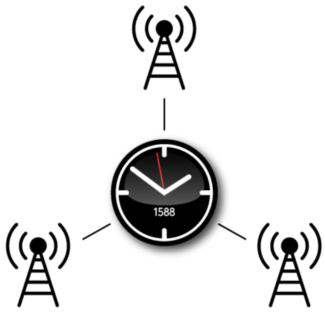
conemtech
connected embedded controllers



M50 Application Notes

Time and Frequency
Synchronization Components
5.10

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Introduction

The newest processors in Conemtech Network Communications series cover a range of applications, from low-end femtocell or industrial I/O units to high accuracy network time source products. This report covers three of the most common applications – Remote IO, Femtocell/Picocell and GrandMaster. In all of them the C32 or C34 processor located in the M50 form factor can be designed in at very low effort. The three applications in the following will describe how low. But first an overview about the Conemtech multi-level offering.

Overview of the Conemtech Product Offering

The Conemtech C3 core is a processor with an unusually flexible architecture. The flexibility is derived from an extensively writable microcode. This enables development of on-chip peripherals and highly efficient application specific functions defined and adjustable by the microcode. This patented technology has been used in the components C32 and C34 where a hardware timestamping unit is able to timestamp both incoming and outgoing packets on the Ethernet channels with a very high resolution and accuracy.

The processors also offer additional interfaces, such as high-speed DMA, MII/RMII, SPI, COM, ADC, DAC and GPIO (General Purpose I/O interface), thus meeting the different demands in data throughput and flexibility. Together with integrated TCP/IP and IEEE1588/PTP v2 protocol software it makes C32 and C34 'complete and ready-to-go' solutions for time and frequency distribution and synchronization based on the IEEE1588 standard. Further firmware releases can extend their application to new areas, such as IEEE802.1 AS.

In order to shorten the development time for a full application Conemtech has developed a set of processor modules and system modules at different integration levels. With the release of the M50 system module product range the offering has been brought to a level where the integration of a Precise Time Protocol unit is limited to PCB routing for an LCC84 component. No software driver is required. From this very high level of component, the development engineer has the option to start programming the device, more or less advanced.

Customers can choose from three levels of integration:

Level	Integration
A. Entry level – a PHY Replacement Application	Placement of the LCC84 component M50-34 in the schematics and on the PCB. The component acts as a PHY. It can output a synthonized frequency, precise pulse and time of day for use by the local environment.
B. Programmed T&F Controller	Definition of the M50 as a subsystem to a host processor. Control and Monitor of T&F functionality by the API's inside the module. The module connects to host by e.g. SPI or telnet. The different API's enable user control at different levels of the PTP processing, Loop Controller and peripheral I/O's.
C. Application Processor Replacement	At this advanced level the complete application is moved to the M50 module eliminating the need for a host processor. The programmer can use the advanced IDE to port the existing code to the M50-34 C-language environment. Many of the C32 and C34 peripherals are available on the pins of the LCC84 package.

Application 1 – A Remote IO PHY Replacement Circuit

The M50 is designed to enhance the Ethernet interface with a minimum of design change from a traditional Ethernet circuitry. The module could be seen as a drop in replacement for an existing PHY circuit, including its peripheral passive components. Like in the remote I/O application in figure 1.

