



Chromadigm CHS Transmitter

Quick Setup Guide

InnoTrans Chromadigm CHS Transmitter
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A	1/06/2016	Initial release
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1 Important Safety Instructions

- Carefully read all safety and operating instructions contained in this user guide before operating this equipment, and retain them for future reference.
- Follow all installation and operating instructions. Pay attention to all warnings and cautions in the user guide as well as those that are affixed to this equipment.

1.1 Electric Shock Hazard

This equipment meets applicable safety standards.

WARNING:

To reduce risk of electric shock, perform only the instructions that are included in the operating instructions. Refer all servicing to qualified service personnel only.

Adhere to the following safety warnings and guidelines:

- Dangerous Voltages
 - Only qualified service personnel are allowed to perform equipment installation or replacement.
 - Disconnect power before servicing the unit.
 - Only qualified service personnel are allowed to remove chassis covers and access only field replaceable pluggable accessories.
- Grounding
 - Do not violate the protective grounding by using extension cables, power cables, or other devices on the mains power without a protective ground conductor.
 - If this equipment is equipped with an external grounding terminal, attach one end of an 18-gauge wire (or larger) to the grounding terminal; then, attach the other end of the wire to a ground, such as a grounded equipment rack.

1.2 Installation Site

When selecting the installation site, comply with the following:

- Maintain a Protective Ground - The protective ground lead of the building's electrical installation should comply with national and local electrical and safety requirements.
- Environmental Condition – The installation site should be dry, clean, and ventilated. Do not use this equipment where it could be at risk of contact with water. Ensure that this equipment is operated in an environment that meets the requirements as stated in this equipment's environmental specifications.

1.3 Installation Requirements

WARNING:

Allow only qualified service personnel to install this equipment. The installation must conform to all local codes and regulations.

1.4 Equipment Placement

WARNING:

Avoid personal injury and damage to this equipment. An unstable mounting surface may cause this equipment to fall.

- Install this equipment in a restricted access location.
- Place this equipment close enough to a mains AC outlet to accommodate the length of this equipment's power cord.
- Route all power cords so that people cannot walk on, place objects on, or lean objects against them.
- Make sure the mounting surface or rack is stable and can support the size and weight of this equipment.
- Make sure that the rack is placed on a stable surface. If the rack has stabilizing devices, install these stabilizing devices before mounting any equipment in the rack. The mounting surface or rack should be appropriately anchored according to manufacturer's specifications.
- Ensure this equipment is securely fastened to the mounting surface or rack to protect against damage.
- This equipment has openings for ventilation to protect it from overheating. To ensure equipment reliability and safe operation, do not block or cover any of the ventilation openings.

WARNING:

Avoid personal injury and damage to this equipment. Mounting this equipment in the rack should be such that a hazardous condition is not caused due to uneven mechanical loading.

CAUTION:

Installation of this equipment in a rack should be such that the amount of airflow required for safe operation of this equipment is not compromised.

1.5 Power Connections

Connection to AC Power source

Important: If this equipment is a Class I equipment, it must be grounded.

- Connect this equipment only to the power sources that are identified on the equipment-rating label.
- Overcurrent protection breakers or fuses must be sized appropriately for the total current rating of the modules and accessories contained within a system chassis or multiple chassis that are connected to a common mains circuit.
- This equipment may have two power sources. Be sure to disconnect all power sources before working on this equipment.
- If this equipment **does not** have a main power switch, the power cord connector serves as the disconnect device.

Connection to -48 VDC Power Source

- Use at least #16 AWG wire for all DC power wiring.
- Overcurrent protection breakers or fuses must be sized appropriately for the total current rating of the modules and accessories contained within a system chassis.
- Follow the recommended practices of the DC power system manufacturer.

CAUTION:

Consider the connection of this equipment to the supply circuit and the effect that overloading of circuits might have on overcurrent protection and supply wiring.

1.6 Fuse Replacement

To replace a fuse, comply with the following:

- Disconnect the power before changing fuses.
- Identify and clear the condition that caused the original fuse failure.
- Always use a fuse of the correct type and rating. The correct type and rating are indicated on this equipment.

1.7 Laser Safety

This equipment may contain or be connected to an infrared laser source that transmits intensity-modulated light and emits invisible radiation.

WARNING: Avoid Personal Injury

The laser light source on this equipment or the fiber cables connected to this equipment emit invisible laser radiation. Avoid direct exposure to the laser light source.

