not represent and ideal reference design for an end product and does not fulfill the regulatory standards for an end product.

Table of Contents

1. Preface

1.1 Cautions

This document may be, wholly or partially, subject to change without notice.

1.2 Trademarks

*All brand or product names used in this manual are trademarks or registered trademarks of their respective companies or organizations.

Designer's Notebook

The PE-HMI1 was jointly designed by the Reneas IoT Solutions Team and Serious Integrated, Inc.: http://www.seriousintegrated.com/ Notes formatted in this style are from the *Design Team* and may be helpful in the analysis of the design and the design of your own hardware. These are our notes only, and the recommendations and comments therein are subject to the Disclaimer and Precautions notes at the beginning of this document.

1.3 Copyright

1.4 Website

http://www.renesassynergy.com/

1.5 Glossary

CPU	Central Processing Unit	HMI	Human Machine Interface
GUI	Graphical User Interface	USB	Universal Serial Bus

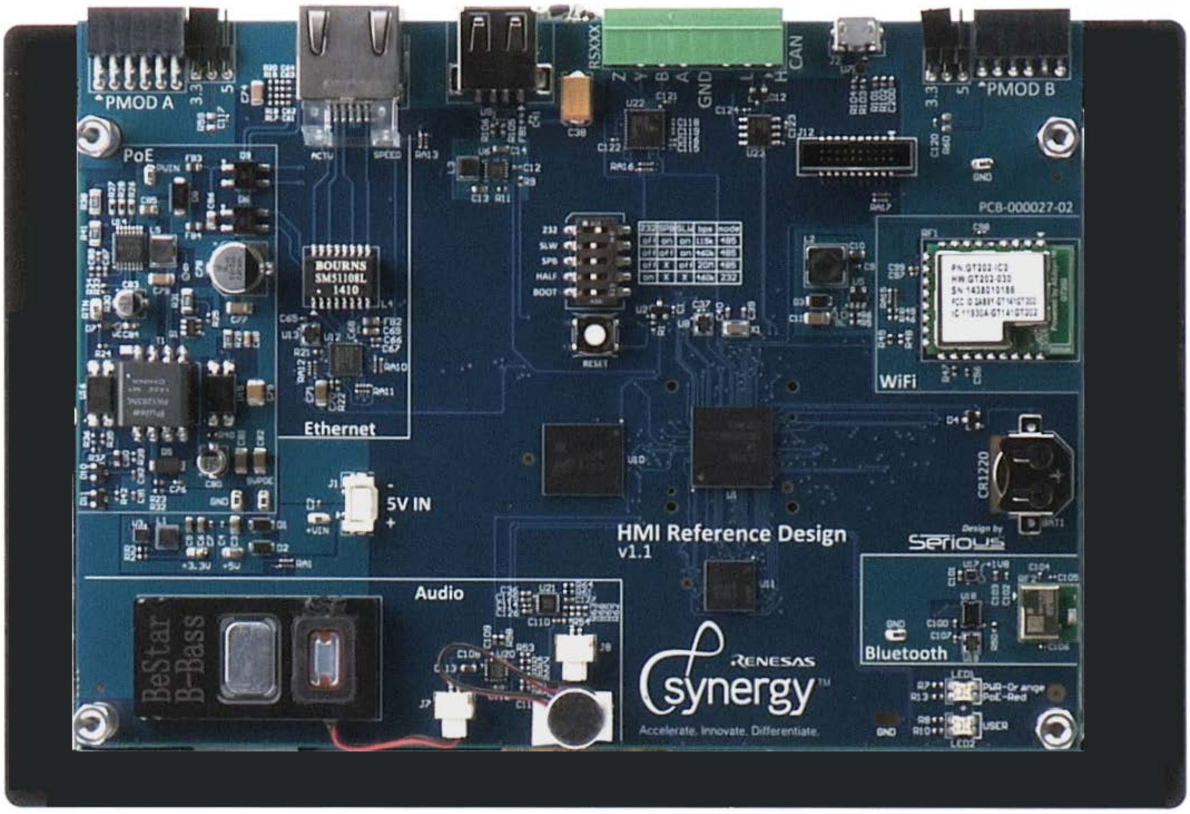
2. Introduction and Purpose

The Renesas Synergy PE-HMI1 S7G2 WVGA HMI Product Example is a flexible and full-featured Human Machine Interface plus communications platform based on the Synergy S7G2 Microcontroller. While production worthy, the PE-HMI1 is primarily intended for software and hardware developers to experiment and evaluate the extensive I/O features of the S7G2 on the PE-HMI1 prior to development of their own customized hardware.

The PE-HMI1 contains several communications ports, including 10/100 Ethernet with Power over Ethernet support, CAN, RS232/RS485, USB Host, and USB Device. In a slight deviation from a pure product example, the board includes two popular Pmod™ connectors for external prototyping modules from Digilent (http://www.digilentinc.com/) and other vendors, making it attractive for software and systems developers to add unique functionality such as sensors and custom networking for prototyping purposes.

For more information on the Synergy PE-HMI1, visit www.renesassynergy.com

2.1 Hardware



The PE-HMI1 has two main elements:

- A full featured S7G2 MCU-based processing and I/O board
- A 800x480 Multi-Viewing Angle (MVA) LCD with 24-bit RGB color interface and capacitive touch sensing

These elements come pre-assembled in the PE-HMI1 kit in an acrylic enclosure along with various cables, power supplies, and accessories.

The MCU/memory subsystem of the PE-HMI1 includes:

- Synergy S7G2 MCU with
  - 240MHz ARM Cortex™-M4 core with 640 kB on-chip RAM, 4MB on-chip FLASH
  - On chip graphics controller, including JPEG decoder and video frame capture engine unit
- 32 MB 120MHz SDRAM
- 2GB e•MMC intelligent NAND flash “drive on a chip”
- 32.768kHz RTC crystal and 24MHz MCU clock

The PE-HMI1 has a rich power subsystem supporting the needs of the MCU and I/O, including:

- Power input 802.3af-compliant Power over Ethernet or 5V using 2.1-mm barrel connector
- High efficiency 5V to 3.3V system power DC-DC converter
- Current managed USB Host 5V power supply
- High efficiency constant-current LCD backlight boost power supply

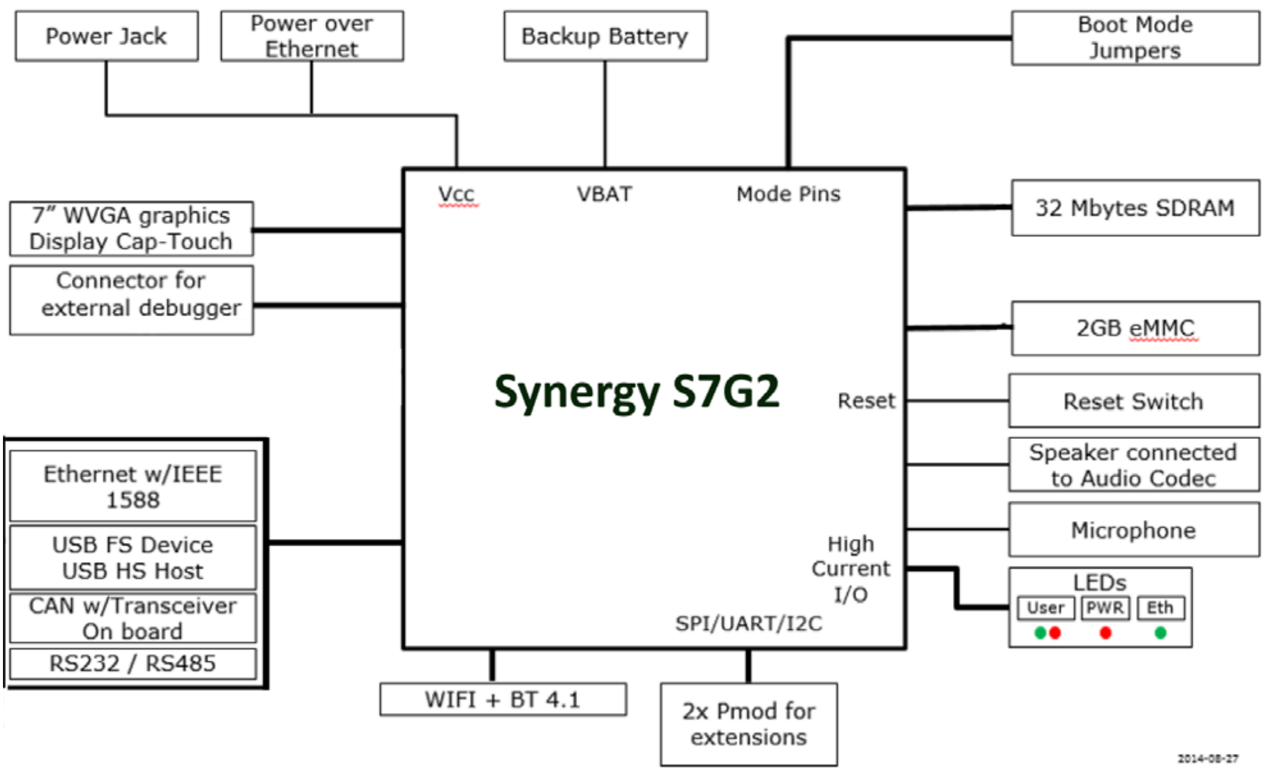
The I/O features of the PE-HMI1 are typical of many feature-leading HMI-equipped embedded systems, including:

- CAN plus RS232/RS485 port on an industrial-style 3.5-mm screw terminal plug connector
- 10/100 Ethernet Port on standard RJ45 CAT5/6 jack with dual indicator LEDs
- Mono audio with 1W speaker and microphone
- Full Speed USB 2.0 Device port (Micro-B)
- High Speed USB 2.0 Host port (Type-A) with available current-managed 5V@500mA power
- Coin-cell battery-backed real time clock and calendar
- Qualcom/Atheros QCA4002 WiFi
- Bluetooth dual mode (Classic & BLE)
- Ambient light sensor, reset button, power indicator LED

Venturing outside the realm of a true product example, the PE-HMI1 also includes two Digilent Pmod ports, one 2x6-pin version with Type 2A (expanded SPI) and Type 4A (expanded UART) support and the other with the more limited 1x6 UART capabilities. This enables software and systems developers to add functionality to the PE-HMI1 specific to their own application in advance of developing their own custom hardware.

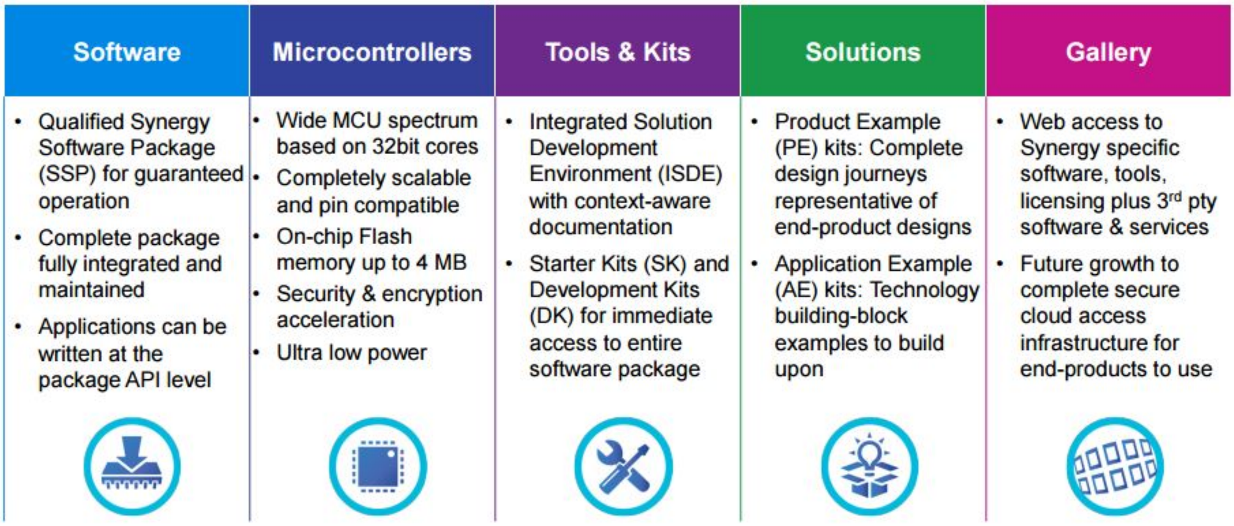
2.2 Hardware Block Diagrams

The PE-HMI1 has the following basic hardware block diagram:



2.3 Software and Software Development Tools: The Synergy Platform

The Renesas Synergy Platform is a new, easy-to-use, qualified platform designed to accelerate time to market, reduce total cost of ownership and remove many of the obstacles engineers face as they develop embedded products. With this new platform, product development can start at the API level, providing more time to design innovative and differentiated features for IoT devices. The Renesas Synergy Platform integrates qualified software with a new family of MCUs and an ecosystem of tools and support options into one scalable and secure platform:



See the Synergy website for more information: http://www.renesassynergy.com.

2.4 Usage Models

The PE-HMI1 is designed as an initial hardware product example platform as well as software development platform for OEM applications not only requiring sophisticated LCD-based GUI Human Machine Interface (HMI) capabilities but also extensive communications. The platform has some direct machine-control GPIO available through the Pmod ports, although the platform will often be used in conjunction with an OEM’s intelligent I/O and power subsystem, possibly communicating with that subsystem over RS232, RS485, or UART/SPI.

For more extensive GPIO connectivity, more flexible port assignments and experimentation with MCU features, the complete Synergy S7G2 Development Kit DK-S7G2 is recommended.

3. Getting Started

The PE-HMI1 assembly comes pre-assembled, and requires no initial assembly to operate out of the box.

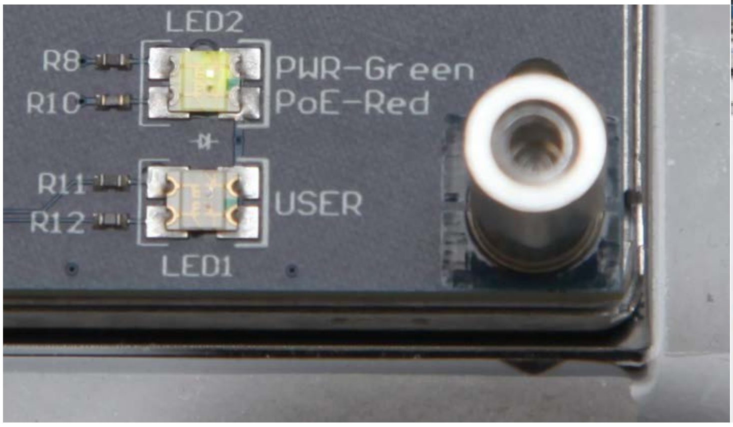
Some elements, such as the LCD to the top bezel, are bonded with high performance adhesive: do not attempt to detach the LCD or disassemble any element not fastened by screws.

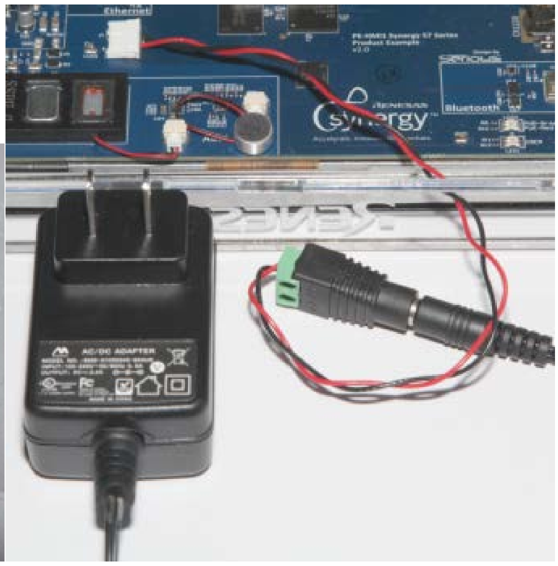
3.1 Powering the PE-HMI1

The PE-HMI1 can be powered via two different methods: the 5V direct input power connector and the 802.3af-compliant Power-over-Ethernet capability.

Connect the supplied UL/CSA/CE/PSE-certified 802.3af PoE power injector to the PE-HMI1 with the supplied Ethernet cable and power the injector from any standard 110/220-V wall socket. When the PoE power is present and active, LED1 will be RED.

Alternatively, use the small barrel jack adapter cable and your own 2.1-mm positive-center 5-V barrel jack power supply to power the PE-HMI1 directly. When the 5-V direct power input is present and active, the LED1 power indicator will be GREEN.





There is no overvoltage protection on the 5-V direct power input: applying more than 5.5-V (for example, incorrectly using a 12V adapter) or using a reverse-polarity barrel plug will permanently damage the unit.

When both the PoE power and the 5-V direct power input are present, the PoE supply will automatically shut down and the 5-V power supply will be used. There might be a very short time when LED1 shows both RED and GREEN (i.e. ORANGE) during the transitionary period as both supplies are applied or one is removed.

