Hardware Reference

# M20 Microcontroller Module

Revision 1.0

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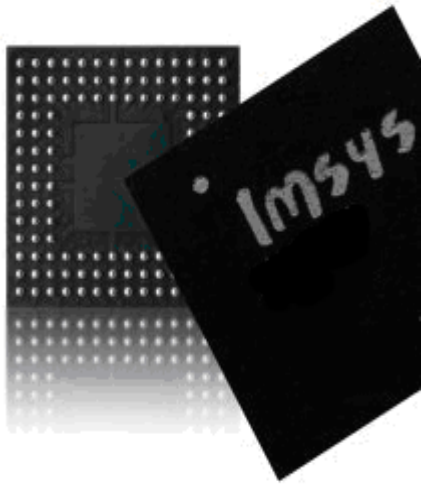


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# Revision History

| Document: STO-DEV7022-CB | |
|---|---|
| Previous revision: - | |
| **Section** | **Changes since last revision** |
| | First release |

# Table of Contents





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# 1. About this document

This document describes an IM3000-based microcontroller module offered to OEM customers for evaluation of Imsys platform for embedded control, for functional prototypes of customer products and development of application software, and for use in customer products.

The circuit board design described here can also be used as a starting point for optimized customer designs (schematics etc are available from Imsys).

The document mainly describes the pinout of the module connector and other physical aspects of the module. The operation of the IM3000-series micro-controller, as well as the specifications of the firmware platform, the tools, and the development system, are described elsewhere.

# 2. General description

The figures below show the M20 module in natural size.

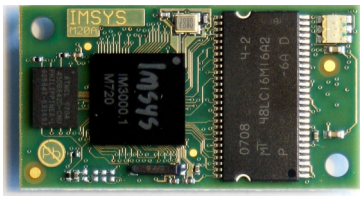


*Figure 1: Top side*

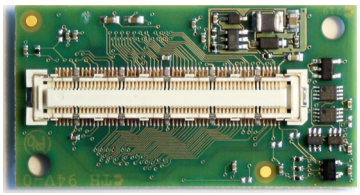

*Figure 2: Bottom side*

## 2.1. Key features

- IM3000-series microcontroller
- 8-32 MByte SDRAM memory
- 2-8 MByte flash memory
- Efficient switching power supply regulator
- Rugged FX10 connector
- RoHS compliant

## 2.2. Peripherals

The available peripheral interfaces vary with the specific member of the IM3000 series microcontroller with which the module is equipped, but can include:

- 2 Ethernet controllers, for direct connection to MII or RMII PHY's
- 3 asynchronous serial ports
- I2C, SPI, generic serial interface
- Dual DAC, and 8-channel ADC
- High-speed DMA-supported I/O bus, and generic 8-bit data interface


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### 2.3. Block diagram

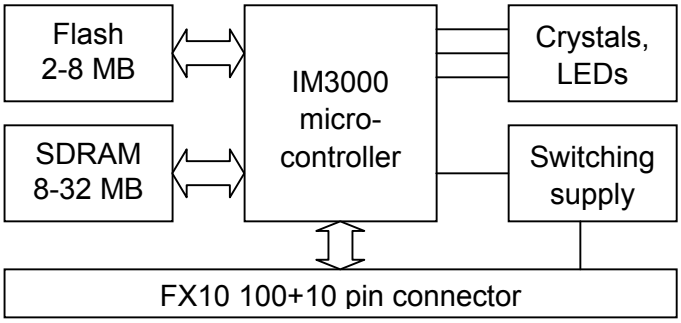


*Figure 2: Block diagram*

# 3. Physical dimensions

### 3.1. Dimensions

The module, when in place on the socket board, will be parallel to that. Its printed circuit board is 1.2 mm thick, and the distance between this and the socket board is either 4 or 5 mm, depending on the connector used on the socket board.

The design is specified to withstand very high shock acceleration, when the module is securely fastened using both mounting holes.

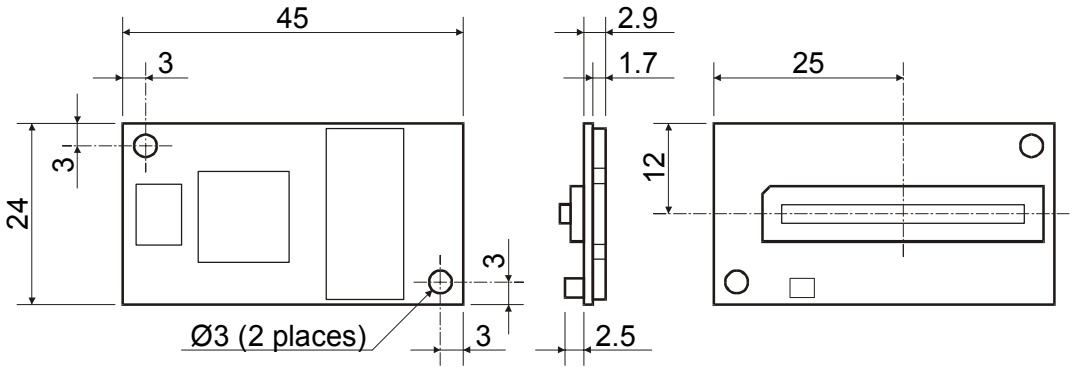


*Figure 3: Dimensions (unit: mm)*


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### 3.2. Connector

The module connector is an FX10 receptacle, made by Hirose. It has 100 signal connections, plus 10 dedicated ground connections.

