MEDIATECHNOLOGYSYSTEMS INC.

PROFESSIONAL MULTI-CHANNEL POWER AMPLIFIERS

DS-Series
DHV Series

766 LAKEFIELD ROAD, WESTLAKE VILLAGE, CALIFORNIA 91361 U.S.A. www.mediatechnologysystems.com
Part # MAN-0308-MCA-RevB

FCC Compliance Notice & Interference Statement.

THIS DEVICE COMPLIES WITH PART 15 OF THE FCC RULES. OPERATION IS SUBJECT TO THE FOLLOWING CONDITIONS. THIS DEVICE MAY CAUSE HARMFUL INTERFERENCE. THIS DEVICE IS DESIGNED TO ACCCEPT AND OPERATE WITH ANY INTERFERENCE RECEIVED. THIS INCLUDES INTERFERENCE THAT MIGHT CAUSE UNDESIRED OPERATION.

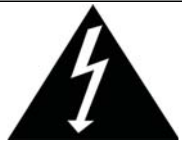
CAUTION: ANY CHANGES OR MODIFICATIONS MADE WITHOUT THE EXPRESS APPROVAL AND PERMISSION OF MANUFACTURER, VOID RESPONSIBILITY OF MANUFACTURER FOR COMPLAINCE.

THIS EQUIPMENT HAS BEEN TESTED BY A COMPETANT BODY AND FOUND TO COMPLY WITH THE LIMITS FOR A CLASS-B DIGITAL DEVICE, PURSUANT TO PART 15 OF THE FEDERAL COMMUNICATIONS COMMISSION RULES. THESE LIMITS ARE DESIGEND TO PROVIDE REASONABLE PROTECTION AGAINST HARMFUL RF ENERGY IN A RESIDENTIAL INSTALLATION.

THIS EQUIPMENT, IF NOT PROPERLY INSTALLED IN ACCORDANCE WITH THIS MANUAL, LOCAL, STATE AND NATIONAL RECOMMENDED PRACTICES, MAY CAUSE HARMFUL INTERFERENCE TO RADIO COMMUNICATIONS. SUCH INTEFERENCE AND CAN BE DETERMINED BY SWITCHING THE DEVICE ON AND OFF. THERE IS NO GUARANTEE THAT THE DEVICE WILL NOT CAUSE INTERFERENCE. TO RADIO AND TELEVISION RECEPTION. USER IS ENCOURAGED TO TRY TO CORRECT ANY INTERFERENCE BY ONE OR MORE OF THE FOLLOWING MEASURES:

-RE-ORIENT OR RELOCATE THE RECEIVING ANTENNA
-INCREASE THE DISTANCE OF ANY EQUIPMENT AND THE DEVICE.
-CONNECT THE DEVICE TO A DIFFERENT A/C POWER CIRCUIT OUTPUT TO THE RECEIVER
-CONSULT QUALIFIED TECHNICIAN OR A RADIO.TV SPECIALIST FOR ASSISTANCE.

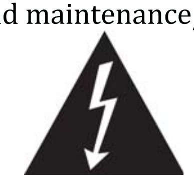
Explanation of Symbols



TO PREVENT ELECTRIC SHOCK DO NOT REMOVE COVER.
NO USER SERVICABLE PARTS INSIDE. REFER TO QUALIFIED AND CERTIFIED SERVICE PERSONNEL. SMPS/PFC CARRY POTENTIALLY LETHAL VOLTAGES.

CAUTION
RISK OF ELECTRIC SHOCK DO NOT OPEN

The exclamation mark in a triangle is intended to alert the use to the user to the presence of important operating and maintenance/service instructions in this manual.



The lightning flash in a triangle is intended to alert the user to the presence of un-insulated “dangerous” voltages with the product’s chassis that may be sufficient to create a risk of electric shock to humans.

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1 Welcome

1.1 Important Safety Instructions

- Important Safety Instructions:
- Read these instructions.
- Keep these instructions.
- Heed all warnings.
- Follow all instructions.
- Do not use this apparatus near water.
- Clean only with dry cloth.
- Do not block any ventilation openings. Install in accordance with the manufacturer's instructions.
- Do not install near any heat sources such as radiators, heat registers, stoves, or other apparatus (including amplifiers) that produce heat.
- Do not defeat the safety purpose of the polarized or grounding-type plug. A polarized plug has two blades with one wider than the other. A grounding type plug has two blades and a third grounding prong. The wide blade or the third prong is provided for your safety. If the provided plug does not fit into your outlet, consult an electrician for replacement of the obsolete outlet.
- Protect the power cord from being walked on or pinched particularly at plugs, convenience receptacles, and the point where they exit from the apparatus.
- Only use attachments/accessories specified by the manufacturer.
- Unplug this apparatus during lightning storms or when unused for long periods of time.
- Refer all servicing to qualified service personnel. Servicing is required when the apparatus has been damaged in any way, such as power-supply cord or plug is damaged, liquid has been spilled or objects have fallen into the apparatus, the apparatus has been exposed to rain or moisture, does not operate normally, or has been dropped.

1.2 Introduction

The Media Technology Systems Series of multi-channel power amplifiers are professional products specifically designed for Systems Integration, Commercial, Industrial applications. To get the maximum performance from your product, please read and study the contents of this manual.

Features: MTSI amplifiers are sophisticated products designed for their applications using many decades of accumulated experience in all areas of design, manufacture, and an understanding of final use and abuse of these products.

In large installations, power usage is a significant consideration. MTSI multi-channel amplifiers all feature SMPS with PFC and Class-D output stages, to maximise efficiency and space. The amplifier family consists of 2 ranges with different functions and applications:

DHV: 70/100V Control & Monitoring amplifiers
DS: 4/8Ω Control & Monitoring amplifiers

The specifics of each of these model series will be covered in this text. Since much of the basic functionality of these amplifiers is common, this manual is designed to cover the complete range. Take care to refer to the text for specific details or differences between models.

Each MTS multichannel amplifier features Power Factor Correction, a Switch Mode Power Supply and Class-D output stages, for maximum efficiency, cool operation and consistency of performance on any A/C power.

These amplifier series are designed for a number of different system uses and vary in sophistication and specification according to the demands of each application

1.3 How to use this manual.

This manual provides you with valuable information for safely and correctly installing, setting up and operating your amplifier. It is not possible to cover all aspects of installation and application of complex product. However, we have attempted to supply all critical and essential information, plus advice and explanations where relevant. There is a great body of work re amplification and sounds systems best practices, available from many sources on line. MTSI will, from time to time add "White Papers" and Application Notes to our website. As well as additional information on amplifier use and other valuable information.

It is particularly important that you read this manual and especially the Warnings and Cautions.

1.4 Terminology: Functions, Names & Acronyms.

Attenuation/Attenuator: An attenuator is used to reduce the level of an incoming signal. Many think the "volume" control on typical audio equipment makes the power of the amplifier greater. In fact amplifiers are typically pre-set with a specific amount of gain. The input attenuator or volume control is used to vary the amount of signal that is allowed through to the amplifier's gain section.

BGM - Back Ground Music: Typically low-level ambient music such as one would find in an elevator or super-market.

Bridge Mode: Bridge mode allows the installer to configure two amplifier channels to drive one given loudspeaker load with four times the power than either of the single amp channels alone. There are important factors and considerations to understand when using this mode of operation. In effect two amplifiers are driven out of phase with each-other and their output connections are made to work in push-pull mode on each side of the speaker plus/minus load connection. In bridge mode, a nominal 8 Ω loudspeaker "looks" to each of the two amps connected, like a 4Ω load. For example: A two channel pair of amplifiers with 300 Watts capability each into 4Ω can now deliver 600 Watts into an appropriately rated speaker load of 8Ω. Normally one 300 Watt into 4Ω amp can only deliver 150 Watts into the 8Ω load. But using Bridge Mode, we can now power the same loudspeaker to 600 Watts should it be required and the speaker rated for that power level.

Note: 70/100 Volt amplifiers are not "bridge mode" capable.

Do Not Use 2 Ω or 4Ω loads across a bridged output pair. The minimum impedance usable is 8Ω. It should be understood that in this mode, each of the amplifiers in the bridged pair is looking at half the total speaker load impedance. Thus an 8Ω load actually presents the minimum 4Ω load to each amplifier in the pair.

Class-D Amplification: A switching amplifier or class-D amplifier is a electronic amplifier where the active devices (especially in the output stage) are operated as on/off switches. Class-D amplifiers have the potential to provide audio power at higher efficiencies that alternative methods further increasing the efficiency of the systems and valuably reducing wasted energy dissipated as heat.

Amplifier efficiency vs Loudspeaker efficiency. Class A-B amps are typically around 40% or so, class-D can be much higher. 100 Watts of input power gives you 40 Watts of audio electrical power and 60 Watts of heat. See above. It should be noted that loudspeakers are a completely different order of transducer. The best and most efficient single woofer available anywhere on the market today has only around 2% efficiency! For every 100 Watts we push into that speaker only 2 "acoustic" Watts of audio (Sound Pressure Level) is produced, with 98 Watts coming out as heat. And this example uses the highest efficiency speaker! Typical home stereo speakers may convert electrical power into SPL at 0.1% or worse. Electrical power not converted into "work" moving the piston, must be dissipated as heat. Heat is the great enemy of loudspeakers and as you can understand, there is a lot of heat to get rid of. Speakers are not particularly good at venting this waste heat, particularly when driven at high levels for long periods. Damage or failure is often the result of poorly chosen or designed systems. It is advisable to check the speaker manufacturer's data, in particular the power compression numbers. Power Compression is a phenomena where the heat build up in a speaker's voice coil raises the impedance of the coil from its nominal or spec'd level to sometimes double or more. Thus an 8Ω load, under high sustained levels, can easily turn into a 16Ω load with the result of having half the efficiency. The requires double the level of drive power to make the original desired sound pressure level, and so on downwards in a spiral and burn-out as the operator increases the power to get back to the desired levels. The better the loudspeaker the better its ability to convert electrical energy into "work" =output and the less heat dissipated. The better the loudspeaker design the better its ability to dissipate heat without damage. Larger voice coils, proper top-plate and gap design, air flow, high temperature materials, etc., all provide improvements, but cost more money to make. Good system design and anticipation of the performance demands, with sufficient numbers of loudspeakers for coverage and power can make the difference between a poor and unreliable system and a great system for the customer's needs.

CMRR: Common Mode Rejection Ratio, is the ability for an input circuit to reject noise interference and other artefacts induced on the input signal lines. A balanced line, or differential input has two, opposite and equal, plus and minus, input connections and a centre ground reference. The cable has two conductors and a shield or ground connection. At the transmit/send/source end of the cable the audio signal is split and one side is inverted in phase. Over a run of cable any hum, buzz or other electromagnetic inference, not effectively shielded b y the cable is picked up and theoretically induced equally on both the plus and minus conductors. Thus we have the intended signal running out-of-phase and any induced noise running in-phase across the two conductors. These opposite and equal signals are brought into a differential amplifier where the phase of one of the signal that was in inverted is put back into phase and the two signals added together. The signals since they are complementary add together. The noise which was in phase is inverted added together but now out of phase and thus cancelled. The instrumental Instrumentation input is of the highest quality where the circuits and values of the components are closely matched. The more closely matched the two sides of the input are the greater the ability of the circuit to reject and common mode signals.

COMMs Board: MTSI designation for the Communications Module that manages internal communications and external interface, control etc.

D .C. A Direct Current offset on the speaker terminal of more than +/-5v DC.

DEGSON: The 'Degson' -type connector is a pair of high current, latching, output connectors used for speaker and 70/100V Line loads. Rated at 300V/15A these connectors are reliable, of high quality, and simple to install and re-configure.

Fault: The LED when illuminated indicates a fault has occurred in one of the amplifier modules that has triggered the automatic protection circuitry to suspend operation of that channel. There are automatic sensing circuits in the amplifier that constantly monitor and re-check circuits. Should the fault condition continue for some time, disconnect the signal input and the speaker-load and re-cycle the power switch. If the fault condition continues, refer to a qualified and MTSI approved service technician.

Hi-Pass Filter – HPF: A High Pass Filter is used to roll-off or attenuates signals below a selected frequency. For example a 100 Hz HPF with a 6dB per octave roll-off characteristic will have a nominal response that is -3dB at 100 Hz from the normal flat bandpass, and will be -9dB down at 50 Hz. A 12dB per octave filter is double that of the 6dB type. In an amplifier the HPF is classically used to limit the power an amplifier is asked to supply at low frequencies. Typically distributed loudspeakers and many Voice Coil loads used for voice, paging and BGM do not require low frequency content below 100 - 120 Hz. These loudspeakers are designed for speech frequency range efficiency and optimized in the system for power and

Latency: Effectively the difference in the time delay of a signal from send to receive. Low latency is considered in the 2ms to 12ms range. Above the 12ms latency the delay between an original signal and the reproduced signal becomes perceptible and detracts from the intelligibility of the communication. Note: In paging applications latency is not an issue since there is rarely "open-microphone" use as in entertainment or other "Live" uses.

Module Micro: This board is fitted to each two channel amplifier module of networked and Control & Monitoring series amplifiers. It provides networked series amplifiers with remote VCA control for level and gain, metrics gathering and transmission and other amplifier board automation and communications.

Multi-channel Mode: In two channel amplifiers the word Stereo is often used to describe Left and Right, or separate multi-channel mode. Since MTS amplifiers are available from 2 to 8 channels in 2 channel increments, we will use the term – multi-channel.

Peak: The LED when lit indicates a high level signal is present at the amplifier's input. Caution should be exercised since signals at this level are close to, or are clipping the amplifier. Occasional peaks are acceptable. Constant peak indication should prompt a review of the system and its use demands. MTSI amplifiers have graceful overload characteristics which progressively, rather than catastrophically clip.

Load Condition: A mismatched load such as a short circuit load or non-standard low impedance load.

Phoenix/Euro Type Connector: Phoenix-type 3 circuit connectors are used for audio signal input to the amplifier channels. Input impedance is 20k Ω balanced, 10kΩ unbalanced.

Power: The Power LED when lit, indicates power is applied to the unit.

Power Factor: The power factor of an AC electric power system is defined as the ratio of the real power to the apparent power, and is a number between 0 and 1. A pure resistive load has a PF of 1. Real power is the capacity of the circuit for performing *work* within a particular time. Apparent power is the product of the current and voltage of the circuit.

Power Factor Correction: A PFC provides the means of increasing the power factor within an electrical system and therefore its efficiency. It can be an active or passive input circuit that changes the power factor of the input current to a device so that it is closer to a Power Factor of 1.0. Numerous benefits include reduced input line current and lower input harmonics. It is also a technique for counteracting the undesirable effects of electric loads that create a power factor (p.f.) that is less than 1 (one). In commercial applications with the potential for multiples of amplifiers required for emergency paging where life could be at risk, (UPS) uninterruptable power supplies are often used. The size and cost of these battery backup systems is reduced when the efficiency of the powered items is improved. Additionally power saved is beneficial to the operating costs of a facility as well as the environment.

RS-485: An IEEE standard protocol for signal distribution. http://en.wikipedia.org/wiki/RS-485

Signal Present: The LED illuminates with the presence of a low level signal at the amplifier's input. This is a useful feature for visually confirming signal flow to this point in a sound system.

SMPS: Switch Mode Power Supply, is a type of power supply topology, which takes the incoming potential energy from the A/C power line and "chops" it into very short pulses. In the MTSI series amplifiers, we use an SMPS frequency of 100KHz Normal Linear Power Supplies use the incoming A/C wave form (typically 50 or 60 Hz and either 120V or 240V) and rectify the energy into DC, which is stored in the supply capacitors. This is a PFC - Power Factor Corrected

Standby LED: This LED illuminates when the amplifier is held in a non-operational state. When un-lit, the amplifier is on-line and ready for use within 3 seconds.

Termination-1: Commonly use term for connecting input and output cables.

Termination-2: In the networked and control & monitoring amplifiers, the RS485 connector is provided with a "termination" selector switch to apply a 150Ω resistive load to the I/O. This is often used to "load" the TX/RX driver. Check the requirements of the interfacing device and select the appropriate setting.

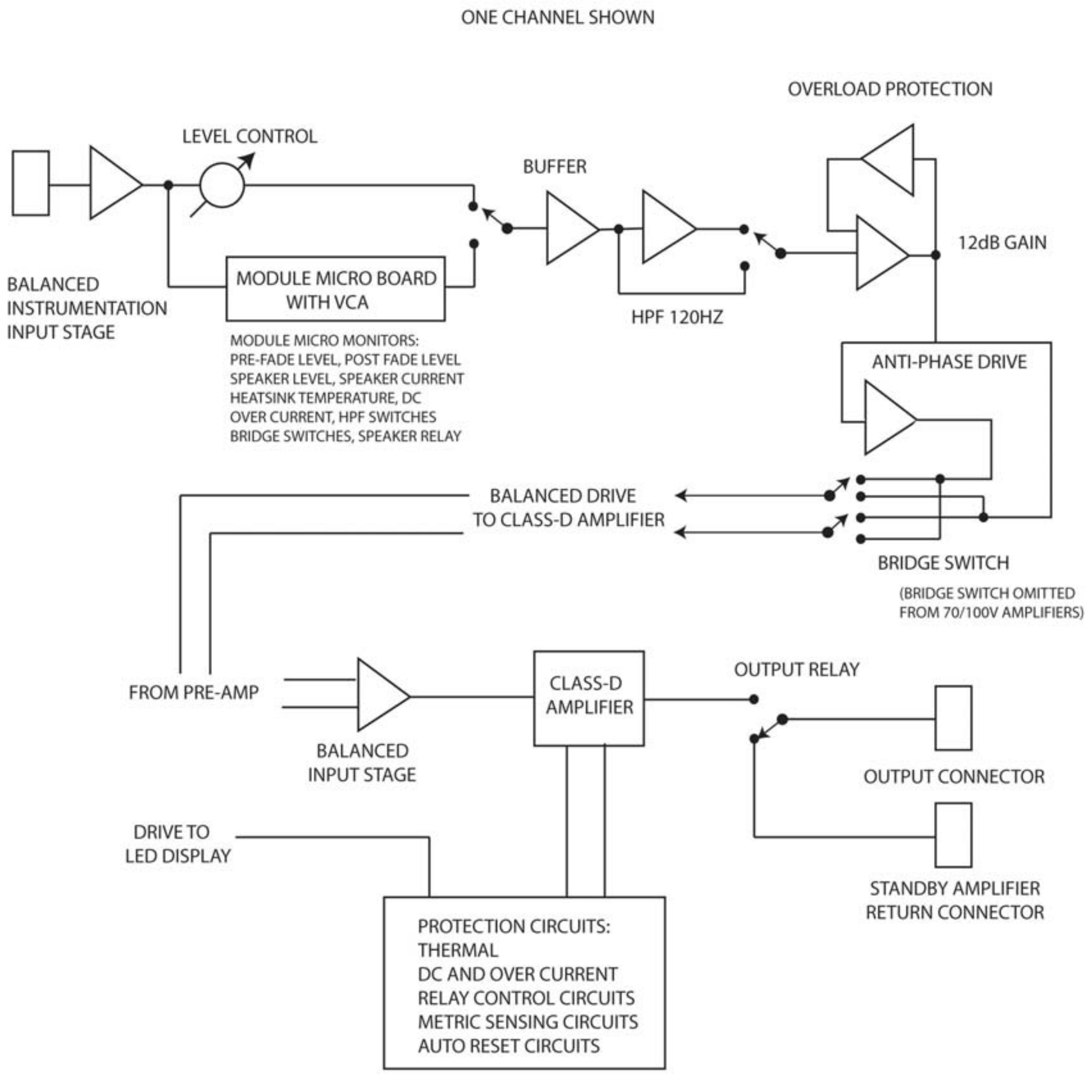
Thermal: heat-sink temperature has reached 75 deg C.

1.5 MTSI Multi-Channel Amplifier: Models/Options

DHV-Series: The DHV Series of modular power amplifiers are designed of application to Paging applications using 70 or 100 Volt Line, constant voltage distribution system. Prior to powering the amplifier select either 70 or 100 V on the mode selector beneath the AC power switch. At power up the DHV amplifier will configure its SMPS/PFC supply to provide the appropriate rail voltages and gain settings for this type of operation.

DS-Series: DS Series Multichannel power amplifiers are designed for application to low impedance, 4, 8 and 16Ω direct loudspeaker loads. The minimum nominal load impedance on all this series is 4Ω.

1.6 Amplifier Signal Path:



This description refers to one channel of a power amp module. Note: MTS amplifiers are constructed using two channel amp modules. Depending on the output power required, the chassis may be configured for up to 8 channels with a maximum "chassis" total audio output of 2400w.

For example:

8 channels. 4 of any 2 channel module of 75, 150 or 300W per channel.
4 channels. 2 of any 2 channel module to a maximum of 2 dual channel 600w modules.
2 channels. One of any two channel module up to a maximum of 1, dual channel 1,200 watt module.

Signal Flow: A balanced analog signal is fed into each 3.5mm three pin input socket. (unbalanced connections may be used, but depending on signal levels, the risk of noise interference is significantly increased) Please refer to the section later in this manual where a full description is available on how to connect to the various ports on the rear panel of the amplifier.

The incoming audio signal is routed through a fully balanced *instrumentation amplifier*. This vastly superior input circuit, outperforms the simple single op-amp type used by most manufacturers, greatly improving CMRR and providing superior rejection of unwanted ultra sonic signals.

The output of the instrumentation input stage is converted to a single ended signal for further processing through the module.

After the input stage, a switch selects the routing through either a passive trim potentiometer (in basic amp models) or through the Module Micro.

In the Control and Monitoring section, the signal may be controlled by a VCA (Voltage Controlled Amplifier). For applications requiring higher gain where there might not be an external pre-amps, such as in some paging situations, an additional 12dB of gain is available at this stage. The VCA is part of the Module Micro Board, which is fitted to all control and monitoring and networked models, where its primary function is to sense and communicate all important parameters and conditions within EACH channel of amplification.

The following functions are performed and monitored by the Module Micro processor board:

1. Module Signal Gain, when this card is used an extra 12dB of voltage gain is available.
2. Input Level Control.
3. Post fader level control
4. Speaker output voltage monitoring
5. Speaker Current: (through monitoring this data the connected computer can calculate instantaneous power. Since program signals are stochastic and loudspeakers represent highly dynamic elements in the system, smoothing or averaging is desirable for information to be of any value. This function is the job of the monitoring computer program. MTSI supplies the raw data rather than interpreting anything so)
6. Heat sink temperature.
7. Speaker relay control .
8. The position of the HPF and bridging selectors is monitored. (not available on 70/100v line type modules). The operator may check the settings of the physical switches by viewing their status on the computer console.
9. Protection: If an amplifier channel exhibits a DC offset of greater than 5v on the speaker terminal.
10. Protection: If the output current has exceeded a safe value for that particular type and power rating of the amp module.
11. Individual amplifier channel speaker relays may be turned opened or closed by the operator.

Standby Amplifier Connection: Each amplifier output channel features an additional special input to which the output of a Standby Amplifier may be connected. In the unlikely event of a faulty amp channel, the amp's protection circuits automatically lift the connection from the internal amp to its normal output. At the same time, the relay connects the incoming 'Standby Amplifier 'through the speaker relay terminals, to the original speaker load. (Any other channel or amp may be used as backup/standby, even one in the same chassis. However, for complete redundancy it is advisable to use a completely separate Standby Amplifier chassis.)

An internal selector switch bypasses the Module Micro and selects between "simple" or micro processor mode. This switch is NOT user accessible.

The signal is passed through a unity-gain buffer which assures a low impedance drive for the High-Pass filter section. The switch selectable HPF is 12dB per octave, Butterworth response with its -3dB point at 120 Hz.