3.2 Connecting the Programmer/Debugger

The kit comes with the “lite” edition of the powerful and full-featured Segger J-Link series of JTAG debugger/programmers. For faster and more powerful debugging, explore the Segger J-Link product line as well as the IAR I-jet product line.

To connect the included Segger J-Link Lite ARM debugger, with the power removed from the PE-HMI1 carefully plug in the polarized end of the 20 pin fine-pitch ribbon cable header into the corresponding socket on the PE-HMI1. Pin 7 is removed on the header and blocked on the IDC cable header to ensure correct orientation. The other end of the cable plugs into the Segger J-Link Lite unit. Then connect the USB Mini B cable to the J-Link Lite ARM and your PC. The PC powers the debugger but cannot power the PE-HMI1. Installing the Synergy tools also installs the corresponding driver for the debugger, so there is no need to independently download and install the tools from the Segger website. In fact, the Synergy ISDE ensures (even in the presence of other drivers on your PC) that its own internal version of the Segger drivers are used to ensure compatibility and reliable debugging.

4. Specifications

4.1 DC Characteristics

The DC characteristics of the I/O elements of the platform are governed by the underlying AC timing characteristics of the individual components. Consult the bill of materials and component data sheets for more information.

Specification	Minimum	Maximum	Unit
PoE Voltage	44	57	VDC
Power		12.75	W
5-V Direct Input Voltage	4.0	5.5	VDC
Power		10	W

4.2 Environmental Characteristics

The PE-HMI1, while designed with production-worthy methods and components, is not designed as a production unit to be used direction in OEM equipment. Contact Renesas for a list of hardware design partners who can develop and deliver production-ready platforms based on the ingredients used in the PE-HMI1 kit.

The environmental characteristics are separated into two components: the PCB with circuitry and the Liquid Crystal Display with Touch Panel; the PCB will continue to operate in its full operational range even if the LCD is outside its operational range.

Specification	Permissible			
	Minimum	Typical	Maximum	Unit
Storage Temperature	-30	25	80	C
Humidity (Non-condensing)			90% < 50C 60% > 50C	RH
PCB Operating Temperature	-40	25	80	C
LCD Operating Temperature	-20	25	70	C

4.3 Physical Characteristics

The outer dimensions of the PE-HMI1, with enclosure, are approximately 254 x 343 x 57 mm. Weight of the unit is approximately 907 grams.

5. Power

The PE-HMI1 has 2 power input options:

- 802.3af-compliant 13W maximum Power over Ethernet to 5-V supply
- 5-V direct power input

The 5-V direct power input overrides any PoE supply present, turning off the PoE power supply. When either power input is present, 5-V is supplied to the on-board power subsystems:

- 3.3V buck switcher for the PE-HMI1 MCU and most I/O
- LCD Backlight boost constant-current supply
- USB Host current-managed 5-V-output supply

In addition to these main power options and subsystems, the Real Time Clock Calendar (RTCC) internal to the Synergy S7G2 MCU has a battery backup power input.

A detailed discussion of each input and subsystem follows.

5.1 Direct 5-V Input

5 V may be directly applied to the circuit through J1 Molex 503471-0200. The mating header for this connector is the 503473 housing with 503485 crimp pins. By virtue of the extensive use of switching power supplies on the design, this voltage can be anywhere from 4.5 to 5.5 V. Note if PMODs are used at 5 V there may be a narrower range required for this voltage based on the voltage tolerance of the specific PMODs.

There is no overvoltage/polarity protection on the 5-V direct power input: applying more than 5.5 V (for example, incorrectly using a 12V adapter) or reversing polarity will permanently damage the unit.

Designer's Notebook

We saw this connector gaining traction in the burgeoning LED lighting industry and we were attracted to its low cost, good power handling (2A per pin), wide temperature range (-40 to +85C), strong locking features, and good distribution availability. The hand assembly crimp tool was also reasonably priced

Most development kits include some sort of input voltage production, such as a bridge rectifier and a voltage clamp, just in case the intrepid software developer or marketing person plugs the wrong adapter into the board; as a Product Example this extra circuitry is not included as most production designs would be targeted at a well-controlled power environment not subject to this issue and those circuits, to be effective, add significant cost. The sister design to the PE-HMI1 for the Synergy S7G2 MCU, the Synergy S7G2 Development Kit, does include such circuitry.

5.2 Power over Ethernet Input

The PE-HMI1 includes an 802.3af-compliant Power over Ethernet input power supply. Included in the PE-HMI1 kit is an inexpensive PoE power injector to demonstrate this usage. You can plug a standard non-PoE Ethernet network connection into the power injector, and the output of the injector will include the network signals plus up to 13W of power for the PE-HMI1. If your environment has PoE VoIP phones, you can use one of these lines to power the PE-HMI1 instead of using the injector.

Take care with selecting and using so-called PoE power injectors; many are not 802.3af compliant and are cheaper devices used to power surveillance cameras etc. Use of a non-802.3af compliant source may damage the PE-HMI1.

The circuit, managed by a TPS23753A, is a fully 1500V isolated design compliant with the IEEE 802.3af specification for Class 0 (12.95W) devices. The circuit is capable of generating as much as 10W of output power at 5 V. When a PoE-capable device is connected to a PoE-capable source, a negotiation process is performed in the hardware to select the power level required by the device (and supported by the source). If this negotiation process fails, including the absence of a PoE capable supply, the PoE power supply does not turn on.

The PoE circuit is designed to, but not tested or certified for, 1500V isolation. Take care in probing this circuit with the (up to) 57V present. Consider using a fully certified module-level product in your design.

Aside from the negotiation and isolation aspects, the heart of the PoE design is a buck switcher converting the 44 to 57VDC on the PoE line to 5-VDC required by the PE-HMI1. The PoE switcher is turned off when the direct 5-V input supply is provided. This is similar in behavior to a VoIP phone where the supply of the wall adapter power overrides the PoE input.

The detailed operation of this circuit is beyond the scope of this TRM; consult page 7 of the schematics for the full details of the design and the TPS23753A documentation as well as the various TPS23753A Evaluation Modules.

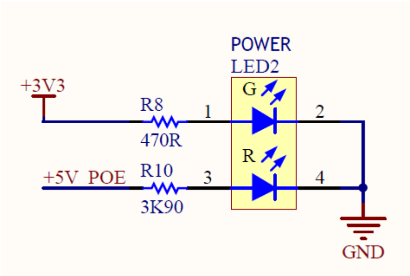
Designer's Notebook

We wanted to explore the usage model, for example, of a conference room scheduling device on the wall where 110/220VAC was expensive to pull and awkward to mount. In an office building a new AC circuit install can cost well over $1000! And then you have an ugly wall blob and barrel jack to your device. With the proliferation of PoE powered VoIP desk phones, PoE switches reducing per-port costs down below $50, as well as Ethernet line a fraction of the installation cost compared to AC power, the PoE circuit was a great addition to the product example.

We originally researched off-the-shelf PoE modules that were fully isolated, certified and cost effective. There are many such modules from Asian suppliers, but domestic sources were difficult to find and those that existed were very expensive. A carefully sourced supply chain from Asia may be your best avenue if you want a certified implementation.

We found this to be a very challenging circuit! It took 4 revisions to get the layout and individual component selections correct, including the opto-isolator required for the enable in order to shut the supply down in the presence of the direct 5-V input. BOM selection was equally challenging to match the flyback transformer to the on-board magnetics for the signaling lines. The TPS23753A design guidelines and evaluation kits were useful but used BOM components we felt were either too expensive or inadequately specified. We purposely increased the voltage capabilities of several capacitors and components to 100V as we discovered, in various discussions with FAEs and in research, PoE can sometimes glitch up to 80V and exceed the often-specified 63V limit on capacitors. We chose to use the highest reliability electrolytic capacitors without going to extremes and cost-prohibitive parts, however it is possible with careful design and validation and in consultation with the manufacturer some or all of the non-input electrolytics could be replaced by ceramics.

5.3 Power LED



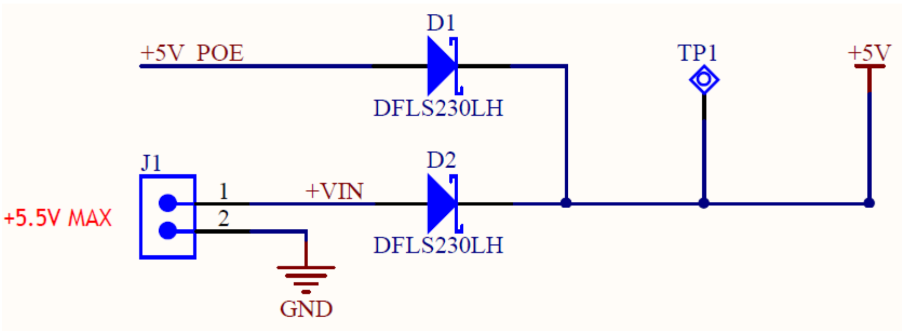
LED2 on the PE-HMI1 indicates the currently used source of power on the system. LED2 has two LEDs in one package (red, green) so three colors can be visible: red, green, and orange (when both are lit).

When the green portion of LED2 is lit, the system is currently under power. When the red portion of LED2 is lit, the PoE supply is currently active.

Therefore LED2 orange indicates PoE power is being used, and LED2 green indicates 5-V Direct Input power is active.

5.4 +5-V Main Voltage Rail

Low-drop Schottky diodes merge the two power inputs (direct 5-V input and PoE 5 V) such that whichever is available and higher is delivered downstream as the power rail **+5V** to various switching power supplies for MCU/logic/memory, LCD backlight boost and USB Host power.



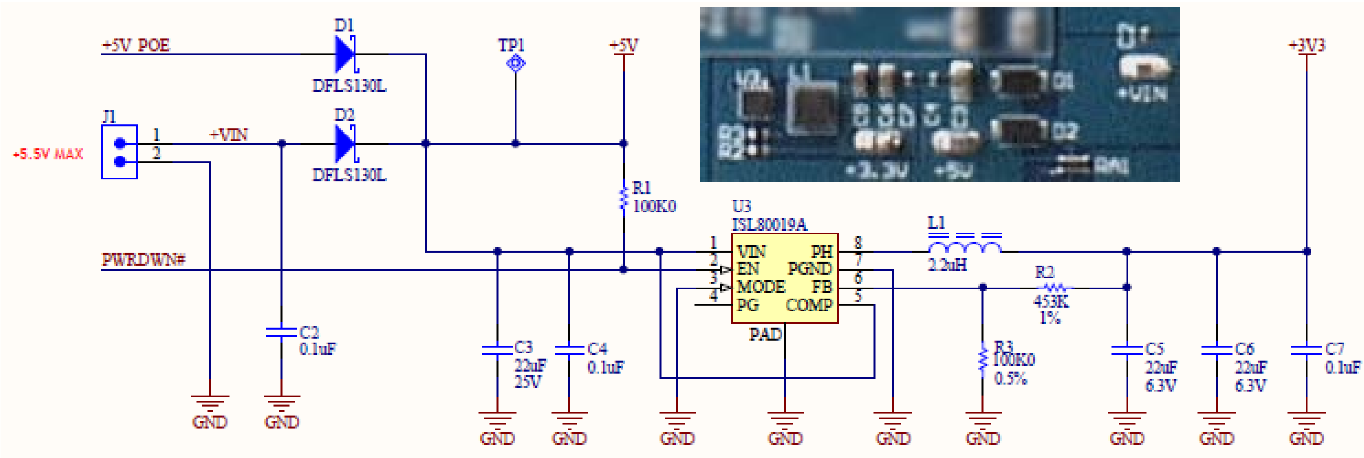
Designer's Notebook

This circuit ensures that power from one input does not flow backwards into the other power input's circuitry which, if connected but off, would often damage that power supply. In the transitionary period where potentially both circuits are on, it ensures only the higher of the two is delivered downstream and prevents the two supplies from clashing.

The DFLS230LH diode is popular for this application as it has a very low forward voltage and with a 30V V_{br} it can also be used in the LCD backlight circuit. You can cost optimize this with a cheaper one at the expense of some heat dissipated in the diode due to extra losses – there is a lot of margin between the 5-V input and the required Vmin for the regulator. Obviously, if your design eliminates one of the two power input circuits, you do not need these diodes to steer/select the input source. We initially calculated 1A capacity on these diodes based on 1.5A output of the switcher at 90% efficiency: 1.5 A/0.90*3.3 V/5.5 V = 1 A, however the LCD backlight, audio, and USB host supplies are parallel to the 3.3V switcher, so the total for the whole board is nearer to 2A. See the power budget discussion below.

5.5 3.3-V Main Power Subsystem

Almost all the circuits on the board require 3.3 volts, including MCU, memory, and logic. The dual low-drop 1A merge the two power inputs (direct 5-V input and PoE 5 V) such that whichever is available and higher is delivered to the ISL80019A buck switcher. This switcher, using a tiny inductor, creates 3.3V at up to 1.5A for the PE-HMI1. The PWRDWN# signal is marked here explicitly, but is not used elsewhere on this platform: the 100-kΩ R1 ensures the supply is always enabled.



Designer's Notebook

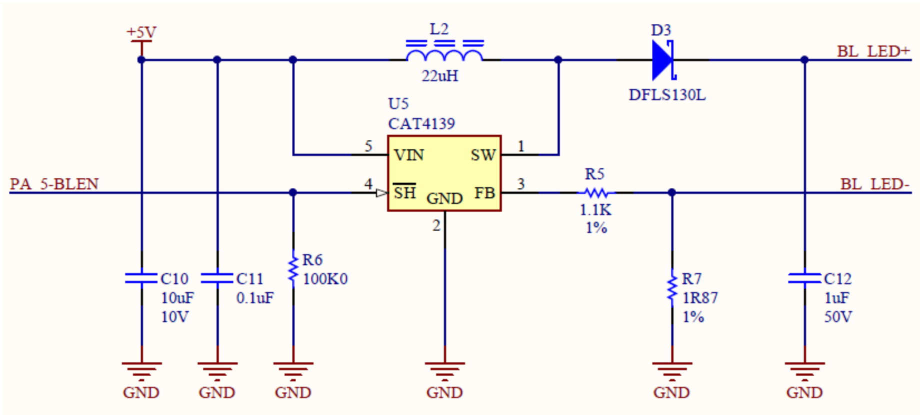
The two precision feedback resistors at R2/R3 set the output voltage to 3.3V, as at the time of the design there was no fixed-output version of this switcher. While there are many such switchers from many vendors (and we looked at many!) we use this one for its package (2 mm x 2 mm DFN!), excellent efficiency (up to 95%), and very competitive pricing. At typical-worst-case 90% efficiency and VIN (5.5 V), the power lost in the switcher is approximately (5.5-3.3) = 2.2 V*1.5 A*10% = 0.33 W * 71C/ W Tja = 23 degrees rise, a very acceptable temperature.

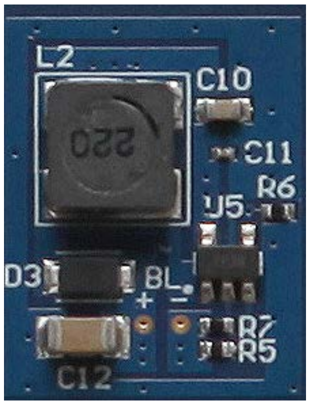
The 22µF output capacitors are small 0603 ceramic caps, saving significant space and improving long term reliability over electrolytic options. Pay special notice to the 6.3V rating on the output caps: when using ceramics as buck switcher outputs you want to provide ample voltage headroom to avoid DC bias issues which can reduce the effective capacitance significantly. Most buck switcher data sheets talk about this phenomenon extensively. The switching inductor, a Bourns SRN3015-2R2M, is a great compromise between small size (2 mm square), efficiency (72mΩ DCR), and price. It is also fully shielded, a consideration for a 2MHz high frequency switcher design to manage EMI emissions. If your board has more space or is less cost restrictive, you may look at a physically bigger inductor or higher technology inductor to reduce DCR, further improve efficiency, and thereby reduce unwanted heat dissipation due to switcher losses.

5.6 LCD Backlight Power Subsystem

The LCD on the PE-HMI1 is backlit by an array of LEDs. This array requires a constant current supply of 160 mA at approximately 9.6VDC, or approximately 1.5W. The ability to pulse width modulate (PWM) this supply is important to enable well-controlled backlight dimming, and the ability to turn off the backlight is important for power management. Factoring in the boost conversion efficiency approximately 1.75W of power from the input +5-V supply. Unlike other power systems where typical is normally much less than maximum, this is a typical number as the LEDs are actually run at this power.

The **+5V** main power signal feeds a constant current boost controller delivering this 160mA to the LCD backlight.





A PWM-capable MCU port bit is connected to this controller's SH# (shutdown) pin:

MCU			Schematic Net Name	Operation
Port	Mode	PSEL		
PA05	GTIOC11A_B:I/O	00011	PA_5-BLEN	LCD Backlight Enable (active high, weakly off @RESET#)

Designer's Notebook

The CAT4139 is a very efficient constant current backlight boost supply. The two precision feedback resistors at R5/R7 set the output current, in this case to 160mA. We used the 22µH Bourns SRR5028-220Y to balance physical size, cost, and efficiency in a shielded package; you can improve efficiency with a lower DCR than the 120mΩ of this specific part at the expense of a larger package and/or higher cost. We measure typical efficiencies of this circuit of approximately 88%, so the 5-V input power required for this circuit is about 1.5W/0.88 = 1.70W out of the total 5W power budget.