The figure below shows the pin numbering of the module connector. The chamfer at pin 1 is present also on the mating header connector, but it is solely a pin 1 marker and does not prevent insertion of the module the wrong way.

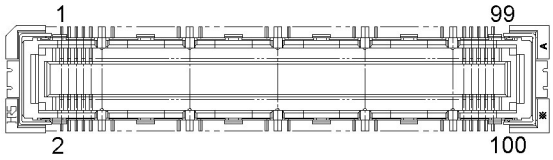


*Figure 4: FX10 receptacle pin numbering*

The 10 dedicated ground pins are not included in the pin numbering and do not appear in the pin list below. Nevertheless, all of the corresponding pins in the socket board must be connected to signal ground.

The mating connector on the socket board is a header, and can be any of the following types:

- FX10A-100P/10-SV or FX10B-100P/10-SV for 4 mm board-to-board distance
- FX10A-100P/10-SV1 or FX10B-100P/10-SV1 for 5 mm board-to-board distance

# 4. Pin list

The pins of the connector are listed roughly in the order from pin 1 through the odd numbered pins up to pin 99, then back along the other edge from pin 100 down to pin 2.

The order of pins within a few of the pin groups does not follow this ordering, where this would disrupt the logical sequence of pins. These pin groups are marked with **Note!** in the Pin # column.

The codes in the Type column are: I for Input, O for Output, B for Bidirectional, P for Power, (PU) for Pull Up, and (PD) for Pull Down.

| Pin group | Pin # | Pin name | Type | Description |
|---|---|---|---|---|
| Misc. | 1 | RSTIN | I (PU) | Active low reset input |
| | 3 | MPLL_TSTO | O | PLL test / timestamp out |
| | 5 | MSDIN | I (PU) | Serial debug data in |
| | 7 | MCKOUT0 | O | Debug clock |
| | 9 | MX1_CK | I | External clock input (1.8 V level) |
| | 11 | MCKOUT1 | O | Programmable clock |
| | 13 | MSDOUT | O | Serial debug data out |
| | 15 | MIRQOUT | O | Active low debug interrupt |


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| Pin group | Pin # | Pin name | Type | Description |
|---|---|---|---|---|
| GPIO / Generic Serial Interface | 17 | PD5_GSIIN | B | Port D bit 5 / GSI input |
| | 19 | PD6_GSIIO | B | Port D bit 6 / GSI bidirectional |
| | 21 | PD7_GSICK | B | Port D bit 7 / GSI clock |
| GPIO / I/O bus | 23 | PJ4_INEXT | B | Port J bit 4 / Active low I/O bus read strobe |
| | 25 | PJ5_ILDOUT | B | Port J bit 5 / Active low I/O bus write strobe |
| | 27 | PJ6_ILIOA | B | Port J bit 6 / Active low I/O bus address strobe |
| | 29 | PJ7_ICLK | B | Port J bit 7 / I/O bus clock |
| | 31,33, 35,37, 39,41, 43,45 | PI0_ID0 - PI7_ID7 | B | Port I / I/O bus data |
| | 47,49, 51,53, 55,57, 59,61 | PH0_IDREQ0 - PH3_IDREQ3, PH4_IDACK0 - PH7_IDACK3 | B | Port H / I/O bus DMA channels 0-3 control signals |
| | 63,65, 67,69, 71,73, 75,77 | PC0_IDREQ4 - PC4_IDREQ7, PC5_IDACK4 - PC7_IDACK7 | B | Port C / I/O bus DMA channels 4-7 control signals |
| Supply | 79 | VCC18 | P | Optional 1.8V power supply |
| Misc. | 81 | MRSTOUT | O | Active low reset output |
| | 83 | MWAKE | I (PD) | Active high wake-up input |
| | 85,87 | MIRQ0, MIRQ1 | I (PU) | Active low interrupt signals |
| | 89 | MRXOUT | O | RTC test / Active high power supply wake-up output |
| GPIO / Async. serial ports | 91,93, 95,97 | PJ0_UTX1, PJ1_URX1, PJ2_URTS1, PJ3_UCTS1 | B | Port J bits 0-3 / Serial port 1 |
| | 99, 100, 98,96 | PE0_UTX2, PE1_URX2, PE2_URTS2, PE3_UCTS2 | B | Port E bits 0-3 / Serial port 2 |
| | 88,92, 90,94 **Note!** | PE4_UTX3, PE5_URX3, PE6_URTS3, PE7_UCTS3 | B | Port E bits 4-7 / Serial port 3 |
| Misc. | 86 | WP | I (PD) | Active low flash write protect |