The final pre-amplification stage contains a 12dB gain section, a balanced drive stage and an over drive compressor which prevents any possibility of amplifier clipping. This final protection limiter is set well above the normal linear signal levels required to give the rated power any the specific amplifier and thus does not interfere or create any audible change in a normal signal. Only under catastrophically high input levels, where severe clip would be apparent, does the limiter/compressor come into effect.

Loudspeakers can handle surprisingly high, short term-transient overdrive signals but are easily damaged by high levels of amplifier clipping. The limiter/compressor thus provides additional protection for the loudspeakers from misuse and abuse.

The signal flows to the Bridge Switch (not available in the 70/100v modules) which allow those 4/8Ω or "voice coil" modules to be operated in bridge mode.

NOTE: When operated in bridge mode, each channel of a bridged pair of amps "sees" 50% of the total load impedance it is driving. Thus a 4 Ω speaker load presents a 2 Ω load to each of the bridged pair of amplifiers. Since this is below the rated output impedance of the amplifier(s), caution must be exercised when connecting any speaker load to a bridged pair of amp channels. Check and confirm that the load is within driveable parameters.

Line type (70/100v) modules have a control buss and sensing which automatically changes the control & monitoring metrics and control circuits to suit each different model, as well as the adjusting the overall gain structure of the amplifier. 100v operation requires +3dB more gain over 70V. This function keeps the input sensitivity at -8dBr whether the amplifier is in 70 or 100v mode.

The balanced signal is fed to a balanced input stage which then drives the Class-D power amplifier. The output of each channel is fed through the contacts of a high current speaker relay which performs two functions. Firstly it facilitates the option of using of an external standby channel amplifier (see above) and secondly performs muting duty holding the relay open until all internal sensing and management determines the system is performing to spec and is stable.

Should for any reason, a channel's heat sink temperature reach an unsafe level (>70 deg C), the speaker relay is disengaged and the load is 'lifted'. The relay will automatically re-engage once the heat sink temperature as dropped to a safe level.

An over-current condition will trigger two protection circuits. Firstly the Class-D amplifier is shut down virtually instantaneously (1/400,000th of a second) and secondly the speaker relay is disengaged. These actions prevent damage to the Class-D amplifier and the load. An auto-reset circuit will re-engage these functions after about 5 seconds. If the fault condition still exists the process is repeated until it is corrected.

The LED display is driven from each module. The Signal Present, green LED displays (as you'd expect!) the presence of a low level signal at the input. The red LED displays signal peaks which approach the maximum output of a channel. The amber LED displays a fault condition.

1.7 Power Supply Description:

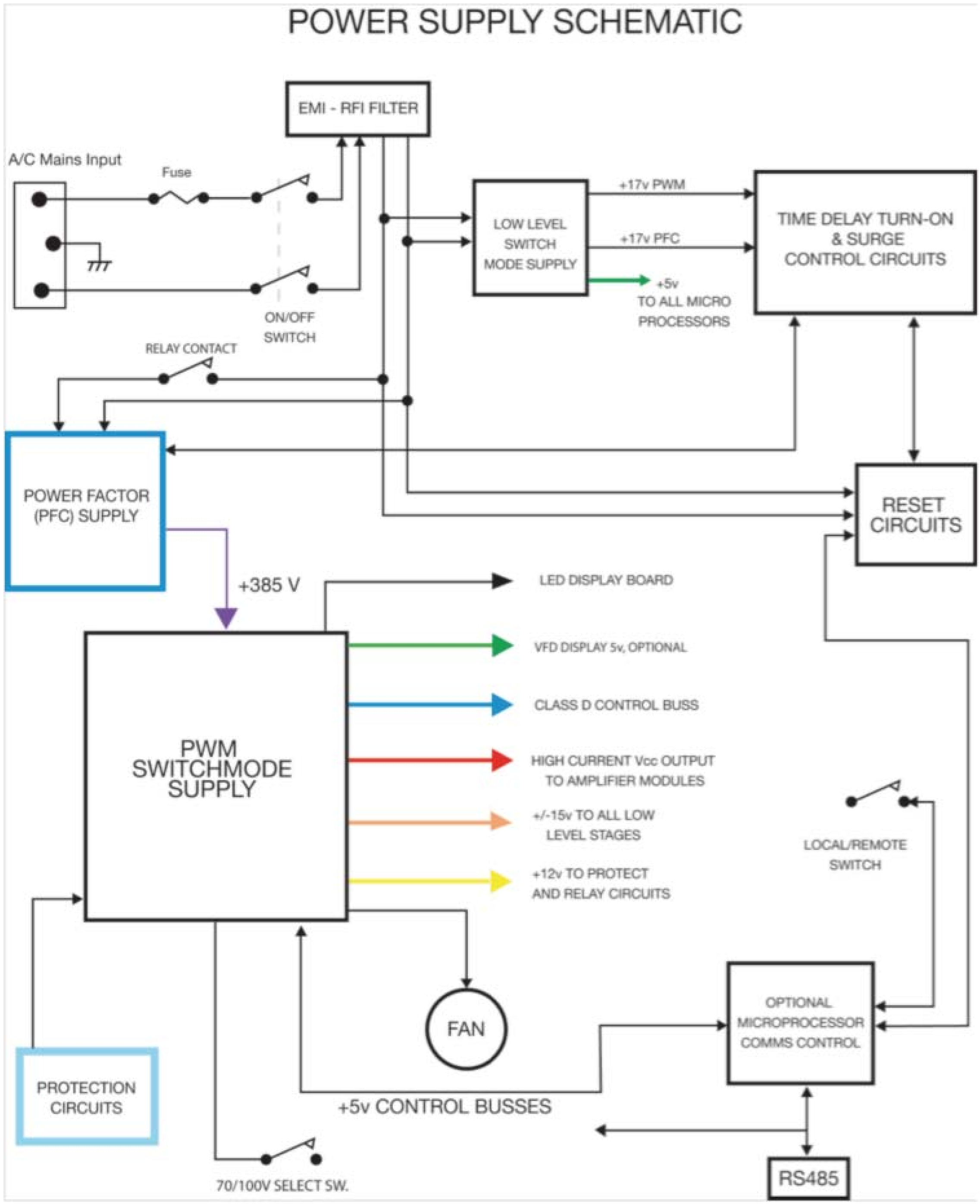
All MTS amplifiers use a Power Factor Corrected (PFC) Switch Mode Power Supply (SMPS). This type of supply has several advantages over their linear counterparts. Firstly the power supply conforms to new regulations , either proposed or in place in certain countries, which demand that any supply over 70 watts be a PFC type. An ideal PFC supply is "seen" by the A/C mains supply – wall socket, as a pure resistive load. MTS amplifiers achieve a high and close to theoretically perfect power factor in excess of 0.99. Last the supply draws less current from the AC supply saving the consumer expense over the life of the amplifier.

Importantly, MTSI has designed the SMPS so there is no need for a voltage selection switch. Since the amplifier will work on any nominal A/C mains input from 85 to 265 Volts and at any A/C frequency from 47-63Hz. Thus these amplifiers will deliver full rated power on virtually any input voltage even when 'brown outs' or poor stability can shut down or severely reduce required output power, in other less sophisticated products.

The A/C mains enters through a standard IEC connector, then a fuse and then a DPST power switch. For reliability this switch is designed with 100 amp surge capability even though the normal turn on surge is less than 0.5 amp. Next, an EMI/RFI filter blocks the transmission of interference back into the mains supply maintaining 'clean' power in the system for low system noise.

Micro processor versions of MTSI amplifiers require that the sensing and management circuits are kept active as long as the power switch is turned on, allowing the amplifier to be turned on by remote control.

We employ an additional low level SMPS power supply to power the Module Micros and Comms Board. This SMPS also provides start up voltages to get the main supply up and running.


POWER SUPPLY SCHEMATIC
EMI - RFI FILTER
A/C Mains Input
Fuse
ON/OFF
SWITCH
LOW LEVEL
SWITCH
MODE SUPPLY
+17v PWM
+17v PFC
+5v
TO ALL MICRO
PROCESSORS
TIME DELAY TURN-ON
& SURGE
CONTROL CIRCUITS
RELAY CONTACT
POWER FACTOR
(PFC) SUPPLY
RESET
CIRCUITS
+385 V
LED DISPLAY BOARD
VFD DISPLAY 5v, OPTIONAL
CLASS D CONTROL BUSS
PWM
SWITCHMODE
SUPPLY
HIGH CURRENT Vcc OUTPUT
TO AMPLIFIER MODULES
+/-15v TO ALL LOW
LEVEL STAGES
+12v TO PROTECT
AND RELAY CIRCUITS
LOCAL/REMOTE
SWITCH
FAN
OPTIONAL
MICROPROCESSOR
COMMS CONTROL
PROTECTION
CIRCUITS
+5v CONTROL BUSSES
RS485
70/100V SELECT SW.

1.8 Amplifier Power-up Sequence.

The Media Technology Systems multichannel power amplifier family consists of two series of control and monitoring products. Within these sophisticated products are a number of components and subsystems. For proper operation, a timed and monitored sequence of events takes place in which power supplies and circuits are activated. This section describes this turn on sequence and timing.

There are six power supply systems within the amplifier.

All microprocessor circuits are powered by a high current 5 Volt supply.

The main pulse width modulator control section, which itself controls the main switch mode supply, operate on low current supplies.

Another low current supply feeds the control circuits for the Power factor Corrector.(PFC)

A fully regulated 12 Volt supply feeds all control relays and protection circuitry.

Two regulated +/-15 Volt supplies feed all low-level analog audio stages.

Class-D amplifier stages are driven by the main high voltage, high current supplies.

The order and timing in which these supplies and circuits are activated is critical to the correct operation of the amplifier.

When A/C power is applied by turning ON the rear panel power switch, the small SMPS supply is energized. At this time the main supply is off. The main PWM switch mode section is activated and is dependent on the peak value of the A/C mains input for its initial operation. At this time it is not ready for normal operation. After a TWO second delay, the PFC is activated which then allows the PWM section to deliver its required voltages. In another TWO seconds the surge suppression circuits are bypassed. The power supply is now ready to deliver current to the various circuits throughout the amplifier.

However, the amplifier is not yet ready to go into full operation. Firstly the Class-D outputs are held off, until the main supply is fully activated. When stable, the Class-D control buss is turned on and with it, the Class-D amplifiers. An additional wait of approximately TWO seconds allows the amplifier to intelligently check and confirm all parameters are correct and only then close the output speaker relays.

The MTSI amplifier is a sophisticated ‘system’ in one box, with many functions and parameters needing to be confirmed before the next stage can be activated. Conditions such as A/C power, in-rush current, temperature, etc., need to be checked and confirmed as stable in order to proving reliable and long-lived operation. All this is done automatically without need for external intervention.

The turn on cycle is controlled from a remote terminal. In this condition, only the small SMPS supply in the amplifier is active. The operator is able to turn the amplifier on from the remote terminal. The Comms card then instructs the power supply to commence its turn on cycle.

Should the link between the remote terminal and the amplifier be lost, the Local/Network switch on the front panel allows full control of both turn on and operation of the amplifier's digital functions.

Each time AC power is removed from the amplifier chassis, either by turning the power switch off or through an unintentional loss of A/C power, the power supply resets to zero and forces a fresh turn on cycle.

1.9 Timing of Turn-on Sequence:

Switching on the rear panel power switch, activates a Standby Supply in approx. 200 milliseconds.

This standby supply energizes (a), (b) and (c) above.

Depending on the model of amplifier, there are differences between internal components, sequences and operations.

A control signal is fed to the amplifier which, when activated powers-on a high current relay. This allows A/C mains to be applied to the main Switch Mode Power Supply.

At this point, the Main Bus Capacitors are powered. This voltage is dependent upon the peak value of the incoming A/C mains, which differs around the world. Nominally the range of voltages found is between 100 – 240V and 50/60 Hz. However, often the actual line voltage can vary as much as 20% above and below these nominal levels. In MTS amplifiers a PFC stage is used to control and regulate the supply to maintain stable and consistent performance to specifications regardless of the country with which the product is being operated.

Power Factor Correction: In the next two seconds the PFC control circuits are activated and the bus voltage reaches an operating value of approximately 385 volts. The main Switch Mode circuits operate on this bus power.

About one second later the Surge Control circuit bypasses the Surge-Guard components allowing current to be drawn from the supplies.

When monitoring deems conditions to be stable, and within approximately three seconds, the Class-D Control Bus is activated.

Two to three seconds later, the individual Output Speaker Relays are energized placing the amplifier in operational mode.

The entire sequence from turn-on to amplifier operation is approximately eight to ten seconds.

Front panel Standby (red) and Power (blue) LEDs: On initial power up, both LEDs are illuminated. Indicating that the Power is on and that the amplifier sections are in Standby mode. Once the Class-D control bus is activated the standby LED is turned off.

1.10Installing Your Amplifier:

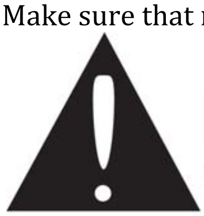
What is Included: Each MTSI Amplifier is shipped with the following:

- An A/C power cable, IEC type with appropriate mains plug for the region in which it is sold.
- Phoenix/Euro-type input connectors, as required per channel.
- Degson-type speaker load output connectors, as required per module.
- Basic Owner's/Operator's Manual and other documentation.
  For full documentation on amplifier software, control and other protocols, please refer to www.mediatechnologysystems.com website for downloads and additional valuable information. Or contact your official distributor.

Rack Mounting of Equipment: MTSI amplifiers are build to industry standard 19"/48.25cm, rack mount dimensions, and are 2U – 3.5"/8.9cm in front panel height.
Use four screws of appropriate thread pitch and size to your rack. Since the amplifier is designed for low profile to reduce rack space, it is advisable to consider supporting the rear of the amplifier. Most rack systems have available hardware to provide this support where needed. Be sure to support the rear of the amplifier as the front rack-ear screws are fitted.

In fixed installations rear support is recommended. In any portable or mobile system, it is mandatory.

Air Flow and Cooling Requirements: MTIS amplifiers pull cool air in from the right side panel through the electronics and out of the left side (as you look from the front).
Make sure that your rack is supplied with cool air flowing through the rack.
Make sure that nothing can block the airflow in or out of the equipment.



Assure there is no obstruction of the air flow to, or from the amplifier inlet and outlet vents. Make sure the rack has sufficient air flow to cool ALL the equipment installed in the rack.

A/C Mains Power Connection: MTSI amplifiers are designed to operate on all standard A/C Power voltage and frequencies found Worldwide. There is no requirement to set selectors etc.

IEC Socket: The IEC socket is designed so the connector can only fit in one way. Make sure to align properly and that the connector is seated fully into the socket. Do no force the connector.

Power Cable: Use the power cable supplied with the amplifier or an equivalently rated replacement. Make sure the line cable is of at least #14 AWG (American Wire Gauge). Use of cable with thinner conductors can cause overheating of the cable and risk of fire and safety.

Incoming Power Requirements: Make sure that the power circuit, cables, sockets, breakers etc., feeding your amplifier are rated to support the power indicated on the rear panel of your amplifier (in Watts). Care should be taken to assure that the power distribution arrangements are sufficient for the nominal A/C Voltage and the resultant current being sourced by your amplifier.

1.11Setup

Unpacking your amplifier: It is recommended that the carton and packing material is retained so the amplifier may be shipped for service should this be required. Any damage caused by improper packaging will not be covered under warranty. Should you chose to dispose of the carton and packaging, make sure to dispose of these parts according to local, state and national requirements and good ecological practice.

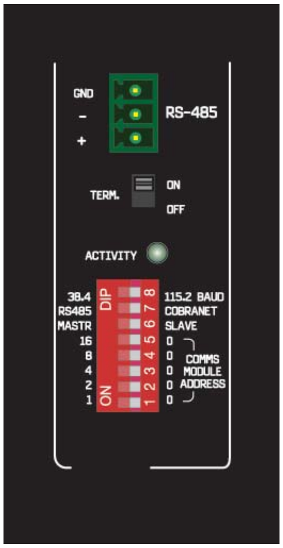
What comes with your amplifier: A full set of input and output "line" connectors are fitted as standard to your new MTSI multi-channel amplifier. An IEC power cable is supplied that is appropriate to the territory within which the amplifier is supplied. Should you chose to change this cable, make sure the replacement is of appropriate power capacity and that it has all three conductors properly connected.

Installing your amplifier: When installing your amplifier to appropriately designed and installed rack rails, make sure to mount using four screws. These screws should be of a size and strength to support the amplifier. Although MTSI amplifiers are intended for fixed installation, should you consider rackmounted amplifiers in mobile applications, make sure to support the rear of the amplifier.

Ensure proper cooling: MTSI amplifiers are Class-D/SMPS/PFC designs. As such they are highly efficient, generating considerably higher output levels for given input power. In conventional amplifiers, often, over 50% of the power input to the amplifier is dissipated as heat. Heat is the enemy of electronics as well as being wasteful. Even though the MTSI amplifiers are efficient, there is heat generated internally that must be dissipated and vented. A fan is installed that draws air from the left side of the amplifier, throughout the components and sub assemblies, and out of the right side of the product. Make sure that there is good airflow in the installation rack.

High Pass Filters: The Hi-Pass, or Lo-Cut filters on MTSI amplifiers are designed to smoothly reduce or limit the amount of low frequency energy in a signal. In Paging – Voice systems where communication if the primary function, excessive low frequency energy is detrimental since it reduces available headroom in the system by amplifying signals that often are not audible. Secondly, loudspeakers are protected against damage through excessive low frequency energy from dropped mics, switching noise, 'Breath POP's" etc.

Comms Module DIP Switches:



RS485 ground and termination selector: (where fitted) See relevant section.

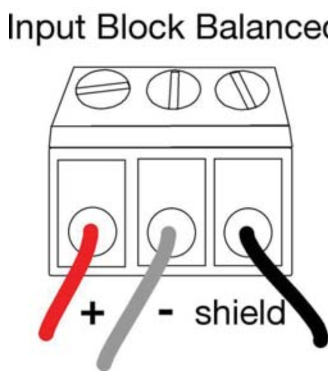
70/100 Volt Power Supply Selection/Set-up: To operate in either 70V or 100V mode, the amplifier must be 'booted up' with the 'Output Mode' selector switch in the desired setting. ***After any action to change this switch, the amplifier must be re-started.***

The internal sensing and changes to gain structure and control & monitoring rely on the amplifier booting with the switch in the intended operating position. Do not change this setting whilst the amp is powered up!

1.12 Input Wire and Connectors:

Each channel input uses a Euro/Phoenix type input connector set. The line connectors are supplied with your amplifier. It is recommended that balanced connections are used for all inputs in professional applications, since significantly less hum, buzz or other noise are induced on the signal, particularly in long cable runs such as are found in installations.

Cable/Line Connections: For balanced input connect as below.

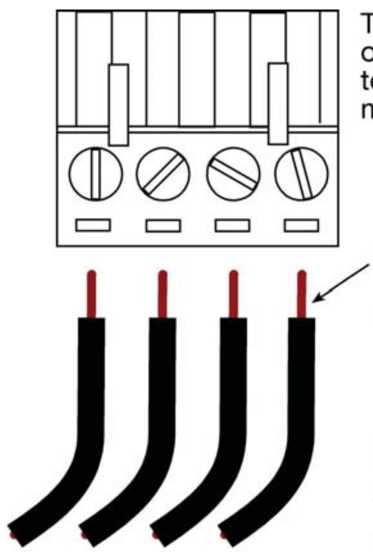


Note: The 'Line Input' Phoenix/Euro type connectors on the left side of the I/O area show the Channel Number, the plus, minus and GND or shield. In the interests of reducing ground anomalies in large systems where signals may be routed from remote sources with the opportunity for ground anomalies, it is common practice to 'lift' the shield on a signal cable, at the source, or send and connect it at the receiving end. Under any and all circumstances, for safety, check and make sure that proper A/C and systems grounding is practiced. Your MTSI amplifier is designed in keeping with correct safety grounding approved under international accepted standards. It is also designed with an understanding of the 'Real-World' circumstances of systems installation. The instrumentation differential input, the signal grounding practice and other build aspects are designed to provide the minimum opportunity for A/C and signal borne noise and interference to contaminate your program material and system functionality.

1.13 Output Wire and Connectors:

AMPLIFIER OUTPUT SAFETY WARNING:
Do not touch output terminals while the amplifier is powered on. It is good practice to only make connections or changes whilst an amplifier, or equipment is off. Amplifier outputs can output hazardous energy!

When choosing and installing speaker cable, always use the heaviest wire gauge possible. Undersized speaker cable can have a significant amount or "R" which, by raising the impedance, will reduce usable power delivered the speaker(s), where it is desired. Power dissipated in the cables is wasted as heat!



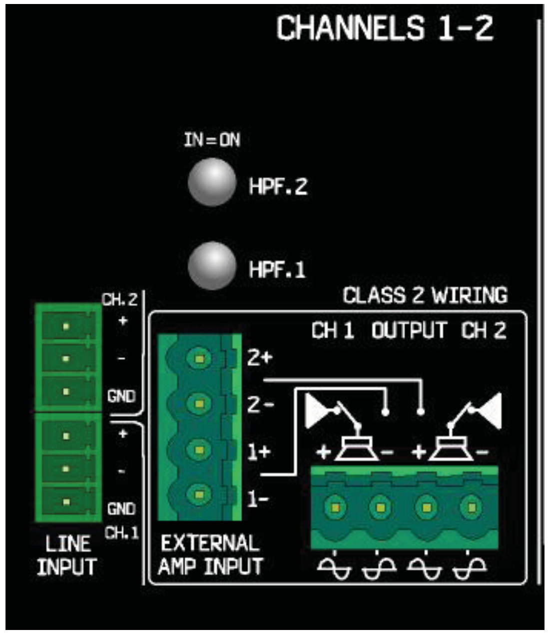
The Degson connector is designed to only insert on one orientation. Make sure to terminate wires according to rear panel markings for phasing etc.

Strip Wires: 0.30"/8mm

Conductor/Wire Size: #10 - #18
4.0 - 1.0 mm

Note: Make sure to loosen screw fully before inserting wire. Securely tighten screw after insertion.
Assure there are no loose strands of wire. Twist loose ends before insertion.

The following graphic is extracted from the DHV-Series amplifier rear panel, and shows the output connectors for main speaker and standby amplifier input.



Note: Phase and other nomenclature for inputs and outputs.

1.14A/C Mains power requirements:

MTSI amplifiers use PFC/SMPS supplies which do not require any change of settings for normal operation on all internationally found standard voltages, and frequencies. Further, the SMPS assures full specified output on voltages from 85V A/C to 250 V A/C. Thus on the often found sagged or browned out power supply, the MTS amplifier will deliver full rated power and headroom. (see notes). This ability notwithstanding, care should be taken in designing the power distribution to the amplifier(s) and equipment that is capable of supporting the sustained power required for proper operation. Insufficient cable capacity can cause heat to build up in the power supply cables to the amp racks, causing a voltage drop. The ability of the MTS amplifiers to deliver full specified power on any voltage even if it has sagged can exacerbate problems with a poorly specified and installed A/C power delivery system.

Each MTSI amplifier is marked on the rear panel with the nominal power requirements, in Watts. Connect the appropriate A/C power line cord to the IED socket. Note the pins are oriented to allow connection in only the correct orientation. Do not lift the ground connection.

2 Control and Monitoring

The DS and DHV series utilize an 8 bit microprocessor with 10 A-D measurement ports. There is one microprocessor for each pair of amplifier channels and another microprocessor to handle both RS485 communications & the SMPS control and monitoring.