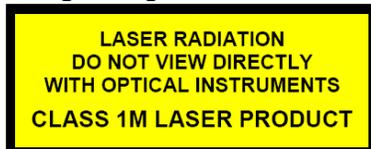
Viewing the laser output (if a transmitter) or fiber cable with optical instruments may pose an eye hazard.

This equipment may only be installed, operated and serviced by authorized personnel trained in the safe handling and operation of fiber optic cables and laser sources.

- Do not apply power to this equipment if the fiber is unmated or unterminated.
- Do not look into an activated fiber with optical instruments such as magnifiers, or microscopes.

1.8 Laser Power and Warning Labels

This equipment may contain or be connected to other equipment containing Class 1M laser sources. The following labels adhered to each product will indicate the type of laser source utilized along with general laser radiation labels.



2 Product Introduction

The Chromadigm CHS transmitter is a full 1002 MHz RF spectrum transmitter with four ITU DWDM lasers multiplexed onto a single optical output port in a 1 RU chassis. The CHS incorporates InnoTrans' Chromadigm CHIRP Cancellation and Clipping Mitigation technology, significantly advancing the performance of analog optical DWDM systems. The technology allows up to 44 consecutive, 100 GHz spaced ITU channels, while delivering exceptional MER and error-free, pre-FEC BER performance. Being void of distance tuning provides the flexibility to simply split the optical output into route diverse fiber rings without performance degradation or having to re-tune the transmitter when switched between different lengths of fiber.

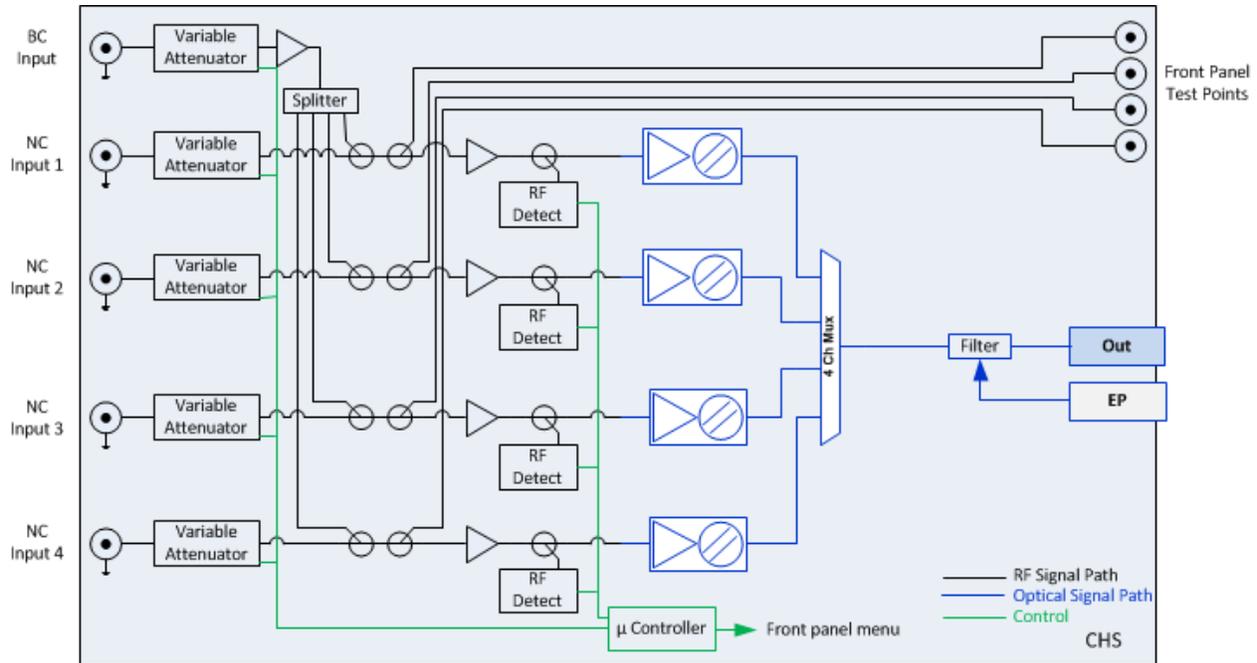
The CHS transmitter with its innovative technology sets the performance standard in DWDM full band systems offering a unique set of benefits:

- CHIRP Cancellation for distance independent performance
- Adaptive Clipping Mitigation for error-free QAM performance
- High OMI for superior CNR/MER performance
- Full utilization of the ITU DWDM spectrum
- Extended reach to eliminate remote Hubs
- Four integrated DWDM transmitters multiplexed on a single output
- Reduced network complexity for decreased operating expense
- Drop in upgrade for node segmentation and Hub eliminations
- Increased network reliability

The Chromadigm CHS is available with +6 dBm, +9 dBm or +12 dBm output power to support a wide variety of applications. Integrated, optical express ports can be added for extracting return path wavelengths or multiplexing additional forward path CHS chassis together.