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| Pin group | Pin # | Pin name | Type | Description |
|---|---|---|---|---|
| GPIO / Ethernet MII / Ethernet RMII | 84,82, 80,78, 76,74, 72,68 **Note!** | PF0_ETXEN, PF1_ETXCLK, PF2_ETXD0, PF3_ETXD1, PF4_ERXDV, PF5_ERXER, PF6_ERXD0, PF7_ERXD1 | B | Port F / Ethernet MII / 1st Ethernet RMII |
| | 70,64, 66,60, 58,62, 56,54 **Note!** | PG0_ETXER, PG1_ERXCLK, PG2_ETXD2, PG3_ETXD3, PG4_ECOL, PG5_ECRS, PG6_ERXD2, PG7_ERXD3 | B | Port G / Ethernet MII / 2nd Ethernet RMII |
| Supply | 52 | VBAT | P | 3V battery backup for RTC |
| GPIO / Generic Parallel Interface | 50,48, 46,44, 42,40, 38,36 | PB0_GPI0 - PB7_GPI7 | B | Port B / Generic Parallel Interface |
| Supply | 34 | GNDA | O | Analog ground reference output for ADC/DAC |
| | 32 | VREGEN | I | Active high enable for the on-board 1.8V linear regulator |
| | 30,28 | VCC33 | P | Optional 3.3V power supply |
| Analog | 26,24, 22,20, 18,16, 14,12 | ACH0 - ACH7 | I | Analog to Digital Converter multiplexer inputs |
| | 10,8 | AOUT0, AOUT1 | O | Digital to Analog Converter outputs |
| | 6 | EXTREF | I | Optional external voltage reference input for ADC |
| Supply | 4 | VRAWEN | I (PU) | Active high enable for the on-board 3.3V switch regulator |
| | 2 | VRAWIN | P | Optional unregulated 4.5-25V power supply |


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## 4.1. Pin descriptions

Almost all pins in the connector are directly connected to the IM3000 microcontroller, and to nothing else. Detailed descriptions of their functions can thus be found in the IM3000 Family Microcontrollers Data Book.

Exceptions to the above include supply related pins, which are dealt with in the next section, and the few signals listed below:

- MX1_CK: This pin is not connected to anything in most variants of the module, since the on-board crystal is normally used. If the module is equipped for external clocking, then the external clock shall be applied to this pin. The clock signal level must in that case be maximized to 1.8V.
- WP: This pin is connected to the write-protect pin of the on-board flash device. When pulled low or left open, the boot sector of the flash is write-protected. Typically only pulled high to do initial flash programming during manufacturing.
- ACH7: This analog input is biased to 0.9 V through 4.7 Mohm resistors to ground and the 1.8 V supply. Otherwise no difference compared to the other seven analog inputs.

## 4.2. Power supply

### *4.2.1. 3.3 V Supply*

The module needs 3.3 V power for the on-board memory components and the microcontroller's I/O supply. This can be provided in two ways:

- Using the on-board switching regulator. In this case, unregulated 4.5 - 25 V is applied to VRAWIN, and VRAWEN is held high (1.8 - 25 V) or left open. Pulling VRAWEN low (below 0.4 V) will power down the module.

  The excess current supply capability of the regulator is available at the VCC33 pins and can be used to power additional 3.3 V circuitry on the socket board.
- Using external regulated 3.3 V. If regulated 3.3 V is already available on the socket board, it can power the module through the VCC33 pins. In this case VRAWIN and VRAWEN are left unconnected.

  This option can be used when the switching noise from the on-board regulator might otherwise cause EMC problems.


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### *4.2.2. 1.8 V Supply*

The module also needs 1.8 V power for the microcontroller's core supply. There are two alternatives for this as well:

- Using the on-chip linear regulator. If VREGEN is held high, the microcontroller's integrated linear regulator is used to provide 1.8 V.

  The excess current supply capability of the regulator is available at the VCC18 pin and can be used to power additional 1.8 V circuitry on the socket board.
- Using external regulated 1.8V. If regulated 1.8 V is already available on the socket board, it can power the module through the VCC18 pin. In this case VREGEN shall be held low.

  This option can be used to avoid the extra power dissipation of the linear regulator, if a more efficiently regulated 1.8 V supply is available.

### *4.2.3. RTC supply*

The VBAT pin can be supplied from a lithium cell battery (typically 3.0 V) to provide power for the on-chip Real-Time Clock while other power supplies to the module are off.

If RTC operation during power-off is not necessary then VBAT can be left unconnected, the RTC is supplied from the main 3.3 V supply while that is powered.

### *4.2.4. Analog ground*

The GNDA pin provides an analog ground reference to off-module circuitry connected to the analog interfaces (ADC/DAC).

If no such circuitry exists, then GNDA can be left unconnected.

## 4.3. IEEE1588

In some variants of the M20 module, there is support for the Precision Time Protocol according to the IEEE1588 standard. For this to be enabled, some connections must be present on the socket board.