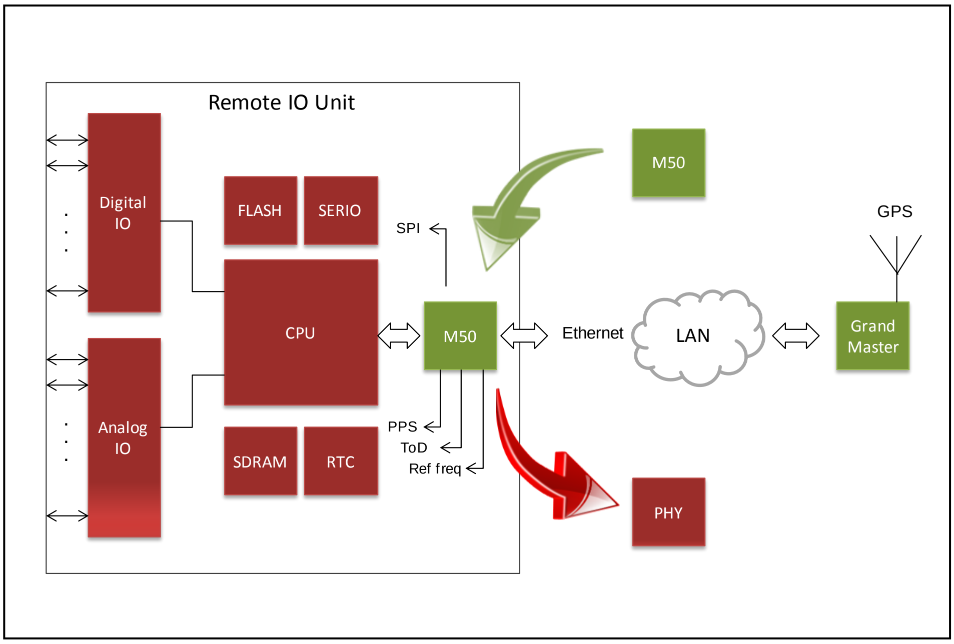

Figure 1: Replacing PHY of Remote IO unit

The PCB integration is to remove the old PHY and its peripheral components. The M50 connects to the magnetics and connector on one side (Tx, Rx, Link LED etc). The other side connects to the reduced MII interface of the processor. See Figure 2.

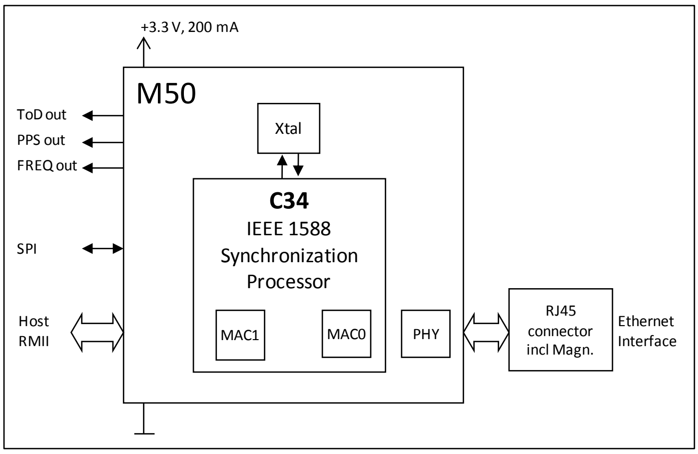

Figure 2: PHY replacement schematics

In this application the developer can chose to use e.g. the SPI interface to control the basic performance of the module, or a telnet port. Without such control inputs the unit operates on its default parameters. If there is a centralized timing controller in the network, the M50 can be monitored and controlled remotely. Without control this is an integration example on level A (see page 3).

For a reliable time and frequency output the M50 requires a Precise Time Protocol (PTP) Grandmaster in the network. The on-board crystal oscillator can provide short term holdover.

Application 2 – A Femtocell Network Interface

The femtocell represents the smallest cell defined today (rem. 2010) of the cellular network. It is normally related to the 4G technologies WiMax or LTE, but is also used in relation to the 3G networks. For the purpose of this application note the following description can also represent the picocell level of hierarchy. The different business models used for the two are not important here. One should however remember that the picocell often carries a higher payload on the Ethernet due to its higher capacity in terms of simultaneous users. The M50 is designed to handle a radio traffic payload of up to 60 Mbit/s in a Fast Ethernet network using the feed-through mode. If higher data rates are required a simple three-way switch can be inserted in the Ethernet path. However, the benefit of using just one IP address for the base station is lost as the PTP and Wireless processors will receive different IP addresses from the server with this setup.

Figure 3 shows how the M50 connects in between the wireless base band processor and the Ethernet port of the femtocell. Due to the high requirements on timing accuracy and frequency stability and the complex network of its deployments, the monitor and control of the M50 and its network loop controller will be assumed either by a centralized control or by the host processor in the femtocell, the wireless baseband processor.