3 Block Diagram and Operation

The following block diagram depicts the RF and optical signal flow through the Chromadigm CHS transmitter.



Chromadigm CHS Transmitter Block Diagram

The CHS transmitter has four ITU C-Band laser transmitters, each operating at a discrete wavelength, multiplexed together onto a single optical output. There are five RF input ports, a Broadcast (BC) RF input and four Narrowcast (NC) input ports. The RF signals that are common to each of the four wavelengths are connected to the BC input port. The common RF loading into the BC RF input port should occupy the RF spectrum to at least approximately 270 MHz to avoid SRS crosstalk degradation. The four NC RF input ports are utilized for channels which are unique to each individual ITU laser or wavelength and should be placed above 270 MHz.

The BC signal 1st passes through a variable RF attenuator. The attenuator is either automatically set through the feedback loop when operated in the AGC mode or may be set in the manual mode via the chassis front panel menu display, LAN or Local RS232 connection. Next the BC signal is amplified and split into four paths, one for each transmitter wavelength, and then combined with each of the four NC input signals. The NC RF input signal 1st passes through a variable RF attenuator. The attenuator is either automatically set through the feedback loop when operated in the AGC mode or may be set in the manual mode via the chassis controller interfaces, same as the BC operation. The NC channels are then combined with the BC channels creating a full-spectrum of channel loading from 54 MHz to 1002 MHz. The combined signal is coupled to a -20 dB front panel RF test point. The signal is amplified and then passes through a directional coupler used to sample the RF signal for the AGC control loop back to the input variable attenuators and the through path is applied to the optical laser.

Our patented Clipping Mitigation circuit is also within the RF path to mitigate instantaneous peak bursts of the Analog or QAM modulated signals which normally would overdrive the laser briefly resulting in bit errors of the QAM signals. It is important to note that the five RF variable attenuators are controlled together (ganged together) by the AGC feedback or by manual adjustment of the attenuator setting. Changing the attenuation value steps each attenuator together by the selected amount. It is therefore important that the RF levels connected to the chassis are closely balanced between each NC port. The microcontroller will adjust the four attenuators based on the sampled port with the highest composite total power reading.

The laser modulates the RF signals onto an optical signal with an assigned wavelength between ITU C-Band channel 20 to 63 then the optical signal is CHIRP cancelled and passes to the output port. An optional optical express port may be added for multiplexing additional forward path wavelengths or extracting return path wavelengths for connection to other equipment.

4 Module Setup

4.1 Setting RF input levels

The RF signals that are common to each of the four ITU lasers are connected to the BC input port. The common RF loading into the BC RF input port should occupy the RF spectrum up to approximately 270 MHz to avoid SRS crosstalk degradation.

The Narrowcast (NC) signal for each individual ITU laser transmitter is connected to the corresponding laser transmitter input port. Note that the NC input should be all QAM signals.

Determining the proper rear panel RF input level is important to ensure optimum transmitter performance. The following will provide guidance in calculating the proper adjustment to the per channel RF level for your actual channel loading from the reference channel loading level to ensure the proper total RF input power requirement is achieved.

Each CHS transmitter is factory optimized for a rear panel total input power of +38 dBmV for the combined BC and NC signals. This level provides 3 to 4 dB of reserve gain for the AGC operation. The reserve gain is the amount of headroom above the +38 dBmV reference level.

All QAM channels

The all QAM reference channel loading and per channel input level is 155 ITU-T J.83 Annex B QAM 256 channels between 54 - 1002 MHz set to 16 dBmV. The RF per channel level of 16 dBmV is calculated from the total power as follows:

$$\begin{aligned} \text{Total Power} - [10 \cdot \log_{10}(\text{channel load})] \\ 38 \text{ dBmV} - [10 \cdot \log_{10}(155)] = 38 \text{ dBmV} - 22 = 16 \text{ dBmV} \end{aligned}$$

Using the same formula to adjust for a lower channel loading such as a 750 MHz system with 110 channels:

$$38 \text{ dBmV} - [10 \cdot \log_{10}(110)] = 38 \text{ dBmV} - 20.4 = 17.6 \text{ dBmV}$$

Therefore with 110 of all QAM channel loading the correct rear panel RF input level is 17.6 dBmV at the input of both the BC and NC ports.