- MPLL_TSTO (Ethernet timestamp output) must be connected to PC1_IDREQ5 (capture timer input)
- PC3_IDREQ7 (spike train output) must be connected to PB5_GPIO5 (interrupt capable input)

In addition, if the module is equipped for external clocking, that external clock (usually from a VCTCXO) must be connected to MX1_CK.

The spike train output can be used on the socket board to create a programmable pulse train signal by clocking a toggle-flipflop with it.

The above connections are already made on any socket board sold together with an IEEE1588-enabled module in a development kit.


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# 5. Specifications

## 5.1. Metrics

| Metric | Value |
|---|---|
| Dimensions | 45 x 24 x 6.1 mm |
| Weight | 5 g |
| Shock tolerance | 200 G when screw-secured, 50 G otherwise |
| Operating temperature | 0 – +70 °C |
| Storage temperature | -40 – +150 °C |
| MTBF | TBD |

## 5.2. DC Electrical Characteristics

| Parameter | Symbol | Min | Typ | Max |
|---|---|---|---|---|
| Switching 3.3 V regulator supply (when used) | $V_{RAW}$ | 4.5 V | | 25 V |
| Regulator efficiency ($V_{RAW}$ = 12 V) | $E_{RAW}$ | | 80 % | |
| 3.3 V regulator output current ($V_{RAW}$ ≥ 4.7 V) | $I_{33OUT}$ | | | 400 mA |
| 1.8 V linear regulator output current | $I_{18OUT}$ | | | 70 mA |
| I/O voltage supply | $V_{IO}$ | 2.97 V | 3.3 V | 3.63 V |
| Core voltage supply | $V_{CORE}$ | 1.62 V | 1.8 V | 1.98 V |
| RTC battery backup supply | $V_{BAT}$ | 2.7 V | 3.0 V | 3.63 V |
| I/O supply current ($V_{IO}$ = 3.3V, no I/O load, $f_{CORE}$ = 167 MHz) | $I_{IO}$ | | TBD | TBD |
| Core supply current ($V_{CORE}$ = 1.8V, $f_{CORE}$ = 167 MHz) | $I_{CORE}$ | | TBD | TBD |
| RTC backup current | $I_{BAT}$ | | TBD | |
| Input low voltage | $V_{IL}$ | | | 0.8 V |
| Input high voltage | $V_{IH}$ | 2.0 V | | |
| Output low voltage ($\|I_{OL}\|$ = max) | $V_{OL}$ | | | 0.4 V |
| Output high voltage ($\|I_{OH}\|$ = max) | $V_{OH}$ | 2.4 V | | |
| Output drive current (GPIO pins) | $\|I_{OL}\|$,$\|I_{OH}\|$ | 2/8 mA | | |

## 5.3. AC Electrical Characteristics

| Parameter | Symbol | Min | Typ | Max |
|---|---|---|---|---|
| On-board main oscillator frequency | $f_{OSC}$ | | 20 MHz | |
| On-board RTC oscillator frequency | $f_{RTC}$ | | 32768 Hz | |
| Core & SDRAM frequency | $f_{CORE}$ | 20 MHz | | 167 MHz |
| External oscillator frequency on MX1_CK | $f_{EXT}$ | 5 MHz | | 41.7 MHz |


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# 6. Variants

| Variant | Clock | RAM | Flash | Notes |
|---|---|---|---|---|
| M210 | 167 MHz | 32 MB | 8 MB | Used on-board oscillator. |


