

<b>Project</b>	CERN-TMS
<b>Date</b>	2007-06-14
<b>Reference</b>	Cern-tms/tmsSigGen
<b>Version</b>	1.0
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## 1. References

- IT-3384/AB: Technical Specification for a new trajectory measurement system for the CERN Proton Synchrotron.
- Alpha Data's TMS Tender "pre-design-1.5".
- Emailed questions answered by Jeroen Belleman of CERN.
- Visit to CERN on 2006-06-20
- TMS design documents systemDesign, pupeFpgaDesign, pupeBoardDesign.
- TMS Development and Support website at: <http://portal.beam.ltd.uk/support/cern/>.

## 2. Introduction

This document covers the usage of the Trajectory Measurement System's signal generator. The tmsSigGen is designed to produce simulated Proton Synchrotron test signals for testing and support of the CERN Trajectory Measurement System.

The tmsSigGen can produce live signals through an Arbitrary Waveform Generator PCI card or create ASCII files with the data from a specific PS cycles period.

To gain an understanding of the overall systems design please refer to the [systemDesign](#) document

## 3. Signal Generator Hardware

The tmsSigGen's hardware is based on an 8 Channel, 12-Bit, 150 MHz (MS/sec) Arbitrary Waveform Generator PCI card. The card used is Chase Scientific Company's DA8150. The data-sheet for this board is available at: <http://www.chase2000.com/da8150/da8150.pdf>



Each of the boards 8 outputs provides 2Volts peak to peak into 50 Ohm's through an SMA connector. There is also a TTL Marker output. This has been used to drive the CYCLE\_STOP signal. The channels are allocated as follows:

<i><b>Channel</b></i>	<i><b>Pupe</b></i>	<i><b>Level Shift</b></i>	<i><b>Usage</b></i>
1	Ana1-a	No	Sigma
2	Ana1-b	No	DeltaX
3	Ana1-c	No	DeltaY
4	RefClk	Yes	SYSTEM_CLOCK (10Mhz square wave)
5	T8	Yes	FREF (437KHz approx square wave)
6	T6	Yes	INJECTION
7	T7	Yes	HCHANGE
8	T2	Yes	CYCLE_START
Marker	T3	No	CYCLE_STOP (Not implemented as yet)

Each of these channels is connected directly to the appropriate TMS's digital timing and analogue signal inputs through an SMA to LEMO-00 adapter lead.

The DA8150 board is installed in a conventional PC based computer running the Fedora Core 6 Linux operating system.



### 4. Signal Generator Software

The **tmsSigGen** or **tmsSigGenGui** applications generates the test signals that are produced by the DA8150 Arbitrary Waveform Generator PCI card. The **tmsSigGen** application is a simple, command line, application allows the generation of a complete PS machine cycles or sub-cycles. The **tmsSigGenGui** is a GUI application that provides the same functionality. It is relatively easy to add a new test cycle to the program to allow a particular aspect of the TMS to be tested.

The **tmsSigGen** application has the following command line options:

<i>Option</i>	<i>Description</i>
-t <type>	Specifies the test signal type (beam1, beam2 etc)
-T	List all test types supported
-l <n>	Signal level (1.0 is full scale)
-s <freq>	Sample rate (Default 150MHz for card and 125MHz for file)
-p <period>	TMS period to output, defaults to complete TMS cycle.
-o <fileName>	Outputs data to an ASCII file rather than signal generator card
-c <num>	Channel number to output, default is all
-i 1	Set integer output mode (14 bits)

The **tmsSigGen** generates a set of data for each orbit of the PS. This set of data is repeated multiple times before moving onto the next set of data. The FREF clock frequency is modified slightly so that its waveform fit into the signal generators repeat rate. The actual frequencies used are displayed on running the **tmsSigGen** application.

The following PS periods are defined:

<i>Period Number</i>	<i>Description</i>
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1	Calibration Period
2	Harmonic0 Period
3	Harmonic1 Period
4	Harmonic2 Period
5	Harmonic3 Period

## 5. Signal Generator Tests

The tmsSigGen application is designed to emulate a number of different PS machine cycles. The software generates data for a complete PS machine cycle of about 1.2 seconds and repetitively outputs this data. A number of different PS machine cycles are supported and it is relatively easy to add different cycles for testing different attributes of the TMS system. See the TMS Technical Specification document for more information on the PS machine cycles. This is at:

<http://portal.beam.ltd.uk/support/cern/tenderInfo/IT3384Specification.pdf>

The following signal generator test signals are currently supported:

<i>Test name</i>	<i>Description</i>
beam1	Outputs a repetitive 1.2 seconds TMS Cycle with a beam. The beam has 4 particles at harmonic 8.
beam2	Outputs a repetitive 1.2 seconds TMS Cycle with a beam. The beam has 4 particles at harmonic 8 moving to 4 particles at harmonic 8
beam3	Outputs a repetitive 1.2 seconds TMS Cycle with a beam. The beam has 4 particle bunches at harmonic 8 moving to 8 particle bunches at harmonic 16

## 6. Software Installation

There are three components to the software that needs to be installed. All of these components are available as Linux RPM binary packages, Linux RPM source packages or in raw source code form. The first two components are the DA8150 driver and API library, the third package is the tmsSigGen application itself. The packages are named: da8150, da8150-driver and tmsSigGen.

The RPM binary packages can be simply installed using the Linux “rpm -i <package>” command after downloading the packages.