Mix of Analog and QAM channels

The mix of Analog and QAM reference channel loading and per channel input level is 80 NTSC analog (54 – 550 MHz) set to 18 dBmV and 75 ITU-T J.83 Annex B QAM 256 channels (258 - 1002 MHz) set to 12 dBmV. The RF level per channel for analog and QAM is calculated from the total power as follows:

Since there is a 6 dB power level difference between the QAM and analog channels it is easier if we convert the QAM channels to an equivalent analog power level in the formula below. The QAM RF level being 6 dB lower means the QAM power level is 1/4th the analog level. As a point of reference, -3 dB is 1/2 power and -6 dB is 1/4th power.

$$\begin{aligned} \text{Total Power} &= [10 \cdot \log_{10}(\text{Analog channel load}) + (\text{QAM channel load}/4)] \\ 38 \text{ dBmV} &= [10 \cdot \log_{10}(80) + (75/4)] = 38 \text{ dBmV} - 20 = 18 \text{ dBmV} \end{aligned}$$

Therefore the analog channels are set to 18 dBmV and the QAM channels are 6 dB lower or 12 dBmV.

Using the same formula to adjust for a decrease in the number of analog channels to 30 and increase the number of QAM channels to 124 and calculate the correct input level for each:

$$38 \text{ dBmV} - [10 \cdot \log_{10}(30) + (124/4)] = 38 \text{ dBmV} - 17.8 = 20.2 \text{ dBmV}$$

Therefore the analog channels are set to 20.2 dBmV and the QAM channels 6 dB lower or 14.2 dBmV.

4.2 Configuring the CHS transmitter

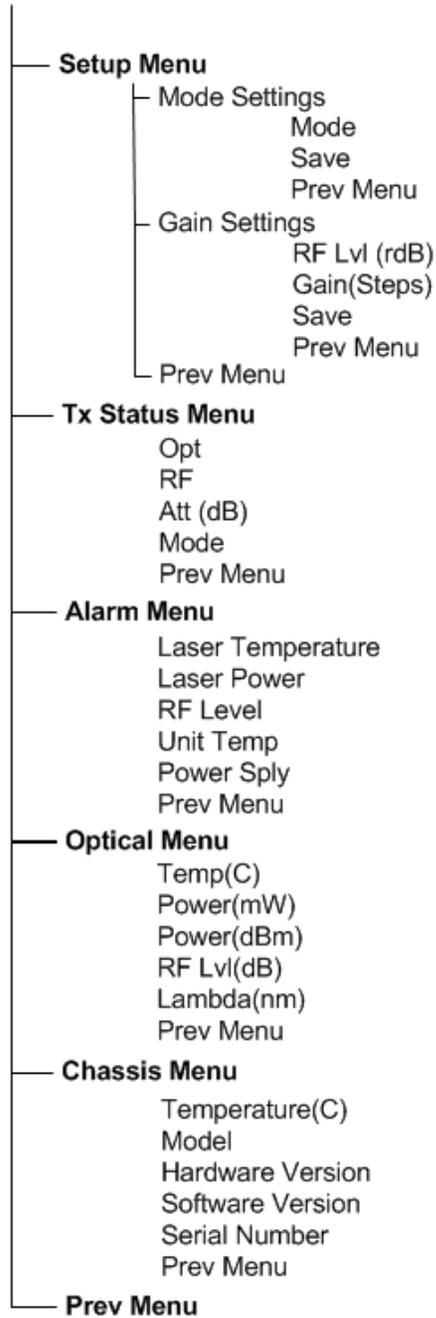
The setup, configuration and verifying the RF drive level for the CHS transmitter requires the operator to become familiar with the front panel configuration menus. Refer to the InnoTrans Document No: 2000010, Chromadigm Chassis – User Interface as a supplement to the following procedures which will reference the associated display parameters.

The following CHS menu tree will assist in navigating the front panel display.