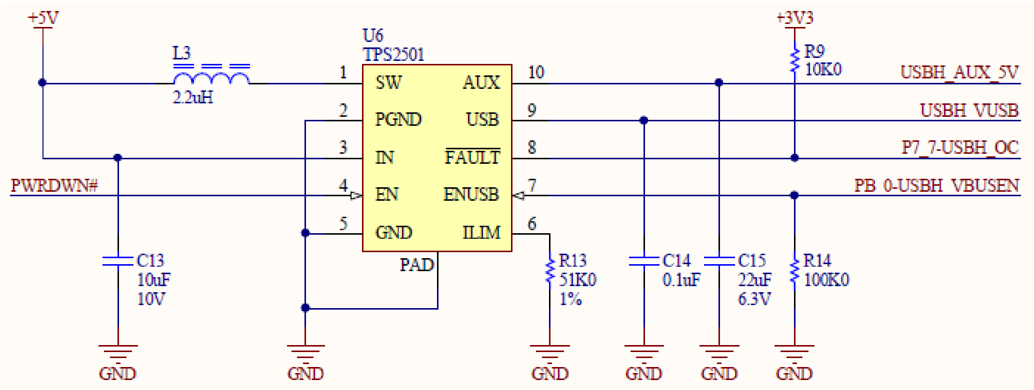
R6 ensures that on RESET# and until the MCU explicitly turns it on, the supply is powered off to minimize startup power requirements. Software can choose to "soft on" the power by carefully increasing the PWM percentage over a (for example) 1 second period.

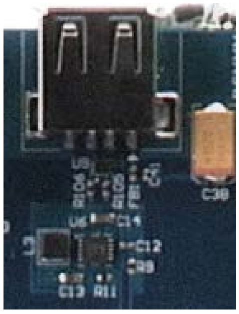
The LCD display used in the PE-HMI1 has very high performance and efficiency LEDs for a 7" display: most displays of this size require 2W or even 3W of power for the backlight at this brightness so pay special attention to the backlight power needs of your chosen display.

Note that in the even the LCD display is disconnected (for example, during initial board testing prior to LCD attach) the CAT4139 clips the open-loop voltage to 28V. This is why the diode in the circuit is rated at 30V Vbr and the output 1µF capacitor is rated above 30V, even though the typical LCD backlight voltage is 9.6V for this display.

5.7 USB Host Power Subsystem

While the USB Host Type-A connector could have been driven directly from +5V (or at least via a high-side FET power switch for enable control), the design incorporates a current limited design to ensure that an inappropriate high-load device does not crash the board or overstress the main power system.





R13 sets the current limit: in this design 51.0kΩ indicates a limit of ~500mA. At currents above this limit, the voltage on the output to the connector drops precipitously to limit the current to this maximum. The **FAULT#** open drain output from the chip indicates when the chip is in current-limiting mode and can be used by software to detect this fault condition.

The chip has two enables (**EN**, **ENUSB**) that enable the buck/boost supply to operate and enable the USB output respectively. As mentioned above, the **PWRDWN#** signal is inactive and unused on this design, so the chip is always enabled when the board has power; the buck/boost supply takes minimal power when the USB output is off. The USB output voltage is enabled by the active-high **PB_0-USBH_VBUSEN** signal with a weak **R14** pull-down to ensure on initial power-up the USB host circuit is off and does not cause a power-up stress on the system. The alternate backup 5.1V from **AUX** is not used on this design.

MCU			Schematic Net Name	Operation
Port	Mode	PSEL		
P707	USBHS_OVRCURA	10100	P7_7-USBH_OC	USB Host Over Current fault (active low)
PB00	USBHS_VBUSEN	10100	PB_0-USBH_VBUSEN	USB Host Power Enable (active high, reset condition low)
-	-		PWRDWN#	Not connected on this design (weakly pulled inactive)
-	-		USBH_AUX_5V	Aux 5.1V output unused on this design
-	-		USBH_VUSB	Power managed 5-V output to USB A host connector

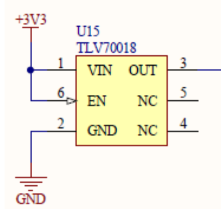
Designer's Notebook

The TPS2501 may be a bit overkill for this circuit, but is used a in many of our other designs as it is a buck/boost switcher as well as a current manager, so on many of our boards the input power can dip as low as 3.6V and the USB Host can still be powered at the correct 5-V output. It is also a little difficult to find current-limiting USB power switches that work in the sub-1A space (most are designed for USB chargers and designed for 1A+).

The current limit description in the TPS2501 data sheet is quite tricky to follow – there are several modes the chip can use. In this case, the current limit set by the 51.0kΩ resistor limits the USB Host Type-A connector to supply a maximum of ~500mA. Therefore the typical maximum power from the +5-V main rail for the USB Host Power is 2.5W (assuming a 5-V input requiring little buck/boost conversion).

5.8 Bluetooth Module Power

The on-board Bluetooth module is a 1.8V device. Since the power on this circuit is minimal, a simple and inexpensive LDO accomplishes the task, in conjunction with level translators to bridge the 1.8V I/O domain of the module with the 3.3V MCU domain. Note this LDO is powered by the +3V3 rail to minimize power dissipation in the LDO (vs. using the 5-V rail).



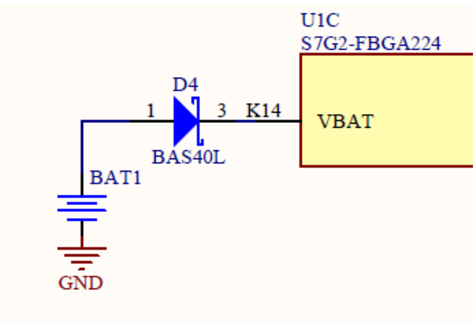
Designer's Notebook

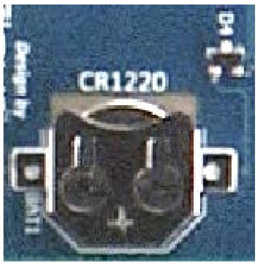
There are many Bluetooth modules we could have chose – see the Bluetooth section of this manual for more information. In this case, the strengths of the selected module outweighed the cost and complexity of adding a separate 1.8V power domain. If your design does not need the capabilities of this module, and can (for example) do a simple BLE module or even no Bluetooth at all, this whole power domain can be eliminated.

5.9 Real Time Clock (RTC) Battery Backup Power

The Renesas S7G2 MCU has a built-in Realtime Clock (RTC) with calendar function. In order to maintain time and date integrity when the system power is removed, the S7G2 has the ability to auto-manage the power switchover to a battery backup system.

The PE-HMI1 includes a CR1220 battery Lithium coin cell for this purpose, connected through a diode to prevent reverse current flow into the cell.





When replacing the battery, ensure correct orientation: the flat side (+) should be up and away from the PCB surface, and the rounded side (-) should be contacting the PCB surface.

5.10 Power Budgets

The following table summarizes the power budgets associated with each subsystem, including the typical efficiency losses through each corresponding power conversion subsystem:

Subsystem	Power Requirements (W)		Power Supply	Typical Efficiency	5-V Input Power (W)	
	Typ	Max			Typ	Max
USB Host	0.500	2.500	TPS2501	100%	0.500	2.500
LCD BL	1.530	1.530	CAT4139	88%	1.750	1.750
LCD Logic	0.280	0.396	ISL80019A	92%	0.304	0.430
Audio	TBD	TBD	-	100%	TBD	TBD
MCU & Memory	TBD	TBD	ISL80019A	92%	TBD	TBD
Ethernet	TBD	TBD	ISL80019A	92%	TBD	TBD
CAN	TBD	TBD	ISL80019A	92%	TBD	TBD
RS232/485	TBD	TBD	ISL80019A	92%	TBD	TBD
WiFi	TBD	TBD	ISL80019A	92%	TBD	TBD
Bluetooth	TBD	TBD	TLV70018 ISL80019A	*92%	TBD	TBD

Take care to ensure the total power used, including any Pmods, is under the maximum 10W capability of the power subsystem.

6.Graphics Capacitive Touch LCD

One of the most important features of the PE-HMI1 is the high resolution LCD graphic color display with the following characteristics:

- 800x480 pixel resolution
- Multi-viewing angle (MVA) technology for excellent visibility at nearly any viewing angle in portrait or landscape mode
- Integrated capacitive touch controller with I2C interface
- Full 24-bit color RGB interface

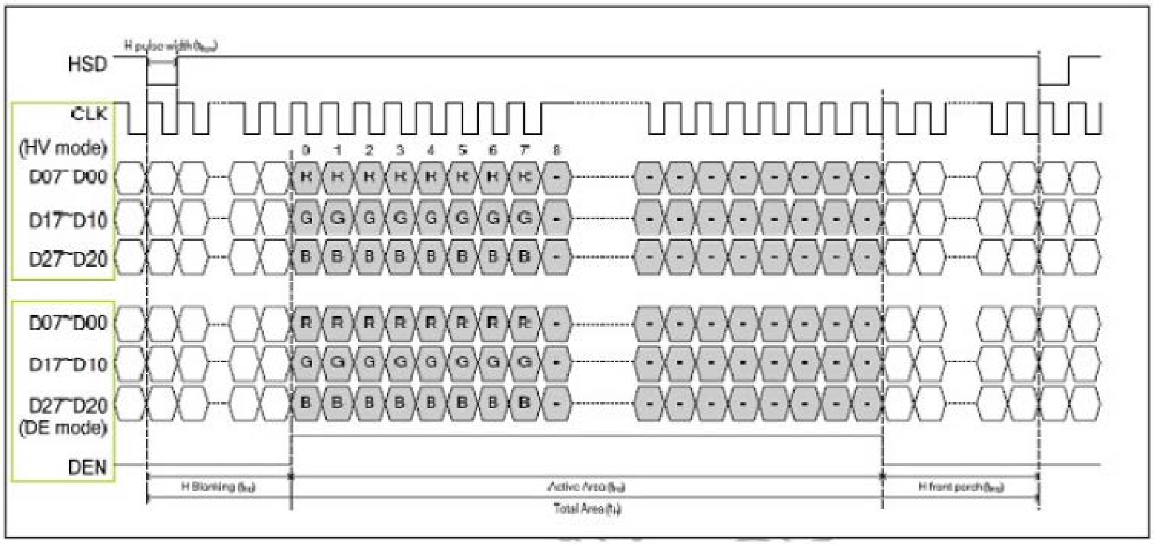
6.1 LCD Interface

Typical of displays with resolution at and below 800x480 (WVGA), the PE-HMI1 LCD uses a parallel RGB (red green blue) interface rather than a higher performance but more expensive LVDS interconnect. While most commercial displays and systems use 16-bit color (RGB565), this color range is inadequate for modern user interfaces that make heavy use of color gradients. The superior color capability of full 24-bit color (RGB888) enables smooth shading on gradients as compared to the "jagged" color stepping common on gradients in a 16-bit color environment.

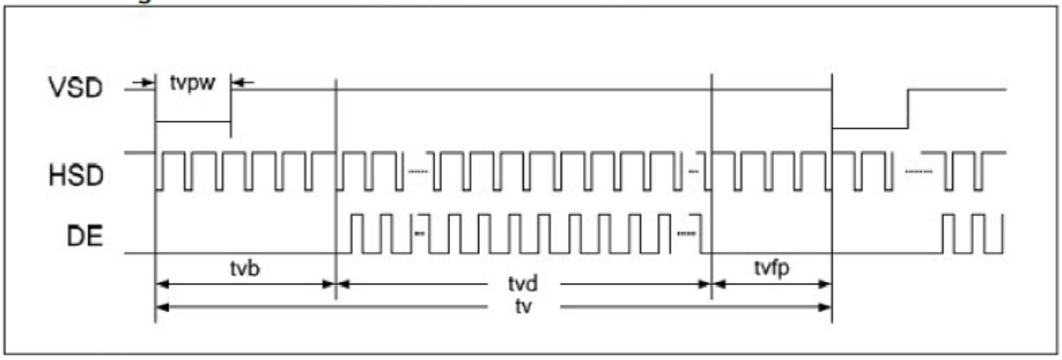
However, the LCD and the S7G2 MCU graphics controller can both be operated in 16-bit or 24-bit color mode as enabled in software. For graphics speed and memory efficiency, a dual 16-bit frame buffer only requires 1,536,000 bytes of RAM, whereas a dual 32-bit frame buffer (you must use 32-bit words in order to support 24-bit color) requires double that at 3,072,000 bytes.

The LCD has the following timing requirements:

Horizontal timing



Vertical timing



Horizontal timing

Parameter	Symbol	Spec.			Unit
		Min.	typ.	Max.	
Horizontal Display Area	thd		800		DCLK
DCLK frequency	fclk	-	30	50	MHz
One Horizontal Line	th	862	1056	1200	DCLK
HS pulse width	thpw	1	-	40	DCLK
HS Back Porch (Blanking)	thb		46		DCLK
HS Front Porch	thfp	16	210	354	DCLK
DE mode Blanking	th-thd	85	256	400	DCLK

Vertical timing

Parameter	Symbol	Spec.			Unit
		Min.	typ.	Max.	
Vertical Display Area	tvd		480		T_H
VS period time	tv	513	525	650	T_H
VS pulse width	tvpw	3	-	20	T_H
VS Back Porch (Blanking)	tvb		23		T_H
VS Front Porch	tvfp	7	22	147	T_H
DE mode Blanking	tv-tvd	30	45	170	T_H

RGB data is connected to the MCU as follows:

MCU			Schematic Net Name	Operation
Port	Mode	PSEL		
P513	LCD_DATA16_B	TBD	P5_13-LCD_D16	LCD R0 (LSB)
P805	LCD_DATA17_B	11001	P8_5-LCD_D17	LCD R1
PA11	LCD_DATA18_B	11001	PA_11-LCD_D18	LCD R2
P914	LCD_DATA19_B	11001	P9_14-LCD_D19	LCD R3
P915	LCD_DATA20_B	11001	P9_15-LCD_D20	LCD R4
P909	LCD_DATA21_B	11001	P9_9-LCD_D21	LCD R5
P910	LCD_DATA22_B	11001	P9_10-LCD_D22	LCD R5
P902	LCD_DATA23_B	11001	P9_2-LCD_D23	LCD R6 (MSB)
PA09	LCD_DATA8_B	11001	PA_9-LCD_D8	LCD G0 (LSB)
PA08	LCD_DATA9_B	11001	PA_8-LCD_D9	LCD G1
P615	LCD_DATA10_B	11001	P6_15-LCD_D10	LCD G2
P905	LCD_DATA11_B	11001	P9_5-LCD_D11	LCD G3
P906	LCD_DATA12_B	11001	P9_6-LCD_D12	LCD G4
P907	LCD_DATA13_B	11001	P9_7-LCD_D13	LCD G5
P908	LCD_DATA14_B	11001	P9_8-LCD_D14	LCD G6
P901	LCD_DATA15_B	11001	P9_1-LCD_D15	LCD G7 (MSB)
P804	LCD_DATA0_B	11001	P8_4-LCD_D0	LCD B0 (LSB)
P803	LCD_DATA1_B	11001	P8_3-LCD_D1	LCD B1
P802	LCD_DATA2_B	11001	P8_2-LCD_D2	LCD B2
P606	LCD_DATA3_B	11001	P6_6-LCD_D3	LCD B3
P607	LCD_DATA4_B	11001	P6_7-LCD_D4	LCD B4
PA00	LCD_DATA5_B	11001	PA_0-LCD_D5	LCD B5
PA01	LCD_DATA6_B	11001	PA_1-LCD_D6	LCD B6
PA10	LCD_DATA7_B	11001	PA_10-LCD_D7	LCD B7 (MSB)

The LCD control and backlight signals are wired as follows to the MCU:

MCU			Schematic	Operation
Port	Mode	PSEL	Net Name	
P900	LCD_CLK_B	11001	P9_0-LCD_CLK	LCD Pixel dot clock
P313	LCD_TCON2_B	11001	P3_13-LCD_DE	LCD Data Enable (active high)
P315	LCD_TCON0_B	11001	P3_15-LCD_HSYNC	LCD Horizontal Sync
P314	LCD_TCON1_B	11001	P3_14-LCD_VSYNC	LCD Vertical Sync
PA03	GPIO	-	PA_3-LCD_ON	LCD Logic Enable (active high, weakly inactive on RESET#)
-	-	-	BL_LED-	LCD Backlight LED String Cathode
-	-	-	BL_LED+	LCD Backlight LED String Anode

6.2 Capacitive Touch Controller

The LCD on the PE-HMI1 includes a capacitive touch sensor system and built-in FocalTech Systems FT5302 controller in a 20 transmit by 12 receive-line sensor configuration. The controller has the following features:

- 400-kHz I2C interface with activity interrupt out
- 5 finger simultaneous multi-touch detection
- Palm detection for lock function, and
- <100 idle-to-active touch response time

The FT5302 controller operates on the MCU's I2C bus as follows:

Address			I2C Bus	Max kHz	Location	Device
7-bit	Read	Write				
0x38	0xF1	0xF0	1	400	LCD	FocalTech FT5302 Touch Controller

The I2C Device Summary lists all the I2C devices on the PE-HMI1.