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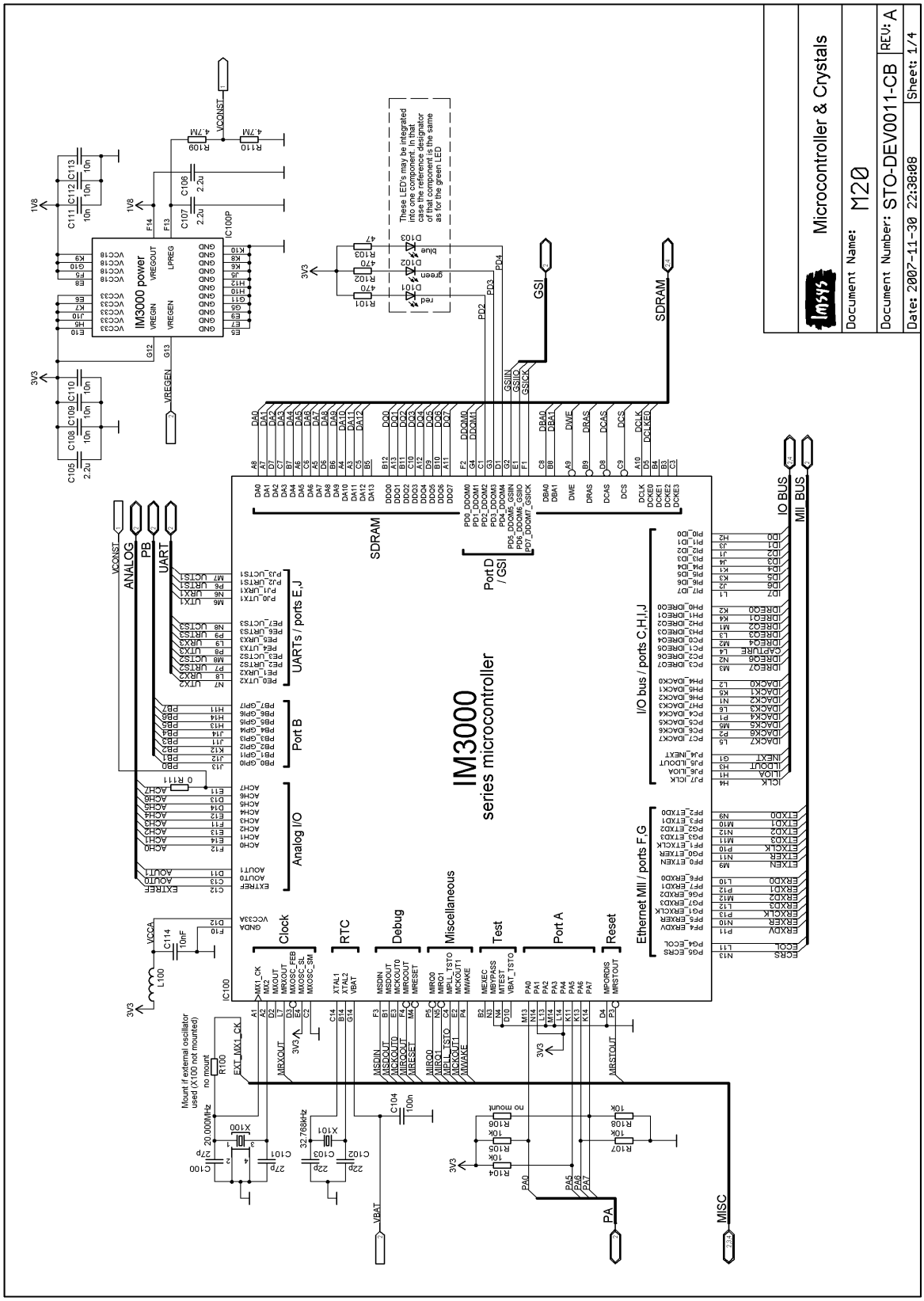
# Appendix A. Schematics



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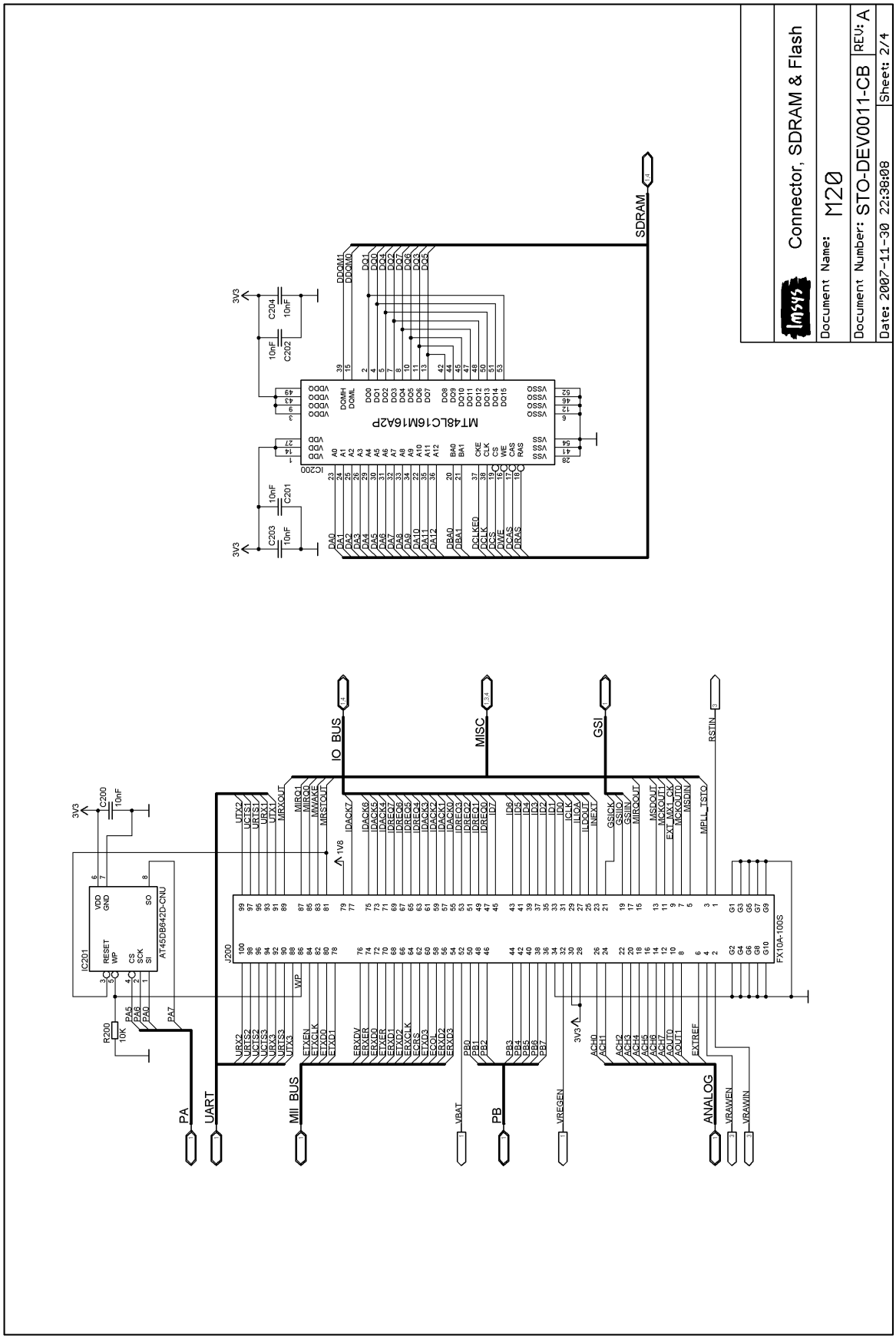