2.1 Amplifier Parameters

There are potentially up to 8 amplifier modules in each amplifier chassis, where each amplifier module has the following parameters

Parameter in each 2 channel amplifier module	Size	External Read/Write Status
Signal Level 1 Pre	8 bit	R
Signal Level 2 Pre	8 bit	R
Signal Level 1 Post	8 bit	R
Signal Level 2 Post	8 bit	R
Output Current 1	10 bit	R
Output Current 2	10 bit	R
Output Voltage 1	10 bit	R
Output Voltage 2	10 bit	R
Temperature	8 bit	R
Attenuation 1	8 bit	R/W
Attenuation 2	8 bit	R/W
Mute 1	1 bit	R/W
Mute 2	1 bit	R/W
DC Fault 1	1 bit	R
DC Fault 2	1 bit	R
Short Cct Fault 1	1 bit	R
Short Cct Fault 2	1 bit	R
HPF 1	1 bit	R
HPF 2	1 bit	R
Clip 1	1 bit	R
Clip 2	1 bit	R
Bridge Mode	1 bit	R

Table 2.1: Amplifier module parameters

Where…

- R = read only
- R/W = read and write
- Pre = Analog input signal, pre-attenuator
- Post = Analog input signal, post-attenuator

- Bridge mode is ONLY applicable to the low impedance models and has 2 settings- bridge or low impedance, the 70volt and 100volt models are already bridged output on all channels.

In addition to the amplifier modules, there is a host processor monitoring the communications and main power supply. The host processor has the following parameters

Parameter in SMPS module	**Size**	**External Read/Write Status**
Supply +15v	8 bit	R
Supply +5v	8 bit	R
Main Amp +Vcc	8 bit	R
Amplifier model	8 bit	R
PFC Thermal	8 bit	R
SMPS Thermal	8 bit	R
Standby	1 bit	R/W
Local/Network	1 bit	R
Modules Present	8bit	R
Over Current Fault	1 bit	R
Over Voltage Fault	1 bit	R

Table 2.2: Amplifier host processor parameters

The full data format of each amplifier module (Table 2.3) and main amplifier host processor (Table 2.4) are given below.

2.1.1 Data format for each amplifier module host processor (module 1, channels 1&2 shown).

Note: Bit stuffing is involved for the output voltage and current, where the high bits (bits 9 & 10) of each sequence of 4 bytes are stuffed into the 5th byte. For example, bits 9 & 10 for OCUR1 are bits 1 & 2 of the 5th byte, bits 9 & 10 for OCUR2 are bits 3 & 4, of the 5th byte and so on. The color coding used for the first byte (in Table 2.3 above) will match the location of the high bits to the lower byte.

Name	Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1
SIG1PE	Bit8	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1
SIG1PO	Bit8	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1
SIG2PE	Bit8	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1
SIG2PO	Bit8	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1

OCUR1	Bit8	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1
OCUR2	Bit8	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1
OVOL1	Bit8	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1
OVOL2	Bit8	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1
HIGH BITS	Bit10	Bit9	Bit10	Bit9	Bit10	Bit9	Bit10	Bit9
TEMP1	Bit8	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1
ATT1	Bit8	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1
ATT2	Bit8	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1
FAULT1	0	0	Clip2	Clip1	SC2	SC1	DC2	DC1
STATUS1	X	X	X	X	0	Bridge	HPF2	HPF1
CONTROL1	X	X	X	X	0	0	Mute2	Mute1

Table 2.3: Amplifier Module processor dataset

Where…

SIG1PE = Signal, channel 1, pre attenuator
SIG2PO = Signal, channel 2, post attenuator
OCCUR1 = Output current, channel 1
OVOL2 = Output voltage, channel 2
TEMP1 = Temperature, Module 1
ATT1 = Attenuation setting, channel 1
FAULT1 = Clip, Short Circuit and DC protect status of module 1 (ie channels 1 & 2)
STATUS1 = Status of module 1, ie bridge settings and high pass filter settings
CONTROL1 = Output relay settings for module 1 (ie channels 1 & 2)
X = Not valid, as only bottom ASCII byte is transmitted

2.1.2 Data format for RS485 port and SMPS host processor

Name	Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1
VCC5	Bit8	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1
VCC15	Bit8	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1
VCCAMP	Bit8	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1
MODEL	100v	70v	0	1200W	600W	300W	150W	75W
PFCTM	0	0	0	0	0	0	0	0
SMPSTM	Bit8	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1
FAULTM	X	X	X	X	0	LOCAL	OVRVOL	OVRCUR
CONTROLM	X	X	X	X	0	0	0	Standby
STATUSM	Module8	Module7	Module6	Module5	Module4	Module3	Module2	Module1

Table 2.4: SMPS processor dataset

Where…

VCC5 = +5volt rail
VCC15 = +15volt rail
VCCAMP = Main amplifier power rail

PFCTM = PFC module temperature. Future provision, so all bits set to zero.
SMPSTM = SMPS module temperature
FAULTM = Front panel Local/Network setting and over current and over voltage fault status for power supply
CONTROLM = Standby operation. There are 2 power supplies in the amplifier, a small low voltage SMPS that drives the +5volt supply and a large SMPS that drives the +/-15volt and +/-VCC rails. The ControlM bit will allow the main SMPS to be switched on/off, leaving only the small 5volt rail in operation (ie Standby mode).
Note 1: To switch off the amplifier completely, the main power switch on the rear of the amplifier must be toggled.
Note 2: When the amplifier is put into standby, the gain of each channel will be switched immediately to OFF (-115.5dB) and the previous gain values stored. When the amplifier is brought out of standby, the gain will be ramped up to the previous stored gain settings AFTER the output relays have engaged. This will avoid large signals 'pitting' the relay contacts. If a preset is used to bring the amplifier out of standby, then the gain changes associated with that preset will be used in place of the last stored values. If the gain is adjusted at any time during standby, the gain will remain at OFF, but the new gain values will be used in place of the stored values when the amplifier becomes active.
STATUSM = Presence of up to 8 dual channel amplifier modules.
MODEL = whether the amplifier is 75watts, 150watts….1200watts and if the output is low impedance, 70volt or 100volt
X = Not valid, as only bottom ASCII byte is transmitted
Note: There will always be an amplifier processor present, so table 15 will always be applicable. However, there will be between 1 and 8 amplifier modules present, so Table 2.3 will apply to EACH amplifier module.

As the data is transmitted in ASCII format, there will be two bytes of ASCII for each byte of HEX data. The actual transmitted datasets are given in tables 2.5 and 2.6 below.

2.1.3 Data format for amplifier module host processor

Name	ASCII	Name	ASCII
SIG1PEL	Byte 1	SIG15PEL	Byte 1
SIG1PEH	Byte 2	SIG15PEH	Byte 2
SIG1POL	Byte 1	SIG15POL	Byte 1
SIG1POH	Byte 2	SIG15POH	Byte 2
SIG2PEL	Byte 1	SIG16PEL	Byte 1
SIG2PEH	Byte 2	SIG16PEH	Byte 2
SIG2POL	Byte 1	SIG16POL	Byte 1
SIG2POH	Byte 2	SIG16POH	Byte 2
OCUR1L	Byte 1	OCUR15L	Byte 1
OCUR1H	Byte 2	OCUR15H	Byte 2
OCUR2L	Byte 1	OCUR16L	Byte 1
OCUR2H	Byte 2	OCUR16H	Byte 2
OVOL1L	Byte 1	OVOL15L	Byte 1

OVOL1H	Byte 2		OVOL15H	Byte 2
OVOL2L	Byte 1		OVOL16L	Byte 1
OVOL2H	Byte 2		OVOL16H	Byte 2
HIGH BITSL	Byte 1		HIGH BITSL	Byte 1
HIGH BITSH	Byte 2		HIGH BITSH	Byte 2
TEMP1L	Byte 1		TEMP8L	Byte 1
TEMP1H	Byte 2		TEMP8H	Byte 2
ATT1L	Byte 1		ATT15L	Byte 1
ATT1H	Byte 2		ATT15H	Byte 2
ATT2L	Byte 1		ATT16L	Byte 1
ATT2H	Byte 2		ATT16H	Byte 2
FAULT1L	Byte 1		FAULT8L	Byte 1
FAULT1H	Byte 2		FAULT8H	Byte 2
STATUS1	Byte 1		STATUS8	Byte 1
CONTROL1	Byte 1	…	CONTROL8	Byte 1

Table 2.5: ASCII data transmission format for amplifier module dataset

Where: Byte 1 & Byte 2 = 0x30 (ASCII "0") ~ 0x39 (ASCII 0x39) and 0x41 (ASCII "A") ~ 0x46 (ASCII "F"). In the case of the single ASCII byte Status signals, the upper 4 bits are discarded.

2.1.4 Data format for comms module host processor

Name	ASCII
VCC5L	Byte 1
VCC5H	Byte 2
VCC15L	Byte 1
VCC15H	Byte 2
VCCAMPL	Byte 1
VCCAMPH	Byte 2
MODEL	Byte 1
MODEL	Byte 2
PFCTML	Byte 1
PFCTMH	Byte 2
SMPSTML	Byte 1
SMPSTMH	Byte 2
FAULTM	Byte 1
CONTROLM	Byte 1
STATUSM	Byte 1
STATUSM	Byte 2

Table 2.6: ASCII data transmission format for comms module dataset

Where: Byte 1 & Byte 2 = 0x30 (ASCII "0") ~ 0x39 (ASCII "9") and 0x41 (ASCII "A") ~ 0x46 (ASCII "F"). In the case of the single ASCII byte Status signals, the upper 4 bits are discarded.

2.2 Metrics

2.2.1 Pre & Post attenuator signals

Both Pre and Post attenuator signals will be represented by an 8 bit hexadecimal value, transmitted as 2 ASCII characters, where 1 step in the 8bit value represents 0.25dBu and the full range is -40dBu...+23.75dBu. The actual range for each signal will be limited to a more practical meter range of 48dB, as follows

- Pre attenuator signal
  - 0x40 = -24dBu.
  - Every 0x01 step = 0.25dBu
  - 0xA0 = 0dBu
  - 0xFF = +23.75dBu-nominal max

- Post attenuator signal
  - 0x00 = -40dBu
  - Every 0x01 step = 0.25dBu
  - 0xA0 = 0dBu
  - 0xBF = +7.75dBu-nominal max

The Host PC would need to multiply the 8 bit reading by 0.25dBu and subtract either 24dBu or 40dBu for the Pre and Post signals respectively, to obtain the correct value.

2.2.2 Output Current & Voltage signals

The output current and voltage signals are transmitted as a 10bit signal with 3 ASCII characters representing the three hex digits. The signal will vary from 0x000 to 0x3FF, where one bit is represented as follows...

- 75watt low impedance (voltage) = 34.7 millivolts/bit
- 75watt low impedance (current) = 13.58 milliamps/bit
- 75watt 70volt (voltage) = 125.8 millivolts/bit
- 75watt 70volt (current) = 3.46 milliamps/bit
- 75watt 100volt (voltage) = 174.6 millivolts/bit
- 75watt 100volt (current) = 2.45 milliamps/bit
- 150watt low impedance (voltage) = 45.6 millivolts/bit
- 150watt low impedance (current) = 19.18 milliamps/bit
- 150watt 70volt (voltage) = 125.8 millivolts/bit
- 150watt 70volt (current) = 6.93 milliamps/bit
- 150watt 100volt (voltage) = 174.6 millivolts/bit

- 150watt 100volt (current) = 4.9 milliamps/bit
- 300watt low impedance (voltage) = 62.9 millivolts/bit
- 300watt low impedance (current) = 27.72 milliamps/bit
- 300watt 70volt (voltage) = 125.8 millivolts/bit
- 300watt 70volt (current) = 13.86 milliamps/bit
- 300watt 100volt (voltage) = 174.6 millivolts/bit
- 300watt 100volt (current) = 9.8 milliamps/bit
- 600watt low impedance (voltage) = 87.3 millivolts/bit
- 600watt low impedance (current) = 39.19 milliamps/bit
- 600watt 70volt (voltage) = 125.8 millivolts/bit
- 600watt 70volt (current) = 27.72 milliamps/bit
- 600watt 100volt (voltage) = 174.6 millivolts/bit
- 600watt 100volt (current) = 19.6 milliamps/bit
- 1200watt low impedance (voltage) = 125.8 millivolts/bit (Note 1200watt low impedance is the same as 1200watt 70volt)
- 1200watt low impedance (current) = 55.43 milliamps/bit (Note 1200watt low impedance is the same as 1200watt 70volt)
- 1200watt 70volt (voltage) = 125.8 millivolts/bit
- 1200watt 70volt (current) = 55.43 milliamps/bit
- 1200watt 100volt (voltage) = 174.6 millivolts/bit
- 1200watt 100volt (current) = 39.19 milliamps/bit

The host processor would need to multiply the 10 bit reading by the scaling factor above to obtain the correct value.

2.2.3 Temperature

The temperature signals are transmitted as an 8bit hexadecimal format signal with 2 ASCII characters representing the hexadecimal digits. The temperature range is 98degC, where -10degC = "00" (ASCII 0x30, 0x30)... 88degC = "62" (ASCII 0x36, 0x32). The host PC would need to convert hex to decimal and subtract decimal "10" from the value transmitted to get degC

2.2.4 Voltage rails

The voltage rails will all be transmitted as a 8 bit signals. The signal will vary from 0x00 to 0xFF, where one bit is represented as follows...

- +5volts = 7mV per step: Multiply the 8 bit result by 7mV (to get the voltage offset) and then add 4 volts to get the actual rail voltage
- +15volts = 21mV per step: Multiply the 8 bit result by 21mV (to get the voltage offset) and then add 12 volts to get the actual rail voltage
- 75w Vcc= +/-29v, ie 40.5mV per step: Multiply the 8 bit result by 40.5mV (to get the voltage offset) and then add 23 volts to get the actual rail voltage
- 150w Vcc= +/-39v, ie 54.4mV per step: Multiply the 8 bit result by 54.4mV (to get the voltage offset) and then add 30 volts to get the actual rail voltage
- 300w Vcc= +/-55v, ie 76.8mV per step: Multiply the 8 bit result by 76.8mV (to get the voltage offset) and then add 42 volts to get the actual rail voltage

- 600w Vcc= +/-77v, ie 107mV per step: Multiply the 8 bit result by 107.5mV (to get the voltage offset) and then add 58 volts to get the actual rail voltage
- 1200w low impedance and all 70volt models Vcc= +/-110v, ie 153.6mV per step: Multiply the 8 bit result by 153.6mV (to get the voltage offset) and then add 84 volts to get the actual rail voltage
- 100volt Vcc= +/-154v, ie 215mV per step: Multiply the 8 bit result by 215mV (to get the voltage offset) and then add 116 volts to get the actual rail voltage

Note: All the values are peak signals, voltages and currents

2.2.5 Attenuator settings

The attenuators range from +12dB to -51.5dB in 128 steps of 0.5dB per step and the 129th step is -115.5dB (ie "Off"). This gives a more practical gain range. The algorithm is

GAIN = ROUNDOWN(x/2)+128, where x is 1-255.

In effect, the typical 8 bit gain control is shifted 1 bit to the right and the MSB is set to '1'.

The amplifier firmware will remember the last gain setting before power down and will power up with the same gain setting (unless presets are used).

A chart showing some common settings is given below…

ATT	HEX	dB
255	FF	12.0
254	FE	12.0
253	FD	11.5
252	FC	11.5
251	FB	11.0
250	FA	11.0
…		
231	E7	6.0
230	E6	6.0
…		
207	CF	0.0
206	CE	0.0
…		
183	B7	-6.0
182	B6	-6.0
…		
159	9F	-12.0
158	9E	-12.0
…		
135	87	-18.0
134	86	-18.0
…		
111	6F	-24.0
110	6E	-24.0

87	57	-30.0
86	56	-30.0
...		
47	2F	-40.0
46	2E	-40.0
...		
7	07	-50.0
6	06	-50.0
5	05	-50.5
4	04	-50.5
3	03	-51.0
2	02	-51.0
1	01	-51.5
0	00	-115.5

Examples of Gain control codes and settings

2.3 V-BUS: RS485 control port protocol

The V-BUS protocol specification covers communication between one or more MTS DS/DHV Series amplifiers and a host processor or peripheral control panel. In the case of a Host processor, the MTS amplifier operates in slave mode and only responds to polling from the host.

The host can be a simple PC with a custom application or a 3rd party DS control system product (eg AMX or Crestron).

When switched to Master mode, the MTS DS/DHV series amplifiers poll the attached MTS wall controls (TBA). The wall controls are simple volume panels or source selectors. At present, Master mode is disabled.

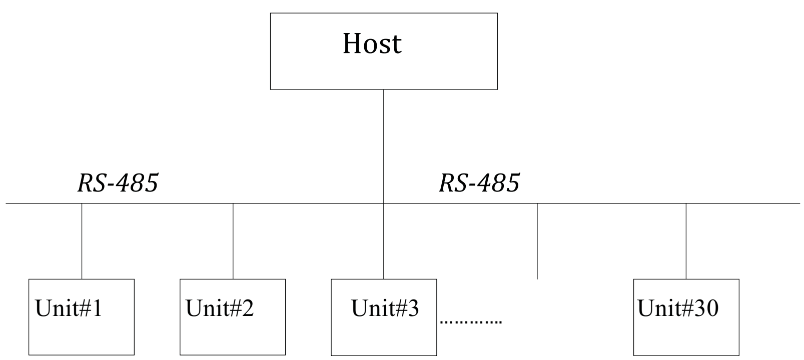


Figure 2.1 Network Configuration of V-Bus Communication

2.3.1 Attenuator settings

Hardware interface of RS-485 line is shown in Table 2.7.

No.	Item	Description
1	Communication system	Two-wire, half-duplex
2	Synchro system	Asynchronous (out of synchronization)
3	Line control system	Polling / selecting
4	Data bit	8 bits
5	Parity	None
6	Stop Bit	1 stop bit
7	Error control system	BCC (checksum)
8	Bit transmission order	LSB first
9	Baud rate	38.4 or115.2 [kbps] (set using DIP switches)
10	Text length	Max. 524 [bytes]

Table 2.7 Hardware Interface of RS-485 Port

2.3.2 ASCII Codes

ASCII codes used in V-BUS communication are listed in Tables 2.8 & 2.9 below…

	00	10	20	30	40	50	60	70
00			SPC	0		P		p
01				1	A	Q	a	q
02	STX			2	B	R	b	r
03	ETX			3	C	S	c	s
04				4	D	T	d	t
05		NAK		5	E	U	e	u
06	ACK			6	F	V	f	v
07				7	G	W	g	w
08				8	H	X	h	x
09				9	I	Y	i	y
0A					J	Z	j	z
0B					K		k	
0C					L		l	
0D					M		m	
0E					N		n	
0F					O		o	

Table 2.8 ASCII character set

Due to addressing limits for the single character UA (unit address-see section 2.4), the extended ASCII character set used the Microsoft Windows will be used to extend the formal 7bit ASCII character set to 8 bits and 255 addresses-see Table 2.9 below

ASCII Character Codes Chart 2

Dec	Hex	Char	Dec	Hex	Char	Dec	Hex	Char	Dec	Hex	Char
128	80	Ç	160	A0	á	192	C0	└	224	E0	α
129	81	ü	161	A1	í	193	C1	┴	225	E1	ß
130	82	é	162	A2	ó	194	C2	┬	226	E2	Γ
131	83	â	163	A3	ú	195	C3	├	227	E3	π
132	84	ä	164	A4	ñ	196	C4	─	228	E4	Σ
133	85	à	165	A5	Ñ	197	C5	┼	229	E5	σ
134	86	å	166	A6	ª	198	C6	╞	230	E6	µ
135	87	ç	167	A7	º	199	C7	╟	231	E7	τ
136	88	ê	168	A8	¿	200	C8	╚	232	E8	Φ
137	89	ë	169	A9	⌐	201	C9	╔	233	E9	Θ
138	8A	è	170	AA	¬	202	CA	╩	234	EA	Ω
139	8B	ï	171	AB	½	203	CB	╦	235	EB	δ
140	8C	î	172	AC	¼	204	CC	╠	236	EC	∞
141	8D	ì	173	AD	¡	205	CD	═	237	ED	φ
142	8E	Ä	174	AE	«	206	CE	╬	238	EE	ε
143	8F	Å	175	AF	»	207	CF	╧	239	EF	∩
144	90	É	176	B0	░	208	D0	╨	240	F0	≡
145	91	æ	177	B1	▒	209	D1	╤	241	F1	±
146	92	Æ	178	B2	▓	210	D2	╥	242	F2	≥
147	93	ô	179	B3	│	211	D3	╙	243	F3	≤
148	94	ö	180	B4	┤	212	D4	╘	244	F4	⌠
149	95	ò	181	B5	╡	213	D5	╒	245	F5	⌡
150	96	û	182	B6	╢	214	D6	╓	246	F6	÷
151	97	ù	183	B7	╖	215	D7	╫	247	F7	≈
152	98	ÿ	184	B8	╕	216	D8	╪	248	F8	°
153	99	Ö	185	B9	╣	217	D9	┘	249	F9	∙
154	9A	Ü	186	BA	║	218	DA	┌	250	FA	·
155	9B	¢	187	BB	╗	219	DB	█	251	FB	√
156	9C	£	188	BC	╝	220	DC	▄	252	FC	ⁿ
157	9D	¥	189	BD	╜	221	DD	▌	253	FD	²
158	9E	₧	190	BE	╛	222	DE	▐	254	FE	■
159	9F	ƒ	191	BF	┐	223	DF	▀	255	FF	

Table 2.9: Extended ASCII character set

2.4 Communication Protocol

The dataset for the V-BUS communcations uses HEX for the housekeeping data (STX, ETX, UA, SA, BCC, SEL, DAT) and ASCII for the user data communication (CMD, SIZE, DATA) between host and each unit. ASCII implies that each hex byte is converted to a 2-byte ASCII code. V-BUS communication is defined in detail below.

2.4.1 Amplifier address

Table 2.10 shows the relevant addresses. The emboldened rows are relevant to V-BUS. The other addresses are for G-Bus compatibility. The maximum number of units to be connected to V-BUS is 32.

Addresses are configured using the DIP switches on the back of the unit.

No.	Equipment	Address	Max. number
1	Reserved	0x00~0x1F	32
2	Reserved	0x20~0x3F	32
3	Host	0x41	1
4	Reserved	0x42~0x4B	10
5	Reserved	0x4C~0x4F	4
6	Reserved	0x50~0x5F	16
7	Amplifiers	0x60~0x7F	32
8	Wall Panels	0x80~0xFF	128

Table 2.10 Peripheral equipments and address assign

2.4.2 Transmission control code

Table 2.11 shows transmission control codes used for V-BUS communication protocol.

No.	Control code	ASCII code	Function
1	STX	0x02	Beginning of transmission packet (message)
2	ETX	0x03	End of transmission packet (message)
3	ACK	0x06	Acknowledge
4	NAK	0x15	Negative acknowledge
5	POL	0x50	Polling sequence ("P" of ASCII code)
6	SEL	0x53	Selecting sequence ("S" of ASCII code)
7	DAT	0x44	Unit data ("D" of ASCII code)

Table 2.11 Transmission control codes

2.4.3 Time Limitation

Communications timing limitations for the host processor are listed in Table 2.12. See section 2.6 for details of the communication sequence regarding time limitations.

In V-BUS operation, the time from POL transmission to Global Read data reception from the RS485 port for 4 Amp modules is 12mS. (130 bytes = 1300 transmission bits @ 115200 bps = 8.9mS plus POL command and processing time). It would be recommended not to update faster than 20mS at 115.2kbits/sec. Similarly, 60mS at 38.4kbits/sec.

.

No.	Description	Time [ms]
1	Permissible waiting time after POL / NAK transmission	40
2	Permissible waiting time after SEL transmission	40
3	Delay time until retransmission in case of NAK reception after SEL transmission	120
4	Minimum time of POL cycle across units	5
5	Response waiting time of POL transmission to the unit caused transmission failure	10

Table 2.12 Time limitations

2.4.4 Number of retransmissions

Table 2.13 shows the number of retransmissions permissible by the Host processor. POL, SEL and DAT are the names of transmission block dataset elements. See section 2.6 Polling Sequence and 2.6 Selecting Sequence for details of the communication sequence regarding retransmission issues.