The controller is connected as follows:

MCU			Schematic Net Name	Operation
Port	Mode	PSEL		
PA02	GPIO	-	PA_2-TOUCH_RST#	Touch Controller Reset (active low)
P205	SCL1_A	00111	P2_5/SCL1	Touch Controller I2C Bus Clock
P206	SDA1_A	00111	P2_6/SDA1	Touch Controller I2C Bus Data
P008	IRQ12-DS	ISEL	P0_8/IRQ12-DS-TOUCH_IRQ#	Touch Controller Activity Interrupt (open drain active low)

The signal PA_2-TOUCH_RST# signal is asserted on/after RESET# via a weak pull-down and the PA02 GPIO must be configured and deasserted in software in order to release the touch controller from its reset condition.

Similar to nearly all touch controllers, the FocalTech FT5302 instruction set and data sheet are available only under non-disclosure agreement from FocalTech Systems.

7. MCU Subsystem (MCU, Memory, Clocking, Reset)

The heart of the PE-HMI1 design is the MCU subsystem, comprised of:

- Synergy S7G2 240-MHz Cortex-M4 MCU by Renesas
- 32-MByte 100-MHz SDRAM
- 2-GByte embedded MultiMedia Card (e•MMC)
- 32.768-kHz RTCC crystal and 24-MHz MCU clock
- System reset

7.1 Synergy S7G2 MCU by Renesas

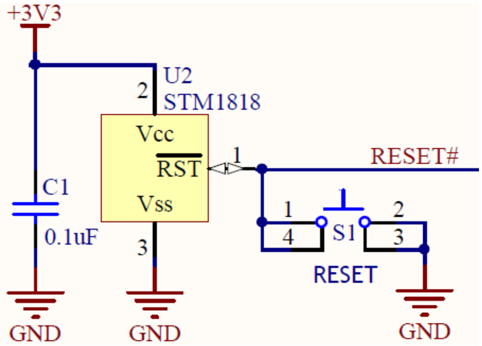
The Synergy MCU family has several members; the PE-HMI1 uses the S7G2 MCU with the following key features:

- 240-MHz ARM Cortex™-M4 processor with FPU
- 120-MHz 4MB program FLASH
- 640-kB on-chip SRAM
- 64-kB data flash (100,000 E/W cycles)
- LCD Controller with 800x600x24-bit capability and BitBLT/JPEG acceleration
- 120MHz x16 SDRAM controller
- 224 pin 13x13 mm 0.8 mm pitch BGA

The MCU is fully described in the Synergy S7G2 Group User's Manual: Hardware; see Additional Information for links to obtaining Synergy and other design documentation.

7.2 System Reset

The PE-HMI1 includes a small system reset chip, designed to not only reset the MCU but all on-board peripherals. On power-up, the system reset is asserted low for approximately 100-250mS and then is released to rise high with a simple pull-up resistor. Pushbutton S1 on the baseboard is connected directly to this **RESET#** signal – the reset chip automatically senses the pushbutton and, when pressed (**RESET#** grounded) debounces the switch and initiates a reset cycle as if power were being applied for the first time.



The **RESET#** signal is connected to the MCU as follows:

MCU			Schematic Net Name	Operation
Port	Mode	PSEL		
RES#	RES#		RESET#	System Reset (open drain, active low, weakly pulled high)

7.3 MCU Boot Mode

The S7G2 MCU boot mode is selectable by the levels present on the **MD** pin on the MCU when **RES#** is de-asserted. The PE-HMI1 DIP Switch (S3 position 6) which controls the MD pin and MCU boot mode:

MD	S3.6 Position	Description
0	On	Boot into USB boot loader
1	Off	Boot from MCU FLASH

Normally, the PE-HMI1 should be operated with S3.6 in the “off” position to boot normally from the MCU’s FLASH. The operation of the built-in USB boot loader is beyond the scope of this document; see Additional Information.

7.4 SDRAM

The Synergy S7G2 MCU has a full on-chip SDRAM controller capable of operating external x16 SDRAM at up to 120MHz.

The PE-HMI1 RZ Module has this SDRAM connection (address, data, control) isolated on the module connected to one Micron 32-MByte SDRAM device capable of operation to 100 MHz.

The SDRAM address/data bus is connected to the MCU as follows:

MCU			Schematic Net Name	Operation
Port	Mode	PSEL		
P310	A15	01011	P3_10/A15	MCU A15
P309	A14	01011	P3_9/A14	MCU A14
P308	A13	01011	P3_8/A13	MCU A13
P307	A12	11011	P3_7/A12	MCU A12
P306	A11	11011	P3_6/A11	MCU A11
P305	A10	11011	P3_5/A10	MCU A10
P304	A9	11011	P3_4/A9	MCU A9
P303	A8	11011	P3_3/A8	MCU A8
P302	A7	11011	P3_2/A7	MCU A7
P301	A6	11011	P3_1/A6	MCU A6
P111	A5	01011	P1_11/A5	MCU A5
P112	A4	01011	P1_12/A4	MCU A4
P113	A3	01011	P1_13/A3	MCU A3
P114	A2	01011	P1_14/A2	MCU A2
P115	A1	01011	P1_15/A1	MCU A1
P801	DQ15	01011	P8_1/DQ15	MCU D15 (msb)
P800	DQ14	01011	P8_0/DQ14	MCU D14
P603	DQ13	01011	P6_3/DQ13	MCU D13
P604	DQ12	01011	P6_4/DQ12	MCU D12
P605	DQ11	01011	P6_5/DQ11	MCU D11
P614	DQ10	01011	P6_14/DQ10	MCU D10
P613	DQ9	01011	P6_13/DQ9	MCU D9
P612	DQ8	01011	P6_12/DQ8	MCU D8
P107	DQ7	11011	P1_7/DQ7	MCU D7
P106	DQ6	11011	P1_6/DQ6	MCU D6
P105	DQ5	11011	P1_5/DQ5	MCU D5
P104	DQ4	11011	P1_4/DQ4	MCU D4
P103	DQ3	11011	P1_3/DQ3	MCU D3
P102	DQ2	11011	P1_2/DQ2	MCU D2
P101	DQ1	11011	P1_1/DQ1	MCU D1
P100	DQ0	11011	P1_0/DQ0	MCU D0 (lsb)

The SDRAM control bus is connected to the MCU as follows:

MCU			Schematic Net Name	Operation
Port	Mode	PSEL		
P611	SDCS	01011	P6_11/SDCS#	SDRAM Chip Select (active low)
P311	RAS	11011	P3_11/RAS#	SDRAM Row Address Strobe (active low)
P312	CAS	11011	P3_12/CAS#	SDRAM Column Address Strobe (active low)
P610	WE	TBD	P6_10/WE#	SDRAM write enable (active low)
P608	DQM1	TBD	P6_8/DQM1	SDRAM I/O data mask enable for D15 to D8
P601	DQM0	TBD	P6_1/DQM0	SDRAM I/O data mask enable for D7 to D0
P609	CKE	TBD	P6_9/CKE	SDRAM Clock Enable
P602	SDCLK	11011	P6_2/SDCLK	SDRAM Clock

Designer's Notebook

This was a much-debated tradeoff in the whole team. On one hand, we really wanted to use the high speed SDRAM to enable the 120MHz operation. The Synergy DK-S7G2 Development Kit design did exactly that to demonstrate the maximum performance of the solution. On the other hand, as a product example, we wanted to demonstrate products we have strong confidence will have long term availability based Micron's. Micron's "PLP" list indicates which of their products are targeted for long-term availability, and the 120MHz-capable parts in full -40 to +85C and BGA package were not on that list. In addition, going with a slower part would enable far more sourcing solutions since the faster parts would drop in as alternates. We chose to make the decision we'd make for high-volume products: to favor long term supply stability over that extra 20% of performance on the external memory. Your company's relationship with memory suppliers such as Micron, ISSI, Samsung and others may uncover a different result, or your design lifetime may not be as long as the typical industrial HMI target of 15 years, and you may be able to design your own device taking advantage of the full 120MHz capability of the S7G2 memory controller.

Note at the slightly slower speed and the tight layout, it was unnecessary to use series "dampening" resistors in our design, but a higher speed design or using the larger TSSOP packages (i.e. longer and less balanced traces) may require an increased focus on managing signal integrity. Our experience with the higher speed SDRAM chips is they have very strong output drivers to achieve these speeds, and these output drivers can easily cause ground-bounce/over/undershoot issues and even latch-up conditions on connected chips if not properly designed and the PCB layout is inadequate.

7.5 Embedded MultiMediaCard (e•MMC)

The PE-HMI1 includes a large on-board FLASH storage device, the 2 Gigabyte Micron embedded MultiMediaCard, ("e•MMC ").

The e•MMC device conforms to the JEDEC MMC Specification (v4.41 or later), and provides large and reliable storage for files and objects, as well as have two linear and reliable areas for direct booting. FLASH-less MCUs, such as the Renesas RZ A1/H MCU can boot directly from an e•MMC 's boot area with an on-MCU boot loader that copies the FLASH boot code to RAM and executes it. The Synergy S7G2 MCU has on chip FLASH which supports the boot operation, and the PE-HMI1 e•MMC device cannot be booted from, but rather is a cost effective storage mechanism for large user interfaces, fonts, images, web pages, machine logging data, and more.

The e•MMC can only communicate with a CPU via a dedicate interface similar to the one used to drive SD Cards. In fact, an e•MMC device is nearly identical to an SD Card, just in chip vs. plug-in card packaging. The on-chip controller in the e•MMC takes care of all wear levelling, bad block management, and more, greatly simplifying software interactions as compared to a raw NAND flash.

The e•MMC is connected to the S7G2 MCU on channel 1 of the SDIO/MMC controller as follows:

MCU			Schematic Net Name	Operation
Port	Mode	PSEL		
P506	SD1CD	10101	P5_6/SD1CD	e•MMC Card Detect input
P507	SD1WP	10101	P5_7/SD1WP	e•MMC Write Protection input
P903	GPIO	-	P9_3-MMC_RST#	e•MMC reset GPIO (active low)
P501	MMC_CMD	10101	P5_1-MMC_CMD	e•MMC command output, response input signal
P500	MMC_CLK	10101	P5_0-MMC_CLK	e•MMC Clock (MCU→MMC)
P502	MMC_D0	10101	P5_2-MMC_D0	e•MMC D0 (lsb)
P503	MMC_D1	10101	P5_3-MMC_D1	e•MMC D1
P504	MMC_D2	10101	P5_4-MMC_D2	e•MMC D2
P505	MMC_D3	10101	P5_5-MMC_D3	e•MMC D3 (msb)

The **P9_3-MMC_RST#** signal holds the e•MMC in reset when asserted, and is weakly asserted by a pull-down on/after **RESET#** until MCU software configures the GPIO and actively de-asserts the signal.

Designer's Notebook

The choice of the e•MMC was also hotly debated. We had two basic options: a large Quad SPI NOR serial flash, such as the Micron N25Q series, or the e•MMC . It really could have gone either way, but in the end we chose the e•MMC . Both e•MMC and serial FLASH are supported on our design for the full-featured Synergy DK-S7G2 Development Kit and only the serial FLASH on the SK-S7G2 Starter Kit design.

Serial FLASH is supported on the S7G2 in full QSPI mode, with a maximum clock of 60 MHz, enabling high speed transfers at a very cost effective price in a small package with modest (0.8 mm) ball pitch or even DFN/SOP-style packaging for small densities (<16 megabytes). The Micron N25Q series in a single BGA can be as large as 128 *Megabytes*! On the other hand, the 0.7 *second* typical erase times of the large NOR serial flashes adds extra complexity to the software designer, forcing background erases, erase-suspend challenges (if the FLASH device needs to be accessed during a background erase), as well as (typically) integrating these sophisticated features into the file system stack.

Some systems use a fully linear GUI-asset format: images, fonts, etc., are all put in a fully linear manner in bulk storage for rapid access without file system overhead. The S7G2 MCU supports direct-addressing mode to serial FLASH, so the external assets would appear to software as if they were completely memory mapped – no SPI-port reads and writes would be required.

However, often modern high-performance HMI designs need to support very sophisticated customer GUIs with replaceable assets and many different user experience elements. A real file system, such as a FAT32 file system, is an absolute must in these designs for simple and reliable management of GUI ingredients. We also have sophisticated IoT connectivity and built-in upgradability, so it is common for customers to log data and do frequent updates to the device, prompting long term concerns of wear leveling, background erase/writes while the GUI is operational, etc. While these file systems are often implemented on top of serial FLASH in smaller smaller-screen designs, with the PE-HMI1 we favor e•MMC strongly for several reasons:

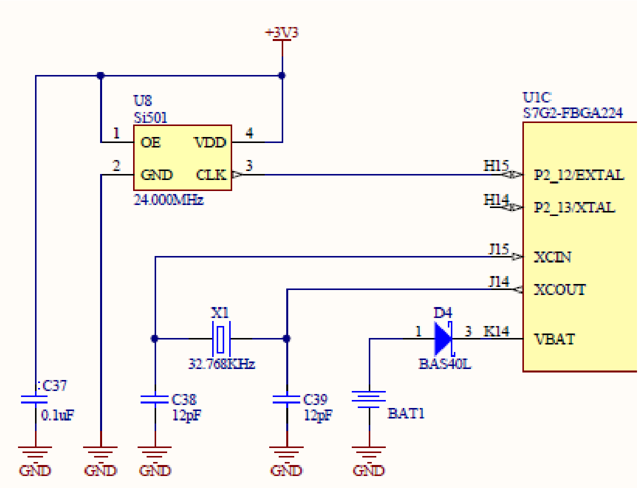
- Built-in background erase and wear levelling
- Scalable to 8 Gigabytes
- More cost effective at 2 Gigabytes than serial FLASH devices at 128Mbytes
- High performance
- Standardized in the industry by JEDEC with long life supply alternatives

Because the PE-HMI1 was so full featured, we were slightly pin constrained so there was no way to use a full 8-bit e•MMC interface and had to compromise to a 4-bit interface. Even with this constraint, we felt the strengths of the e•MMC -based system solution outweighed the serial QSPI solution.

If your GUI is fairly straightforward, you have limited GUI assets/data, update your GUI/data infrequently, and have a packaging/compiling mechanism for managing and updating these linearly packed assets, the serial FLASH is probably the best choice for your design. You can experiment with this using the DK-S7G2 Development Kit which includes a 4.3” WQVGA resistive touch LCD.

7.6 MCU Clock Sources

On the PE-HMI1 there are two local clocks used by the MCU. A simple 32.768 kHz tuning fork crystal is attached to the MCU to drive the on-chip Real Time Clock (RTC) with calendar function. An on-board lithium coin-cell battery provides backup capability for the RTC. The MCU, with a single 24MHz clock, can internally generate all the frequencies necessary for the LCD controller, core, and peripherals including USB.



Designer's Notebook

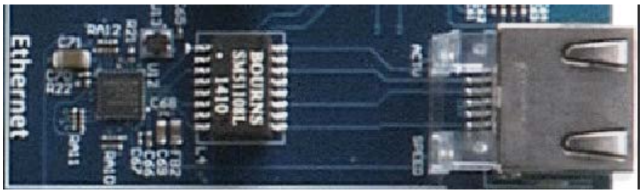
Until very recently, the MEMs oscillator business was vibrant and these devices were more configurable than their crystal counterparts and often far more competitively priced especially in smaller packages. In addition, stability and other operational parameters were becoming equivalent to better quality crystals. This is why we originally chose to use the Si501 in this circuit. However, with the recent (and untimely) exit of SiLabs from the MEMs business and the increasing uncertainty in the MEMs oscillator supply chain, future revisions of the PE-HMI1 will replace the Si501 with a traditional (albeit more expensive) 24MHz crystal +

8.Communications

The PE-HMI1 includes extensive on-board communications peripherals, including:

- 10/100 Ethernet
- Bluetooth dual mode Classic and BLE
- WiFi
- CAN plus RS232/485, including differential and single ended, full and half duplex support
- High Speed USB 2.0 Host and Device ports
- 6-pin Digilent PMOD* port with Type 1 (GPIO), 2 (SPI), and 4 (UART) support
- 12-pin Digilent PMOD* port with Type 1 (GPIO), 2A (expanded SPI), and 4A (expanded UART) support

8.1 10/100 Ethernet



The S7G2 has an on-chip 10/100 Ethernet MAC with RMII interface. The PE-HMI1 brings these signals to a Micrel KSZ8091RNB RMII PHY through a magnetics-down design to a standard RJ45 10/100 CAT5 jack.