Chromadigm Transmitter (CHS) Menu Tree

Greeting:

InnoTrans Communications
Chromadigm AGC



4.2.1 AGC mode

Operating in the AGC mode provides for plug-and-play RF level setting as the transmitter automatically sets the internal attenuators for the optimal laser drive level and OMI. The following provides the procedures and associated menus for configuring the CHS transmitter with the front panel display in the AGC mode. The CHS transmitter will be in the AGC mode as a default.

1. Connect power to the chassis.
2. With a combined Broadcast/Narrowcast total RF power of 38 dBmV as determined in 3.1, plug the Broadcast cable into the BC port and the four Narrowcast cables into the associated NC ports.
3. From the front panel RF Test Points confirm the Narrowcast QAM RF channels are set to the same level as the Broadcast QAM RF channels on each port. If not, correct the level difference coming into the chassis on each individual NC port.
4. Using the front panel menu navigate to the Tx Status Menu as follows. A CHS with 12 dBm output power is utilized in the example.

Press center key to enter sub menus. Press the down key until the cursor is highlighted on the Tx Status Menu.



Press center key to advance to the Tx Status Menu.



This menu displays the optical power of each laser (OPT:) where each laser is displaying 12 dBm \pm 0.2 dB and the “reference RF level” (RF:) is displaying the reference input level to each laser as 0 dB \pm 0.5 dB which is the expected reference level with a rear panel RF input level of +38 dBmV total composite RF power of the BC and NC combined signal.

5. Navigate to the RF menu to check for proper AGC reserve gain. Press the down key to move the cursor to the RF menu.



The RF menu now displays the reference RF level for each laser and the reserve gain “ATT (dB)”, in this case +3.2. The reserve gain should be between +3 to +4 with a rear panel RF input level of +38 dBmV total composite RF power of the BC and NC combined signal.

The setup is now confirmed to be correct.

4.2.2 MGC mode

The following provides the procedures and associated menus for configuring the CHS with the front panel display in the MGC mode.

1. Connect power to the chassis.
2. With a combined Broadcast/Narrowcast total RF power of 38 dBmV as determined in 3.1, plug the Broadcast cable into the BC port and the four Narrowcast cables into the associated NC port.
3. From the front panel RF Test Points confirm the Narrowcast QAM RF channels are at the same level as the Broadcast QAM RF channels on each port. If not, correct the level difference coming into the chassis on each individual NC port.
4. Using the front panel menu navigate to the Setup/Mode Settings menu.

Press center key to enter sub menus



The cursor is on the Setup Menu, press the center key to enter the Setup Menu, and then press the center again key to enter Mode Setting.



5. Under the Mode Settings menu place the unit in MGC mode and save the setting.

The Mode default is AGC. Press the right or left key to toggle to MGC and press the center key. The Mode changes from AGC to MGC however the change is not initiated until the action is saved. The current mode is shown in the parenthesis in the Save line shaded below.



Press the down key to move the cursor to the Save position.



Press the right or left key to toggle between Save No and Yes.



Press the center key to select yes. The mode status in the parenthesis will change from AGC to MGC.



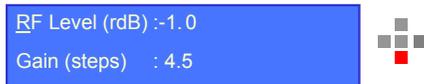
- Next navigate to the Setup/Gain Settings menu to set the attenuators for the proper laser drive level.

In the Mode/Gain Setting menu press the down key to move the cursor to Gain Setting. Press the center key to select.



- The Gain Setting Menu displays the RF reference level, *RF Level (rdB)*, and the attenuator gain step setting, Gain (steps). The gain setting is adjusted for a RF Level of 0.0 ± 0.5 dB. In the example below the reference level is -1.0 so the attenuator needs to be adjusted.

Press the down key to move the cursor to Gain (Steps)



- Adjust the Gain (Steps) to add or remove the attenuation steps until the *RF Lvl* displays 0.0 ± 0.5 dB in the TX Status/RF menu.

Press the select key and press the right or left key to change the Gain (Steps) setting to obtain a reference level of 0.0 ± 0.5 dB.



Press the center key to select the new value and press the down key to navigate to the Save menu.



- Save Gain (Steps) value.

Press the down key to move the cursor to Save. Press the right or left arrow key to toggle between Save: No and Yes.



Press the select key to save. Note the value in the parenthesis has now changed to the new value.



10. Navigate to the TX Status menu to check the RF value of each port.



The RF menu now displays the reference RF level for each laser and the reserve gain “ATT (dB), in this case +3.2. The reserve gain should be between +3 to +4 with a rear panel RF input level of +38 dBmV total composite RF power of the BC and NC combined signal.

The setup is now confirmed to be correct.