**Thermal Printer Notes**

**Thermal Printer Technical Manual**

“Thermal Printer Techical Manaul 2\_22\_2008 (2).pdf”

* Fujitsu FTP-628USL401 print head made by Fujitsu Component Ltd.
  + Non-impact, line type which has heating elements lined up throughout the printing width
  + The mechanism is simple, compact, maintenance is easy, and use is stable even in a poor environment, high speed printing possible. Thermo-sensitive paper can be stored for a long time, life is guaranteed for 10 years
  + Thermal printers have a general business use (POS, printing labels/receipts, ticket machine)
  + Disadvantages: special paper required, storage of paper is dependent on the environment
* Connectors
  + Print head connector (CN3), 30-pin
    - Molex 52610-3071 -> 52610-3072
  + Cutter connector (CN4), 8-pin
    - Molex 52610-0871 -> 52610-0872
* Power
  + Print head 4.2-8.5VDC 0.38A (2.4A peak) at 7.2V
  + Motor 4.2-8.5VDC 1A max
  + Cutter 4.75-8.5VDC 1A max
  + Logic 3.0-5.25VDC 0.1A max
  + VDD\_5V from BBB uses DC power supply rated at 3A (should be enough to cover max(printhead+BBB)
* Sensing
  + Thermistor; measures print head temperature
  + Photo-interruptor; detects marks and paper out, paper run, home position detection
  + Sliding switch; releases platen, platen open detection
* Motors
  + Paper feed motor
  + Cutter motor
  + Drive voltage is 4.2~8.5 V
  + Max printing speed is 80 mm/s
* Functionality (of interface board)
  + Test print function
  + Paper out detection (paper must be kept within 1mm from the photo sensor)
  + Paper near end detection (external mechanical switch)
  + Platen open detection
  + Thermal head temp abnormal detection (thermistor)
  + Blow out fuse detection
  + Head voltage abnormality detection
  + Cutter trouble detect
  + Motor power saving function
  + Mark detection (GS < command)
  + MCU operation abnormality detection (WDT?)
  + Power on/off sequence detection
  + Motor over-current protection (fuse)
  + Hardware timer
  + Dots/line
  + Dots font
  + Bar code commands
  + Character registration
  + Paper feed function (/ATF signal)
* Communication
  + Data to the main unit must be received at a required speed (>246 Kbps)
  + Image data by driver software
  + Centronics parallel interface can support 224 kbps
* Installation conditions
  + Installation condition 1-1 with paper feed direction upward is the most preferable so that paper moves debris to the outside
  + Or condition 2-1 with cutter; should prevent paper debris from dropping into itself causing double cutting
  + Roll paper should be loaded with direction outward away from the printer (condition 3-1)
* Printer Drive Circuit

|  |  |  |  |
| --- | --- | --- | --- |
| Signal Name | Signal Content | Description | PRU Signal |
| DATA IN(DI) | Head input data | Data input signal to head |  |
| CLOCK (CLK) | Data transfer clock | Synchronization clock for transmitting head data |  |
| DATA OUT (DO) | Head output data | Data output of end of data. Some product do not have this signal (NC). | Serial resistor to prevent SC |
| /LATCH | Data latch signal | Pulse signal for latching data to head |  |
| STROBE (STB) | Strobe terminal | Power ON gate signal having both positive and negative logic |  |
| TH | Thermister | Output at both ends or only at one end |  |
| VDD/GND (VDD) | Head logic power supply |  | VDD\_3V3 |
| VH/GND (VH) | Head power supply |  | VDD |