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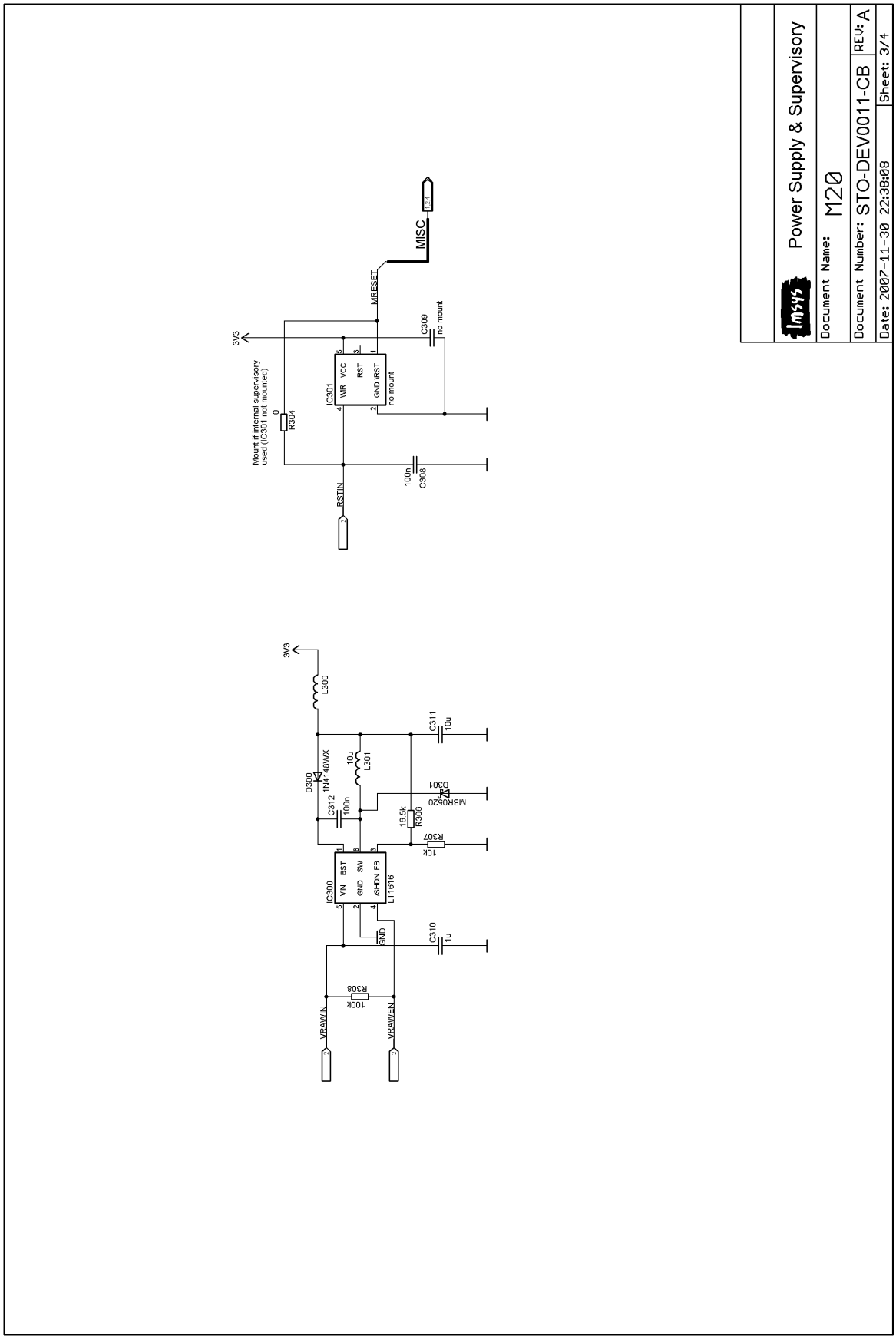