No.	Description	Number
1	POL transmission (nonresponding after POL or NAK transmission)	2
2	SEL transmission (nonresponding after SEL transmission or receiving NAK)	2
3	DAT transmission (BCC failure of receiving data after POL transmission)	2
4	POL transmission (nonresponding after POL transmission to the unit caused transmission failure)	0

Table 2.13 Number of retransmissions permissible

2.4.5 Transmission Block

Transmission data set blocks used in V-BUS communication are listed in Table 2.14.

No.	Packet Name	Description
1	POL	Polling (Query from Processor to unit)
2	SEL	Selecting (Data transmission from Processor to unit)
3	DAT	Data (Data transmission from unit to Processor)
4	ACK	Acknowledge
5	NAK	Negative acknowledge

Table 2.14 Transmission blocks

2.4.6 Common Format

All transmission blocks begin with "STX" and end with "ETX" as a common format. Note these are entered as HEX and not ASCII format. Destination and Source addresses are specified in the second and the third byte respectively. The fourth byte should be POL, SEL, DAT, ACK or NAK, which will indicate the type of transmission block. SA (Station Address) and UA in Figure 2.2 show Host address and unit address respectively.

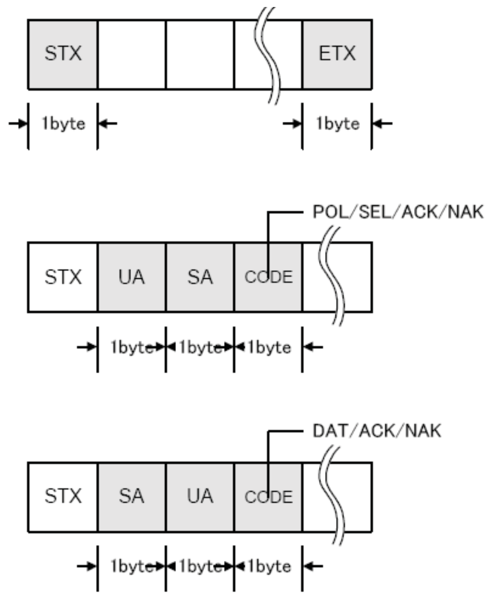


Figure 2.2 Common format of transmission packet

Details of each transmission block in the diagram above are described below.

2.4.7 Polling Block

Polling block is a block transmitted from Host to Unit when starting the polling sequence. Content of the polling block is shown in Figure 2.3.

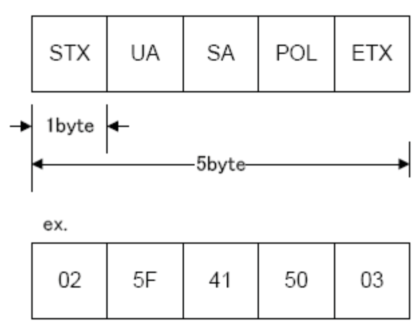


Figure 2.3 Transmission block of polling sequence

2.4.8 Selecting Block

The Selecting block is transmitted from the Host to the Unit when starting a selecting sequence. Contents of the selecting block is shown in Figure 2.4.

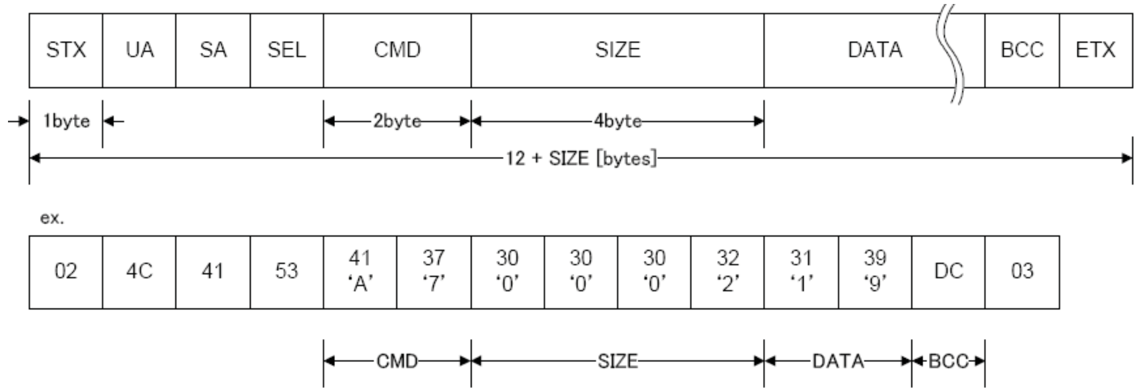


Figure 2.4 Transmission block of selecting sequence

CMD specifies the command number defined for each unit. SIZE specifies byte size of the DATA section. DATA specifies data defined for each CMD. BCC specifies check sum of CMD, SIZE and DATA parts. See 2.5.12 BCC Calculation for calculation method of BCC and see Command Format for details about CMD and DATA.

Note that the processor sends a selecting block to set up the data type returned by the poll instruction.

2.4.9 Data Block

Data block is a block transmitted from the Unit to the Host. The content of the data block is shown in Figure 2.5. CMD, SIZE, DATA and BCC are identical to the selecting block described above.

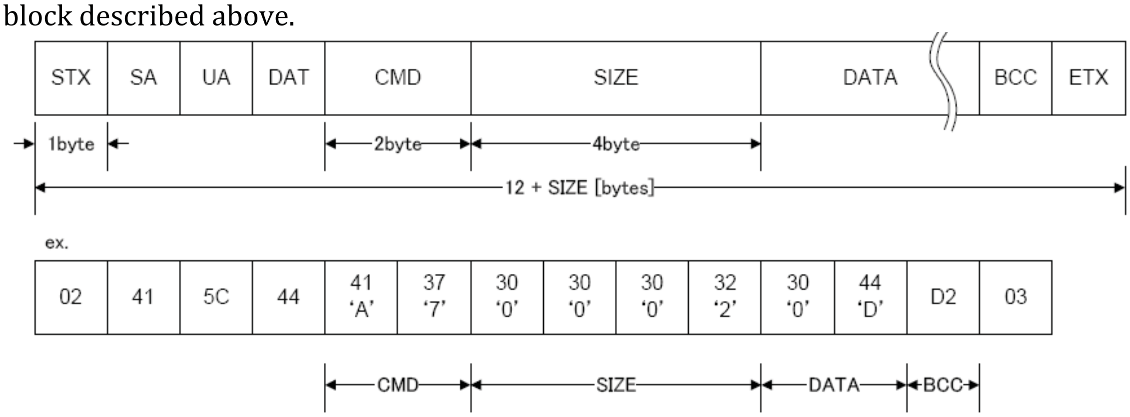


Figure 2.5 Transmission blocks of unit data

2.4.10 Acknowledge

Transmission block of acknowledge (ACK) is shown in Figure 2.6.

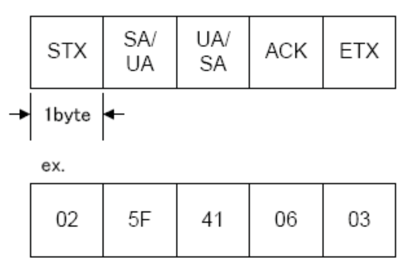


Figure 2.6 Transmission block of acknowledge

2.4.11 Negative Acknowledge

Transmission block of negative acknowledge (NAK) is shown in Figure 2.7.

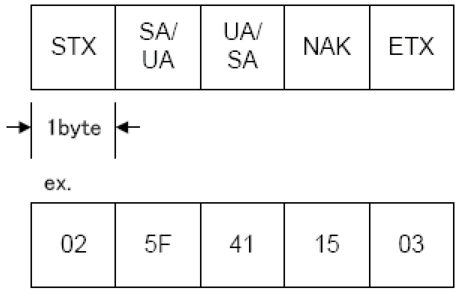


Figure 2.7 Transmission block of negative acknowledge

2.4.12 BCC Calculation

BCC is a check sum added when transmitting selecting block and data block. It specifies a calculated check sum of the shaded part in Figure 2.8 (CMD, SIZE and DATA) with 1 byte.

Figure 2.9 shows calculation method of BCC.

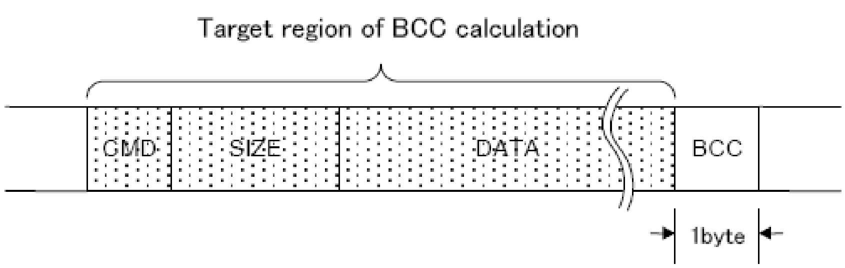
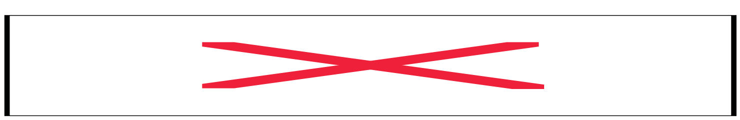


Figure 2.8 Data used for the BCC calculation



i: location in the region of BCC calculation
n: byte number in the region of BCC calculation
DATA (i): data of ith byte
MOD: remainder
OR: logical sum

Figure 2.9: BCC calculation method

A BCC calculation example is shown in Figure 2.10 below.

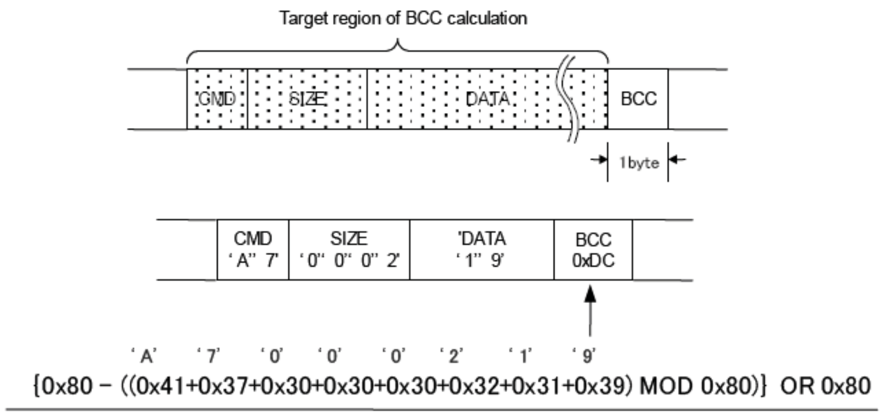


Figure 2.10 Example of BCC calculations

2.5 Communication Sequence

2.5.1 Polling Sequence

2.5.1.1 With Data Transmission

Figure 2.11 shows the sequence of data transmission to the Host processor for the polling sequence.

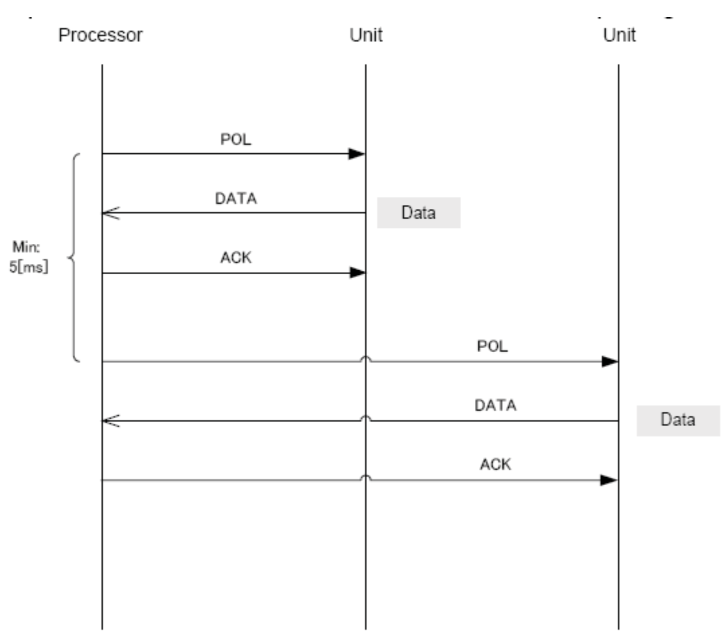


Figure 2.11 Polling sequence (with data transmission)

2.5.1.2 Without Data Transmission

Figure 2.12 shows the polling sequence when there is no data transmission to the Host processor. The unit sends a NAK when there is no data to be transmitted to the Host.

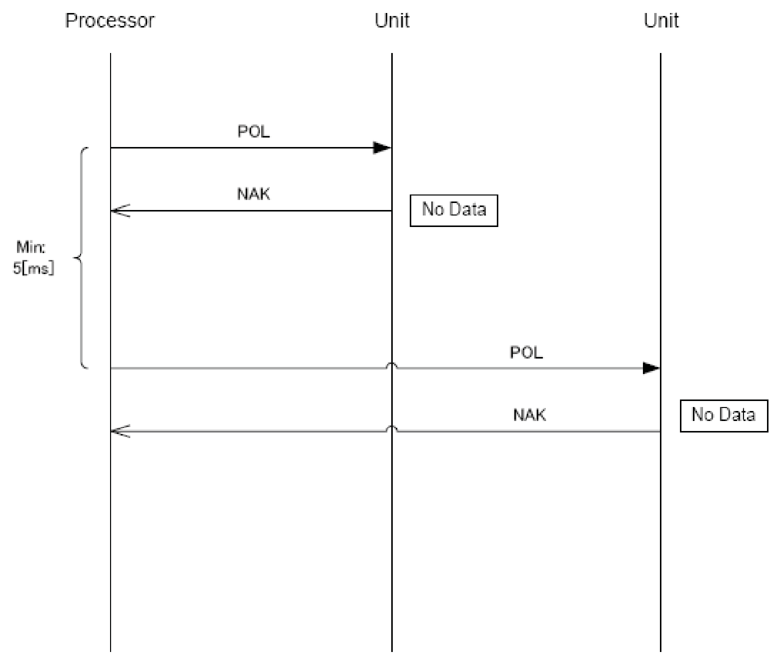


Figure 2.12 Polling sequence (without data transmission)

2.5.1.3 Timeout

Figure 2.13 shows the sequence in the event of no response to the POL transmission from the Host and Figure 2.14 shows sequence in the event of no response to the NAK transmission from Host.

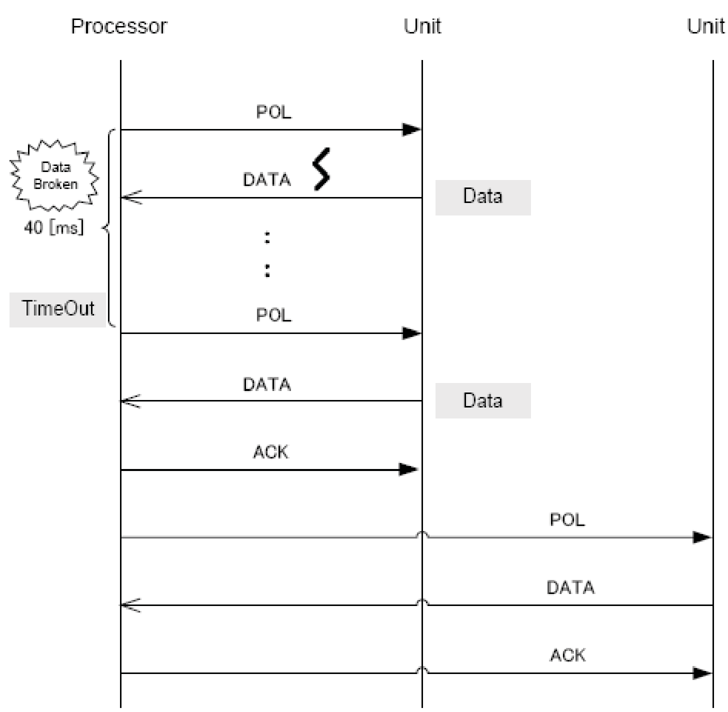


Figure 2.13 Polling sequence (timeout 1)

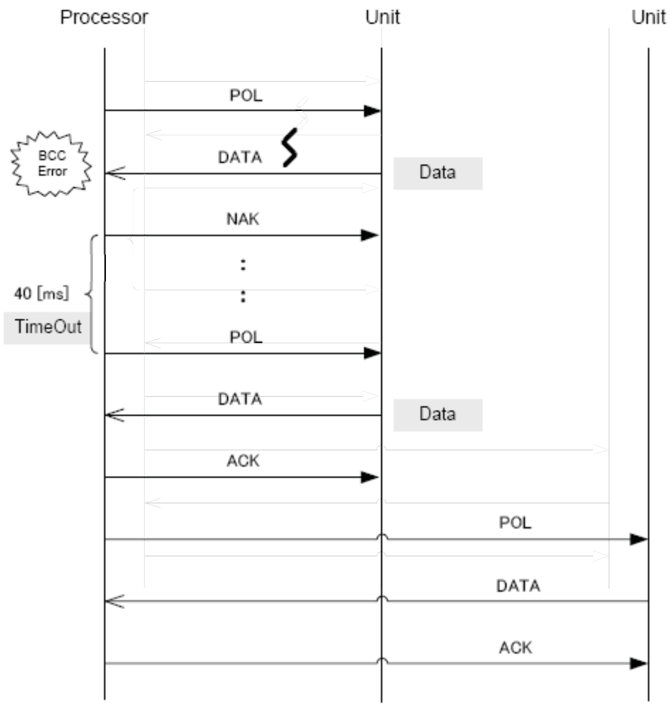


Figure 2.14 Polling sequence (timeout 2)

2.5.1.4 Retry

Figure 2.15 shows the sequence of data retransmission when data received from the unit is corrupted (BCC failure).

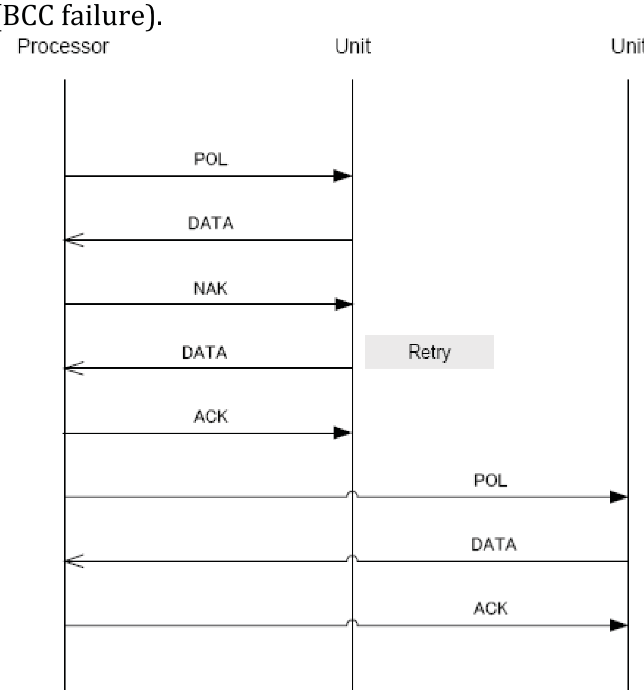


Figure 15 Polling sequence (Retry)

2.5.1.5 Excess Retry (BCC Failure)

Figure 2.16 shows the sequence in the event of multiple attempts at NAK transmission caused by BCC failure. The unit shall wait for the next polling sequence.

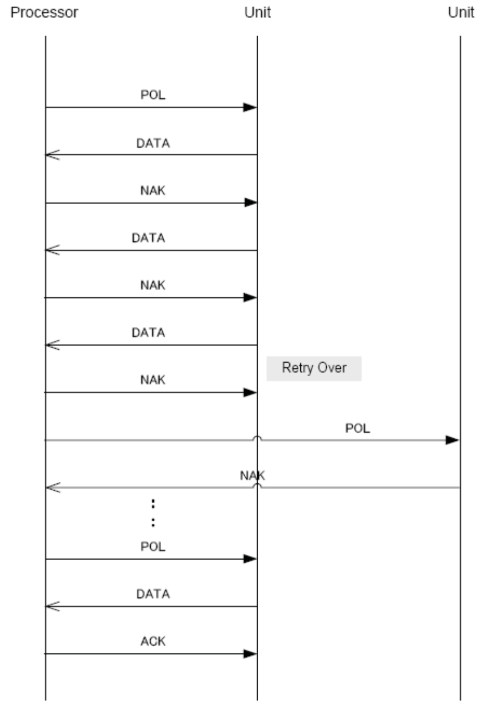


Figure 2.16 Polling sequence (excess retry by BCC failure)

2.5.1.6 Excess Retry (not-responding)

Figure 2.17 shows the sequence in the event of multiple attempts at POL transmission caused by a non-responsive Unit.

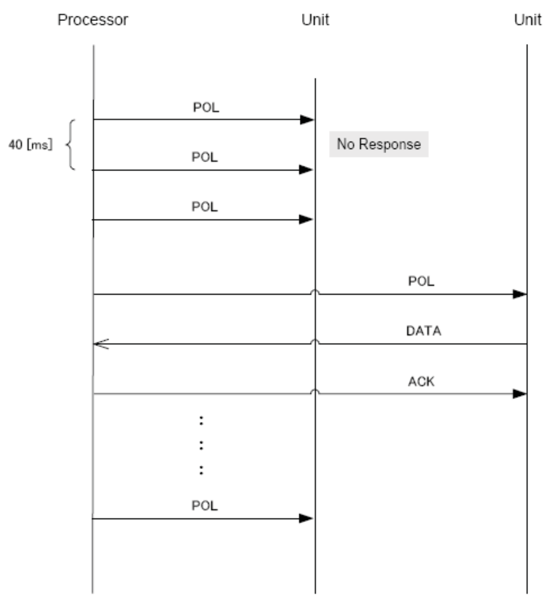


Figure 2.17 Polling sequence (excess retry)

2.5.1.7 Recovery from Transmission Failure

The host regards the unit with 'excess retry' as a communications failure (maybe the unit has lost the connection). After the next poll, the sequence process for recovery (waiting time of 10ms, no retry) shall be executed as shown in Figure 2.18.

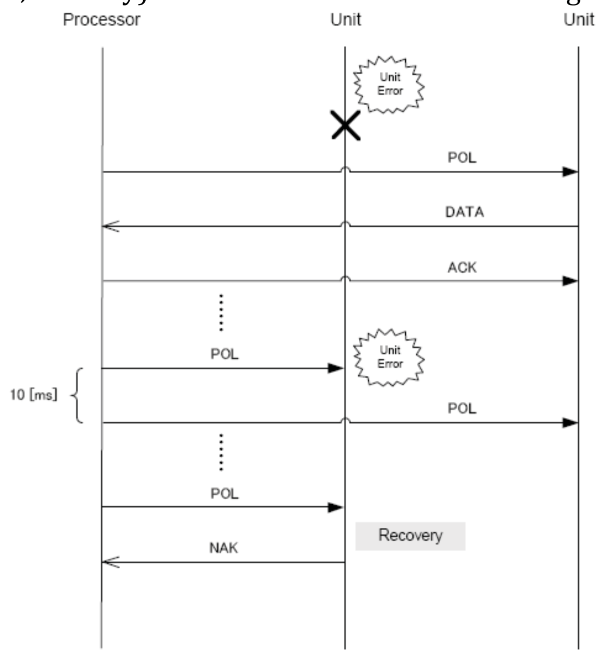


Figure 2.18 Recovery from Transmission Failure

2.5.2 Selecting Sequence

2.5.2.1 Data Transmission

Figure 2.19 shows the sequence of data transmission from Host to unit.