The RMII interface is connected to the SGS7 MCU as follows:

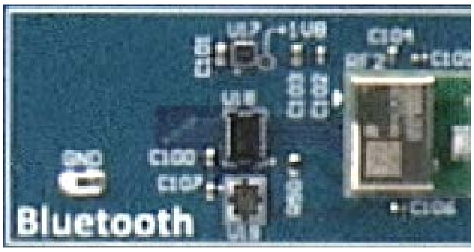
MCU			Schematic Net Name	Operation
Port	Mode	PSEL		
P706	GPO	-	P7_6-ETH_RESET#	Holds PHY in reset (active low)
P002	IRQ8-DS	ISEL	P0_2/IRQ8-DS-ETH_IRQ#	PHY Interrupt (active low)
P404	ET1_MDIO	10111	P4_4/ET1_MDIO	Management data I/O
P403	ET1_MDC	10111	P4_3/ET1_MDC	Management data clock
P705	RMII1_CRS_DV	10111	P7_5/RMII1_CRS_DV	Carrier detection
P704	RMII1_RX_ER	10111	P7_4/RMII1_RX_ER	Receive error
P702	RMII1_RXD0	10111	P7_2/RMII1_RXD0	Receive data 0 (LSB)
P703	RMII1_RXD1	10111	P7_3/RMII1_RXD1	Receive data 1
P701	REF50CK1	10111	P7_1/REF50CK1	Transmit clock
P405	RMII1_TXD_EN	10111	P4_5/RMII1_TXD_EN	Transmit enable
P700	RMII1_TXD0	10111	P7_0/RMII1_TXD0	Transmit data 0 (LSB)
P406	RMII1_TXD1	10111	P4_6/RMII1_TXD1	Transmit data 1

The **P7_6-ETH_RESET#** signal holds the Ethernet PHY in reset when asserted, and is weakly asserted by a pull-down on/after **RESET#** until MCU software configures the GPIO and actively de-asserts the signal.

Designer's Notebook

We debated using a simple magnetics-included jack, but opted to figure out a 100% SMD design. Finding a true SMD PoE-capable jack with LEDs was surprisingly problematic! Eventually we found this one from Amphenol that uses LEDs on the board and a light pipe. Unfortunately, the Bourns magnetics are about 1 mm too tall to rotate it 90° and nestle it up inside the "uprights" of the light pipes – we needed to leave room to insert the light pipes post-reflow which is why the there is a PCB gap between the two elements.

8.2 Bluetooth Classic + BLE



Bluetooth connectivity is rapidly being adopted in a variety of HMI-related applications, whether for simple Beacon support or for more sophisticated usage models including field device updates.

The Panasonic ENW–89823A3KF fully-certified module includes the popular CC2560B controller, and supports both high data rate Classic as well as BLE operating modes.

The module is connected (through the level translation) to the MCU as follows:

MCU			Schematic Net Name	Operation
Port	Mode	PSEL		
PB01	GPIO	-	PB_1-BT_SHUDN#	Bluetooth Shutdown (active low)
P708	RXD1	00101	P7_8/RXD1	Bluetooth UART RxD
P709	TXD1	00101	P7_9/TXD1	Bluetooth UART TxD
P711	CTS1#	00101	P7_11/CTS1	Bluetooth UART CTS#
P712	GPIO	-	P7_12-RTS1	Bluetooth UART RTS#

Designer's Notebook

In another nod to the verging-on-dev-kit nature of the Product Example, we wanted to include both Bluetooth operating modes so that, depending on your specific application, you could experiment with the mode you needed. If you need Bluetooth you'll probably optimize this implementation down to the specific single-mode radio you actually need for your product.

8.3 WiFi 802.11 b/g/n

The PE-HMI1 includes a Longsys GT202 WiFi module, based on a Qualcomm/Atheros QCA4002 device and has the following features:

- 802.11 b/g/n 2.4GHz support with integrated power amplifier
- Low power modes and fast wake-up times
- Integrated AllJoyn® software to ensure seamless connectivity and services
- Integrated IPv4/IPv6 networking and WPS, WPA, WPA2, WEP security with SSL Client with AES encryption
- Fully FCC and CE certified

The WiFi module is connected to the MCU as follows:

MCU			Schematic Net Name	Operation
Port	Mode	PSEL		
P904	GPIO	-	P9_4-WIFI_PWD#	WiFi Shutdown (active low)
P001	IRQ7-DS	ISEL	P0_1/IRQ7-DS-WIFI_IRQ#	WiFi Interrupt
P410	MISOA_B	00110	P4_10/MISOA	WiFi RSPIA MISO
P411	MOSIA_B	00110	P 4_11/MOSIA	WiFi RSPIA MOSI
P412	RSPCKA_B	00110	P4_12/RSPCKA	WiFi RSPIA Clock
P413	GPIO	-	P4_13/SSLA0	WiFi RSPIA Slave Select (active low GPIO)

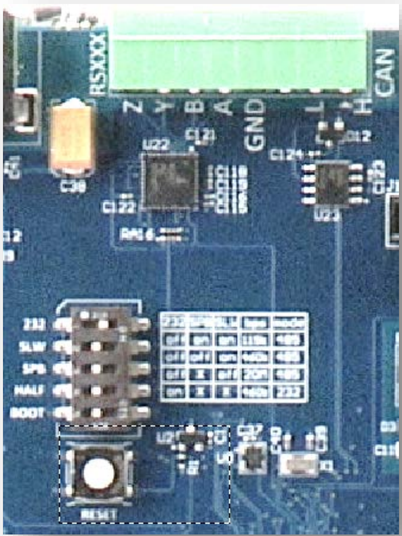
Designer's Notebook

The QCA4002 has some of the most available drivers in the ecosystem. In addition to the internal stacks, which can speed and minimize software development, the module also permits bypassing all the upper stack layers and doing these software tasks on the SGS7. In this model, you can have more complete control of connectivity to the network, including seamless roaming between wireless and WiFi.

If you have a different WiFi module you'd like to try with the PE-HMI1, you can use one of the Pmod™ ports to connect your module of choice.

For simplicity of certification and distribution as an example, we used the version of the module with integrated antenna. In reality, most designs will want to use a module with an external patch/whip antenna connected via micro-coax to an U.FL connector on the module in order to get the WiFi signal out of the OEM's product chassis.

8.4 Industrial Networking CAN & RS232/485



The large green 3.5-mm connector J10 delivers RS232, RS422, or RS485 as well as high performance CAN to external industrial networks. A screw terminal plug is supplied, enabling easy wiring of termination or daisy chained cabling. The connector's signals are clearly marked on the PCB as follows:

Pin	Name	Description
1	CANH	CAN Transmit/Receive H
2	CANL	CAN Transmit/Receive L
3		Unconnected
4	GND	Ground
6	RSXXX_A	Receive inverting input
7	RSXXX_B	Receive non-inverting input
8	RSXXX_Y	Transmit inverting output
9	RSXXX_Z	Transmit non-inverting output

There is no termination facility on the PE-HMI1; if cable termination is required insert a 75 ohm resistor across the appropriate signals at the screw-in connector.

Note that two additional UARTs and an additional CAN port are available on the Pmod™ Port; only one of those UARTs is in a standard Digilent PMOD configuration however it is possible to create custom non-standard PMODs for that port and access these extra serial interfaces.

Designer's Notebook

Many industrial communication modules use this configuration and we wanted to support a wide variety of target industrial networking and in-chassis communications connectivity. Using this on the PE-HMI1 is definitely stretching the "Product Example" concept into more dev kit territory – your design will likely optimize this down to the specific connectivity you need and correspondingly reduce the BOM cost and footprint as well as reducing the need for the DIP switch configurability.

8.4.1 RS232, RS422, and RS485

The PE-HMI1 employs an Intersil ISL41387IRZ-T multi-protocol transceiver has the following key features:

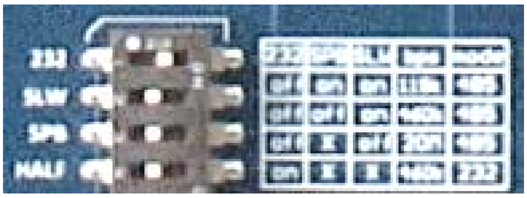
- Selectable RS232 or RS485/RS422
- ±15kV (HBM) ESD protected
- Single ended or differential
- Half or full duplex
- Large (2.7V) differential V_{OUT} for improved noise immunity in RS485/RS422 networks
- Full failsafe (open/short) RX in RS485/RS422 mode
- RS232 transmit rates up to 650kbps, receive rates to 2mbps
- RS485/RS422 data rates up to 20Mbps
- RS485/RS422 slew rate limit options for 460kbps and 115kbps

It is an excellent choice for many RS485 point-to-point and multi-drop networks and works particularly well in many industrial PLC configurations. The dual mode support enables, via the S4 DIP switch, RS232 instead of RS485 levels. Only one mode (RS232 or RS422/485) can be supported at any given time, and the mode is not software selectable – it is assumed that the installation process and environment determines which transmission standard is being connected.

The transceiver is connected to the MCU's UART as follows:

MCU			Schematic Net Name	Operation
Port	Mode	PSEL		
PB06	GPIO	-	PB_6-RS_DEN	RSxxx Transmit Drive Enable (active high)
P508	GPIO	-	P5_8-RS_ON	RSxxx Transceiver Enable (active high)
P509	TXD5	00101	P5_9/TXD5	RSxxx Transmit Data
P510	RXD5	00101	P5_10/RXD5	RSxxx Receive Data

The DIP Switch S3 enables a variety of features on this port. The legend on the Baseboard PCB can help with these settings:



8.4.1.1 RS232 or RS422/RS485 Mode

DIP switch `S3.1` controls which standard the transceiver conforms to; setting this switch ON puts the transceiver in RS232 level mode; the switch OFF puts the transceiver in RS422/RS485 mode.

8.4.1.2 Slew Rate and Speed Limiting (RS422/RS485 only)

In RS422/485 mode, DIP switch `S3.2` and `S3.3` control the slew rate and speed limits respectively. Set these switches as slow as possible but adequate for the target network rate according to the table.

8.4.1.3 RSXXX Half/Full Duplex Selection

The RSXXX port can operate in full duplex mode where data can be independently and simultaneously flowing *in* the receive and *out* the transmit pins. It can also be configured to operate in half duplex mode where input/output data is often carried on the same wire(s) and the directionality takes turns.

The main difference between the modes lies in how the transmit and receive enable of the transceiver are configured and used. In full duplex mode, the transceiver receive data is always enabled and being processed by the MCU. In half duplex mode, the receive data is only valid when not transmitting – this avoids receive MCU algorithms from "seeing" the same data that they send if the network shares the same wires for transmit and receive. Full duplex mode always implies separate network wires for transmit and receive. Even then, you may not want to always have your transmitter enabled – there are many custom networks where the "master" in a network owns one network wire (or pair in differential mode) and can broadcast at any time to the “slaves” whereas the slaves must share the return line according to some convention to avoid collisions.

Given the many possible combinations on custom networks, there are two key elements that need to be addressed:

1. Is the receiver always on, delivering data to the MCU’s UART all the time, or is the network wiring half duplex and the receiver disabled during transmission to avoid “seeing your own packets”?
2. Is the transmitter always on, or must it be only turned on when the UART transmits on the network?

8.4.1.4 Receive Enable: Full and Half Duplex Selection

DIP switch **S3.4** controls how the RSXXX transceiver’s *receiver* is enabled. When **S4.4** is **OFF** (full duplex mode), a weak pull-up on the RSXXX transceiver’s **RXEN** pin ensures that by default the RSXXX transceiver’s receiver is always enabled and delivering data to the MCU.

When **S3.4** is **ON** (half duplex mode), the RSXXX transceiver’s **RXEN** pin is connected to GND. In this mode, the RSXXX transceiver’s receive enable is controlled by its **RXEN#** which is connected to the opposite polarity **DEN** (drive enable) pin. In this configuration, whenever the transmitter is enabled, the receiver is disabled and the receive data “marks idle” with a weak pull-up.

8.4.1.5 Transmit Enable

The transceiver’s transmit drive enable (**DEN**) pin (when asserted/high) turns on the output drivers on the transceiver and presents UART transmit data onto the network. To avoid any network glitches on power-up, this is always held low (inactive) until the MCU explicitly asserts this signal active/high.

8.4.1.6 Mode & Speeds Summary Table

The following table summarizes the state of the transceiver as configured by the DIP switch and the RXEN/DEN GPIO signals from the MCU:

DIP Switches				MCU Control		TX/RX Status			Max Speed (Mbps)	Mode
232	SLW	SPD	HALF	PB_6 RS_DEN	P5_8 RS_ON	P5_10 RXD5	Y	Z		
OFF	OFF	OFF	OFF	0	X	B-A	-	-	20	422/485
				1			TXD5#	TXD5		
			ON	0	X	B-A	-	-		
				1		H*	TXD5#	TXD5		
	ON	OFF/ON	OFF	0	X	B-A	-	-	0.460/0.115	
				1			TXD5#	TXD5		
			ON	0	X	B-A	-	-		
				1		H[1]	TXD5#	TXD5		
ON	X	X	OFF	0	1	A#	-	-	0.460	232
				1			TXD5#	TXD5		
			ON	0		A#	-	-		
				1		H*	TXD5#	TXD5		
			OFF	0	0	A#	-	-	0.460	
				1			TXD5#	DNU[2]		
			ON	0		A#	-	-		
				1		H*	TXD5#	DNU[2]		

[1]P5_10-RXD5 has a weak pull-up, ensuring that when the receiver is disabled the receive data will mark high.

[2]Do not use

8.4.2 CAN

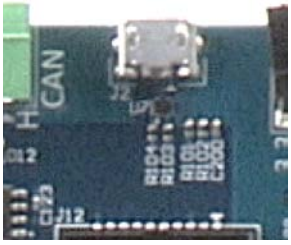
The CAN transceiver on the PE-HMI1 Baseboard is implemented with an Infineon IFX1050GVIO or similar device with the following specifications:

- CAN data transmission rate up to 1 Mbaud
- Suitable for 12V and 24V network applications
- Excellent EMC performance (very high immunity and very low emission)
- ISO/DIS 11898 compatible

The transceiver is connected to the MCU's CAN1 port as follows:

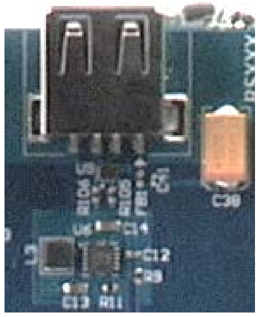
MCU			Schematic	Operation
Port	Mode	PSEL	Net Name	
P512	CTX1_B	10000	P5_12/CTX1	CAN1 Transmit Data
P511	CRX1_B	10000	P5_11/CRX1	CAN1 Receive Data

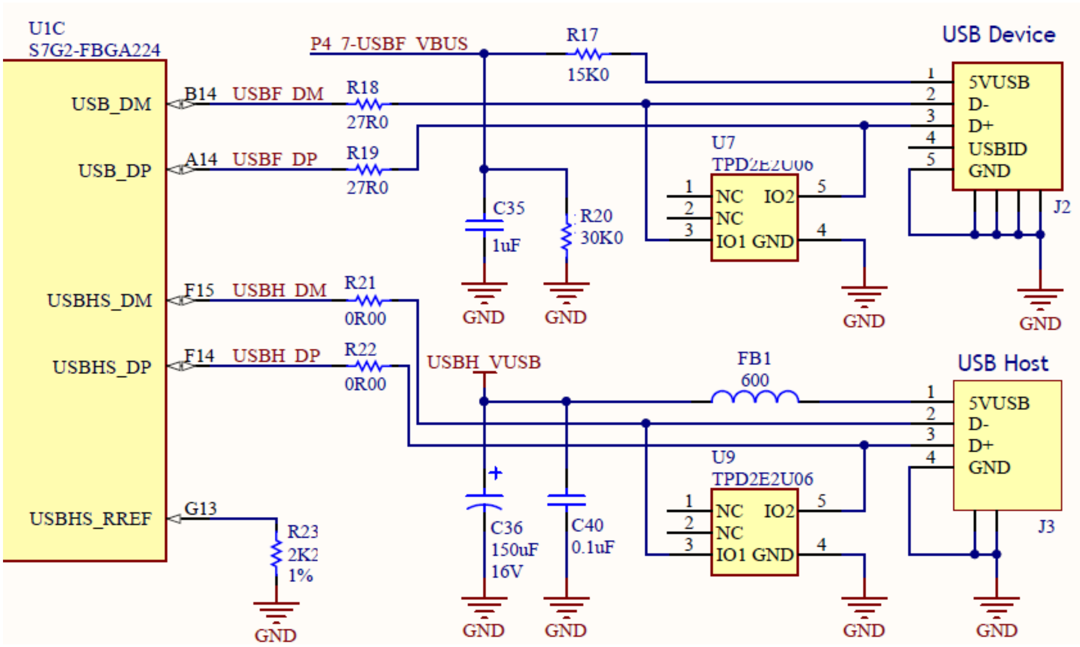
8.5 USB Host and Device



The Synergy S7G2 MCU features independent USB 2.0 Host and USB 2.0 Device (or "function") ports; the Host port capable of High Speed 480mbps data rates, the Device port limited to Full Speed 12mbps.