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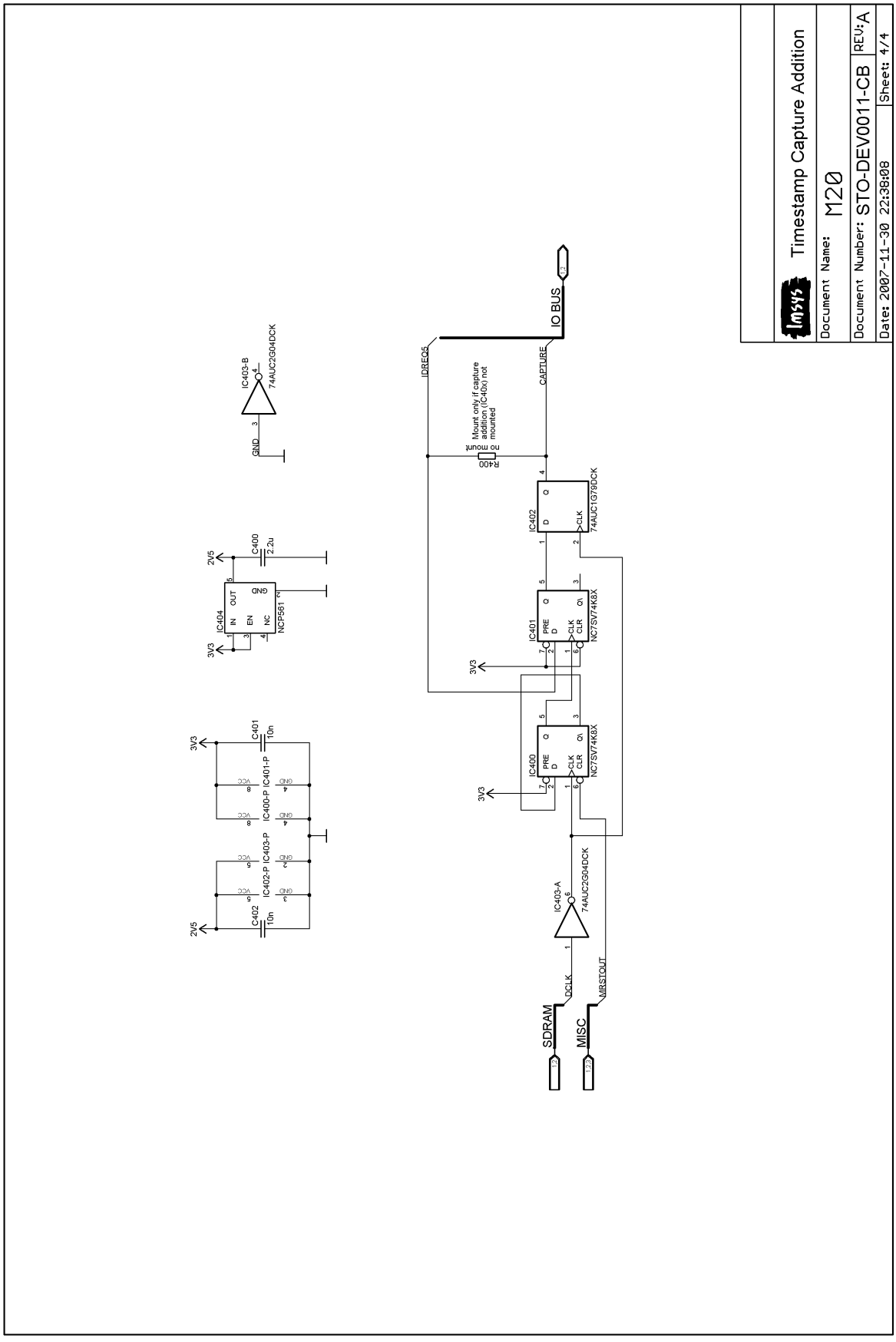




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# Appendix B. Bill of Materials