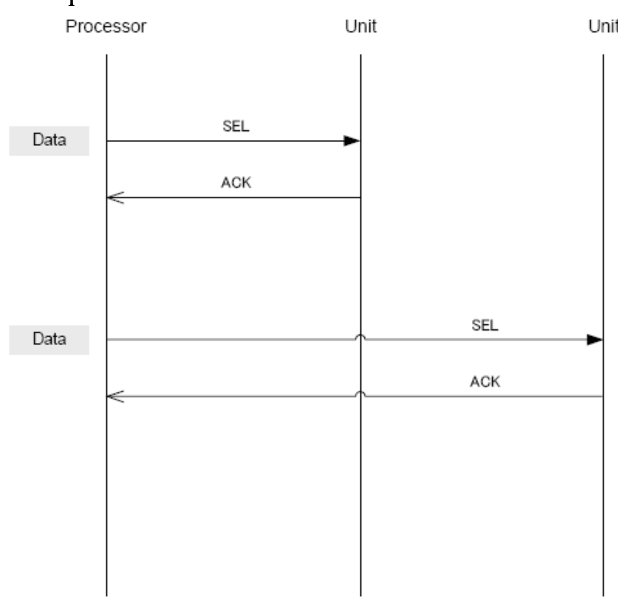


Figure 2.19 Selecting sequence (data transmission)

2.5.2.2 Retry

Figure 2.20 shows the sequence for data re-transmission when data received from the unit is corrupted (BCC failure).

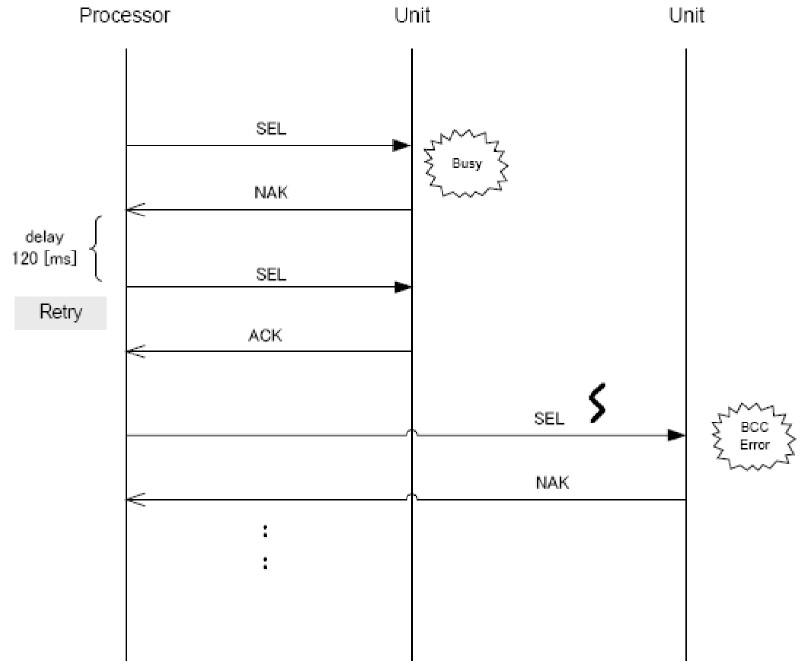


Figure 2.20 Selecting sequence (retry)

2.5.2.3 Excess Retry (BCC Failure)

Figure 2.21 shows the sequence in case of excess retry of data retransmission in the selecting sequence.

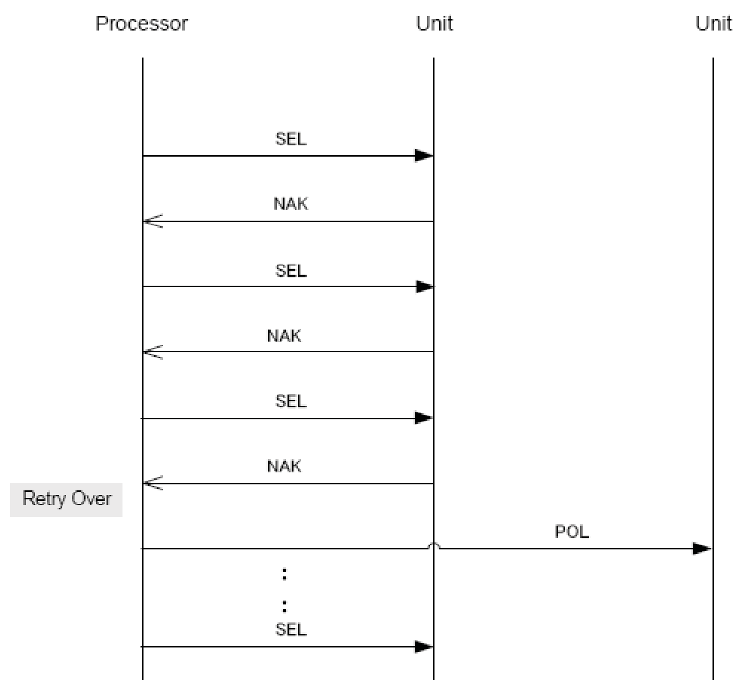


Figure 21 Selecting sequence (excess retry caused by BCC failure)

2.5.2.4 Excess Retry (not responding)

Figure 2.22 shows the sequence in the event of 'excess retry' of the SEL command transmission by a non-responsive unit.

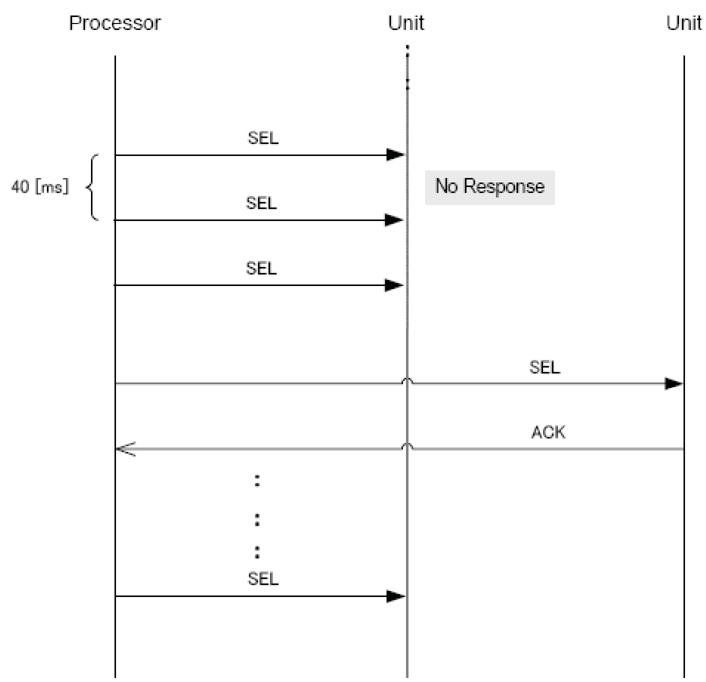


Figure 2.21 Selecting sequence (excess retry by nonresponding)

2.6 2.6 Amplifier Command Format

2.6.1 Amplifier DIP switch settings

Table 2.15 below shows the DIP switch settings

Action	DIP Switch
RS485 address bit 0	SW1
RS485 address bit 1	SW2
RS485 address bit 2	SW3
RS485 address bit 3	SW4
RS485 address bit 4	SW5
Master/Slave operation	SW6
RS485/Cobranet	SW7
38.4/115.2 kbits/sec	SW8

Table 2.15 DIP switch settings

Where…

SW1…SW5 set the 32 addresses for the amplifier

SW6 sets whether the amplifier is the master or slave
SW7 sets whether the amplifier is connected to external devices, or to the optional cobranet accessory. In the Cobranet setting, the RS485 addresses are ignored.
SW8 sets the RS485 port speed as 38.4 kbits/sec or 115.2 kbits/sec. The default setting is 115.2kbits/sec, but where the amplifier is in master mode and wall controls are more than 500meters away from the amplifier, the speed can be reduced to 38.4kbits/sec to extend the range to 1000meters.

Note: Internal amplifier bus only operates at 115.2 kbits/sec. External V-BUS can operate at 38.4 or 115.2 kbits/sec.

2.6.2 Amplifier Address number

The 32 possible amplifier addresses correspond to the DIP switch settings as follows

DIP Switch	V-BUS
00000	0x60
00001	0x61
00010	0x62
...	
11111	0x7F

Table 2.16 Amplifier Address

2.6.3 Amplifier Command numbers

Command numbers are in the range shown in Table 2.17 is assigned to the command part "CMD" in transmission block (CMD) for every unit.

No.	Equipment	Range of command number
1	Reserved	---
2	Host	---
3	Reserved	0x40 ~ 0x4B
4	Reserved	0x4C~0x4F
5	Reserved	0x40 ~ 0x7F
6	V-BUS Amplifiers	0x80 ~ 0x9F
7	Reserved	0xA0 ~ 0xBF

Table 2.17 Range of command numbers assigned to amplifiers

Unit received polling from Host transmits command number and data block in data format corresponding to the command number to Host on a timely basis. Similarly, Host transmits command number assigned to every unit and selecting block in data format corresponding to the command number.

Details of command number of every unit and corresponding data format are described below.

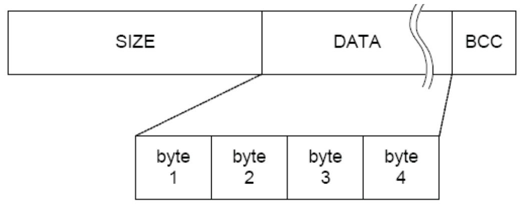


Figure 2.22 Data allocation example of command DATA part

2.6.4 Amplifier selecting Sequence (write)

An example of the communications between the Host processor and slave amplifier is given in Figure 2.23 below

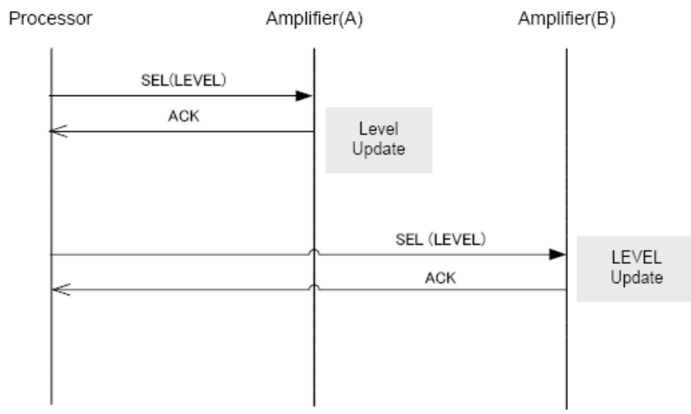


Figure 2.23 Control of Attenuation

2.6.5 Amplifier selecting sequence (read)

Due to the large amount of data, there are options for either reading all, or only particular sections of the amplifier settings and metrics. This is done as follows:

- Default power up is amplifier command 0x87, ie a global read command. If the host processor simply POL's the amplifier (see Figure 2.25 below), then the responding DATA will contain all possible amplifier settings and metrics, ie 242 bytes of data (if all 8 possible modules are present). The 242 bytes are made up of 224 bytes (28 bytes x 8 modules) from Table 2.3, plus 16 bytes from Table 2.4, plus 2 bytes defining which modules are present.
- The Host PC can modify the responding DATA, by sending a SEL instruction to the amplifier(s) prior to a POL instruction (see Figure 2.24 below). The SEL instruction will contain one of the commands from Table 18 (below), followed by qualifying bytes. The command will then instruct the amplifier to only respond with the DATA packet corresponding to that command. For example, if the SEL instruction is used to send command 0x82, then only attenuation data will be sent back from the amplifier on the next POL instruction.

  Note: Different amplifiers can be set up with different SEL instructions. For example, amplifier 1 could be set up with a 0x82 command and amplifier 2 could be set up with a 0x86 command. On the next POL instruction, amplifier 1 will respond with attenuation data only and amplifier 2 will respond with signal data only.

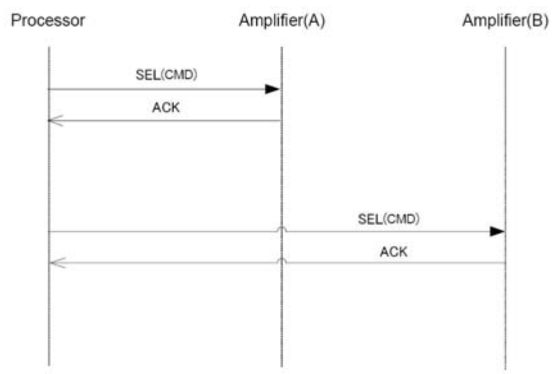


Figure 2.24 Using the SEL instruction to upload an amplifier DATA read command

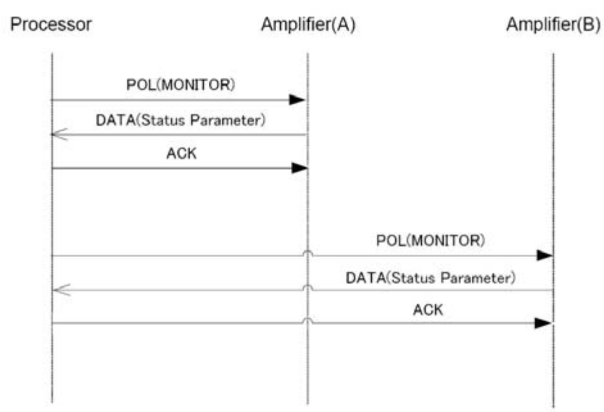


Figure 2.25: Using the POL instruction after the SEL instruction

- In addition to limiting the DATA packet to a particular type of data, the Host PC can apply a filter to limit the response to changed data only and certain amplifier modules only. The amplifier command will be accompanied by 3 data bytes, where byte 1 sets whether the DATA packet contains all data or only updated data and bytes 2 & 3 (ASCII format requires 2 bytes) sets which modules are to transmit in the DATA packet, as follows…
  - If byte 1 is set to 0 (ASCII 0x30), then all requested data will be sent for valid and available amplifier modules. If the amplifier modules are not present, then no data will be sent for that module, even if requested.
  - If byte 1 is set to 1 (ASCII 0x31), then only data that has changed since the last POL instruction will be sent. In this situation, Bytes 1 and 2 of the responding DATA packet will contain a mask on which valid and available modules are responding with changed data, ie bits 111111111 correspond to modules 1, 2 …8 respectively.
  - If Byte 1 is set to 1 and no data has changed since the last POL, then the amplifier will respond with a NAK (see Figure 12).
  - Byte 2 & 3 are a switch (or mask) that determines which amplifier modules are to respond, where bits 111111111 correspond to modules 1,

2 …8 respectively. For example if the Bits are 11001010 (Byte 2 = Hex 0C = ASCII 0x43 and Byte 3 = Hex 0A = ASCII 0x41), then only modules 1, 2, 5 & 7 will send data. However, if only the first 4 modules are present, then only modules 1 & 2 would respond to the POL instruction. Note: There is potential confusion relating to what is intended by "MODULEL" and MODULEH". In the rest of the protocol, "H" and "L" indicates the high and low values of the parameter values, but for the amplifier modules "H" and "L" indicate the high and low slot numbers of the amplifier modules (Bit7 is amp module 1 and Bit0 is amp module 8).

Note: There are 6 types of signal, where each is treated slightly differently in terms of the POL of changed values. Otherwise key parameters may toggle between POL cycle and the user would have no indication of the changed state. These are

- Clip: Clip goes high until released by the next POL. It is important for the user to know if he/she is hitting momentary clip.
- SC/DC/FAULTM: Also goes high until released by the next POL. Otherwise momentary faults will not be recorded
- Temperature/VCC: Records the most recent value.
- Bridge/HPF: Rear panel controls, should not change, records the most recent value.
- Mute/ATT/CONTROLM: User controls-no issue-ideally the Host PC should have set these values and have them stored, so records the most recent value.
- MODEL/STATUSM: Should NOT change, so any change of status would indicate a fault, should indicate high until released by the next POL.
- Signal changes since the last POL: Record peak value changes

2.6.6 Amplifier command set (Slave Mode)

Commands sent/received between Host and Slave Amplifier are listed in Table 2.18.

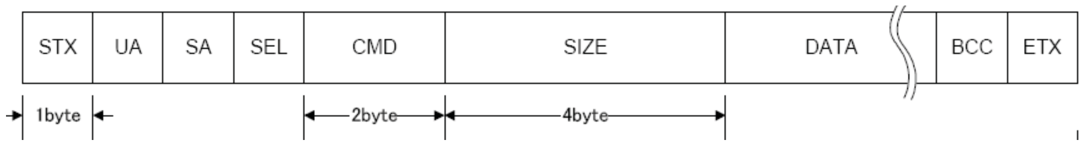
Slave Command	Number
Attenuation Write	0x80
Control Write	0x81
Attenuation Read	0x82
Control Read	0x83
Status Read	0x84
Temperature Read	0x85
Signal Read	0x86
Global Read	0x87
Firmware revision Read	0x8E
Firmware Write	0x8F

Table 2.18 Amplifier commands

Note: Firmware revision read is not included in the Global data packet and must be read though an individual SEL/POL sequence.

2.6.7 Attenuation Write Command

Attenuation data format is described below…



Where…

“CMD” = 0x80, in ASCII format, ie Byte 1 = ASCII “38”, Byte 2 = ASCII “30”
“SIZE” = 0x06..0x21, ie 6-34 bytes of data (again written in ASCII) for 1-8 amplifier modules.
“DATA”: Bytes 1 & 2 = ASCII 0x00…0xFF, where the bit map (11111111) determines which amplifier modules are set by the SEL instruction. Bytes 3…34 are a string (again written in ASCII), where byte addresses 3 & 4 are channel 1 attenuation, 5 & 6 are channel 2 attenuation, etc, as shown in table 2.19 below.

For less than 8 amplifier modules, then the MODULE data, SIZE value and DATA packet will reduce to reflect the smaller number of modules.

Name	Address	ASCII	Name	Address	ASCII
MODULEL	0x00	Byte 1	ATT9L	0x12	Byte 1
MODULEH	0x01	Byte 2	ATT9H	0x13	Byte 2
ATT1L	0x02	Byte 1	ATT10L	0x14	Byte 1
ATT1H	0x03	Byte 2	ATT10H	0x15	Byte 2
ATT2L	0x04	Byte 1	ATT11L	0x16	Byte 1
ATT2H	0x05	Byte 2	ATT11H	0x17	Byte 2
ATT3L	0x06	Byte 1	ATT12L	0x18	Byte 1
ATT3H	0x07	Byte 2	ATT12H	0x19	Byte 2
ATT4L	0x08	Byte 1	ATT13L	0x1A	Byte 1
ATT4H	0x09	Byte 2	ATT13H	0x1B	Byte 2
ATT5L	0x0A	Byte 1	ATT14L	0x1C	Byte 1
ATT5H	0x0B	Byte 2	ATT14H	0x1D	Byte 2
ATT6L	0x0C	Byte 1	ATT15L	0x1E	Byte 1
ATT6H	0x0D	Byte 2	ATT15H	0x1F	Byte 2
ATT7L	0x0E	Byte 1	ATT16L	0x20	Byte 1
ATT7H	0x0F	Byte 2	ATT16H	0x21	Byte 2
ATT8L	0x10	Byte 1			
ATT8H	0x11	Byte 2			

Table 2.19 Command 0x80 Attenuation write.

NOTE: The attenuation is a linear control of gain from -51.5dB to +12dB from 0x01 to 0xFF in 128 steps, plus 0x00 = “Off” (-115.5dB). For most applications, the gain will be used to optimize the incoming signal from sources (CD Players, etc) or processing equipment (Equalizers, Mixing Consoles, etc). The most useful section of the control range will be the topmost 24dB, ie from -12dB to +12dB.

It is recommended that programmers use a non linear approach to the control of the gain. Although a logarithmic or cube law would be best, a simple 3 step linear algorithm can be applied that will move the lowest 50% of the scale into the bottom 25% of the controller and the most important (ighest) 25% of the scale into the top 50% of the scale, as follows…

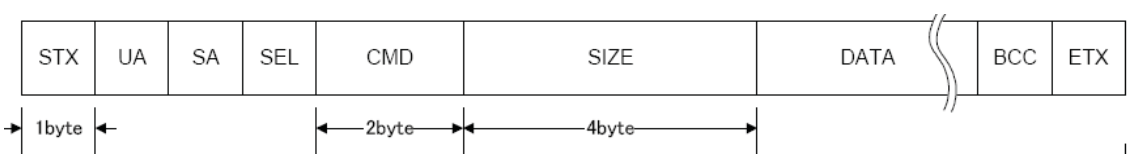
- Slider input from 0x00 to 0x40 would output at a 2x scale factor, ie 0x01 would be doubled to 0x02 & 0x40 would be doubled to 0x80
- Slider input from 0x41 to 0x80 would output at a 1x scale factor, ie 0x41 would be 0x41 + 0x40, ie 0x81 & 0x80 would be 0x80 + 0x40, ie 0xC0
- Slider input from 0x81 to 0xFF would output at a 0.5x scale factor, ie both 0x81 & 0x82 would be 0x41 + 0x80, ie 0xC1 (so the scale only increases 1 step for every 2 increments) and 0xFF = 0x8F + 0x80, ie 0xFF

In addition, if the programmer needs to create a volume control, then a practical range of 18dB is usually sufficient between softest and loudest signal, so the most common technique is to create a limited range plus mute, as follows…

- Mute = 0x00
- Upper limit = loudest required sound (set by trial and error)
- Lower limit = Upper limit less18dB, ie less 0xHH

2.6.8 Control Write Command

Control data format is described below…



Where…

“CMD” = 0x81, in ASCII format, ie Byte 1 = ASCII “38”, Byte 2 = ASCII “31”
“SIZE” = 0x04..0x0A, ie 4-11 bytes of data (again written in ASCII) for 1-8 amplifier modules.
“DATA”: Bytes 1 & 2 = ASCII 0x00…0xFF, where the bit map (11111111) determines which amplifier modules are set by to the SEL instruction. Bytes 3…11 are a string (again written in ASCII), where byte address 3 is the master comms module control, byte 4 is amplifier module 1 controls, etc, as shown in table 2.20 below.

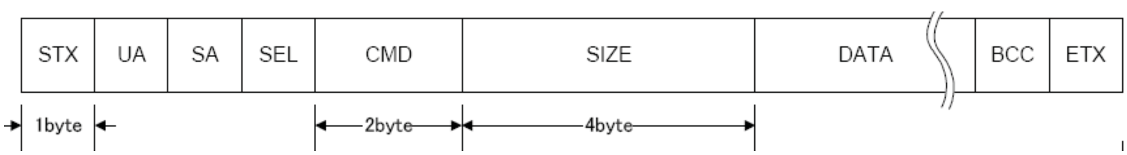
Name	Address	ASCII
MODULEL	0x00	Byte 1
MODULEH	0x01	Byte 2
CONTROLM	0x02	Byte 1
CONTROL1	0x03	Byte 1
CONTROL2	0x04	Byte 1
CONTROL3	0x05	Byte 1
CONTROL4	0x06	Byte 1
CONTROL5	0x07	Byte 1
CONTROL6	0x08	Byte 1
CONTROL7	0x09	Byte 1
CONTROL8	0x0A	Byte 1

Table 2.20 Command 0x81 Control write

Again, for less than 8 amplifier modules, then the Module data, SIZE value and DATA size will reduce to reflect the small number of modules.

2.6.9 Attenuation read Command

In order to read attenuation only, a SEL instruction must be sent to the target amplifier(s) prior to a POL instruction. The amplifier will then respond to subsequent POL instruction with a modified DATA packet. The effects of the SEL instruction are given below…



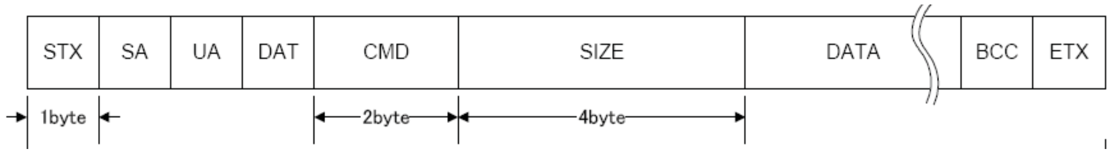
Where…

"CMD" = 0x82, in ASCII format, ie Byte 1 = ASCII "38", Byte 2 = ASCII "32"
"SIZE" = 0x03, ie 3 bytes (ASCII = "33")
"DATA", where…

Byte 1 = 0 (ASCII "30") "ie send all requested parameters, or 1 (ASCII "31"), ie only send those parameters that have changed since the last POL
Bytes 2 & 3 = 0x00…0xFF in ASCII, where the bit map (11111111) determines which amplifier modules reply to the POL instruction.