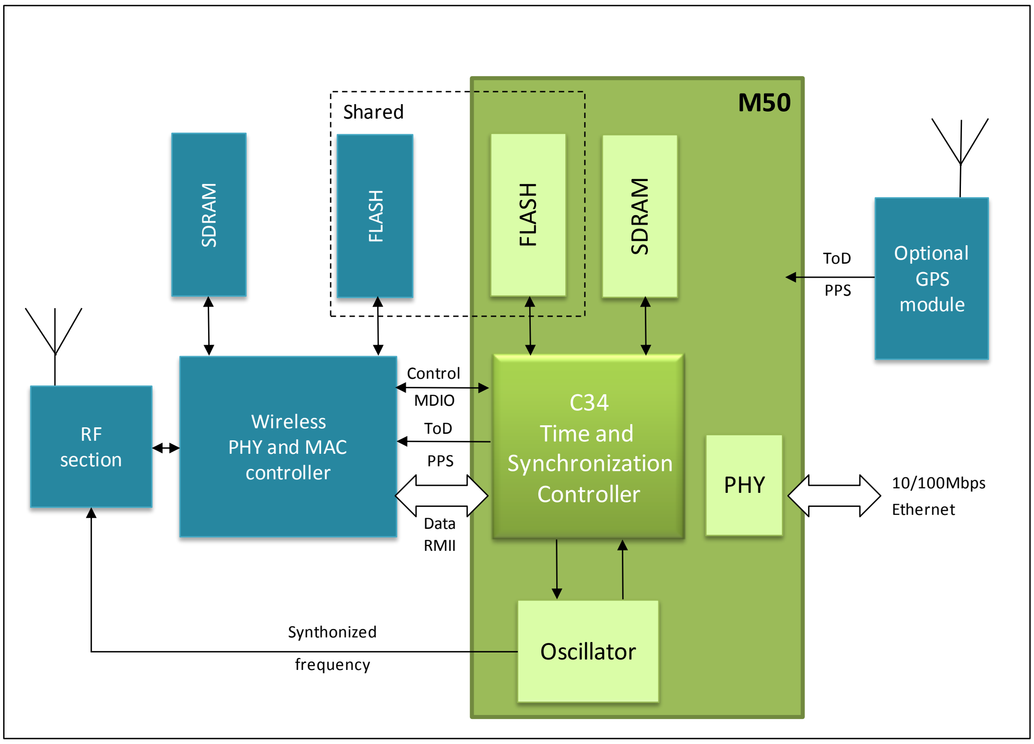

Figure 3: M50 in a femtocell application

In figure 3 an optional GPS has been added. A GPS can be found in many of the first prototypes of femtocells which have appeared on the market. GPS will probably still be used for the outdoor mounted and more expensive units. The M50 features a standardized GPS interface and can be introduced to create a 1588 timing source backup in the event of a satellite black-out.

This integration corresponds to the integration level B of the listing on page 3. The M50 is defined as a subsystem to the wireless controller. The femtocell is a cost sensitive application and the M50 is therefore designed to be booted by the wireless controller making it possible to save cost by not mounting a flash on the M50.

The M50 can provide a synthonized reference frequency of 5/10/20/25 MHz (selectable) feeding the radio of the cell. The RF section contains converters and filters to correct carrier frequency.

The M50 schematics for this application can be seen in figure 4. It is similar to the one in figure 2 with the exception of the two input signals PPS and ToD providing the timing information from GPS as long as it has a high quality reception (see enough satellites).

When the GPS signal is lost, the M50 switches over to use the network based grandmaster as the time source.

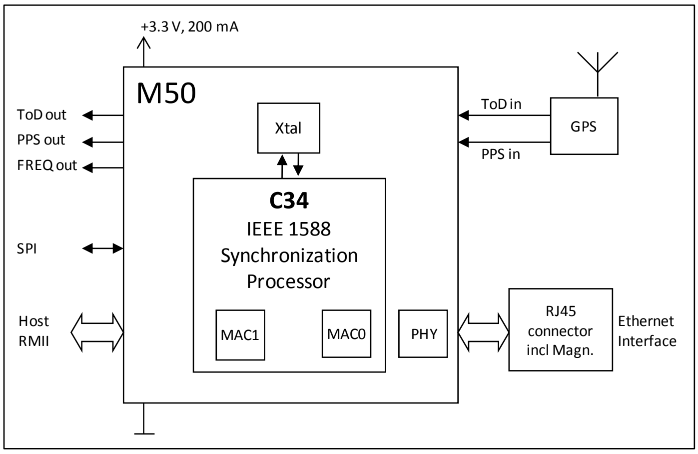

Figure 4: Femtocell schematics for M50

For typical consumer in-door applications the 1588 synchronization will be used thus lowering the synchronization costs considerably versus the GPS or very precise local oscillator alternatives.