* + In the case of battery driving, all lines connected to the head, including the power supply, must be set to "Low" in order to decrease power consumption during standby.
  + The clock frequency depends on the IC in use, and 6 MHz or 8 MHz is used, or 16 MHz
  + CLK terminal needs noise removal like decoupling capacitor (normally 100 – 1000 pF)
  + DI and /LATCH signals needs capacitor as well (100 – 1000 pF)
  + The data (DI) is loaded at the rise of the clock (CLK), and the data must be held stably before and after the rise of the clock, and during periods of tsetup and thold.
  + Clock frequency = NWV / 15625 (MHz)
  + recommend not to increase frequency unnecessarily to avoid noise (increased frequency means increased margin of transfer)
  + The /LATCH pulse is very narrow, so if the capacity of the capacitor is too large, the pulse may not rise, and the latch may be missed (diagram on pg. 48)
  + Input the STROBE signal via the gate based on the hardware timer (see Fig. 46)
  + We recommend that 1 strobe is comprised of a plurality of retrigger pulses to prevent noise affecting the output
  + A large amount of current flows through VH-GND, therefore the VH-GND pattern must take sufficient distance from other signal lines so that voltage is not dropped by the current
    - Connect a 100uF or higher capacitor
    - As a rule, however, connect the GNDs (for VDD and VH) together at the bottom of the power supply input connector terminal inside the substrate.
  + Be certain to wire the logic power supply VDD-GND (VDD) sufficiently away from heavy current patterns, so that noise does not enter from the outside.
    - Also add a 47uF or higher to the logic supply (VDD)
  + If a thermal head is used, the voltage being applied to the head (VH) must be cut during standby. For the switching element, a relay and MOS-FET transistors, which do not cause much leak current, must be used. (see Fig. 50 on pg. 52)
    - For selection, confirm the maximum energizing load current and minimize the drop in voltage.
  + Power on
    - In the initial processing immediately after power ON, be certain to transfer NULL data "0" to the head, and perform latch processing.
    - As a rule, design a sequence such that VH becomes within VDD + 1V at the maximum when VDD rises or falls 80% of the logic applied voltage or more.
    - It is desirable that the rise time of the power supply is short, and design such that the logic voltage rises from 40% to 80% of applied voltage within 10 msec. (see Fig. 52)
    - Latch up
      * To prevent this, it must be noted that reverse voltage is not generated between VDD and the input terminal.
    - VDD/VH is also turned OFF during a hardware reset period.
    - Design circuits such that all control signals are also forcibly set to "Low" during a reset period.
    - Set hardware so that the head is OFF, the motor is OFF and the interface is busy during the reset period.
  + Precautions for grounding
    - During printing, a very heavy current flows through GND (VH) depending on the number of energized dots. Therefore if this current flows into GND (VDD), the logic potential may change and a malfunction may occur.
    - Install the power supply connector near the head, and connect the GND (VH) and the other GND patterns at the bottom of the connector.
  + Precautions for VH
    - Ensure power supplies support such high-speed peak current
    - Power supply which can support peak load current is necessary
    - Voltage may instantaneously drop and cause printing blurs if the peak response is low.
    - Peak load countermeasure in Fig. 57
    - one method is to install an LC filter in the power supply input terminal section, but an allowable DC load of the coil must be checked
  + Thermister control
    - The resistance value of the thermister changes depending on the temperature. Temperature is detected by detecting the change of the resistance value.
    - Normally a thermister is input to the AD converter terminal of the CPU
    - Thermister processing in Fig. 58
      * Generate a highly accurate reference voltage using a shunt regulator, for example, and detect the resistance value by dividing this reference voltage.
      * For an external resistor, use a product with a precision temperature compensation that is less than 2%.
      * For the output stage, it is recommended to attach an appropriate temperature compensation capacitor based on the confirmation of ESD
      * Table 6 on pg. 58
  + Motor drive
    - A stepping motor is used for driving the paper feed motor and the cutter motor of the FTP-607/608/609MCL400 series.

|  |  |  |
| --- | --- | --- |
| Motor type | Signal name | Remarks |
| Stepping motor | MT-A | Bipolar Phase A |
| MT-/A | Bipolar phase /A |
| MT-B | Bipolar phase B |
| MT-/B | Bipolar phase /B |
| DC motor | MT+ | Motor terminal (+) |
| MT- | Motor terminal (-) |

* + - The FTP-608 series uses bipolar systems for the stepping motor drive system
    - Maximum frequency is 3000 at 8.0V ~ 8.5V
    - Controlling phase: the 1-2-phase excitation drive system has smaller step sizes and less noise

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Step | MT-A | MT-B | MT-/A | MT-/B | Step | MT-A | MT-B | MT-/A | MT-/B |
| 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 |
| 1 | 0 | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 0 |
| 2 | 0 | 0 | 1 | 0 | 2 | 1 | 1 | 0 | 0 |
| 3 | 0 | 1 | 1 | 0 | 3 | 1 | 0 | 0 | 1 |
| 4 | 0 | 1 | 0 | 0 |  |  |  |  |  |
| 5 | 1 | 1 | 0 | 0 |  |  |  |  |  |
| 6 | 1 | 0 | 0 | 0 |  |  |  |  |  |
| 7 | 1 | 0 | 0 | 1 |  |  |  |  |  |