If Byte 1 = 0 and Bytes 2 & 3 = 0xFF (11111111), then all *available* modules will respond with data (changed or not since the last POL), eg if Bytes 2 & 3 = 0xFF, but only modules 1 & 2 are present and available, then only data for modules 1 & 2 will be transmitted

The data format for command 0x82 is described below



Where…

"CMD" = 0x82, in ASCII format, ie Byte 1 = ASCII "38", Byte 2 = ASCII "32"
"SIZE" = 0x06..0x22, ie 6-34 bytes of data (again written in ASCII) for 1-8 amplifier modules.
"DATA" (ASCII) will be a sequence as follows (see Table 18 above). If byte 1 = 0, then a NAK is transmitted.

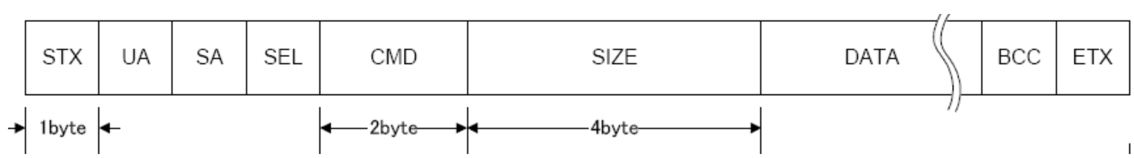
Bytes 1 & 2 = Bit map (11111111) and determines which amplifier modules have replied to the POL instruction.
Bytes 3…34 are the pairs of bytes (in ASCII) corresponding to the attenuation of the 16 possible amplifier channels.

For example, if amplifier modules 1, 2, 3 are present, but only module 2 has changed data since the last POL…

- If SEL has set up command 0x82 to POL all data: Bytes 1 &2 would show modules 1, 2, 3 presenting data and transmit 14 bytes of data
- If SEL has set up command 0x82 to POL changed data: Byte 1 would show module 2 presenting data and transmit 6 bytes of data (the minimum)

2.6.10 Control read command

In order to read control status only, a SEL instruction must be sent to the target amplifier(s) prior to a POL instruction. The amplifier will then respond to subsequent POL instruction with a modified DATA packet. The effects of the SEL instruction are given below…



Where…

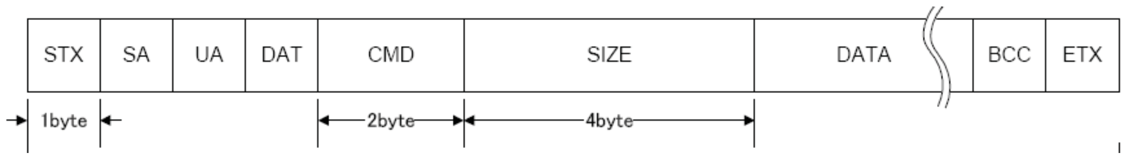
"CMD" = 0x83, in ASCII format, ie Byte 1 = ASCII "38", Byte 2 = ASCII "33"
"SIZE" = 0x03, ie 3 bytes (ASCII = "33")
"DATA", where…

Byte 1 = 0 (ASCII "30") "ie send all requested parameters, or 1 (ASCII "31"), ie only send those parameters that have changed since the last POL

Bytes 2 & 3 = 0x00…0xFF in ASCII, where the bit map (11111111) determines which amplifier modules reply to the POL instruction.

If Byte 1 = 0 and Bytes 2 & 3 = 0xFF (11111111), then all *available* modules will respond with data (changed or not since the last POL), eg if Bytes 2 & 3 = 0xFF, but only modules 1 & 2 are present and available, then only data for modules 1 & 2 will be transmitted

The data format for command 0x83 is described below



Where…

"CMD" = 0x83, in ASCII format, ie Byte 1 = ASCII "38", Byte 2 = ASCII "33"
"SIZE" = 0x04..0x0B, ie 4-11 bytes of data (again written in ASCII) for 1-8 amplifier modules.
"DATA" (ASCII) will be a sequence as follows (see Table 19 above).

Bytes 1 & 2 = Bit map (11111111) and determines which amplifier modules have replied to the POL instruction.
Byte 3 corresponds to the control status of the SMPS
Bytes 4…11 are the bytes corresponding to the control status of the 8 possible amplifier modules.

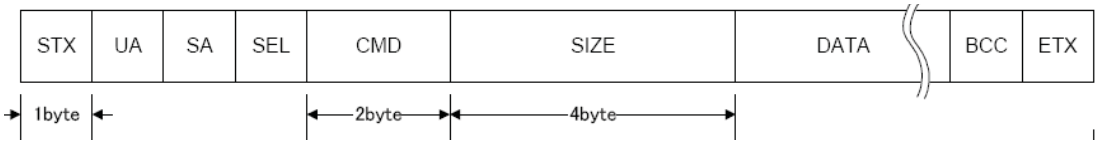
For example, if amplifier modules 1, 2, 3 & 4 are present, but only modules 3 & 4 has changed data since the last POL…

- If SEL has set up command 0x83 to POL all data: Bytes 1 & 2 would show modules 1, 2, 3, & 4 presenting data and transmit 7 bytes of data
- If SEL has set up command 0x83 to POL changed data: Bytes 1 & 2 would show modules 3 & 4 presenting data and transmit 5 bytes of data

Note that Control status for the SMPS is always provided and thus there will not be a NAK for the control status response.

2.6.11 Status Read Command

In order to read operational status only, a SEL instruction must be sent to the target amplifier(s) prior to a POL instruction. The amplifier will then respond to subsequent POL instruction with a modified DATA packet. The effects of the SEL instruction are given below…



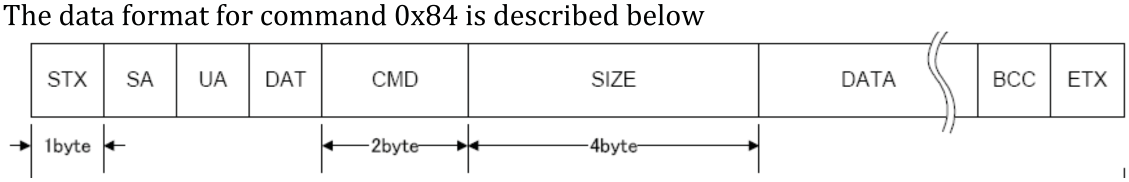
Where…

"CMD" = 0x84, in ASCII format, ie Byte 1 = ASCII "38", Byte 2 = ASCII "34"
"SIZE" = 0x03, ie 3 bytes (ASCII = "33")
"DATA", where…

Byte 1 = 0 (ASCII "30") "ie send all requested parameters, or 1 (ASCII "31"), ie only send those parameters that have changed since the last POL
Bytes 2 & 3 = 0x00…0xFF in ASCII, where the bit map (11111111) determines which amplifier modules reply to the POL instruction.

If Byte 1 = 0 and Bytes 2 & 3 = 0xFF (11111111), then all *available* modules will respond with data (changed or not since the last POL), eg if Bytes 2 & 3 = 0xFF, but only modules 1 & 2 are present and available, then only data for modules 1 & 2 will be transmitted

The data format for command 0x84 is described below



Where…

"CMD" = 0x84, in ASCII format, ie Byte 1 = ASCII "38", Byte 2 = ASCII "34"
"SIZE" = 0x11…0x26, ie up to 38 bytes of data (again written in ASCII)
"DATA" (ASCII) will be a sequence as follows (see Table 18 below).

Bytes 1 & 2 = Bit map (11111111) and determines which amplifier modules have replied to the POL instruction
Bytes 3…14 are the 12 bytes corresponding to the SMPS
Bytes 15…38 are the 24 bytes corresponding to the operational status of 8 possible amplifier modules.

For example, if amplifier modules 1 & 2 are present, and both modules have changed data since the last POL…

- If SEL has set up command 0x84 to POL all data: Bytes 1 & 2would show modules 1 & 2 presenting data and provide 20 bytes of data
- If SEL has set up command 0x84 to POL changed data: Byte 1 would show modules 1 & 2 presenting data and provide 20 bytes of data

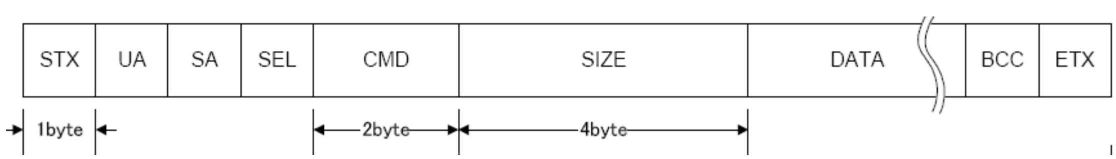
Note that Status for the SMPS is always provided and thus there will not be a NAK for the control status response

Name	Address	ASCII	Name	Address	ASCII
MODULEL	0x00	Byte 1	FAULT3L	0x14	Byte 1
MODULEH	0x01	Byte 2	FAULT3H	0x15	Byte 2
VCC5L	0x02	Byte 1	STATUS3	0x16	Byte 1
VCC5H	0x03	Byte 2	FAULT4L	0x17	Byte 1
VCC15L	0x04	Byte 1	FAULT4H	0x18	Byte 2
VCC15H	0x05	Byte 2	STATUS4	0x19	Byte 1
VCCAMPL	0x06	Byte 1	FAULT5L	0x1A	Byte 1
VCCAMPH	0x07	Byte 2	FAULT5H	0x1B	Byte 2
MODEL	0x08	Byte 1	STATUS5	0x1C	Byte 1
MODEL	0x09	Byte 2	FAULT6L	0x1D	Byte 1
FAULTM	0x0A	Byte 1	FAULT6H	0x1E	Byte 2
CONTROLM	0x0B	Byte 1	STATUS6	0x1F	Byte 1
STATUSM	0x0C	Byte 1	FAULT7L	0x20	Byte 1
STATUSM	0x0D	Byte 2	FAULT7H	0x21	Byte 2
FAULT1L	0x0E	Byte 1	STATUS7	0x22	Byte 1
FAULT1H	0x0F	Byte 2	FAULT8L	0x23	Byte 1
STATUS1	0x10	Byte 1	FAULT8H	0x24	Byte 2
FAULT2L	0x11	Byte 1	STATUS8	0x25	Byte 1
FAULT2H	0x12	Byte 2			
STATUS2	0x13	Byte 1			

Table 2.21 Status Read Dataset.

2.6.12 Temperature Read Command

In order to read temperature only, a SEL instruction must be sent to the target amplifier(s) prior to a POL instruction. The amplifier will then respond to subsequent POL instruction with a modified DATA packet. The effects of the SEL instruction are given below…



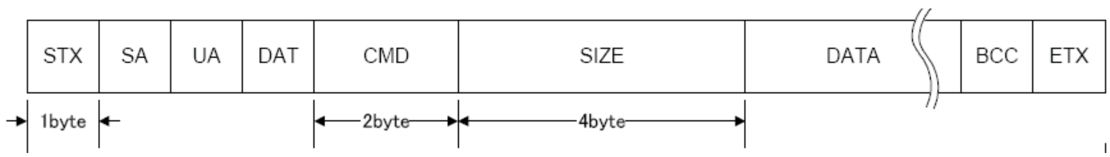
Where…

“CMD” = 0x85, in ASCII format, ie Byte 1 = ASCII “38”, Byte 2 = ASCII “35”
“SIZE” = 0x03, ie 3 bytes (ASCII = “33”)
“DATA”, where…

Byte 1 = 0 (ASCII "30") "ie send all requested parameters, or 1 (ASCII "31"), ie only send those parameters that have changed since the last POL
Bytes 2 & 3 = 0x00…0xFF in ASCII, where the bit map (11111111) determines which amplifier modules reply to the POL instruction.

If Byte 1 = 0 and Bytes 2 & 3 = 0xFF (11111111), then all *available* modules will respond with data (changed or not since the last POL), eg if Bytes 2 & 3 = 0xFF, but only modules 1 & 2 are present and available, then only data for modules 1 & 2 will be transmitted

The data format for command 0x85 is described below



Where…

"CMD" = 0x85, in ASCII format, ie Byte 1 = ASCII "38", Byte 2 = ASCII "35"
"SIZE" = 0x08…0x16, ie up to 22 bytes of data (again written in ASCII)
"DATA" (ASCII) will be a sequence as follows (see Table 19 below).

Bytes 1 & 2 = Bit map (11111111) and determines which amplifier modules have replied to the POL instruction
Bytes 3…6 are the 4 bytes corresponding to the SMPS/PFC temperature
Bytes 7…22 are the 16 bytes corresponding to the temperature status of 8 possible amplifier modules.

For example, if amplifier modules 1 & 2 are present, and both modules have changed data since the last POL…

- If SEL has set up command 0x85 to POL all data: Bytes 1 & 2 would show modules 1 & 2 presenting data and provide 10 bytes of data
- If SEL has set up command 0x85 to POL changed data: Byte 1 would show modules 1 & 2 presenting data and provide 10 bytes of data

Note that temperature for the SMPS is always provided and thus there will not be a NAK for the temperature read response

The dataset is shown in Table 2.22 below, where 0x00/0x01 are the bytes showing the number of modules present, 0x02 is the low data byte of an 8 bit temperature signal for the PFC module, etc…

Name	Address	ASCII	Name	Address	ASCII
MODULEL	0x00	Byte 1	TEMP4L	0x0C	Byte 1
MODULEH	0x01	Byte 2	TEMP4H	0x0D	Byte 2
PFCTML	0x02	Byte 1	TEMP5L	0x0E	Byte 1

PFCTMH	0x03	Byte 2	TEMP5H	0x0F	Byte 2
SMPSTML	0x04	Byte 1	TEMP6L	0x10	Byte 1
SMPSTMH	0x05	Byte 2	TEMP6H	0x11	Byte 2
TEMP1L	0x06	Byte 1	TEMP7L	0x12	Byte 1
TEMP1H	0x07	Byte 2	TEMP7H	0x13	Byte 2
TEMP2L	0x08	Byte 1	TEMP8L	0x14	Byte 1
TEMP2H	0x09	Byte 2	TEMP8H	0x15	Byte 2
TEMP3L	0x0A	Byte 1			
TEMP3H	0x0B	Byte 2			

Table 2.22 Temperature read dataset

2.6.13 Signal Read Command

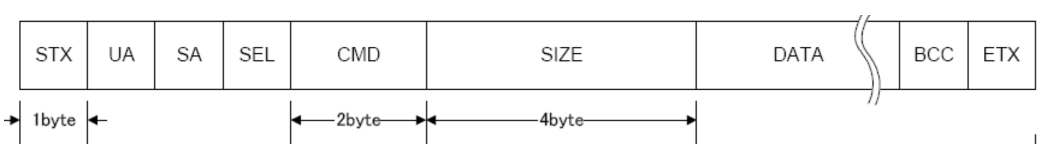
In order to read signal only, a SEL instruction must be sent to the target amplifier(s) prior to a POL instruction. The amplifier will then respond to subsequent POL instruction with a modified DATA packet. The effects of the SEL instruction are given below…

Where…

"CMD" = 0x86, in ASCII format, ie Byte 1 = ASCII "38", Byte 2 = ASCII "36"
"SIZE" = 0x03, ie 3 bytes (ASCII = "33")
"DATA", where…

Byte 1 = 0 (ASCII "30") "ie send all requested parameters, or 1 (ASCII "31"), ie only send those parameters that have changed since the last POL
Bytes 2 & 3 = 0x00…0xFF in ASCII, where the bit map (11111111) determines which amplifier modules reply to the POL instruction.

If Byte 1 = 0 and Bytes 2 & 3 = 0xFF (11111111), then all *available* modules will respond with data (changed or not since the last POL), eg if Bytes 2 & 3 = 0xFF, but only modules 1 & 2 are present and available, then only data for modules 1 & 2 will be transmitted. The data format for command 0x86 is described below



Where…

"CMD" = 0x86, in ASCII format, ie Byte 1 = ASCII "38", Byte 2 = ASCII "36"

“SIZE” = 0x14…0x92, ie up to 146 bytes of data (again written in ASCII).
“DATA” (ASCII) will be a sequence as follows (see Table 20 below). If byte 1 = 0, then a NAK is transmitted…

Bytes 1 & 2 = Bit map (11111111) and determines which amplifier modules have replied to the POL instruction
Bytes 3…146 are the 8 sets of 18 bytes corresponding to the signal condition of the 8 possible amplifier modules.

For example, if amplifier modules 1, 2, 3 are present, but only module 2 has changed data since the last POL…

- If SEL has set up command 0x86 to POL all data: Bytes 1 & 2 would show modules 1, 2, 3 presenting data and transmit 56 bytes of data
- If SEL has set up command 0x86 to POL changed data: Bytes 1 & 2 would show module 2 presenting data and transmit 20 bytes of data (the minimum)

Name	Address	ASCII	Name	Address	ASCII
MODULEL	0x00	Byte 1	….		
MODULEH	0x01	Byte 2	….		
SIG1PEL	0x02	Byte 1	SIG15PEL	0x82	Byte 1
SIG1PEH	0x03	Byte 2	SIG15PEH	0x83	Byte 2
SIG1POL	0x04	Byte 1	SIG15POL	0x84	Byte 1
SIG1POH	0x05	Byte 2	SIG15POH	0x85	Byte 2
SIG2PEL	0x06	Byte 1	SIG16PEL	0x86	Byte 1
SIG2PEH	0x07	Byte 2	SIG16PEH	0x87	Byte 2
SIG2POL	0x08	Byte 1	SIG16POL	0x88	Byte 1
SIG2POH	0x09	Byte 2	SIG16POH	0x89	Byte 2
OCUR1L	0x0A	Byte 1	OCUR15L	0x8A	Byte 1
OCUR1H	0x0B	Byte 2	OCUR15H	0x8B	Byte 2
OCUR2L	0x0C	Byte 1	OCUR16L	0x8C	Byte 1
OCUR2H	0x0D	Byte 2	OCUR16H	0x8D	Byte 2
OVOL1L	0x0E	Byte 1	OVOL15L	0x8E	Byte 1
OVOL1H	0x0F	Byte 2	OVOL15H	0x8F	Byte 2
OVOL2L	0x10	Byte 1	OVOL16L	0x90	Byte 1
OVOL2H	0x11	Byte 2	OVOL16H	0x91	Byte 2
HIGH BITSL	0x12	Byte 1	HIGH BITSL	0x92	Byte 1
HIGH BITSH	0x13	Byte 2	HIGH BITSH	0x93	Byte 2

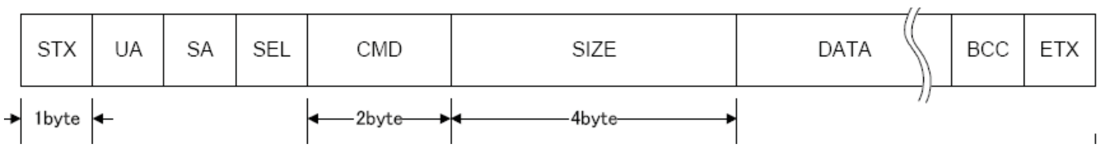
Table 2.23 Signal dataset

Note: Bit stuffing is involved for the output voltage and current, where the high bits (bits 9 & 10) of each sequence of 4 bytes are stuffed into the 5th byte. For example, bits 9 & 10 for OCUR1 are bits 1 & 2 of the 5th byte, bits 9 & 10 for OCUR2 are bits 3 & 4, of the 5th byte and so on.

2.6.14 Global read command

This is the default DATA packet, ie if no SEL instructions are used to limit the size of the data packet, the amplifier will respond with a 242 byte data string.

The SEL instruction can be used to limit the size of the global read command. To do this, the SEL instruction must be sent to the target amplifier(s) prior to a POL instruction. The amplifier will then respond to subsequent POL instruction with a modified DATA packet. The effects of the SEL instruction are given below…



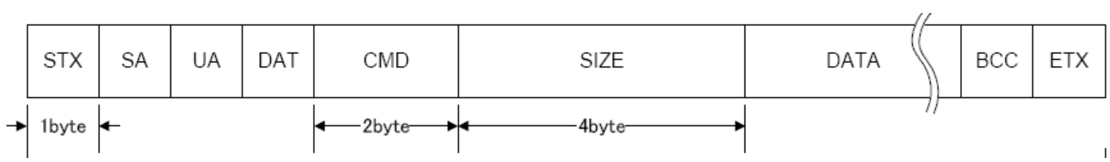
Where…

"CMD" = 0x87, in ASCII format, ie Byte 1 = ASCII "38", Byte 2 = ASCII "37"
"SIZE" = 0x03, ie 3 bytes (ASCII = "33")
"DATA", where…

Byte 1 = 0 (ASCII "30") "ie send all requested parameters, or 1 (ASCII "31"), ie only send those parameters that have changed since the last POL
Bytes 2 & 3 = 0x00…0xFF in ASCII, where the bit map (11111111) determines which amplifier modules reply to the POL instruction.

If Byte 1 = 0 and Bytes 2 & 3 = 0xFF (11111111), then all *available* modules will respond with data (changed or not since the last POL), eg if Bytes 2 & 3 = 0xFF, but only modules 1 & 2 are present and available, then only data for modules 1 & 2 will be transmitted

The data format for command 0x87 is described below



Where…

"CMD" = 0x87, in ASCII format, ie Byte 1 = ASCII "38", Byte 2 = ASCII "37"
"SIZE" = 0x2e…0xF3, ie up to 242 bytes of data (again written in ASCII)
"DATA" (ASCII) will be a sequence as follows

Bytes 1 & 2 = Bit map (11111111) and determines which amplifier modules have replied to the POL instruction
Bytes 3…18 are the bytes corresponding to the SMPS
19…242 are the 8 sets of 28 bytes corresponding to the 8 possible amplifier modules.

Name	Address	ASCII	Name	Address	ASCII
MODULEL	0x00	Byte 1	ATT1L	0x26	Byte 1
MODULEH	0x01	Byte 2	ATT1H	0x27	Byte 2
VCC5L	0x02	Byte 1	ATT2L	0x28	Byte 1
VCC5H	0x03	Byte 2	ATT2H	0x29	Byte 2
VCC15L	0x04	Byte 1	FAULT1L	0x2A	Byte 1
VCC15H	0x05	Byte 2	FAULT1H	0x2B	Byte 2
VCCAMPL	0x06	Byte 1	STATUS1	0x2C	Byte 1
VCCAMPH	0x07	Byte 2	CONTROL1	0x2D	Byte 1
MODEL	0x08	Byte 1	....		
MODEL	0x09	Byte 2	....		
PFCTML	0x0A	Byte 1	SIG15PEL	0xD7	Byte 1
PFCTMH	0x0B	Byte 2	SIG15PEH	0xD8	Byte 2
SMPSTML	0x0C	Byte 1	SIG15POL	0xD9	Byte 1
SMPSTMH	0x0D	Byte 2	SIG15POH	0xDA	Byte 2
FAULTM	0x0E	Byte 1	SIG16PEL	0xDB	Byte 1
CONTROLM	0x0F	Byte 1	SIG16PEH	0xDC	Byte 2
STATUSM	0x10	Byte 1	SIG16POL	0xDD	Byte 1
STATUSM	0x11	Byte 2	SIG16POH	0xDE	Byte 2
SIG1PEL	0x12	Byte 1	OCUR15L	0xDF	Byte 1
SIG1PEH	0x13	Byte 2	OCUR15H	0xE0	Byte 2
SIG1POL	0x14	Byte 1	OCUR16L	0xE1	Byte 1
SIG1POH	0x15	Byte 2	OCUR16H	0xE2	Byte 2
SIG2PEL	0x16	Byte 1	OVOL15L	0xDE3	Byte 1
SIG2PEH	0x17	Byte 2	OVOL15H	0xE4	Byte 2
SIG2POL	0x18	Byte 1	OVOL16L	0xE5	Byte 1
SIG2POH	0x19	Byte 2	OVOL16H	0xE6	Byte 2
OCUR1L	0x1A	Byte 1	HIGH BITSL	0xE7	Byte 1
OCUR1H	0x1B	Byte 2	HIGH BITSH	0xE8	Byte 2
OCUR2L	0x1C	Byte 1	TEMP8L	0xE9	Byte 1
OCUR2H	0x1D	Byte 2	TEMP8H	0xEA	Byte 2
OVOL1L	0x1E	Byte 1	ATT15L	0xEB	Byte 1
OVOL1H	0x1F	Byte 2	ATT15H	0xEC	Byte 2
OVOL2L	0x20	Byte 1	ATT16L	0xED	Byte 1
OVOL2H	0x21	Byte 2	ATT16H	0xEE	Byte 2
HIGH BITSL	0x22	Byte 1	FAULT8L	0xEF	Byte 1
HIGH BITSH	0x23	Byte 2	FAULT8H	0xF0	Byte 2
TEMP1L	0x24	Byte 1	STATUS8	0xF1	Byte 1
TEMP1H	0x25	Byte 2	CONTROL8	0xF2	Byte 1

Table 2.24 Global dataset

For example, if amplifier modules 1, 2, 3 are present, but only module 2 has changed data since the last POL…

- If SEL has set up command 0x87 to POL all data: Byte 1 would show modules 1, 2, 3 presenting data and transmit 102 bytes of data
- If SEL has set up command 0x87 to POL changed data: Byte 1 would show module 2 presenting data and transmit 46 bytes of data (the minimum).

