



## RD12 TTC Transmitter Mini-Crate User Notes

Rev 1.0

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### Introduction

The TTC transmitter mini-crate is intended for experiment and prototyping work by system developers. It provides up to 12 channels of optical TTC signals having characteristics similar to those which can be delivered to 1024 destinations by a normal TTC transmitter crate incorporating a high-power laser source. The crate contains a variable number and type of individual modules which can readily be changed as new components are introduced. The modules are interconnected by Lemo cables on the front panel which allows them to be configured in various ways for carrying out different tests.

These User Notes are updated and expanded from time to time and comments are welcome. The latest revision is available from B.G. Taylor or from the Documents section on the RD12 website <http://www.cern.ch/TTC/intro.html>.

### Identification

The Crate ID No. (e.g., M10) in a circular white label above the right chassis handle allows the records of the status of a crate to be checked. It can be helpful to quote it with any query.

### Safety

The optical output from each channel is invisible infra-red energy at a wavelength of about 1300 nm and power level of up to -14 dBm. Never bring the eye close to the open end of an optical connector when the equipment is powered on.

There are 220v connections to power supplies at the back of the crate. Remove the mains cable from the power input module before any intervention.

## Cooling

The modules contain ECLinPS ICs and power regulators and also temperature-sensitive analogue circuits, optoelectronic components and two quartz oscillators. The power connection from the crate backplane to the ventilation unit under the modules should never be disconnected and some clearance should be provided for air intake below the fans. (e.g., if the crate is operated on a table instead of in a rack it should be supported a little above the table surface). Replacement filters for the ventilation unit are available. As there are different filters for the different types of ventilation unit which have been fitted, be sure to quote the Crate ID No. when requesting them.

## Configuration

The actual configuration of modules supplied in a crate can vary somewhat and the illustration is only representative. From left to right the following modules may be present:

- Optional 4th Triple Tx module
- Optional 3rd Triple Tx module
- Optional -2v Regulator and Fanout module
- Optional 2nd Triple Tx module
- Triple Tx module
- TDM Biphase Mark Encoder module
- 160.32 MHz VCXO-PLL module
- 2v Regulator and Test Switch module
- Clock Generator module
- Optional Demodulator or Monitor Rx module
- Triple Power Supply,  $\pm 15\text{v}$  and  $+5\text{v}$
- Main Power Supply,  $-5.2\text{v}$
- Power supply filter module

## Signal standards

All electrical inputs and outputs at front panel Lemo connectors have 10E ECL signal swings. Balanced signals which have no DC component (e.g., all clocks, the Biphase Mark Encoder output and the Monitor Rx output) are AC coupled and may be viewed directly by an oscilloscope with a  $50\ \Omega$  termination to ground. Signals which are not DC balanced (e.g., Test Switch outputs, A and B Channel data inputs to the Encoder) are standard ECL levels and the input terminations for these are  $50\ \Omega$  to  $-2\text{v}$ .

The standard ECL signal sockets are identified by a round blue label, while the AC-coupled signal sockets have no such label. The outputs are well buffered from internal timing circuits sensitive to skew and jitter by ganged internally-terminated drivers.

You can plug around compatible signals quite freely. For example, if you want to send a square test waveform just plug the 40.08 MHz or 80.16 MHz clock output directly into a Tx module. Or if you want to lock the VCXO to a reference received over an optical link, just plug the Monitor Rx output directly into the VCXO-PLL REF I/P, etc.

## Interconnections

Various module interconnections can be made for test purposes but the interconnections most commonly used for normal operation are as follows:

The Clock Generator module has three 40.08 MHz outputs. One should be linked to the REF I/P to the VCXO-PLL module, one should be linked to the TTCvi module CLOCK IN bc/ecl socket, and the third may be used to trigger an oscilloscope or signal analyser.

The 160.32 MHz O/P of the VCXO-PLL module should be linked to the adjacent 160.32 MHz I/P of the BM Encoder module and one of the SYNC O/Ps of the Encoder module should be linked to the MON I/P of the VCXO-PLL module to close the loop. With these connections the Encoder clock (divided down to 40.08 MHz) is locked in phase with the reference signal from the Clock Generator. If it is desired to lock the 160.32 MHz VCXO to the reference signal without the Encoder present, the MON I/P can be linked to the adjacent 40.08 MHz O/P of the VCXO-PLL module itself.

The 80.16 MHz O/P or the additional 40.08 MHz O/P of the VCXO-PLL module may be used to clock a PRBS generator or other synchronous test equipment for clock jitter or BER measurement. For tests with a PRBS generator the ECL O/Ps of the test generator should be connected to the A and B Channel I/Ps of the Encoder module. If a single channel test generator is used it may be clocked at 80.16 MHz to obtain different data on the A and B channels. (The A Channel data are latched during the first half of the 25 ns bunch crossing interval and the B Channel data during the second half).

