Activities of Seven Solutions & Marubun

Solutions

MARLIBLIN CORPORATION

ALWC2018 May 29, 2018 MARUBUN CORPORATION TOMOKI YONEKAWA

Manager, Positioning Timing Team, Sales Dept.4 Systems Sales & Marketing Division

Introduction to Marubun

MARLIBLIN CORPORATION

Profile

Founded	1844
Incorporated	July, 1947
Head Office	8-1, Niihonbashi Odenmacho, Chuo-ku, Tokyo
Capital	¥6,214M
Fiscal Year	Apr.1-Mar.31
CEO	Shoji Mizuno
Revenue	Consolidated: ¥270,698M (Mar. 2017) Non-consolidated: ¥159,483M (Mar. 2017)
Employees	Consolidated: 1,397 (Mar. 2017) Non-consolidated: 671 (Mar. 2017)
Listed	The 1 st Section of the Tokyo Stock Exchange(7537)

Domain



Revenue Trend(Consolidated)

(Million YEN)



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Introduction to Marubun



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Introduction to Marubun

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One of our subsidiaries, Foresight Techno, is an Engineering company with a cutting edge technology and a sufficient support structure. Foresight Techno can provide not only the maintenance, the field and repair service but also the call center and the consulting service to satisfy **our customer demands**.



About Seven Solutions:

Seven Solutions S.L. is a privately held leading company in <u>accurate sub-nanosecond time</u> <u>transfer, control systems and frequency distribution</u> for reliable industrial and scientific applications. The company has been grown continuously through the years and, at the moment; we are 30 engineers with high experiences and training from hardware to application level.

With more than ten years of expertise in embedded systems design (electronics, Radio Frequency applications, firmware, embedded software), we have already worked successfully in cutting-edge projects from different sectors such as avionics, telecommunications, Smart-Grid, space, military and scientific facilities as particle accelerators and radio-telescopes.

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SERVICES

- Custom electronics design: PCB (carriers, FMCs, XMCs, ...), Time and RF distribution equipment, dependable and safety critical platforms.
- Embedded systems programming: DSPs & SoC software, FPGA gateware, drivers development, dependable firmware for safety-criticial and industrial applications.
- Electronics production externalization: CE/FCC labeling, production test suites, quality control (IPC-610 rules).
- Fast control and system integration: including HW/SW (VME, VPX/OpenVPX, XMC, mictroTCA) and software APIs with EPICS.
- Custom Timing & Control Solutions: accurate calibration, OEM modules, FMC carriers & mezzanines, standalone nodes.



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Introduction to Seven Solutions

Experts in control, timing and synchronization

Seven Solutions has built its reputation as **accurate timing providers** contributing to the development of the **White Rabbit technology (WR)** in close collaboration with **CERN** and other scientific institutions, to bring **sub-nanosecond** time precision to distributed scientific and industrial instrumentation.

Part of our success has been our ability to adapt WR to multiple infrastructures as KM3NeT, CTA or IFMIF-EVEDA as well as to industrial facilities, avionics, radar or telecommunications.



Introduction to Seven Solutions

Key expertise areas

Today, we have long expertise on

Performance Test benches.

Electronics design.

PikeOS.

EPICS.

FPGA IP cores design.





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Products & Project examples

✓ RF & Time distribution✓ RF control systems

RF & Time distribution Product

Synchronization technology key specs

Distribution of global time references in a determinist and dependable way.

- Deterministic <u>time</u> distribution with accuracy \rightarrow 1 ns.
 - Long distances (hundreds of km).
 - Many hops (14 tested keeping subnanosecond accuracy).
 - Sub-nanosecond event timestamps (ps for Ethernet traffic).
 - Dependable: redundant network topologies, holdover, switchover, etc.
- Simultaneous transmission of standard data packets over the same timing link.
- High scalability.
- Packet-based technology compatible with PTPv2 (IEEE-1588)
- Heterogeneous timing interface (PTP, IRIG-B, NMEA, etc).