* + Motor drive circuit
    - When a stepping motor is driven, be certain to perform constant current control if a condition under which excitation current for phase exceeds 500 mA occurs
    - For example, in the case of the FTP-608 MCL series, a 10 motor is used… Therefore a constant current control is required if the applied voltage for driving the motor is 5.6V or more.
    - If speed becomes slower, however, the motor current rises continually, and reaches the maximum current. (Fig. 60)
    - Maximum excitation current of the motor is 450mA with motor diameter at 15mm
    - Use one of the many ICs available that have a constant current circuit for 24V motor driving ICs (see example circuit in Fig. 62 which uses a A6919SLB)
    - Drive ICs for low voltage rarely have these functions. Therefore a feedback circuit must be created to create a constant current circuit. (see Fig. 64)
    - the A-/A phase feedback circuit and the B-/B phase feedback circuit must be separated. The ground side must be separated inside the motor IC.
    - Some MPUs have a built-in PWM function, and external circuits can be decreased by using this function. This is a way of limiting the motor current to be constant by switching each phase output signal.
      * Use PWM for the pulse, and do not perform switching until current reaches a predetermined current.
      * be certain to attach a fuse as a safety measure to the motor circuit to prevent smoking and combustion by a motor short circuit
    - As a safety measure, be certain to insert a fuse in the power supply line to prevent smoking and combustion.
    - For acceleration/deceleration control, normally a trapezoidal control method is used. For example, it is assumed that speed is increased from 800 PPB to a maximum of 3000 PPS.
    - In the FTP-608 MCL series, maximum frequency is about 3000 PPS (8.0V or more)
    - In the FTP-608 MCL series, the drive voltage may fluctuate in a 4.2  8.5V range.
    - Ton define in section 7.3
  + Thermal Shutdown
    - If the timing difference between two ICs is major, a short circuit current may be generated, so mount the ICs close together with a short interconnect, and minimize the difference of signals between ICs.
  + Motor for cutter
    - A cutter requires a home position. A home position sensor is controlled by a photo sensor
  + Sensors
    - No paper detection (photo interrupter, Fig. 71)
    - Platen up detection (micro switch, Fig. 70)
    - Cutter home position detection (photo sensor, Fig. 71)
    - Temperature detection (thermister, Fig. 58)
  + Photo interrupter for paper detection

|  |  |  |
| --- | --- | --- |
| Signal name | Function | Description |
| PHK | Photo diode cathode | Sets IF by resistance r |
| PES | Photo transistor emitter | Generates voltage of IC x R by resistance R |
| VSNS | Photo interrupter power supply | Switching by power supply recommended |

* + - Switch the power supply to the photo sensor, and turn it OFF during standby.
    - Reading output V (PES) from the photo interrupter by an AD converter is recommended.
    - Connect pull down resistors on PHK and PES based on Fig. 71
    - Recommend making the threshold programmable for VSNS
    - Normally, the IF is ~20mA

**FTP-628CU451 Product Specification**

“628CU451 PRELIMINARY Ver01(050531).pdf”

**Datasheet**

“ftp-628mcl401.pdf”

* Low profile (height 21.8mm, width 81.2mm, depth 42.2mm), weighs 98g
* High speed printing at a maximum of 80 mm/s (640 dotlines/s) at 8.5V, 60mm/s for EVM
* Interface board for cutter support (FTP-628DSL491R parallel (centronics) / serial (rs-232c) )
* Dot structure: 384 dots/line
* Dot pitch (horizontal) dot density: 0.125mm (8 dots/mm)
* Dot pitch (vertical) line feed pitch: 0.125mm (8 dots/mm)
* Effective printing area: 48mm
* Number of columns: ANK 32 columns/line (maximum 12 x 24 dot font)
* Paper width: 58mm
* Paper diameter: 60mm (EVM)
* Paper thickness: 60 to 85 um
* Power supply:

|  |  |
| --- | --- |
| For print head | 4.2 - 8.5 VDC average current, 1.8 (2.4)A at 7.2V (print ratio: 12.5%, print speed: 60mm/sec. ) |
| For motor | 4.2 - 8.5 VDC, 1A maximum |
| For cutter motor | 4.75 - 8.5 VDC, 1A maximum |
| For logic | 3.0 to 5.25 VDC, 0.1A maximum |

**PRU/Printer Communication**

* AM335x PRU base address = 0x4A300000
* Serial or parallel interface (RS-232C or Centronics)
* Buffer for storing data in memory?
* Resolution: 8dots/mm
* For image mode, the max # dots/line: 384 (there are 384 heating units)
* Max printing speed is 80mm/s at 8.5V, 25C
* Max power consumption is 2.9A (4.8A spike) for low speed print mode
* VDD for logic is 5V +/- 5%, max current is 0.3A