When operating with a TTCvi these I/Ps should be connected to the A/ecl and B/ecl CHANNEL OUT sockets of the TTCvi module using the same cable lengths for each. Adjust the phase by setting the BC DELAY switch on the front panel of the TTCvi by the procedure described in the TTCvi manual.

When operating with one or two Triple Tx modules, their I/Ps should be linked to the ENC O/Ps of the Encoder module. When operating with three or four Triple Tx modules, an additional -2v Regulator and Fanout module is added and its I/P linked to one of the Encoder O/Ps. The other Encoder O/P drives the first Triple Tx module and the three O/Ps of the Fanout module drive the other three Triple Tx modules. If any Tx modules in the crate are unused, do not leave their I/Ps open but avoid noise generation by connecting them to an Encoder or even just a 40.08 MHz O/P.

## Test switches

The two O/Ps on the -2v Regulator module are simply ECL logic levels which are controlled by the two switches on its front panel. The upper switch controls the upper O/P and the lower switch the lower O/P. Switch up selects logic 1 and switch down logic 0. These O/Ps can, for example, be linked to the A and B Channel data I/Ps of the Encoder for test purposes. With both switches at 0 the output of the Encoder should be a 40.08 MHz square wave and with both switches at 1 it should be an 80.16 MHz square wave. Transmission of the Idle sequence with no trigger accepts and no data being transmitted corresponds to A Channel switch 0 and B Channel switch 1.

## VCXO phase

There is a VCXO phase adjustment accessible from the front panel. Please don't touch it as it is set up on a test bench and, if you have a problem, twiddling this adjustment is sure to get you in deeper trouble. Because the phase is set up in a standard way, you will not have to make any adjustments if you exchange the VCXO-PLL module for another.

## External clock

Normally the system runs from its internal 40.08 MHz clock, selected with the switch on the Clock Generator module in the INT position. However, an external clock of frequency 40.08 MHz  $\pm$ 50 ppm may be supplied to the lowest I/P socket on the Clock Generator module and is selected if the switch is depressed to the EXT position. Note that  $\pm$ 50 ppm is only  $\pm$ 2 kHz so you cannot use a 40.00 MHz source. An ECL swing signal is required and the internal termination is 50  $\Omega$  to ground. To ensure an accurate 50/50 mark/space ratio the clock must be derived by subdivision of an 80.16 MHz source and if no degradation is to occur relative to the internal clock it should have an rms jitter of less than 6 ps and ground offsets between the external source and the mini-crate should be avoided.

## Optical outputs

ST/PC optical connectors such as 3M/Dorran Type FO-6105 should be used to connect optical fibres to the transmitter outputs. Index-matching gel should not be used. Note that a tiny dust particle can completely block the optical output and the dust caps supplied should be kept on unused optical outputs and inputs. Don't touch the ends of the ferrules with fingers and use filtered compressed air for cleaning.

When the ST Tx and Rx receptacles are new the connector ferrules can be quite stiff. In case of low optical signal level check that they are fully home since the bayonet caps can be locked before they are completely inserted.

## Optical fibre

One reel of 100m of connectorised fibre is supplied with each mini-crate to start with. The system is intended for operation with 50/125  $\mu$ m graded-index multimode fibre with a numerical aperture of 0.2 and a minimum bandwidth of 400 MHz.km at 1300 nm. Fibre attenuation at this wavelength should be less than 3 dB/km. For safety reasons, only fibre with a Low-Smoke Zero-Halogen (LSZH) sheath should be used, although if you employ hot melt connectors you may find the low melting point of such material an inconvenience. Optical fibre purchase requisitions at CERN are controlled to enforce the LSZH requirement and if you bring PVC-sheathed fibre to CERN it may not be permitted at the LHC.

## Monitor Rx

Although it is not a standard module of the mini-crate transmitter, a Monitor Rx may be provided for convenience in checking the optical output of any of the transmitters locally. The Monitor Rx can be housed in the crate to the left of the Triple Power Supply. Although this is a large standard slot, the module contains nothing but a small modular optoelectronic receiver with two AC-coupled ECL outputs and a carrier detect indicator. Either of the outputs may be connected directly to an oscilloscope or other test instrument with a 50  $\Omega$  termination to ground.

## Jumpers

Some of the modules such as the Clock Generator, -2v Regulator, VCXO-PLL and Fanout have internal jumpers. These are to allow the same modules to be used in different equipments and their settings should not be changed.

## Lemo cables

During the mid-1990s CERN received a consignment of Lemo cables of all lengths which had defective crimping, causing intermittent contacts, and many of these were distributed

before the defect was discovered. The Lemo cables supplied with the mini-crates have been tested and should be trouble-free but defective ones may be encountered if they are changed. After the manufacturing problem was rectified, the Lemo cables were fabricated with green labels instead of yellow ones. In case any yellow-labelled cables are suspect, change them for green-label ones.

### **Upgrading**

When a mini-crate is upgraded to a full high-power transmitter crate several of the modules and both power supplies can be recuperated, resulting in a cost saving.

### **Support contact**

In case of any problems with your mini-crate transmitter contact:

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