White Rabbit Switch

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White Rabbit LEN

The cost effective node to distribute synchronization



White Rabbit ZEN Time Provider

The ultra-precise standalone node with Redundancy & security features



RF & Time distribution Product

Other products

- Starting kits that will ease the first contact with the White Rabbit technology.
- Embedded nodes designed to be integrated into your product as OEM module.
- PCIe FMC carriers to bring White Rabbit to the user's pc.
- IO cards to starting playing with White Rabbit technology.
- FMC cards designed to produce precise pulse delays and accurate timestamps.
- Standalone node to achieve sub-nanosecond synchronization in your applications.
- and much more...

Other non-timing products include prototyping boards and control systems for avionics, Space, defense, etc.



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IFMIF/EVEDA: LIPAC accelerator

RF Control Systems

- The LIPAC is a fully representative of the IFMIF low energy (9 MeV) accelerator and is completed at Rokkasho in Aomori Prefecture (Japan).
- A total nominal power of 2.65 MW will be injected in the Radiofrequency Quadrupole (RFQ), the Medium Energy Beam Transport (MEBT), and the Superconducting RF Linac (SRF Linac) cavities by means of 18 RF power chains.



Solution



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RF Control Systems

- Development and install the Low-Level Radio Frequency systems (LLRF): responsible to control/tune the RF cavities in the accelerator. It also supports the synchronization, data logging and fast interlock system related to the RF cavities.
- Use of White Rabbit technology for Master Oscillator distribution and timing synchronization (post mortem analysis, fast interlocks and controls)



• And the **RF distribution** for other RF system parts: BPMs, RF monitoring,...



RF Control Systems

Not scalable

x

Ultra-precise RF dissemination

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Scalable

RF Control Systems Project

LLRF system

- Control of acquisition, interlocks and data logger through EPICS platform & CSS/BOY.
- Integration of White Rabbit protocol to synchronize LLRF systems, timing distribution, triggers,...
- Characterization and calibration of the ADC (16chs of 125MSPS) and DAC (2chs of 1,2GSPS).
- Python testing procedure to check the quality of the components (PLL, VCXO, ADC, Attenuators, etc).
- LLRF system maintenance, centralization and updates.





Fablures Hill Con¹⁴ 7, 25 GHz Haudrone 64.4 processor (Marc GH24) Schmall Character Sch 46 GH26 Sch All Antoinen, ECC Sch 24. Antoneosco¹⁴ and sites Landed and rot 70 20 Jonghy-Parts, De Elsenet, 20 SB Landed and rot 70 20 Jonghy-Parts 70-00 Landed and rot 70 20 Jonghy-Parts 70-00 Hand and rot 70 20 Jonghy Fabric Schwart Hand and Sch 20 Key Jonghy Fabric Schwart Mangemet February Antoneosco 20 Key Jongh Tehmant Mangemet February





Beam Pulse Mode			
Beam Pulse Mode	OFF		
Feed Forward Mode	OFF	OFD	
FF Loop Ki	0	0	[0-65K]
Chain Delay (ns)	0	0	[10ns-5us
Conditioning Mode			
Conditioning Mode	OFF	OF	
Auto Mode	OND	ON	
Pulse Width (us)	0	0	[10us-1s]
Pulse Period (us)	0	0	[10ms-30:
Number of Pulses	0.0	0.0	[0-65K]
Chain Delay (ns)	0	0	[10ns-5us
Vacuum Low/High	Low ON	High ON	