The on-module crystal is optimized for low cost and for a master tracking operation. If the network connection is lost in this application, there is no need for holdover in the cell as the data path is closed. The M50 can deliver only short range holdover to shut down calls in a controlled way. If the system setup however is different and the cell should maintain intra-cell calls, an external oscillator of choice can be added to the schematics. The M50 automatically senses the existence of such an external oscillator.

Application 3 – The EdgeGrandMaster, a GPS based Grandmaster

In the PTP standard all nodes are able to act as both master and slaves. The Best master clock algorithm in a slave can select from a number of available masters in a network. If it finds no other it enters a master mode.

In the following application the M50 is locked into a master mode at startup. Its Pulse-per-Second (PPS) and Time-of-Day (ToD) inputs are connected to a reliable time source, in this case a GPS. As long as the M50 module has valid signals on these inputs it can act as a stratum 1 clock in the network (clock based on the UTC reference). In the event of a signal loss the M50 goes into holdover mode for a certain period of time. The quality parameters are configurable. If there is an other active master in the network the unit goes into a passive mode, if not, the unit will be in a free-running state until it receives valid PPS/ToD inputs again.

The network configuration in a PTP system calls for setting the number synchronization per second the master is sending (sync rate) and the number of delay requests a slave is permitted to ask for per second as inputs to its delay measurements. The capacity of a grandmaster is often measured in the number of slaves it can handle. The M50-34 is designed to handle up to approximately 200 slaves simultaneously.

Conemtech claims the space of EdgeGrandMasters which is the opposite of the centralized Timeserver strategy. Many low-cost Grandmaster units can be placed close to the end user equipment – the Edge of the network. The times service becomes more redundant and overall performance potentially increases due to the lower number of hops between the grandmasters and the subscriber units.

Moving to level C of integration (see page 3) a grandmaster unit can be entirely built on the M50 (figure 5). It essentially consists of five elements: a GPS module with an antenna, an M50, an external oscillator (pref. OCXO), the RJ 45 connector with magnetic and a power supply. Such a EdgeGrandMaster has a BoM of less than 80 USD. Feeding power over Ethernet (PoE) is possible due to the low power consumption and doesn't change the BoM too much. Using PoE technology the unit can be fit together with an antenna in a very small box and be placed wherever an Ethernet cable can be routed. No other connections required. The self-configuring PTP network topology solves all configuration problems. The slave units just get another master "in the neighborhood". The EdgeGrandMaster constitutes an easy and straight forward way to deploy the PTP into an existing network without the need for installing new PTP enabled switches in the network.

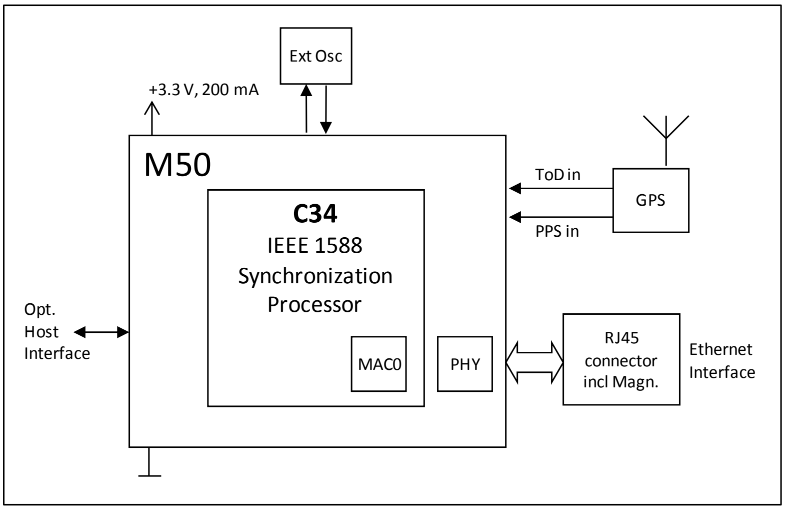

Figure 5: An EdgeGrandMaster Application

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