The USB Device port is exposed via a standard USB Micro-B connector on the PE-HMI1 and is connected to the Full Speed port of the MCU; the USB Host port is exposed via standard USB TypeA connector and is connected to the High Speed port of the MCU.





The ports are connected to the MCU as follows:

MCU			Schematic Net Name	Operation
Port	Mode	PSEL		
P407	USB0_VBUS	10011	P4_7-USBF_VBUS	USB Device ("Function") VBUS Detect
USB_DP	USB_DP	-	USBF_DP	USB Device ("Function") D+
USB_DM	USB_DM	-	USBF_DM	USB Device ("Function") D-
PB00	USBHS_VBUSEN	10100	PB_0-USBH_VBUSEN	USB Host Power Enable (active high)
P707	USBHS_OVRCURA	10100	P7_7-USBH_OC	USB Host Over Current fault (active low)
USBHS_DP	USBHS_DP	-	USBH_DP	USB Host D+
USBHS_DM	USBHS_DM	-	USBH_DM	USB Host D-

The USB host port is current limited to 500mA to prevent inappropriately large current devices from affecting the operation of the PE-HMI1 system. See USB Host Power Subsystem for more information.

Designer's Notebook

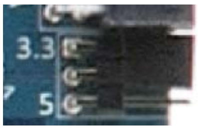
Another debate ensued… which port to put the HS and which one the FS? In the end, we opted to optimize the speed of attached devices to the Host port, including thumb drives and potentially fast wireless devices, etc.

8.6 PMODs

The PE-HMI1 has two Digilent Pmod™ compatible ports: PMOD A is a full 2x6 port and PMOD B is a more limited 1x6. These ports can be used to expand the PE-HMI1 for your own exploration and pre-design software development, as many Pmod™ -compatible plug-in modules are available on the market including serial I/O, various WiFi and Bluetooth units, and a vast array of intelligent sensors.

For information on the Pmod™ convention, see the Digilent website, or read the Pmod™ standard.

While most PMODs require 3 V to operate, some require 5 V. Each port can supply either 3.3 V or 5 V to the attached Pmod™ depending on the position of the co-located jumper shut beside each Pmod™ connector. In the picture to the right, the jumper is shown in the 3.3V position.



Always check the jumper position prior to inserting a Pmod™. Applying 5 V to a 3.3 V PMOD will damage the PMOD and potentially the PE-HMI1: the power to this port is not fused.

The MCU pins connected to the Pmod™ are not 5 V tolerant. Even though some Pmods require 5 V to be powered (using the 5 position of the jumper), **do not connect 5 V or higher signals** to the MCU-connected signals on this port directly. If, for example, a full-level RS232 port is desired use the Digilent Pmod RS232X which plugs into the connector and translates these voltages.

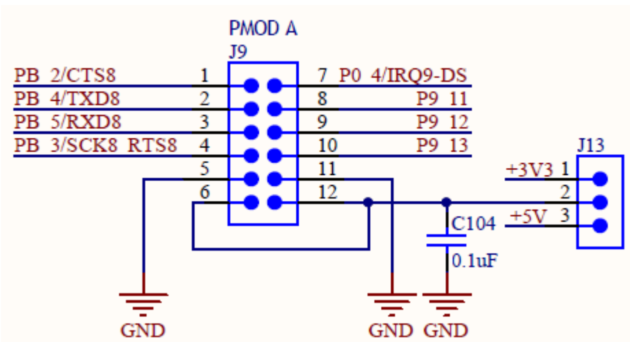
Designer's Notebook

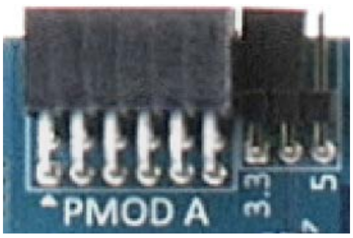
Few real-world products would include a PMOD port – their main use is for dev kits and starter kits to allow expansion to off-the-shelf and custom modules as well as jury-rigged board-to-board/debug connections. Even so, we anticipated you might want to connect to a machine via UART/I2C/SPI or try out a different WiFi module, so this was the best compromise solution to allow some expandability and experimentation with the PE-HMI1 prior to your own hardware being available.

8.6.1 PMOD A: 2x6 Digilent Pmod™ Port

The PE-HMI1 has one Digilent Pmod™ compatible 2x6 host port. It supports, depending on MCU configuration and software, one of these standard Pmod™ configurations:

- Type 1 - GPIO
- Type 2 (SPI) and Type 2A (Expanded SPI with interrupt input)
- Type 4 (UART) and Type 4A (UART with CTS/RTS flow control)





Pay special attention to the pin order of dual row Pmod™ connectors: it is not the zigzag numbering convention normally used for headers. Incorrectly wiring to the Pmod™ connectors may damage your PE-HMI1 or even other connected equipment.

The port is wired to the MCU as follows:

MCU			Schematic Net Name	Operation
Port	Mode	PSEL		
PB02	CTS8#	00100	PB_2/CTS8	PMOD A.1 UART CTS8 (or GPIO, or SPI SS8#)
PB04	TXD8	00100	PB_4/TXD8	PMOD A.2 UART TxD8 (or GPIO, SCL8, or SPI MOSI8)
PB05	RXD8	00100	PB_5/RXD8	PMOD A.3 UART RxD8 (or GPIO, SDA8, or SPI MISO8)
PB03	GPIO	-	PB_3/SCK8_RTS8	PMOD A.4 UART RTS (or GPIO, SPI SCK8)
P004	IRQ9-DS	ISEL	P0_4/IRQ9-DS	PMOD A.7 IRQ9 (or GPIO)
P911	GPIO	-	P9_11	PMOD A.8 External Reset Out
P912	GPIO	-	P9_12	PMOD A.9 GPIO
P913	GPIO	-	P9_13	PMOD A.10 GPIO

Note that the S7G2 MCU's multi-function serial peripheral SCI8 is dedicated to this port, and SCI8 can be configured in UART, SPI, or even I2C mode. This adds the possibility of additional non-standard/custom Pmods that can leverage the I2C connection on pins 2 and 3 by leaving the PSEL register at `00100b` but configuring the SCI8 to operate in I2C mode and adding external I2C bus pull-ups and devices.

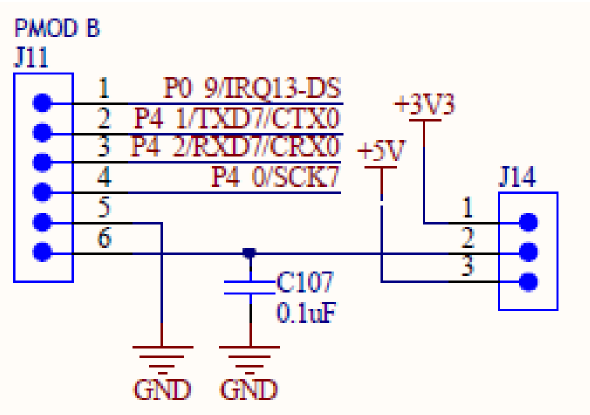
To operate the PMOD A port in SPI master/slave mode, program all four PSEL registers for the 4 SPI signals (SS#, MISO, MOSI, CLK) to `00100b` and set the SCI8 to SPI mode.

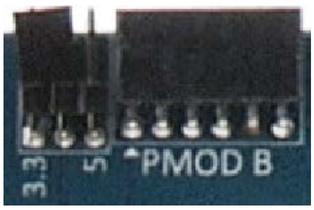
8.6.2 PMOD B: 1x6 Digilent PMOD Port

In addition to the full-featured PMOD A port, the PE-HMI1 has one more limited Digilent Pmod compatible 1x6 port. It supports, depending on MCU configuration and software, one of these standard Pmod configurations:

- Type 1 - GPIO
- Type 4 - UART without CTS/RTS flow control

Note that in addition to the Digilent-standard GPIO and UART modes, pin 2 and 3 also can be software-configured to be an additional CAN port or I2C port to a custom/non-standard PMOD or externally connected device.





The port is wired to the MCU as follows:

MCU			Schematic Net Name	Operation
Port	Mode	PSEL		
P009	GPIO	-	P0_9/IRQ13_DS	PMOD B.1 GPIO (or interrupt 13 input)
P401	TXD7	00101	P4_1/TXD7/CTX0	PMOD B.2 UART TxD7 (or GPIO, SCL7, or CAN0 TX)
P402	RXD7	00101	P4_2/RXD7/CRX0	PMOD B.3 UART RxD7 (or GPIO, SDA7, or CAN0 RX)
P400	GPIO	-	P4_0/SCK7	PMOD B.4 GPIO

To use the CAN port, configure the PSEL bits for both pins to **10000b** and add an external transceiver to the port.

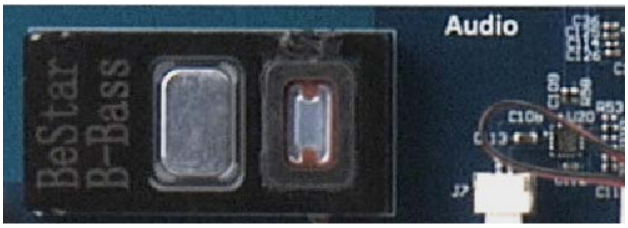
To use the I2C port, configure the PSEL bits for both pins to **00101b** and add external pull-ups and I2C devices to the port. This is the same PSEL configuration as the UART mode; the I2C and UART both are part of the SCI7 multi-function serial peripheral and depending on the configuration of the peripheral you get I2C or UART functionality on these pins.

9. Other I/O

Aside from the LCD with Touch Panel and communications subsystems, the PE-HMI1 includes many other user and IO and system support subsystems, including:

- Mono audio with 1W speaker output and microphone input
- Ambient light sensor
- General purpose pushbutton
- General purpose LED

9.1 Audio Output 1W Amplifier with Speaker

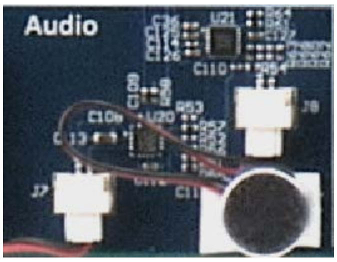


Because the PE-HMI1 is designed for HMI type applications requiring modest audio capabilities, usually prompt sounds and occasionally voice feedback, the PE-HMI1 uses a simple monophonic DAC-driven amplifier/speaker combination. Higher end audio applications where stereo sound and high fidelity are required could leverage the more sophisticated serial sound channels supported on the Synergy S7G2 family with an external codec and high performance amplifier subsystem.

A BeStar B-Bass 1-W speaker is driven by a WM9001 1W Dual-Mode Class AB/D Speaker Driver operated in Class D mode. The input to the WM9001 is AC-coupled from the 12-bit DAC channel 0 of the Synergy S7G2 MCU. A GPIO is used to enable the amplifier, saving power if/when audio output is not required:

MCU			Schematic Net Name	Operation
Port	Mode	SEL		
PA04	GPO	-	PA_4-AUDIO_EN	Speaker audio amplifier enable (active high)
P014	DA0	ASEL0	P0_14/DA0	Speaker audio DAC output

9.2 Microphone Input

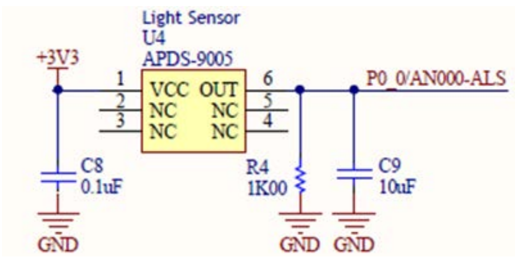


For simple audio input, for example capturing user commands that could be sent to the cloud for speech-to-text interpretation, a microphone input is included on the PE-HMI1.

The inexpensive BeStar electret microphone requires special voltage biasing as well as a dynamic and automatic input gain control in order to effectively capture sounds. The MAX9814 Microphone Amplifier with AGC and Low-Noise Microphone Bias handles all these tasks inexpensively and delivers an analog voltage representation of the incoming sound waveform to an ADC input of the Synergy S7G2 MCU:

MCU			Schematic Net Name	Operation
Port	Mode	SEL		
P005	AN101	ASEL	P0_5/AN101	Microphone analog waveform input

9.3 Ambient Light Sensor



In low-light conditions, the LCD can be so bright it can visually "bloom" and difficult to read. As in mobile phones and tablets, the PE-HMI1 includes a forward-facing through-glass ambient light sensor, enabling software to monitor the ambient light conditions and dynamically adjust the LCD backlight intensity.

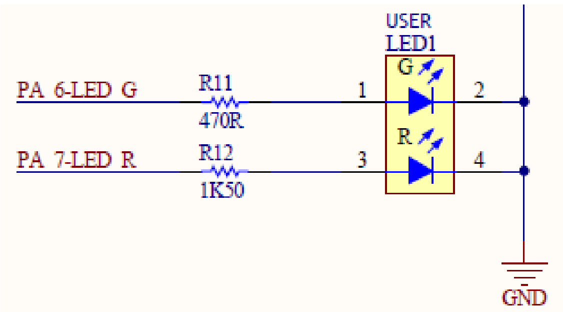
The Avago APDS-9005-020 Ambient Light Sensor (ALS) is a simple device that outputs a current proportional to the ambient light conditions. Through a resistor, this appears as a voltage between 0 and

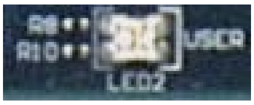
3.3 V on an Analog to Digital Converter (ADC) input on the MCU. Software can poll this ADC periodically. The ALS is connected as follows:

MCU			Schematic Net Name	Operation
Port	Mode	SEL		
P000	AN000	ASEL	P0_0/AN000-ALS	Ambient Light Sensor Analog Input

9.4 User LEDs

The PE-HMI1 has a two-in-one-package LED (red, green, orange=red+green) for any software-directed purpose:

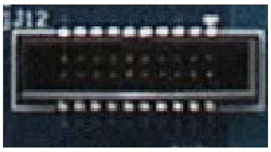




User LED1 is connected as follows:

MCU			Schematic Net Name	Operation
Port	Mode	SEL		
PA06	GPO	-	PA_6-LED_G	User LED Green (active high)
PA07	GPO	-	PA_7-LED_R	User LED Red (active high)

10. JTAG/SWD Programming and Debug



The HMI1 Product Example, unlike a development or starter kit, has no SWD/JTAG debugger on board. Programming/Debugging is done similar to a real product, using the on-board 20-pin Cortex M debug connector J12 with an external Programmer/Debugger – see Connecting a Programmer/Debugger. The connector exposes all the normal required MCU signals:

MCU			Schematic	Operation
Port	Mode	SEL	Net Name	
P108	TMS/SWDIO	-	P1_8/TMS/SWDIO	JTAG test mode select
P300	TCK/SWCLK	-	P3_0/TCK/SWCLK	JTAG test clock
P109	TDO	-	P1_9/TDO/TXD9/TRACESWO	JTAG test data out
P110	TDI	-	P1_10/TDI/RXD9	JTAG test data In
RES#	RES#	-	RESET#	Reset (active low, open drain)
PA12	TCLK	-	PA_12/TCLK	JTAG trace Clock
PA13	TDATA0	-	PA_13/TDATA0	JTAG trace data 0 (lsb)
PA14	TDATA1	-	PA_14/TDATA1	JTAG trace data 1
PA15	TDATA2	-	PA_15/TDATA2	JTAG trace data 2
P813	TDATA3	-	P8_13/TDATA3	JTAG trace data 3 (msb)

11. External Interrupt Summary

MCU			Schematic Net Name	Operation
Port	Mode	PSEL		
P001	IRQ7-DS	ISEL	P0_1/IRQ7-DS-WIFI_IRQ#	WiFi Interrupt
P002	IRQ8-DS	ISEL	P0_2/IRQ8-DS-ETH_IRQ#	PHY Interrupt (active low)
P004	IRQ9-DS	ISEL	P0_4/IRQ9-DS	PMOD A.7 IRQ9 (or GPIO)
P009	GPIO	-	P0_9/IRQ13_DS	PMOD B.1 GPIO (or interrupt 13 input)
P008	IRQ12-DS	ISEL	P0_8/IRQ12-DS-TOUCH_IRQ#	Touch Controller Activity Interrupt (open drain active low)

12. I2C Device Summary

The three I2C interfaces available on the PE-HMI1 are as follows:

MCU			Schematic Net Name	Operation
Port	Mode	PSEL		
P205	SCL1_A	00111	P2_5/SCL1	Touch Controller I2C1 Bus Clock (dedicated)
P206	SDA1_A	00111	P2_6/SDA1	Touch Controller I2C1 Bus Data (dedicated)
PB04	SCL8	00100	PB_4/TXD8	PMOD A.2 I2C8 Bus Clock (non-standard PMOD)
PB05	SDA8	00100	PB_5/RXD8	PMOD A.3 I2C8 Bus Data (non-standard PMOD)
P401	TXD7	00101	P4_1/TXD7/CTX0	PMOD B.2 I2C8 Bus Clock (non-standard PMOD)
P402	RXD7	00101	P4_2/RXD7/CRX0	PMOD B.3 I2C8 Bus Data (non-standard PMOD)