LLRF Main Parameters Setup

Amplitude & Phase	Setup		Write Def
Cavity Voltage (mV)	446.68 mV	446.66 m	[0-1400]
Cavity Volt. (dBm)	3.000 dBm		
Cav. Volt. Limit (mV)	900.00 mV		
Cavity Phase	35.00	35.00	[0-360]°
Amp. Ramp Rate	0.06r 🔻	0.06r 🔻	mV/s
Phase Ramp Rate	0.5 d 🔻	0.5 d 🔻] %/S
Amp RefMin (mV)	300.00 mV	300.04 m	[0-1400]
Amp RefMin (dBm)	-0.458 dBr		
Phase RefMin	45.00	45.00	[0-360] °
PI Limit	800.00 mV	799.99 m	[0-1K] m\
Ki	850	850	[0-1M]
Кр	0.06	0.06	[0-16]
En. AmpPh Loops	Open	Open	
Gain K	1.00	1.00	[0.01-4.0]
Look MO Ref.	OFF		•
Quadrant	1 🔻	1 *]
En. Vcav PhShift	ON	ON	
Phase Shift Vcav	135.00	135,00	[0-360]°
Enable Vctrl PhShift	OFF)
Phase Shift Vctrl	0.00	0.00	[0-360]°
# Samples to Avg	2 🔻	2 🔻]
Filter Stages	0 -	0 -	1

Product examples Solutions

LLRF Control loops:

• Feedback loop (FB loop): Control of the amplitude and phase of each cavity field at 175MHz. (bandwidth req. 10KHz)

FB Stab. test with 200kW Amp: Test > 2h = < 0.15%



- Conditioning loop: Manual and Automatic.
- Beam Pulse (FF loop): Manual and Automatic Feed-Forward loop.
- **Tuning Loops**: Control of the resonance frequency of the cavity. Two type of tuning:
 - Mechanical tuning: step motor control
 - Frequency tuning: modify the RF output frequency to avoid power reflection through the chain.
- Automatic start-up.
- Multi-LLRFs control loop: Master/Slave implementation (RFQ cavities)

Product examples

- RF direct acquisition and generation
- Emergency stop (Fast interlocks control): Reception and processing of authorizations to suppress the excitation of the power amplifiers: less than 900nsec with optocoupled and 1,9usec with dry-contact.
- Signal diagnostic and **post mortem analysis up to 100MSPS**: SDL, FDL, RDL (Extra libraries to process data saved)
- Clock distribution and RF synchronization (WR)
- Temperature compensation

Signal Stability	Features (stand alone mode)
Analog Output	Nominal frequency: 175 MHz
	Harmonics: < -60dBc & Spurious: < -65dBc
Analog Output (Amp & Ph. stability)	Max. Peak Amplitude error: < ± 0.04% full scale
	Max. RMS Phase error: < 0.08° (100Hz-1MHz)
	Amp&Ph. Loop Bandwidth: > 10KHz
Dynamic range	RF adjustable power: -54dBm< X < 14dBm



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International recognition

Seven Solutions has participated in major research projects in collaboration with prestigious institutions as CERN (Switzerland), GSI (Germany), CIEMAT (Spain), and IAA (Spain).

Worth to mention is our professional knowledge and our problem-solving capacity that have allowed us to develop complex analog and digital electronics for leading international facilities like IFMIF-EVEDA, LHC (CERN), FAIR (GSI), CTA and KM3NeT.

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Seven Solutions is a high-tech company providing <u>deterministic synchronization technologies</u> as well as embedded design services for markets as space, defense or telecommunications.

Seven Solutions is the leading company providing White-Rabbit based synchronization technologies. It has grown during last 5 years to become a <u>worldwide reference in innovative timing, control system</u> <u>and Radio Frequency solutions</u>.

We have long expertise on FPGA systems, firmware and RTOS for embedded systems and electronics design. Our solutions are used in several ESA Space missions, Airbus aircrafts, Defense equipment and particle accelerators around the world.

We love challenges and are keen to collaborate!



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Collaboration frame



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The scope of this collaboration is the provision of services in the particle accelerator field in Japan which can include software, control, hardware, gateware, and operation support in order to adapt the functionalities of the control systems through the accelerator (Low Level Radiofrequency Systems, Beam Position systems, timing distribution, radio frequency dissemination, fast interlocks and synchronize post mortem analysis) to the growing requirements of the accelerator installation, conditioning, commissioning and operation.

The services we can provide goes from application level, high level software programming, FPGA programming and hardware to provision of new hardware for timing, RF distribution and synchronization, high level control system routines (developed in EPICS or other remote control systems) and system integration tasks.

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Thanks for your attention!

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