Note that Control status for the SMPS is always provided and thus there will not be a NAK for the global read response

Table 23 above shows where 0x00 is the byte showing the number of modules present, byte address 0x01 is the data byte of an 8bit voltage signal for the SMPS 5volt voltage rail, etc...

Note: Bit stuffing is involved for the output voltage and current, where the high bits (bits 9 & 10) of each sequence of 4 bytes are stuffed into the 5th byte. For example, bits 9 & 10 for OCUR1 are bits 1 & 2 of the 5th byte, bits 9 & 10 for OCUR2 are bits 3 & 4, of the 5th byte and so on.

2.7 Hardware interfacing

2.7.1 RS485: Basics

RS-485 is a bi-directional half-duplex multidrop network using a twisted pair cable. Multidrop implies that multiple transceivers (transmitter and receiver in the same device) may be connected to the line. However, only one transmitter may be active at any given time. Data can flow from any single transceiver (which is transmitting) to one or more transceivers (that are receiving). In contrast, a full-duplex bus, supports simultaneous data flow in both directions. RS-485 is sometimes thought (mistakenly) to be a full-duplex bus because it supports bidirectional data transfer. However, simultaneous bidirectional transfers require not one but two data pairs.

RS-485 transmission lines are differential in nature. There are two wires, A and B. The driver generates complementary voltages on A and B to achieve a differential signal. Transceivers have the ability to tri-state (hi impedance) both A and B.

Receivers are designed to respond to the difference between A and B. The differential voltage should be > 200-mV difference between A and B. Anything less than 200 mV will result in an indeterminate result and corrupted data.

RS-485 can support networks up to 5000’ long and bit rates of up to 10 Mbps. Data rate must be traded off against cable length. Figure 2.26 shows a graph fairly typical of the bit rates and line lengths you can expect.

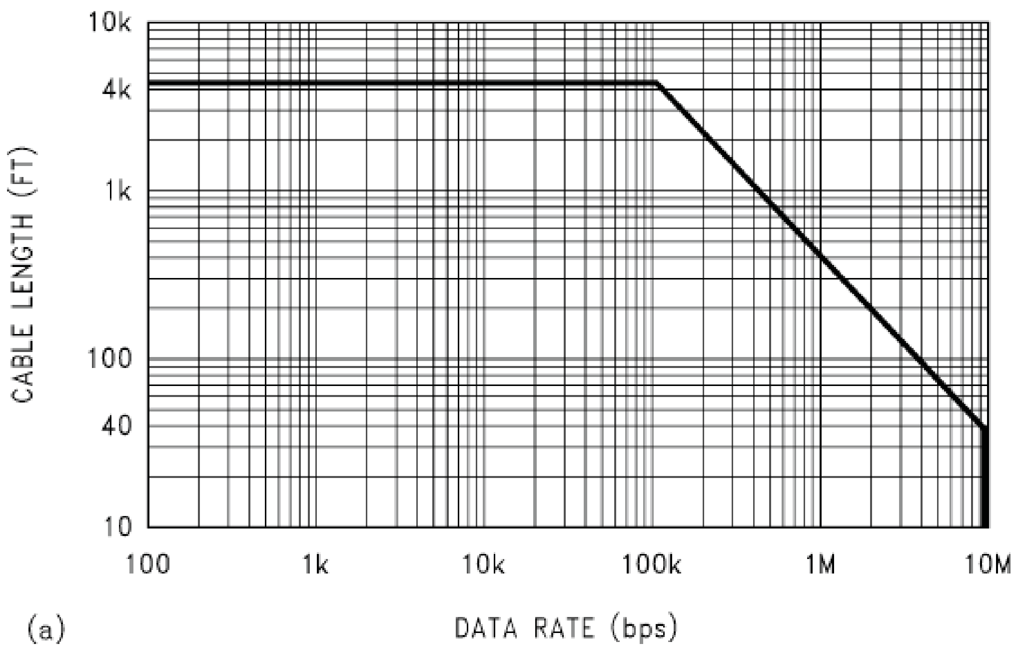


Figure 2.26: Cable vs data rate. MTS amplifiers operate at 115kbps

The TIA/EIA-485-A specification defines a load and states that an RS-485 line driver must be able to drive 32 loads. However, an RS- 485 network can support more than 32 nodes, but ONLY if each node uses ¼ (or less) load driver devices. The MTS amplifiers are designed to permit up to 64 channels on any single system. It does not matter if there are 8 amplfiers x 8 channels or 32 amplifiers x 2 channels. However, the load is limited to 32 standard load devices.

Multiple networks can be chained together using repeaters to accommodate virtually an unlimited number of nodes. However care must be taken to accommodate the propagation delays in large networks with multiple repeaters and long transmission lines, and
the data rate may become unacceptably low.

RS485 network configuration is important. Although all of the topologies shown in Figure 2.27 will work, you should avoid the ones in (a), (c), and (e). Those in (b), (d), and (f), offer much better performance and will suffer less data loss.

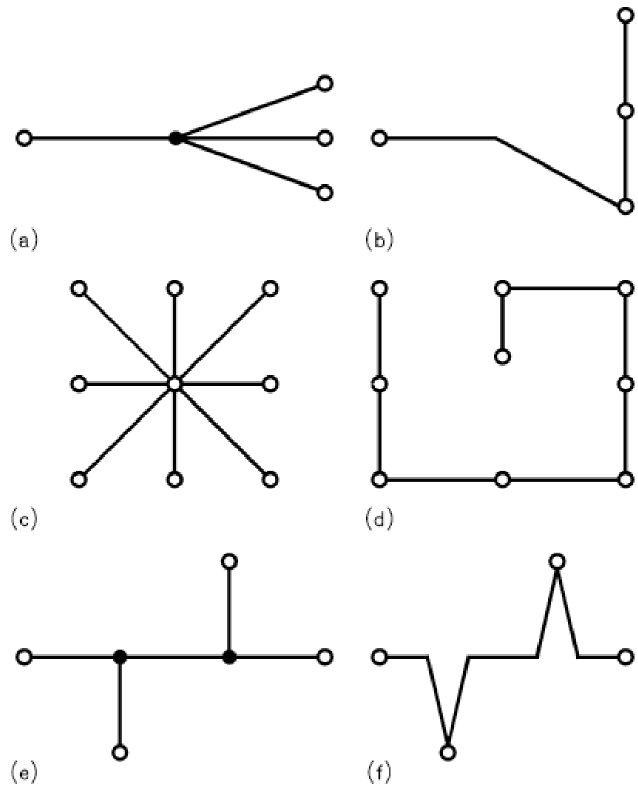


Figure 2.27: Typical RS485 network connections (Topolgies).

The optimal configuration for the RS-485 bus is the daisy-chain connection from node 1 to node 2 to node 3 to node n. The bus must form a single continuous path, and the nodes in the middle of the bus must NOT be at the ends of long branches, spokes, or stubs. Figure 2.27a, 2.27c, and 2.27e illustrate three common but **improper** bus configurations. Figure 2.27b, 2.27d, and 2.27f show equivalent daisy-chained configurations.

Connecting a node to the cable creates a 'stub'. Minimizing the stub length minimizes transmission-line problems. For standard transceivers, stubs should be shorter than 6 inches. A better rule is to make the stubs as short as possible. A "star" configuration (Figure 2.27c) usually does not provide a clean signaling environment even if the cable runs are all of equal length. The star configuration also presents a termination problem, because terminating every endpoint would overload the driver. Terminating only two endpoints solves the loading problem but creates transmission-line problems at the un-terminated ends. A true daisy-chain connection avoids all these problems.

The characteristic impedance of the cable should be 100Ω to 120Ω. A common misconception is that the cable's impedance must be exactly 120Ω, but 100Ω works equally well in most cases. Note that a cable impedance of 120Ω presents a lighter load, which can be helpful if the cable runs are extremely long.

Both ends of the main cable require termination. Another common mistake is to switch the terminating resistor at each MTS amplifier—a practice that causes trouble on buses that have four or more amplifier. The active driver sees the four termination resistors in parallel, a condition that excessively loads the driver. If each of the four nodes connects a 100Ω termination resistor across the bus, the active driver sees a load of 25Ω instead of the intended 50Ω. The problem becomes substantially worse with 32 nodes. Only TWO MTS amplifiers should have the termination resistor switched in and those should be at either end of the daisy chain.

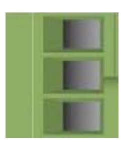
Another major issue in creating reliable RS-485 networks is proper grounding. Although the potential difference between the data-pair conductors determines the signal without officially involving ground, the bus needs a ground wire to provide a return path for induced common-mode noise and currents, such as the receiver's input current. A typical mistake is to connect two MTS amplifiers with only a two wire twisted connection. If you do this, the system may radiate high levels of EMI, because the common-mode return current finds its way back to the source, regardless of where the loop takes it. An intentional ground provides a low-impedance path in a known location, thus reducing emissions.

Note: Using any form of earth ground is a poor choice for referencing RS485 signal grounds on MTS amplifiers. The best method for controlling VGPD is to simply run a third wire (preferably the shield of a twisted pair cable) for the purpose of referencing local signal grounds. A shield both prevents the coupling of external noise to the bus and limits emissions from the bus.

MTS recommends the use of cable designed for use with RS485 networks, such as Belden 9841, or equivalent.

2.7.2 MTS amplifier pin-out

The MTS amplifier uses a 3.5mm mini-Euroblock connection. The termination is shown in Figure 2.28



Ground
B (-ve)
A (+ve)

Figure 2.28: RS485 pinout

2.7.3 70/100volt Connections

It is important to understand 2 issues relating to "Constant Voltage" (CV, usually 70 or 100 volts RMS). These circuits are usually transformer coupled at the loudspeaker and the following must be taken into account.

- Low frequency: The ability of simple ceiling loudspeakers, with a 3watt or 6watt coupling transformer, to handle low frequencies is extremely limited. The transformer can easily saturate and present a short circuit to the amplifier. It is important that the High Pass filter is used to remove all energy below 120Hz.

- DC offset: The DC offset of the amplifier is typically 20 millivolts or less. However, the DC resistance of a CV transformer can be half an ohm or less. This does not matter when long cable runs are connected between the amplifier and load. However, when short cable runs are used, it can be advisable to use non-polarized decoupling capacitors.

2.7.4 V-Bus Monitor Software

MTS has a simple Monitoring application for the serial control port. The current version is VBUSMON 5_0_63 and is available on the MTS website under the downloads section.

VBUSMON is a Windows XP/Vista/Win7 application that can also be used on MAC OS X using either Bootcamp and Windows XP/Vista/Win7, or a virtual machine (VMWare or Parallels) and Windows XP/Vista/Win7.

VBUSMON is intended to provide the user with a straightforward method of looking into the RS485 serial port and inspecting and/or manipulating the internal control & monitoring capability of the amplifier. Its value is primarily as a site testing and commissioning tool for systems integrators.

VBUSMON is a simple "Lua" application that uses the same command set described in section 2.7 above.

Installing VBUSMON is simple… just double click on the VBUSMON_5_0_63.exe and follow the instructions.

VBUSMON connects to the amplifier using the serial port of the host PC or laptop. In the case of a desktop PC, the default options of COM1 or COM2 communicates via the PC's RS232 serial 'COMPORT'. As COM1 or COM2 is RS232 and the MTS amplifiers communicates over RS485 an RS232 to RS485 adapter interface is needed. MTS recommends the B&B model 485D9TB (http://www.bb-elec.com/).

As most laptops no longer have an RS232 COMPORT, it is likely that a USB to RS232 adapter will be used (note: this still needs the RS232 to RS485 interface). In this situation, the standard COM1 or COM2 options may not be applicable and the following procedure is needed:

- Insert the USB to serial adapter and follow the product instructions to load the driver (usually plug and play).
- Click on the Windows "START" menu and right click on "My Computer".
- Select the Hardware and Device manager tabs. There should be a section marked "Ports". Click on the "+" sign to open the tabview and it should show the USB to serial adapter. In the example in Figure 2.29 (below) it is shown as "Prolific USB Serial Comm Port (COM3)".
  This means that the adapter is using COM3 to communicate out of the laptop.

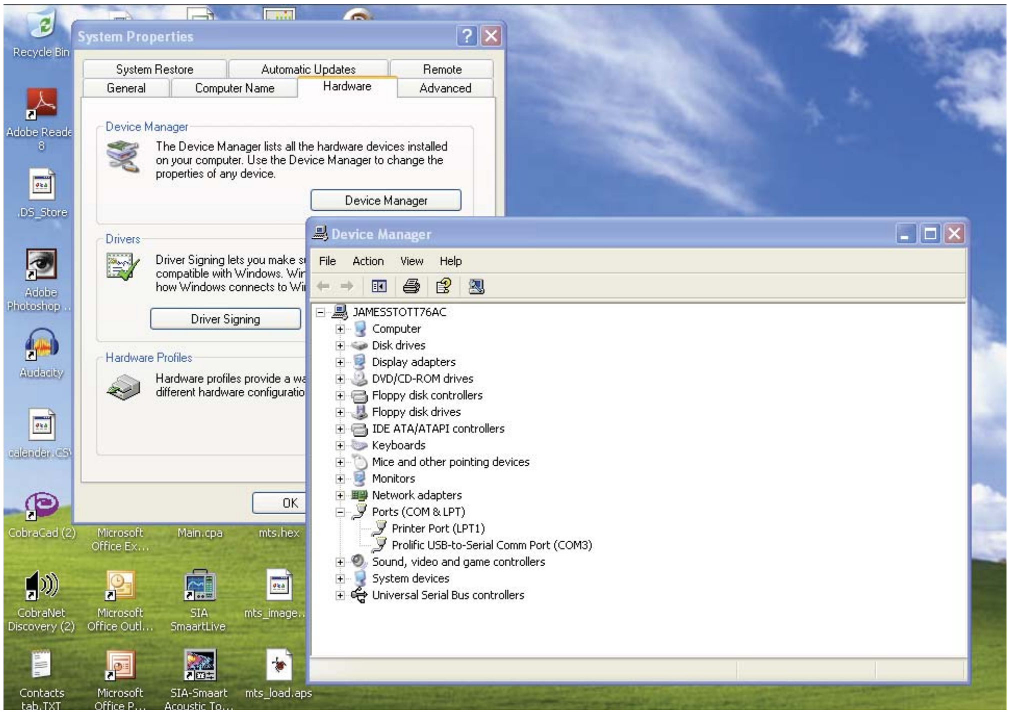


Figure 2.29: Locating the COMPORT used by the USB-Serial adapter.

- The VBUSMON software needs to be set up to communicate through the COM3 port rather than the COM1 or COM2 port. This is done by creating a shortcut on the desktop and right clicking on the shortcut to open its properties (see Figure 2.30).

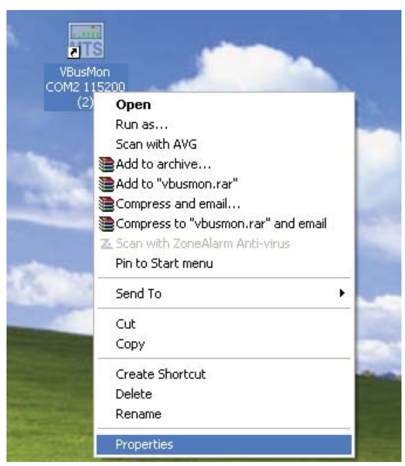


Figure 2.30: Desktop shortcut and properties menu

In the properties menu (Figure 2.31 below), go to the "Target" line and change the ".... VBusMon\Bin\vbusmon.exe" COM2 to COM3 and press "Apply". This will change the default COMPORT used by the VBUSMON application to COM3. Then press "OK" and close the properties menu.

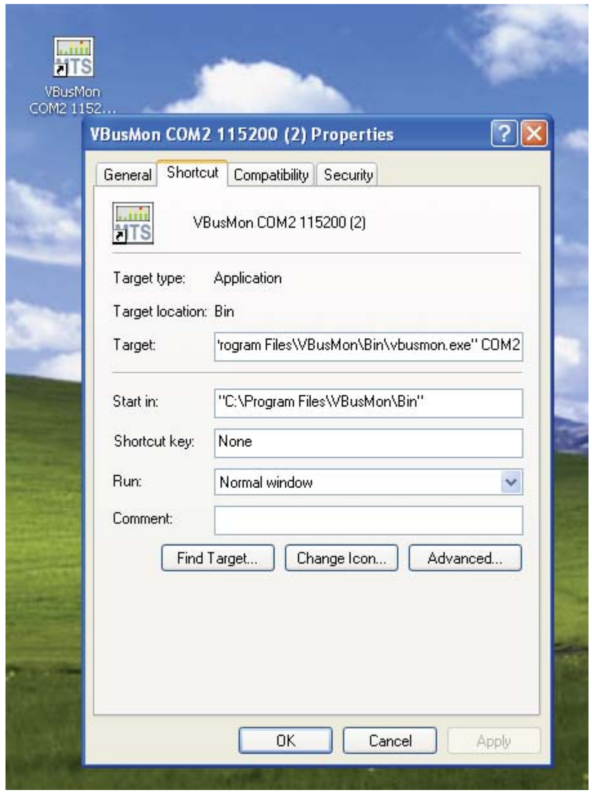


Figure 2.31: Changing the COMPORT target to COM3

Double clicking on the modified VBUSMON shortcut will enable the application to communicate to the amplifier using COM3.

Once the software is loaded, then double click the shortcut to open the application. If an error message appears (see Figure 2.32 (below) it means that the USB to Serial adapter cannot be found at COM3 and is either disconnected or associated with a different COMPORT.

If the USB to serial adapter is setup correctly, then the application will open as shown in Figure 2.33 below.

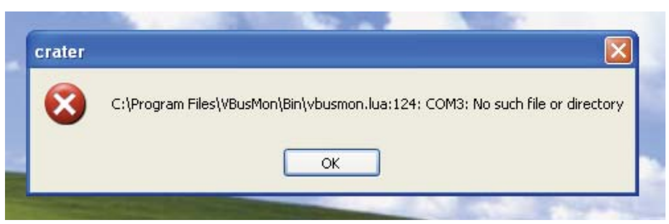


Figure 2.32: COMPORT error

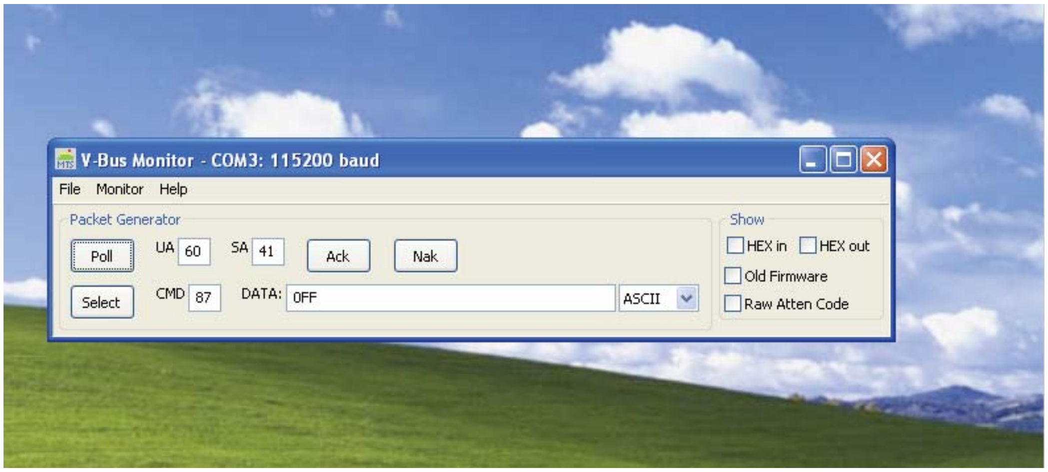


Figure 2.33: VBUSMON application opening page.

The VBUSMON application will allow the manual transmission of the V-BUS command set described in section 2.7 above. The settings are:

- UA (Unit address): This is the RS485 network address set by the DIP switches on the back of the amplifier.
- SA (Sending address): This is the RS485 address of the host computer and should always be set to 41. NOTE: When using VBUSMON with the Cobranet RS485 port, the SA MUST be more than 41 (eg 42), as the 41 address is reserved for the internal amplifier RS485 port.
- ACK and NAK: Allows the user to manually send the acknowledgement and negative acknowledgement responses after receiving data from the amplifier
- Select: Allows the user to send data using the Select (SEL) command.
- CMD: One of the 80-87 commands described in section 2.7.
- Poll: Initiates a command.

The Monitor pull down tab will show 2 options: Log and Signals. These are described as follows:-

- The Signals tab will show the display in Figure 2.34 below. Note: If "Timeout" is shown in the bottom right corner, then the RS485 bus is not connected to the amplifier. If connection is successful, then "OK" will show.

  The rest of the lower right information section will show connection details, product model details, 70 or 100volt line selection, etc.