| Ref | Part number/Value | Description | Package | Mfgr |
|---|---|---|---|---|
| **Integrated circuits (IC)** | | | | |
| IC100 | IM3000-BA10 | Microprocessor | SSBGA-180 | Imsys Tech. |
| IC200 | MT48LC16M16A2P-6:G | SDRAM 16M x 16, 167MHz | TSOP-54 | Micron |
| IC201 | AT45DB642D-CNU | Serial flash 64 Mbit | CASON | Atmel |
| IC300 | LT1616 | Switching voltage regulator | SOT23-6 | Linear |
| IC400 | NC7SV74K8X | Single D-flipflop w/preset and clear | US8 | Fairchild |
| IC401 | NC7SV74K8X | Single D-flipflop w/preset and clear | US8 | Fairchild |
| IC402 | 74AUC1G79DCK | Single D-flipflop, Q output only | SC70-5 | Texas Instr. |
| IC403 | 74AUC2G04DCK | Dual inverter | SC70-6 | Texas Instr. |
| IC404 | NCP561SN25T1G | LDO regulator 2.5V | SOT23-5 | ON Semi. |
| **Crystals (X)** | | | | |
| X100 | FA-238/20MHz/18pF | Crystal, 50ppm | | Epson |
| X101 | MC-146/32768Hz/12.5pF | Crystal, 20ppm | | Epson |
| **Diodes (D,Z)** | | | | |
| D102 | SML-LX3632SISUGSBC | RGB LED, 3.6 x 3.2 mm | 6-pad | Lumex |
| D300 | 1N4148WX | Switching diode | SOD323 | MCC |
| D301 | MBR0520L | Schottky diode | SOD123 | Fairchild |
| **Resistors (R,RV)** | | | | |
| R101 | 470 | Thick film resistor, 1/16W, 1% | 0402 | |
| R102 | 470 | Thick film resistor, 1/16W, 1% | 0402 | |
| R103 | 47 | Thick film resistor, 1/16W, 1% | 0402 | |
| R104 | 10k | Thick film resistor, 1/16W, 1% | 0402 | |
| R105 | 10k | Thick film resistor, 1/16W, 1% | 0402 | |
| R107 | 10k | Thick film resistor, 1/16W, 1% | 0402 | |
| R108 | 10k | Thick film resistor, 1/16W, 1% | 0402 | |
| R109 | 4.7M | Thick film resistor, 1/16W, 5% | 0402 | |
| R110 | 4.7M | Thick film resistor, 1/16W, 5% | 0402 | |
| R200 | 10k | Thick film resistor, 1/16W, 1% | 0402 | |
| R304 | 0 | Thick film resistor, 1/16W, 1% | 0402 | |
| R306 | 16.5k | Thick film resistor, 1/16W, 1% | 0402 | |
| R307 | 10k | Thick film resistor, 1/16W, 1% | 0402 | |
| R308 | 100k | Thick film resistor, 1/16W, 1% | 0402 | |


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| Ref | Part number/Value | Description | Package | Mfgr |
|---|---|---|---|---|
| **Capacitors (C)** | | | | |
| C100 | 27p | Ceramic cap, NP0, 50V, 5% | 0402 | |
| C101 | 27p | Ceramic cap, NP0, 50V, 5% | 0402 | |
| C102 | 22p | Ceramic cap, NP0, 50V, 5% | 0402 | |
| C103 | 22p | Ceramic cap, NP0, 50V, 5% | 0402 | |
| C104 | 100n | Ceramic cap, X7R, 16V, 10% | 0402 | |
| C105 | 2200n | Ceramic cap, Y5V, 16V, -20/+80% | 0603 | |
| C106 | 2200n | Ceramic cap, Y5V, 16V, -20/+80% | 0603 | |
| C107 | 2200n | Ceramic cap, Y5V, 16V, -20/+80% | 0603 | |
| C108 | 10n | Ceramic cap, X7R, 50V, 10% | 0402 | |
| C109 | 10n | Ceramic cap, X7R, 50V, 10% | 0402 | |
| C110 | 10n | Ceramic cap, X7R, 50V, 10% | 0402 | |
| C111 | 10n | Ceramic cap, X7R, 50V, 10% | 0402 | |
| C112 | 10n | Ceramic cap, X7R, 50V, 10% | 0402 | |
| C113 | 10n | Ceramic cap, X7R, 50V, 10% | 0402 | |
| C114 | 10n | Ceramic cap, X7R, 50V, 10% | 0402 | |
| C200 | 10n | Ceramic cap, X7R, 50V, 10% | 0402 | |
| C201 | 10n | Ceramic cap, X7R, 50V, 10% | 0402 | |
| C202 | 10n | Ceramic cap, X7R, 50V, 10% | 0402 | |
| C203 | 10n | Ceramic cap, X7R, 50V, 10% | 0402 | |
| C204 | 10n | Ceramic cap, X7R, 50V, 10% | 0402 | |
| C308 | 100n | Ceramic cap, X7R, 16V, 10% | 0402 | |
| C310 | 1000n | Ceramic cap, Y5V, 16V, -20/+80% | 0603 | |
| C311 | 10µ | Ceramic cap, Y5V, 6.3V, -20/+80% | 0805 | |
| C312 | 100n | Ceramic cap, X7R, 16V, 10% | 0402 | |
| C400 | 2200n | Ceramic cap, Y5V, 16V, -20/+80% | 0603 | |
| C401 | 10n | Ceramic cap, X7R, 50V, 10% | 0402 | |
| C402 | 10n | Ceramic cap, X7R, 50V, 10% | 0402 | |
| **Inductors (L)** | | | | |
| L100 | BK1005HW121-T | Ferrite bead, 120ohm/100MHz/450mA | 0402 | |
| L300 | BK1005HW121-T | Ferrite bead, 120ohm/100MHz/450mA | 0402 | |
| L301 | CBC3225T100MR | Power inductor 10µH | 1210 | Taiyo Yuden |
| **Connectors (P,J)** | | | | |
| J200 | FX10A-100S/10-SV | 100 pin FX10 receptacle, w/guides | | Hirose |
| **59 components total** | | | | |


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