Status LEDs? (5V power supply, error detection light)

**Paper Feed Motor**

* Countermeasures
* Fuse
* Voltage: 4.75 ~ 8.5V
* Max current: 1.1A
* Max current simultaneous motor: 1.5A
* M15SP-1N motor has 18 degrees/step 🡪 20 steps/revolution (2 phase excitation)
* \*Caution：Since there is fear of breakage of a head, be sure to use head voltage less than **8.5V** .
* The head driving power supply is switched by FET, which is controlled by MCU.
* Motor excitation is shutdown by a hardware timer to prevent motor smoking caused by an operation abnormality. Limit the applied pulse width of the head by a hardware timer to prevent head burning by fixing the logic of the thermal head enable signal.
* Motor drive circuit description on pg. 59
* Limit current to 500mA

**Cutter Motor**

* Countermeasures
* Fuse
* Cutter Home Position
  + Photo interrupter sensor
  + When the cutter blade is not in the home position at initialization, the printer automatically positions the cutter.
  + When a paper cut command is received in the state of cutter un-connecting, it will be in a Hardware abnormality state

**Initialization and Reset**

* Power on requirements
* Timing requirements
* When watchdog is occurred, printer goes internal reset state and MCU operation is stopped.
* This function prevents burning of the head caused by the reverse order disconnection of the logic power supply and power supply for the head.
* Standby (all signals and power supply set to low during standby; Be certain that wrap around from the circuit side logic power supply is not generated)

**Head Temperature**

* Thermistor circuit description on pg. 56
* Hardware timer for protection
* FET
* Temperature is detected by the thermistor inside the thermal head to protect the head from heating.
* When abnormal temperature (about 70℃) is detected, the printer stands by in busy status until the temperature drops to the specified temperature (about 60℃).

**Paper Detection**

* Photo interrupter for paper detection, mark detection
* During printing or feeding paper, a paper run out is detected when the sensor continuously detects a black level for about 7mm.
* When the printer detects a paper run out during printing, and if currently printing data exists, the printer automatically enters off-line (BUSY) status after printing one line.
* When paper run out is detected, driving of the **motor is turned OFF**. (take care in software)
* VSNS - photo interrupter power supply
  + Switch the power supply to the photo sensor, and turn it OFF during standby.
* PHK – photo diode cathode sets current IF by resistance r
  + Normally the IF is set to IF = about 20 mA.
* PES – photo transistor emitter generates voltage of IC x R
  + Reading output V (PES) from the photo interrupter by an AD converter is recommended.
  + We therefore recommend making the threshold programmable.

**Platen Switch**

* Microswitch for platen open detection
* When the printer detects platen open during printing, the printer stops driving the head and the motor in one line unit, and the printer automatically enters off-line (BUSY) status.

**Andreas’ Cape Design**

P8.1 🡪GND

P8.2 🡪GND

P8.20 🡪 R31-13 (/NFAULT)

P8.21 🡪 R30-12 (sn74lvc244a enable)

P8.27 🡪R30-8 (AIN1)

P8.28 🡪R30-10 (RIN1)

P8.29 🡪R30-9 (AIN2)

P8.30 🡪R30-11 (RIN2)

P8.39 🡪R30-6 (/LATCH)

P8.40 🡪R30-7 (DATA\_IN)

P8.41 🡪R30-4 (/STB5-6)

P8.42 🡪R30-5 (CLK)

P8.43 🡪R30-2 (/STB2-3)

P8.44 🡪R30-3 (/STB4)

P8.45 🡪R30-0 (PSENSE)

P8.46 🡪R30-1 (/STB1)

P9.1 🡪GND

P9.2 🡪GND

P9.3 🡪3.3V VCC

P9.4 🡪3.3V VCC

P9.5 🡪5V VCC

P9.6 🡪5V VCC

P9.7 🡪SYS 5V VCC

P9.8 🡪SYS 5V VCC

P9.9 🡪PWR\_BUT

P9.10 🡪SYS\_RESETn

P9.26 🡪R31-16 (POUT)

P9.43 🡪GND

P9.44 🡪GND

P9.45 🡪GND

P9.46 🡪GND

3 versions of the cape:

* TPcape Basic (basic features, headers for extended output, VDD\_5V)
* TPcape (with ADC, higher voltage)
* TPcape Ultra (with LCD)
* TPcape Basic
  + No photo interruptor
  + No thermistor
  + No platen detection
  + Just stepper signals, print head signals, strobes