The devices on these channels are as follows:

Address			I2C Bus	Max kHz	Location	Device
7-bit	Read	Write				
0x38	0xF1	0xF0	1	400	LCD	FocalTech FT5302 Touch Controller

13. SPI Device Summary

The SPI interfaces on the PE-HMI1 are as follows:

MCU			Schematic Net Name	Operation
Port	Mode	PSEL		
P410	MISOA_B	00110	P4_10/MISOA	WiFi RSPIA MISO
P411	MOSIA_B	00110	P 4_11/MOSIA	WiFi RSPIA MOSI
P412	RSPCKA_B	00110	P4_12/RSPCKA	WiFi RSPIA Clock
P413	GPIO	-	P4_13/SSLA0	WiFi RSPIA Slave Select (active low GPIO)
P001	IRQ7-DS	ISEL	P0_1/IRQ7-DS-WIFI_IRQ#	WiFi Interrupt
PB02	SS8#	00100	PB_2/CTS8	PMOD A.1 SPI SS8#
PB04	MOSI8	00100	PB_4/TXD8	PMOD A.2 SPI MOSI8
PB05	MISO8	00100	PB_5/RXD8	PMOD A.3 SPI MISO8
PB03	SCK8	00100	PB_3/SCK8_RTS8	PMOD A.4 SPI SCK8
P004	IRQ9-DS	ISEL	P0_4/IRQ9-DS	PMOD A.7 SPI IRQ9

The devices on these interfaces are:

SPI Bus	Slave Select	Max MHz	Location	Device
RSPI A	P4_12/RSPCKA	48	Module	WiF Module
SCI8	PB_2/CTS8		PMOD A	PMOD A Mode 4A

14.MCU Port Summary

14.1 Port 0

Port	MCU Mode	PSEL	Schematic Net Name	Operation
P000	AN000	ASELI	P0_0/AN000-ALS	Ambient Light Sensor Analog Input
P001	IRQ7-DS	ISEL	P0_1/IRQ7-DS-WIFI_IRQ#	WiFi Interrupt
P002	IRQ8-DS	ISEL	P0_2/IRQ8-DS-ETH_IRQ#	PHY Interrupt (active low)
P003				unused
P004	IRQ9-DS	ISEL	P0_4/IRQ9-DS	PMOD A.7 IRQ9 (or GPIO)
P005	AN101	ASELI	P0_5/AN101	Microphone analog waveform input
P006				unused
P007				unused
P008	IRQ12-DS	ISEL	P0_8/IRQ12-DS-TOUCH_IRQ#	Touch Controller Activity Interrupt (open drain active low)
P009	GPIO		P0_9/IRQ13_DS	PMOD B.1 GPIO (or interrupt 13 input)
P010				unused
P011				unused
P014	DA0	ASELO	P0_14/DA0	Speaker audio DAC output
P015				unused

14.2 Port 1

Port	MCU Mode	PSEL	Schematic Net Name	Operation
P100	DQ0	11011	P1_0/DQ0	MCU D0 (lsb)
P101	DQ1	11011	P1_1/DQ1	MCU D1
P102	DQ2	11011	P1_2/DQ2	MCU D2
P103	DQ3	11011	P1_3/DQ3	MCU D3
P104	DQ4	11011	P1_4/DQ4	MCU D4
P105	DQ5	11011	P1_5/DQ5	MCU D5
P106	DQ6	11011	P1_6/DQ6	MCU D6
P107	DQ7	11011	P1_7/DQ7	MCU D7
P108	TMS/SWDIO	-	P1_8/TMS/SWDIO	JTAG test mode select
P109	TDO	-	P1_9/TDO/TXD9/TRACESWO	JTAG test data out
P110	TDI	-	P1_10/TDI/RXD9	JTAG test data In
P111	A5	01011	P1_11/A5	MCU A5
P112	A4	01011	P1_12/A4	MCU A4
P113	A3	01011	P1_13/A3	MCU A3
P114	A2	01011	P1_14/A2	MCU A2
P115	A1	01011	P1_15/A1	MCU A1

14.3 Port 2

Port	MCU Mode	PSEL	Schematic Net Name	Operation
P202				unused
P203				unused
P204				unused
P205	SCL1_A	00111	P2_5/SCL1	Touch Controller I2C Bus Clock
P206	SDA1_A	00111	P2_6/SDA1	Touch Controller I2C Bus Data
P207				unused

14.4 Port 3

Port	MCU Mode	PSEL	Schematic Net Name	Operation
P300	TCK/SWCLK	-	P3_0/TCK/SWCLK	JTAG test clock
P301	A6	11011	P3_1/A6	MCU A6
P302	A7	11011	P3_2/A7	MCU A7
P303	A8	11011	P3_3/A8	MCU A8
P304	A9	11011	P3_4/A9	MCU A9
P305	A10	11011	P3_5/A10	MCU A10
P306	A11	11011	P3_6/A11	MCU A11
P307	A12	11011	P3_7/A12	MCU A12
P308	A13	01011	P3_8/A13	MCU A13
P309	A14	01011	P3_9/A14	MCU A14
P310	A15	01011	P3_10/A15	MCU A15
P311	RAS	11011	P3_11/RAS#	SDRAM Row Address Strobe (active low)
P312	CAS	11011	P3_12/CAS#	SDRAM Column Address Strobe (active low)
P313	LCD_TCON2_B	11001	P3_13-LCD_DE	LCD Data Enable (active high)
P314	LCD_TCON1_B	11001	P3_14-LCD_VSYNC	LCD Vertical Sync
P315	LCD_TCON0_B	11001	P3_15-LCD_HSYNC	LCD Horizontal Sync

14.5 Port 4

Port	MCU Mode	PSEL	Schematic Net Name	Operation
P400	GPIO	-	P4_0/SCK7	PMOD B.4 GPIO
P401	TXD7	00101	P4_1/TXD7/CTX0	PMOD B.2 UART TxD7 (or GPIO, SCL7, or CAN0 TX)
P402	RXD7	00101	P4_2/RXD7/CRX0	PMOD B.3 UART RxD7 (or GPIO, SDA7, or CAN0 RX)
P403	ET1_MDC	10111	P4_3/ET1_MDC	Management data clock
P404	ET1_MDIO	10111	P4_4/ET1_MDIO	Management data I/O
P405	RMII1_TXD_EN	10111	P4_5/RMII1_TXD_EN	Transmit enable
P406	RMII1_TXD1	10111	P4_6/RMII1_TXD1	Transmit data 1
P407	USB0_VBUS	10011	P4_7-USBF_VBUS	USB Device (“Function”) VBUS Detect
P408				unused
P409				unused
P410	MISOA_B	00110	P4_10/MISOA	WiFi RSPIA MISO
P411	MOSIA_B	00110	P 4_11/MOSIA	WiFi RSPIA MOSI
P412	RSPCKA_B	00110	P4_12/RSPCKA	WiFi RSPIA Clock
P413	GPIO	-	P4_13/SSLA0	WiFi RSPIA Slave Select (active low GPIO)
P414				unused
P415				unused

14.6 Port 5

Port	MCU Mode	PSEL	Schematic Net Name	Operation
P500	MMC_CLK	10101	P5_0-MMC_CLK	e•MMC Clock (MCUàMMC)
P501	MMC_CMD	10101	P5_1-MMC_CMD	e•MMC command output, response input signal
P502	MMC_D0	10101	P5_2-MMC_D0	e•MMC D0 (lsb)
P503	MMC_D1	10101	P5_3-MMC_D1	e•MMC D1
P504	MMC_D2	10101	P5_4-MMC_D2	e•MMC D2
P505	MMC_D3	10101	P5_5-MMC_D3	e•MMC D3 (msb)
P506	SD1CD	10101	P5_6/SD1CD	e•MMC Card Detect input
P507	SD1WP	10101	P5_7/SD1WP	e•MMC Write Protection input
P508	GPIO	-	P5_8-RS_ON	RSxxx Transceiver Enable (active high)
P509	TXD5	00101	P5_9/TXD5	RSxxx Transmit Data
P510	RXD5	00101	P5_10/RXD5	RSxxx Receive Data
P511	CRX1_B	10000	P5_11/CRX1	CAN1 Receive Data
P512	CTX1_B	10000	P5_12/CTX1	CAN1 Transmit Data
P513	LCD_DATA16_B	TBD	P5_13-LCD_D16	LCD R0 (LSB)
P514				unused
P515				unused

14.7 Port 6

Port	MCU Mode	PSEL	Schematic Net Name	Operation
P600				unused
P601	DQM0	TBD	P6_1/DQM0	SDRAM I/O data mask enable for D7 to D0
P602	SDCLK	11011	P6_2/SDCLK	SDRAM Clock
P603	DQ13	01011	P6_3/DQ13	MCU D13
P604	DQ12	01011	P6_4/DQ12	MCU D12
P605	DQ11	01011	P6_5/DQ11	MCU D11
P606	LCD_DATA3_B	11001	P6_6-LCD_D3	LCD B3
P607	LCD_DATA4_B	11001	P6_7-LCD_D4	LCD B4
P608	DQM1	TBD	P6_8/DQM1	SDRAM I/O data mask enable for D15 to D8
P609	CKE	TBD	P6_9/CKE	SDRAM Clock Enable
P610	WE	TBD	P6_10/WE#	SDRAM write enable (active low)
P611	SDCS	01011	P6_11/SDCS#	SDRAM Chip Select (active low)
P612	DQ8	01011	P6_12/DQ8	MCU D8
P613	DQ9	01011	P6_13/DQ9	MCU D9
P614	DQ10	01011	P6_14/DQ10	MCU D10
P615	LCD_DATA10_B	11001	P6_15-LCD_D10	LCD G2

14.8 Port 7

Port	MCU Mode	PSEL	Schematic Net Name	Operation
P700	RMII1_TXD0	10111	P7_0/RMII1_TXD0	Transmit data 0 (LSB)
P701	REF50CK1	10111	P7_1/REF50CK1	Transmit clock
P702	RMII1_RXD0	10111	P7_2/RMII1_RXD0	Receive data 0 (LSB)
P703	RMII1_RXD1	10111	P7_3/RMII1_RXD1	Receive data 1
P704	RMII1_RX_ER	10111	P7_4/RMII1_RX_ER	Receive error
P705	RMII1_CRS_DV	10111	P7_5/RMII1_CRS_DV	Carrier detection
P706	GPO	-	P7_6-ETH_RESET#	Holds PHY in reset (active low)
P707	USBHS_OVRCURA	10100	P7_7-USBH_OC	USB Host Over Current fault (active low)
P708	RXD1	00101	P7_8/RXD1	Bluetooth UART RxD
P709	TXD1	00101	P7_9/TXD1	Bluetooth UART TxD
P710				unused
P711	CTS1#	00101	P7_11/CTS1	Bluetooth UART CTS#
P712	GPIO	-	P7_12-RTS1	Bluetooth UART RTS#
P713				unused

14.9 Port 8

Port	MCU Mode	PSEL	Schematic Net Name	Operation
P800	DQ14	01011	P8_0/DQ14	MCU D14
P801	DQ15	01011	P8_1/DQ15	MCU D15 (msb)
P802	LCD_DATA2_B	11001	P8_2-LCD_D2	LCD B2
P803	LCD_DATA1_B	11001	P8_3-LCD_D1	LCD B1
P804	LCD_DATA0_B	11001	P8_4-LCD_D0	LCD B0 (LSB)
P805	LCD_DATA17_B	11001	P8_5-LCD_D17	LCD R1
P806				unused
P807				unused
P808				unused
P809				unused
P810				unused
P811				unused
P812				unused
P813	TDATA3	-	P8_13/TDATA3	JTAG trace data 3 (msb)

14.10 Port 9

Port	MCU Mode	PSEL	Schematic Net Name	Operation
P900	LCD_CLK_B	11001	P9_0-LCD_CLK	LCD Pixel dot clock
P901	LCD_DATA15_B	11001	P9_1-LCD_D15	LCD G7 (MSB)
P902	LCD_DATA23_B	11001	P9_2-LCD_D23	LCD R6 (MSB)
P903	GPIO	-	P9_3-MMC_RST#	e•MMC reset GPIO (active low)
P904	GPIO	-	P9_4-WIFI_PWD#	WiFi Shutdown (active low)
P905	LCD_DATA11_B	11001	P9_5-LCD_D11	LCD G3
P906	LCD_DATA12_B	11001	P9_6-LCD_D12	LCD G4
P907	LCD_DATA13_B	11001	P9_7-LCD_D13	LCD G5
P908	LCD_DATA14_B	11001	P9_8-LCD_D14	LCD G6
P909	LCD_DATA21_B	11001	P9_9-LCD_D21	LCD R5
P910	LCD_DATA22_B	11001	P9_10-LCD_D22	LCD R5
P911	GPIO	-	P9_11	PMOD A.8 External Reset Out
P912	GPIO	-	P9_12	PMOD A.9 GPIO
P913	GPIO	-	P9_13	PMOD A.10 GPIO
P914	LCD_DATA19_B	11001	P9_14-LCD_D19	LCD R3
P915	LCD_DATA20_B	11001	P9_15-LCD_D20	LCD R4

14.11 Port A

Port	MCU Mode	PSEL	Schematic Net Name	Operation
PA00	LCD_DATA5_B	11001	PA_0-LCD_D5	LCD B5
PA01	LCD_DATA6_B	11001	PA_1-LCD_D6	LCD B6
PA02	GPIO	-	PA_2-TOUCH_RST#	Touch Controller Reset (active low)
PA03	GPIO	-	PA_3-LCD_ON	LCD Logic Enable (active high, weakly inactive on RESET#)
PA04	GPO	-	PA_4-AUDIO_EN	Speaker audio amplifier enable (active high)
PA05	GTIOC11A_B:I/O	00011	PA_5-BLEN	LCD Backlight Enable (active high, weakly off @RESET#)
PA06	GPO	-	PA_6-LED_G	User LED Green (active high)
PA07	GPO	-	PA_7-LED_R	User LED Red (active high)
PA08	LCD_DATA9_B	11001	PA_8-LCD_D9	LCD G1
PA09	LCD_DATA8_B	11001	PA_9-LCD_D8	LCD G0 (LSB)
PA10	LCD_DATA7_B	11001	PA_10-LCD_D7	LCD B7 (MSB)
PA11	LCD_DATA18_B	11001	PA_11-LCD_D18	LCD R2
PA12	TCLK	-	PA_12/TCLK	JTAG trace Clock
PA13	TDATA0	-	PA_13/TDATA0	JTAG trace data 0 (lsb)
PA14	TDATA1	-	PA_14/TDATA1	JTAG trace data 1
PA15	TDATA2	-	PA_15/TDATA2	JTAG trace data 2

14.12 Port B

Port	MCU Mode	PSEL	Schematic Net Name	Operation
PB00	USBHS_VBUSEN	10100	PB_0-USBH_VBUSEN	USB Host Power Enable (active high, reset condition low)
PB00	USBHS_VBUSEN	10100	PB_0-USBH_VBUSEN	USB Host Power Enable (active high)
PB01	GPIO	-	PB_1-BT_SHUDN#	Bluetooth Shutdown (active low)
PB02	CTS8#	00100	PB_2/CTS8	PMOD A.1 UART CTS8 (or GPIO, or SPI SS8#)
PB03	GPIO	-	PB_3/SCK8_RTS8	PMOD A.4 UART RTS (or GPIO, SPI SCK8)
PB04	TXD8	00100	PB_4/TXD8	PMOD A.2 UART TxD8 (or GPIO, SCL8, or SPI MOSI8)
PB05	RXD8	00100	PB_5/RXD8	PMOD A.3 UART RxD8 (or GPIO, SDA8, or SPI MISO8)
PB06	GPIO	-	PB_6-RS_DEN	RSxxx Transmit Drive Enable (active high)
PB07				unused