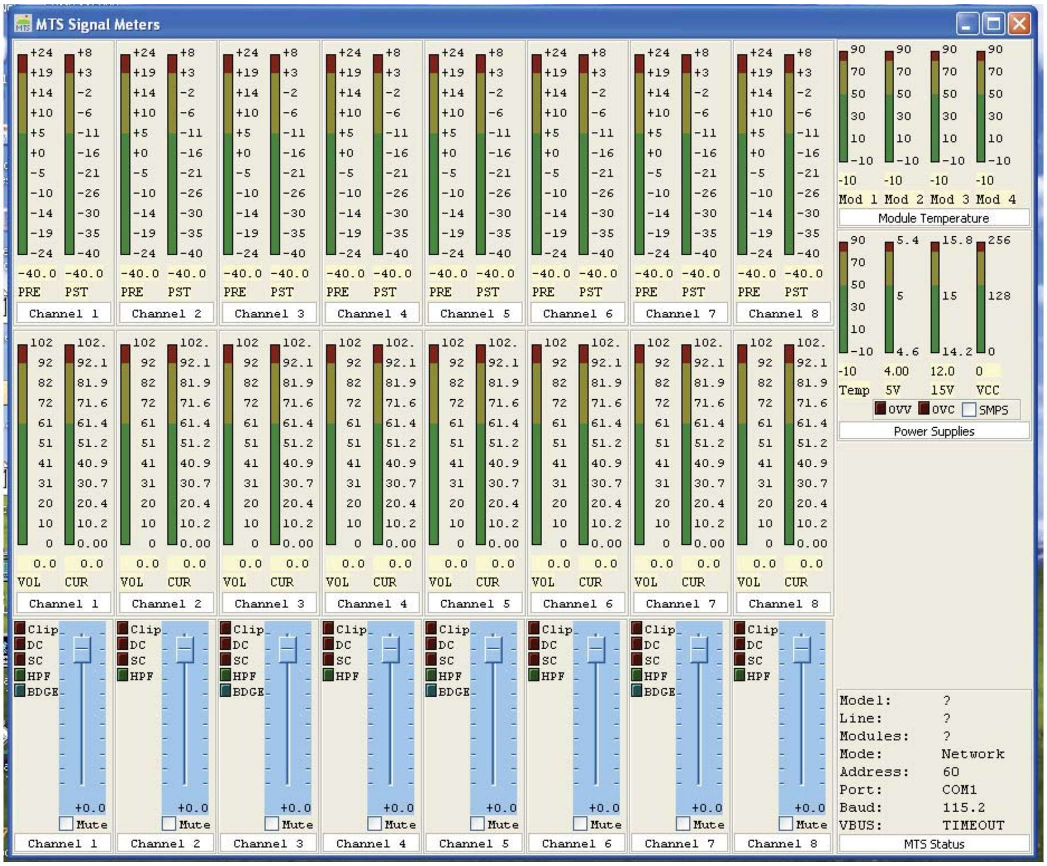


Figure 2.34: VBUSMON Signals page.

Figure 2.35 (below) shows the signals page connected to a COM3004 amplifier, ie 300watts, 70volt setting, 2 amplifier modules (each module is 2 channels, so 4 channels total). The DIP switch address is 60 and the software is communicating on COM1

As the amplifier is only 2 modules/4 channels, the temperature for modules 3 and 4 are zero and the controls for channels 5...8 are set at -51.75dB.

The remainder of the signals page are a graphical representation of the data from the RS485 port. Notes…

- The Attenuation controls are only set when released. The action is not continuous.
- The Attenutation control varies from +12 to -72dB. The +12db allows -8dBu consumer equipment such as CD players to connect directly to the ampifier.
- "Mute" is not setting the gain control to zero, but disconnects the output relay
- "SMPS" switches off the high voltage rails of the SMPS supply feeding the Class D output stages.
- "PRE" is the input stage to the VCA control and is a +24dBu clip signal
- "PST" is the output stage 'post' VCA and at the input stage of the power amplifier. The clip point is set to the clip point of the amplifier, ie +8dBu.
- "VOL is the real time output voltage of the amplifier.

- "CUR" is the real time output current of the amplifier. The output current may appear to be reading low compared to the output voltage, but the scale is set to the worst case 2 ohm (DS-SI series) current limit. The actual current drawn will depend on the load impedance.

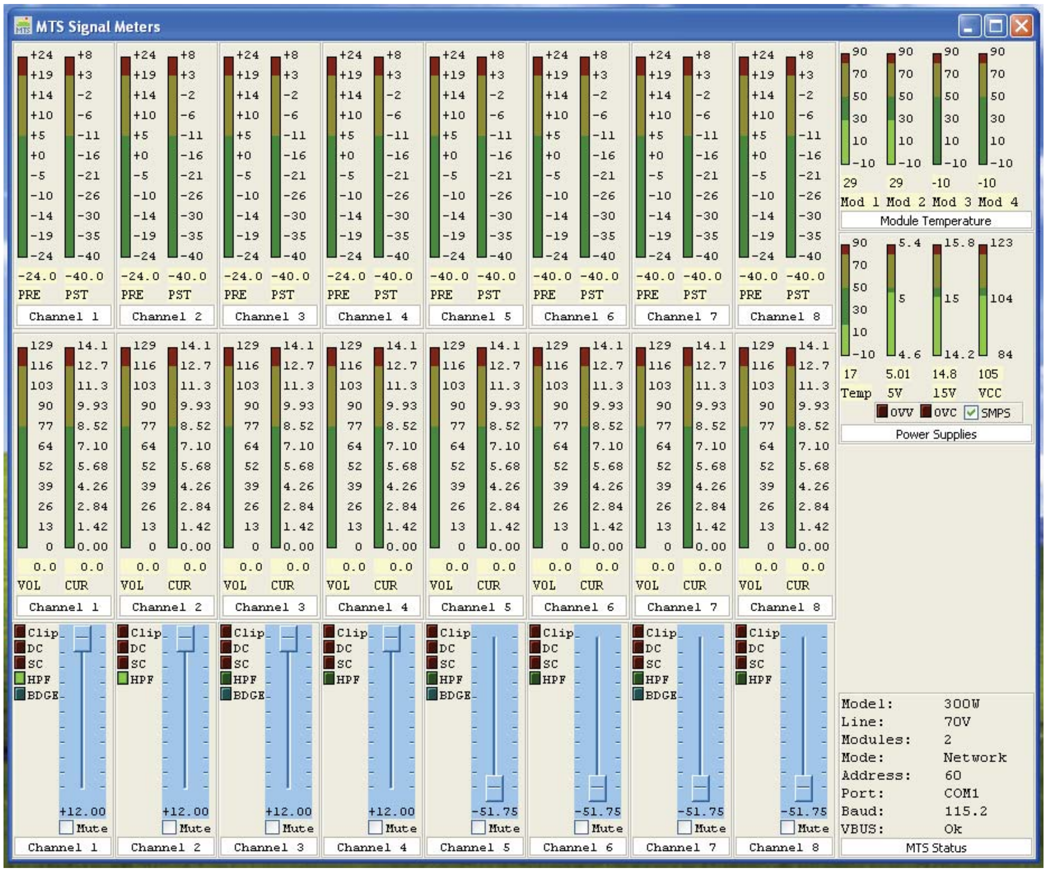


Figure 2.35: Signals page connected to an amplifier

- The Log tab allows the user to monitor the data sent to and from the MTS amplifier, see Figure 2.36 below.

  When any of the buttons are pressed in the VBUSMON page, the RS485 instruction is shown in the Log page. If "hex in" and "Hex out" checkboxes are selected, then the actual hexadecimal code is shown.

  There are also options for viewing the data as ASCII or Hexadecimal.

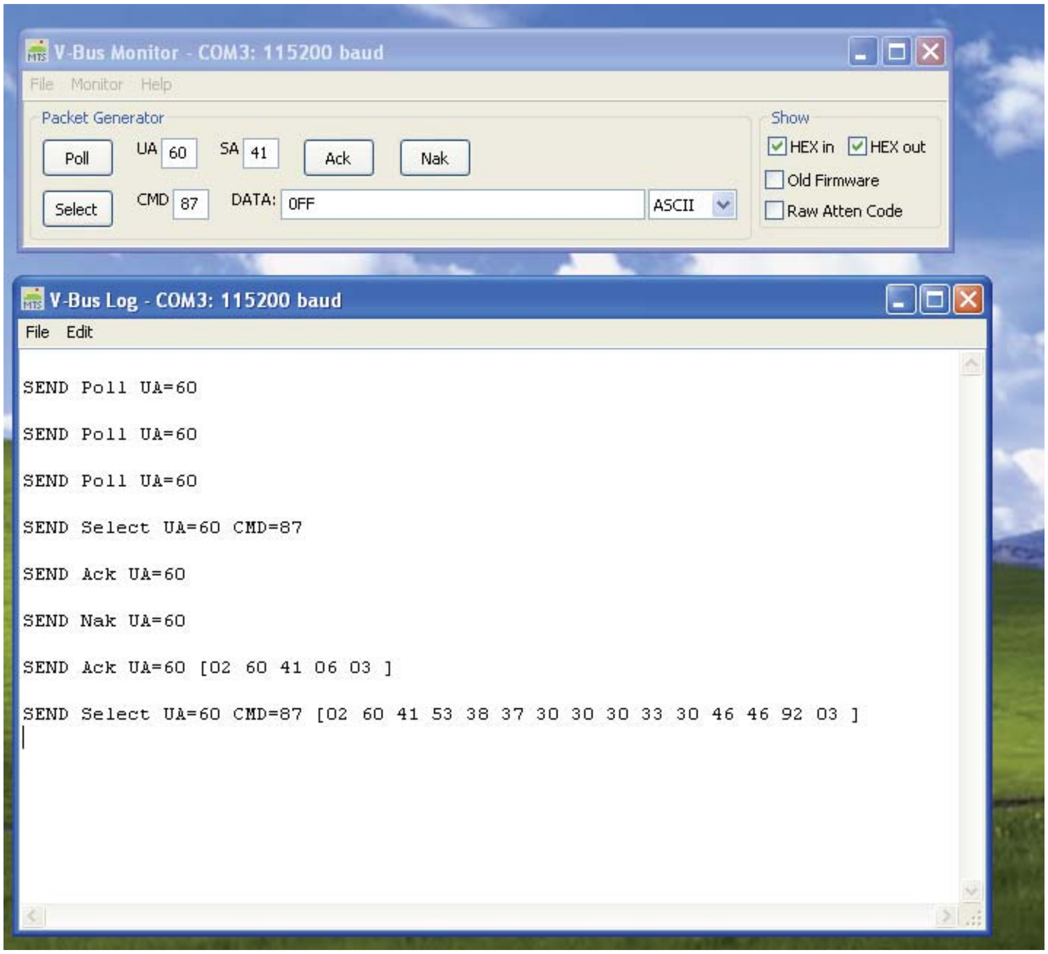


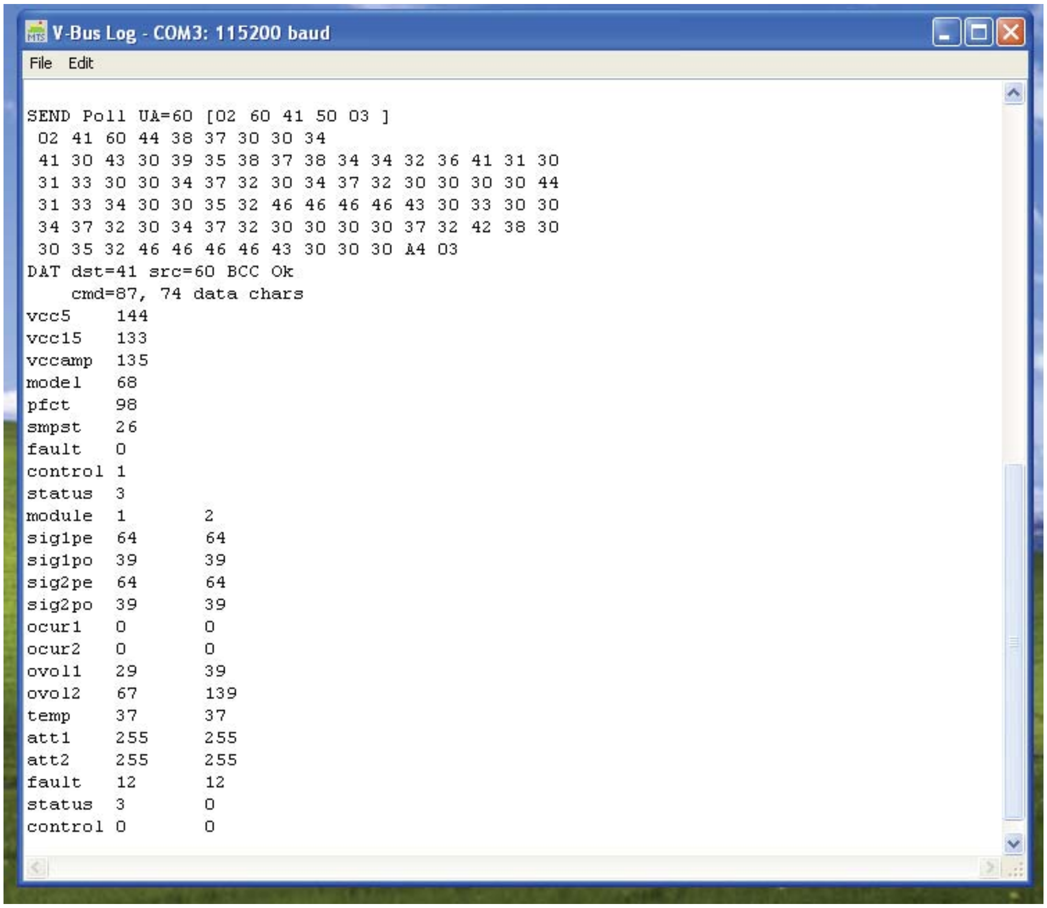
Figure 2.36: VBUSMON Log monitor tab page.

Figure 2.37 below shows the VBUSMON page when connected to an amplifier. A POLL instruction returns a full dataset. As the amplifier is a DHV3004, only 4 channels (2 modules) of data are generated.

For ease of debugging systems, the Log page also shows the hex values of the data against the parameters listed.

For example, VCCamp shows 135. This is an 8 bit value, ie 135 out of a maximum of 256. Section 2.2.4 (above) shows that for a 70volt model, the value 135 should be multiplied by 153.6mV to get 20.736volts. Adding the offset of 84volts gives a total of 104.736 volts.

The Signals page shows a value of 105volts for the DHV3004. As the DHV is a 70/100volt amplifier in 70volt mode, the RMS output of the amplifier will be 70volts, or 100volts peak (70 x 1.414). Adding in the drop across the output devices would require a rail voltage of around 105volts.



V-Bus Log - COM3: 115200 baud

File Edit

```
SEND Poll UA=60 [02 60 41 50 03 ]
 02 41 60 44 38 37 30 30 34
 41 30 43 30 39 35 38 37 38 34 34 32 36 41 31 30
 31 33 30 30 34 37 32 30 34 37 32 30 30 30 30 44
 31 33 34 30 30 35 32 46 46 46 46 43 30 33 30 30
 34 37 32 30 34 37 32 30 30 30 30 37 32 42 38 30
 30 35 32 46 46 46 46 43 30 30 30 A4 03
DAT dst=41 src=60 BCC Ok
    cmd=87, 74 data chars
vcc5    144
vcc15   133
vccamp  135
model   68
pfct    98
smpst   26
fault   0
control 1
status  3
module  1       2
sig1pe  64      64
sig1po  39      39
sig2pe  64      64
sig2po  39      39
ocur1   0       0
ocur2   0       0
ovol1   29      39
ovol2   67      139
temp    37      37
att1    255     255
att2    255     255
fault   12      12
status  3       0
control 0       0
```

3 MTS Control

MTS provides a Control and Monitoring application called “MTS Control”, which is a stripped down version of Stardraw Control 2010.

In some installations, there will be 3rd party control systems (such as AMX and Crestron) and these will be used to provide control and monitoring functionality for the MTS products. MTS Control is intended for those installations, where there is no 3rd party control system.

The full version of Stardraw Control is a licensed software-based universal control platform designed to create custom User Interfaces that can control any remotely-controlled or monitored hardware. See website below for full details.

http://www.stardraw.com/products/stardrawcontrol/

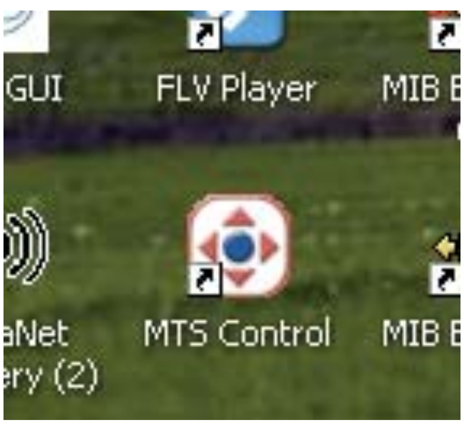
The MTS Control version is provided by MTS at no cost, but is subject to the same copyright and intellectual property rights as the main Stardraw Control. The primary difference is that MTS Control will ONLY control and monitor MTS products. If the user would like to expand the capability of the application, then a full license can be purchased from Stardraw Control.

The MTS Control software is included in the CDROM, along with this manual

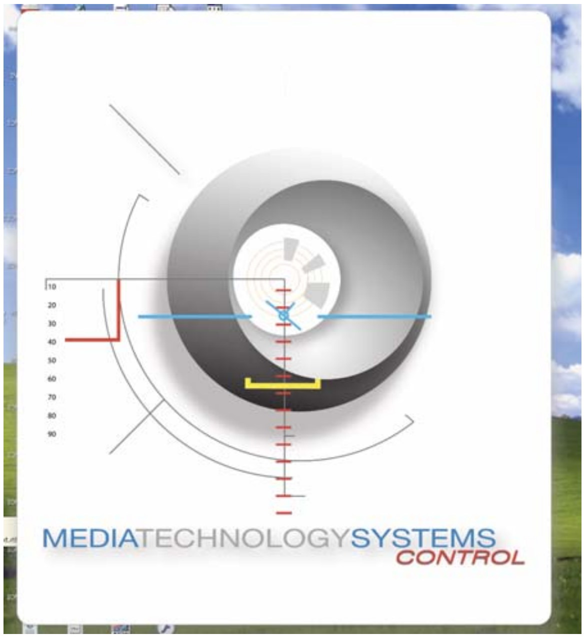
MTS Control is a 20Meg download and requires .net3.5. If .net3.5 is not present on the host computer, then it will attempt to download from the internet and install it automatically.

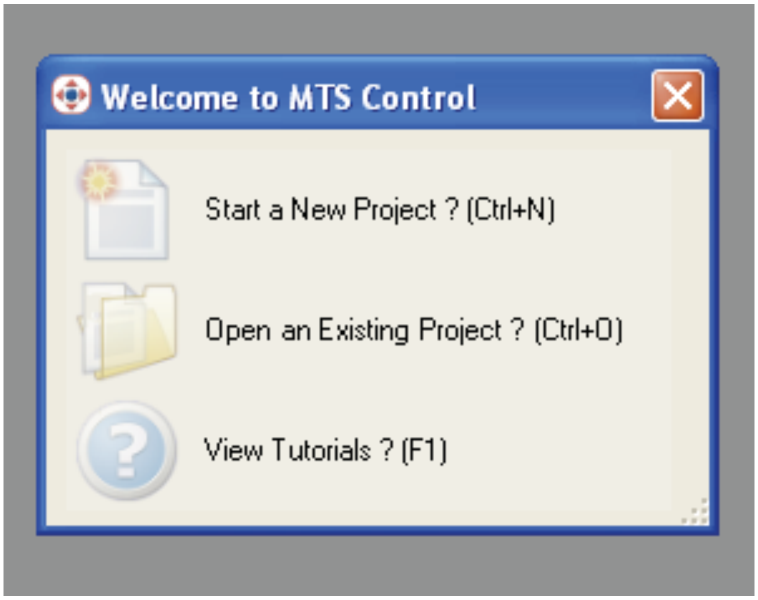
The full download of MTS2010 is a 256Mb as it includes .net 3.5 and SQL Server CE and will install and run as a native 64 bit application as well as 32bit.

Once the application has been downloaded and executed, the MTS Control icon should appear on the desktop – see below.



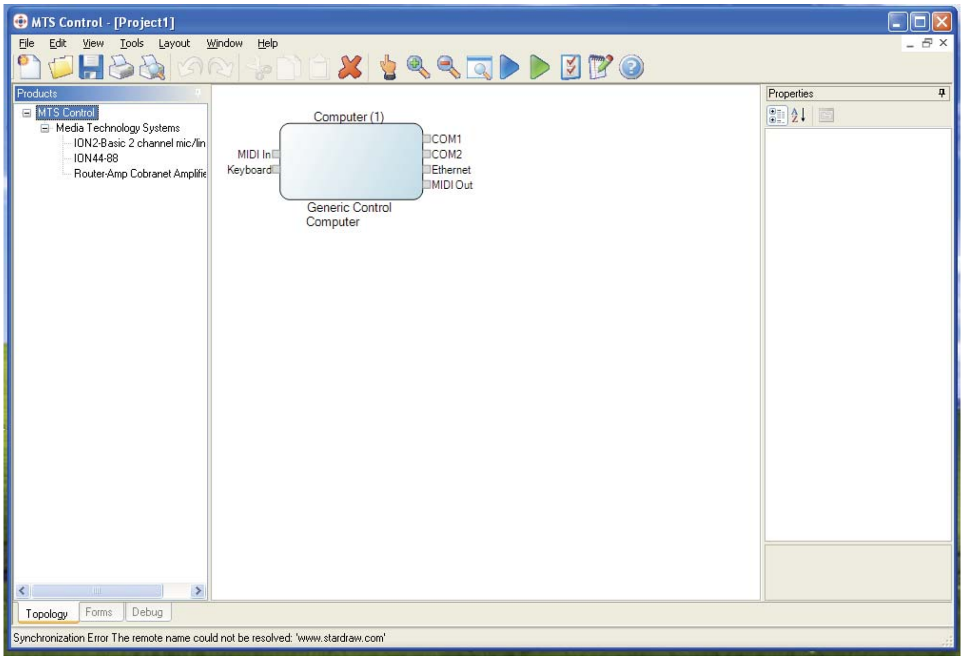
Launching MTS Control will show the following splash screen and then the initial opening menu – see below





At this point a new user should choose "View Tutorials", as it is beyond the scope of this manual to provide in depth training on either Stardraw Control or C# (the language underpinning Stardraw Control). However, some basic movies in swf format have been included on the CDROM.

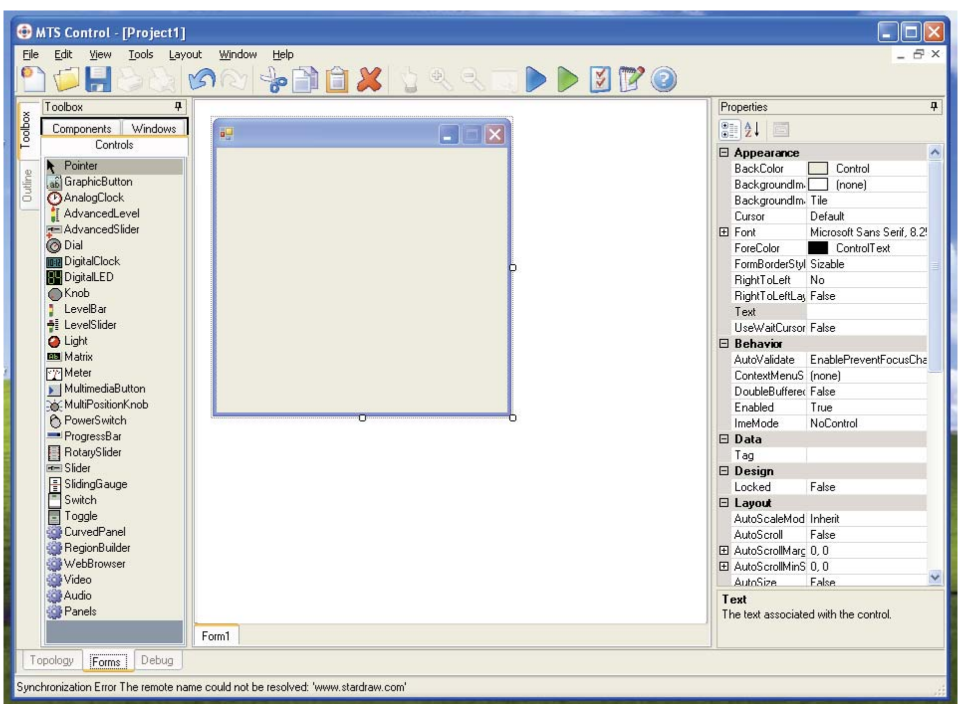
A new project will show the opening Topology View screen given below. Topology View shows the default Computer and allows the user to select the devices in the system.



The devices in MTS Control are the Serial Amplifiers, as well as the Ci interfaces.

As many devices as needed can be added to the panel and connected to the Ethernet or serial port of the Computer.

Once the devices are chosen, the User selects the Forms View (see below) and can start programming the Graphical User Interface.



See Stardraw Control for a full set of tutorial videos.