15. Bills of Materials

Schematic Designator	Mfg	Part Number	Description	QTY	Package
BAT1	Keystone	3000TR	Keystone CR1220 Battery Coin Cell holder	1	
C1, C2, C4, C7, C8, C11, C17, C18, C20, C21, C25, C26, C27, C28, C29, C30, C31, C32, C33, C37, C40, C45, C48, C49, C51, C53, C54, C75, C76, C77, C78, C79, C81, C83, C85, C86, C87, C88, C90, C91, C98, C100, C101, C102, C103, C104, C105, C106, C107, C108, C109, C110, C112, C113, C114, C115, C116, C122, C123, C124, C125, C126	Samsung	CL03A104KP3NNNC	Ceramic Chip Capacitor 0.1µF 10V	62	0201
C3	Samsung	CL21A226MAQNNN	Ceramic Chip Capacitor 22µF 25V	1	0805
C5, C6, C15, C50	Samsung	CL10A226MQ8NRNC	Ceramic Chip Capacitor 22µF 6.3V	4	0603
C9	Samsung	CL10A106MQ8NNNC	Ceramic Chip Capacitor 10µF 6.3V	1	0603
C10, C13, C94	Samsung	CL10A106KP8NNND	Ceramic Chip Capacitor 10µF 10V	3	0603
C12	Samsung	CL31B105KBHNNNE	Ceramic Chip Capacitor 1µF 50V	1	1206
C14	Samsung	CL05A104KO5NNNC	Ceramic Chip Capacitor 0.1µF 16V	1	0402
C16, C34	Samsung	CL05A106MQ5NUNC	Ceramic Chip Capacitor 10µF 6.3V	2	0402
C19, C35, C73, C74, C80, C82, C84, C89, C97, C111	Samsung	CL05A105KO5NNNC	Ceramic Chip Capacitor 1µF 16V	10	0402
C22, C23, C24, C68	TDK	C1005X7R1H104K050BB	Ceramic Chip Capacitor 0.1µF 50V	4	0402
C36	AVX	TPSD157M016R0150	Tantalum Capacitor 7343-31 150µF 16V	1	D
C38, C39	Samsung	CL05C120JB5NNNC	Ceramic Chip Capacitor 12pF 50V	2	0402
C41, C42, C43, C44	TDK	C1005X7S2A103K050BB	Ceramic Chip Capacitor 0.01µF 100V	4	0402
C46, C92, C93	Samsung	CL05A475MQ5NQNC	Ceramic Chip Capacitor 4.7µF 6.3V	3	0402
C47, C96, C127, C128	Samsung	CL05A225MP5NNNC	Ceramic Chip Capacitor 2.2µF 10V	4	0402
C52	Taiyo Uniden	LMK316BJ476ML-T	Ceramic Chip Capacitor 47µF 10V	1	1206
C55	Johanson	202R18W102KV4E	Ceramic Chip Capacitor 1000pF 2KV	1	1206
C56	TDK	C3225X7S3D222K250AA	Ceramic Chip Capacitor 2200pF 2KV	1	1210
C57	Samsung	CL05B681KB5NNNC	Ceramic Chip Capacitor 680pF 50V	1	0402
C58, C60	Samsung	CL31B105KCHSNNE	Ceramic Chip Capacitor 1µF 100V	2	1206
C59	Panasonic	EEE-FK2A220P	Aluminum Capacitor 22µF 100V	1	8x10.2
C61	Panasonic	EEE-FPJ470UAR	Aluminum Capacitor 47µF 6.3V	1	4x5.8
C62, C63	Samsung	CL31A476MPHNNNE	Ceramic Chip Capacitor 47µF 10V	2	1206
C64	Panasonic	EEE-FP1E100AR	Aluminum Capacitor 10µF 25V	1	4x5.8

Schematic Designator	Mfg	Part Number	Description	QTY	Package
C65	TDK	C1608X7R1H224M080AB	Ceramic Chip Capacitor 220nF 50V	1	0603
C66	Samsung	CL21B104KCFSFNE	Ceramic Chip Capacitor 0.1µF 100V	1	0805
C67	Samsung	CL21C102JCFNNNE	Ceramic Chip Capacitor 1nF 100V	1	0805
C69	AVX	06032C331KAT2A	Ceramic Chip Capacitor 330pF 200V	1	0603
C70, C95	TDK	C1005X7R1H223K050BB	Ceramic Chip Capacitor 22nF 50V	2	0402
C71	Samsung	CL10C101JB8NNNC	Ceramic Chip Capacitor 100pF 50V	1	0603
C72	Murata	GRM155R71H822KA88D	Ceramic Chip Capacitor 8.2nF 50V	1	0402
C99	Samsung	CL05A474KP5NNNC	Ceramic Chip Capacitor 0.47µF 10V	1	0402
C117, C118, C119, C120, C121	Samsung	CL03A103KP3NNNC	Ceramic Chip Capacitor 10nF 25V	5	0201
D1, D2, D3	Diodes Zetex	DFLS130L-7	Schottky Diode 30V 1A	3	PowerDI 123
D4	OnSemi	BAS40LT1G	OnSemi Schottky Power Rectifier 40V 120mA	1	
D5	Micro Comm	SK54AFL-TP	Diodes Schottky 5A 40V	1	
D6, D9	Diodes	HD01-T	Diodes Bridge Rectifier 100V 0.8A	2	MiniDIP
D7	Micro Comm	BAS316-TP	Diodes Schottky Switching 500mA 100V	1	
D8	Diodes	SMAJ58A-13-F	Diodes TVS 58V 1W	1	
D10	OnSemi	MMBD7000LT1G	Dual switching diode 100V 200mA	1	
D11	Diodes	TLV431AFTA	Low Voltage Adjustable Shunt Regulator	1	
D12	OnSemi	NUP2105LT1G	Dual Line CAN Bus Protector 350W	1	
FB1	Samsung	CIM05U601NC	Chip Ferrite Bead 600 300mA 25%	1	0402
FB2	Murata	BLM21AG121SN1D	Chip Ferrite Bead 120 800mA 25%	1	0805
FB3, FB4	TDK	MMZ2012R150A	Chip Ferrite Bead 15R0 1.5A	2	0805
J1	Molex	503471-0200	Molex Flexi-Mate Receptacle 2pos	1	
J2	FCI	10118192-0001LF	USB Micro 2.0 Female 5 Pin Right Angle	1	
J3	Samtec	USB-A-S-F-B-SM2-R-TR	USB Type A 2.0 Jack	1	
J4	Amphenol	RJSSE-5381	Amphenol RJ345 8pos w/light pipes	1	SMT
J5	Omron	XF2W-4015-1A	Omron FPC/FFC Connector 40pos Pitch 0.5mm	1	
J6	Omron	XF2W-0815-1A	Omron FPC/FFC Connector 8pos Pitch 0.5mm	1	
J7, J8	JST	SM02B-GHS-TB	JST PH Connector 2 Position Right Angle 2mm Pitch	2	
J9	Samtec	SSW-106-02-F-D-RA	Samtec Female Header 0.1" pitch PMOD 2x6 Right Angle	1	
J10	FCI	20020110-C081A01LF	FCI Terminal Block 3.5mm pitch 8pos Right Angle	1	
J11	Samtec	SSW-106-02-FM-S-RA	Samtec Female Header 0.1" pitch 6pos 1x6 Right Angle	1	
J12	Samtec	FTSH-110-01-L-DV-007-K	20 Position Shrouded Header 1.27mm Pitch Pin #7 Removed	1	
J13, J14	Harwin	M20-9960345	Header 0.1" pitch 3pos 1x3 Right Angle	2	

Schematic Designator	Mfg	Part Number	Description	QTY	Package
L1, L3	Bourns	SRN3015-2R2M	Bourns Semishielded Power Inductor 2.2uH 1.8A	2	
L2	Bourns	SRR5028-220Y	Bourns Semishielded Power Inductor 22uH 2.2A	1	
L4	Bourns	SM51108PEL	Bourns Ethernet Transformer PoE 10/100	1	
L5	Murata	LQH44PN4R7MP0L	Murata Semishielded Power Inductor 4.7uH 1.7A	1	
LED1, LED2	Dialight	598-8610-207F	Dialight Bicolor LED Red/Green	2	1210
LED3	Avago	ASMT-RJ45-AQ502	Avago LED Orange	1	0603
LED4	Avago	ASMT-RF45-AN002	Avago LED Green	1	0603
Q1	Farichild	FDC2512	N-FET 150V 1.4A	1	
R1, R3, R6, R14, R29, R50, R51, R54, R57, R65, R71	Panasonic	ERA-2AED104X	Chip Resistor Thick Film 100K0 0.5% 1/16W	11	0402
R2	Panasonic	ERJ-2RKF4533X	Chip Resistor Thick Film 453K 1% 1/10W	1	0402
R4, R42, R47	Panasonic	ERA-2AED102X	Chip Resistor Thick Film 1K00 0.5% 1/16W	3	0402
R5	NIC	NRC04F1101TRF	Chip Resistor Thick Film 1.1K 1% 1/16W	1	0402
R7	Vishay	CRCW04021R87FKED	Chip Resistor Thick Film 1R87 1% 1/16W	1	0402
R8, R11	Panasonic	ERA-2AED471X	Chip Resistor Thick Film 470R 0.5% 1/16W	2	0402
R9, R43, R52, R56	Panasonic	ERA-2AED103X	Chip Resistor Thick Film 10K0 0.5% 1/16W	4	0402
R10	Vishay	CRCW04023K90FKED	Chip Resistor Thick Film 3K90 1% 1/16W	1	0402
R12	Panasonic	ERA-2AED152X	Chip Resistor Thick Film 1K50 0.5% 1/16W	1	0402
R13	Panasonic	ERJ-2RKF1502X	Chip Resistor Thick Film 51K0 1% 1/10W	1	0402
R15	Panasonic	ERA-2AED101X	Chip Resistor Thick Film 100R 0.5% 1/16W	1	0402
R16, R75	Panasonic	ERA-2AED472X	Chip Resistor Thick Film 4K70 0.5% 1/16W	2	0402
R17	Panasonic	ERJ-2RKF1502X	Chip Resistor Thick Film 15K0 1% 1/10W	1	0402
R18, R19	Panasonic	ERJ-2RKF27R0X	Chip Resistor Thick Film 27R0 1% 1/10W	2	0402
R20	Panasonic	ERJ-2RKF3002X	Chip Resistor Thick Film 30K0 1% 1/10W	1	0402
R21, R22, R37, R39, R60, R61, R68, R69, R70	Vishay	CRCW04020000Z0ED	Chip Resistor Thick Film 0R00 1% 1/16W	9	0402
R23, R58	Panasonic	ERA-2AED222X	Chip Resistor Thick Film 2K20 1% 1/10W	2	0402
R24, R25, R26, R27	Panasonic	ERJ-2RKF75R0X	Chip Resistor Thick Film 75 1% 1/10W	4	0402
R28	Panasonic	ERJ-2RKF6491X	Chip Resistor Thick Film 6K49 1% 1/10W	1	0402

Schematic Designator	Mfg	Part Number	Description	QTY	Package
R30	Panasonic	ERJ-2RKF20R0X	Chip Resistor Thick Film 20R0 1% 1/10W	1	0402
R31, R32	Panasonic	ERJ-2RKF49R9X	Chip Resistor Thick Film 49R9 1% 1/16W	2	0402
R33	Panasonic	ERJ-3EKF1271V	Chip Resistor Thick Film 1K27 1% 1/10W	1	0603
R34	Panasonic	ERJ-3EKF5902V	Chip Resistor Thick Film 59K0 1% 1/10W	1	0603
R35	Panasonic	ERJ-3EKF8062V	Chip Resistor Thick Film 80K6 1% 1/10W	1	0603
R36	Panasonic	ERJ-P06J820V	Chip Resistor Thick Film 82R0 5% 1/2W	1	0805
R38	Panasonic	ERJ-8RQFR56V	Chip Resistor Thick Film 0R56 1% 1/4W	1	1206
R40	Panasonic	ERJ-2RKF4990X	Chip Resistor Thick Film 499R 1% 1/10W	1	0402
R41	Panasonic	ERA-2AED202X	Chip Resistor Thick Film 2K0 0.5% 1/16W	1	0402
R44	Panasonic	ERJ-2RKF4122X	Chip Resistor Thick Film 41K2 1% 1/10W	1	0402
R45	Panasonic	ERJ-8ENF1372V	Chip Resistor Thick Film 13K7 1% 1/4W	1	1206
R46	Panasonic	ERJ-8ENF1132V	Chip Resistor Thick Film 11K3 1% 1/4W	1	1206
R48	Panasonic	ERJ-2RKF1912X	Chip Resistor Thick Film 19K1 1% 1/10W	1	0402
R49	Panasonic	ERJ-2RKF1332X	Chip Resistor Thick Film 13K3 1% 1/10W	1	0402
R53, R55, R62, R63, R64	Panasonic	ERA-2AED103X	Chip Resistor Thick Film 10K0 0.5% 1/16W	0	0402
R59	Vishay	CRCW0402143KFKED	Chip Resistor Thick Film 143K0 1% 1/16W	1	0402
R66, R67	Vishay	CRCW04020000Z0ED	Chip Resistor Thick Film 0R00 1% 1/16W	0	0402
R72, R73	TBD	TBD	Chip Resistor Thick Film 10K0	0	0805
R74	Panasonic	ERJ-2RKF22R0X	Chip Resistor Thick Film 22R0 1% 1/10W	1	0402
RA2, RA3, RA4, RA5, RA6, RA7, RA8, RA10, RA14	Panasonic	EXB-28V472JX	Chip Resistor Array 4K70 5% 1/16W 4 x 0402	9	0804
RA9, RA15	Panasonic	EXB-28V473JX	Chip Resistor Array 47K0 5% 1/16W 4 x 0402	2	0804
RA11, RA12	Panasonic	EXB-28V330JX	Chip Resistor Array 33R 5% 1/16W 4 x 0402	2	0804
RA13	Panasonic	EXB-28V471JX	Chip Resistor Array 470R 5% 1/16W 4 x 0402	1	0804
RA16, RA17	Panasonic	EXB-28V104JX	Chip Resistor Array 100K0 5% 1/16W 4 x 0402	2	0804
RF1	Netcom	GT202-II	Netcom GT202 WiFi Module Ext Antenna	1	SMD

Schematic Designator	Mfg	Part Number	Description	QTY	Package
RF2	Panasonic	ENW–89823A3KF	Panasonic PAN1326 Bluetooth Module	1	SMD
S1	C&K	KSC222J LFS	Sealed Push Button Switch 6.2x6.2x3.5mm	1	SMD J
S3	CTS	219-5LPST	SMD DIP Switch 5Position 2.54mm	1	SMD
SO1, SO2, SO3, SO4	PEM	SMTSO-M3-6-ET	PEM SMT M3 6.0mm Standoff	4	SMD
SPK1	BeStar	B-Bass	BeStar B-Bass Sounder	1	
T1	Pulse	PA1283NLT	Pulse PoE Flyback Transformer 5V 7W	1	SMD
TP1, TP2, TP3, TP4, TP5, TP6, TP7, TP8	Keystone	5015	Keystone SMT Test Point	8	SMD
U1	Renesas	R7FS7G27H2A01CBD#WS2	Renesas S7G2 240MHz 32-bit Cortex M4 MCU WS2	1	FBGA-224
U2	ST	STM1818SWX7F	Low power reset circuit	1	
U3	Intersil	ISL80019AIRZ-T	DC-DC Single Step Down 3.3V 1.5A	1	
U4	Avago	APDS-9005-020	Avago ADPS-9005 Ambient Light Sensor	1	
U5	OnSemi	CAT4139TD-GT3	22V High Current Boost White LED Driver	1	
U6	Texas Instruments	TPS2501DRCR	TI Integrated USB Power switch with boost converter	1	
U7, U9	Texas Instruments	TPD2E2U06DRLR	Two channel 30kV ESD Dual Protection	2	
U8	SiLabs	501AAA-24M0000-DAGR	SiLabs MEMS Oscillator 24.000MHz	1	
U10	Micrel	KSZ8091RNBIA	10/100Base-TX Ehternet PHY EEE	1	
U11	SiLabs	TBD	SiLabs MEMS Oscillator 50.000MHz	1	
U12	Texas Instruments	TBD	TI PoE Interface & Converter Controller	1	
U13, U14	Renesas	PS2501L-1-F3-A	Opto Coupler 80V 5KV DIP4	2	
U15	Texas Instruments	TLV70018DSET	LDO Regulator 1.8V 200mA	1	
U16	NXP	NVT2006bq115#2ceM	Bidirectional Level Translator 6-bit	1	
U17	SiLabs	TBD	SiLabs MEMS Oscillator 32.768KHz	1	
U18	Maxim	MAX9814ETD+T	Maxim Microphone Preamp	1	
U19	Wolfson	WM9001GEFL/R	Wolfson 1W Mono Speaker Driver	1	
U20	Intersil	ISL41387IRZ-T	Intersil ISL41387 RS232/RS485 Transceiver	1	
U21	Infineon	IFX1050GVIO	Infineon CAN Transceiver 1MBaud	1	
U22	Micron	MTFC2GMVEA-0M WT	Micron 2GByte eMMC 3v3	1	
U23	Micron	MT48LC16M16A2B4-7E IT:G TR	Micron SDRAM 256M-Bit 16Mx16 3.3V	1	
X1	Abracon	ABS07-32.768KHZ-T	Crystal 32.769KHz 12.5pF SMT	1	

16. Post Production Modifications

None on v2.0 products.

17. Additional Information

Further information available for this product can be found on the Renesas Synergy website at:

http://www.renesassynergy.com

General information on Renesas Microcontrollers can be found on the global Renesas website:

http://www.renesas.com/

PE-HMI1 v2.0 User's Manual: Hardware

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Renesas Synergy^{TM} PE-HMI1 v2.0

Renesas Electronics Corporation

Компания «ЭлектроПласт» предлагает заключение долгосрочных отношений при поставках импортных электронных компонентов на взаимовыгодных условиях!

Наши преимущества:

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- Консультации по применению компонента;
- Поставка образцов и прототипов;
- Техническая поддержка проекта;
- Защита от снятия компонента с производства.

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