

SmarT-Trigger 4

Intelligent Four Channel Fire Control System

Operation Handbook

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SmarT-Trigger 4 Operation Handbook

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SmarT-Trigger 4 Operation Handbook System overview.

The SmarT-Trigger 4 system is an embedded control approach to multiple source firing and inhibiting during integrated shooting aboard high resolution survey vessels, or when ever multiple sources are being fired from a high resolution survey vessel.

The system comprises of four independent fire control channels housed within a single "2U" 19 inch rack mount enclosure ,together with a fifth channel (input only) which is the master inhibit sequencing channel.

The fifth channel is dedicated to monitoring the system synchronisation input and effecting the control of communications between the controlling PC and each of the four source trigger channels. The master channel processor can respond within 250nS(nanno seconds) to an external trigger event.

The four channels of fire control are controlled by a simple graphic user interface running on a standard "Windows PC", The PC controls the SmarT-Trigger 4 system via a standard serial port.

The four separate channels of source triggering can have their output repetition periods, pulse and closure widths , and output voltage levels set by the user , using the PC Interface.

The four channels can operate as a trigger source at any rate,(1 mSec –16S) or can be triggered externally by a pulse or closure input. The outputs can be delayed by any desired delay time, (assumed to be less than the fire rate) The outputs can also be a function of "**N**" Counts of input trigger , giving a divide by "**N**" function. *(new for Ver 4:00 Toggle output and fixed fire from each channel)*

In addition to the normal capabilities of standard fire control units, each channel of the SmarT-Trigger 4 system can be inhibited for a user set pre determined time during master system data acquisition. This is achieved by a "master" or fifth channel. *(new for Ver 4:00 pre inhibit period brings inhibit on a user set pre trigger period before the next expected trigger)*

With set-up information supplied by the user each channel can make a decision each busy period of the master acquisition system to determine exactly how many shots may be safely issued to the interfering source.

The fire outputs of any one channel of SmarT-Trigger 4 can be moved in time with respect to any other channel output , enabling cross interference between analogue systems to be minimised.

The outputs of every channel have TTL pulse and isolated closures available (four pulse drives and four closure drives) , if channels are been driven from an external trigger source , both closure and TTL pulse input sockets are provided for each channel.

Overall the SmarT-Trigger 4 system aims to provide precise control over multiple source triggering, interference minimisation, and removal of this interference in the modern integrated survey environment.

Ver4:00 fimware offers improvements in system settings storage and autoseup within the Interface unit enabling the unit to store in EEPROM memory , the full settings for four slave and one master channel and to be able to automatically set its self up , upon power up, if no PC control software is present within the first five seconds after power up. The firmware also allows for in field re programming.

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What Can the System Do?:

The Master Synchronisation channel What does it Do ?

- ... runs a standard serial interface to the Controller PC. (Fixed 19200 8 N 1)
- ...monitors both pulse and closure inputs for signalling the start of the inhibit period.
- ...can effect very fast (<200uSecs) update of operating parameters to any source channel
- ...can stop external triggers reaching any of the four source channels.
- ...can generate external triggers to any of the four source channels internally.
- ...can reset the systems highly accurate quarter millisecond clock. (*see note "a" below*)
- ...can reset any of the four source channels counters used for timing.
- ...can inhibit any of the four source channels across the internal data bus.
- ...can control the voltage level of any channels pulse outputs. (5v or 9-12v)
- ...can issue general system timer-counter resets to all four source channels. (*see note "b" below*)
- ...can force each channel to enter fixed fire mode at fixed rate for "x" shots after inhibit ends.

The four trigger source channels, what can they do ?

- ...can generate 4 pulse outputs **A** and **B**, 2 Pulse outputs Each (**A** and **B** outputs can be separate)
- ...can generate 4 isolated transistor closures out (four together with **A** pulses)
- ...can respond instantly to a closure or pulse external trigger.
- ...can respond instantly to a hardware sync from the master channel.
- ...maintains an accurate count of master clock pulses for its own channel timing purposes.
- ...can respond to interrupt driven timing events within 250 nano seconds.
- ...can generate 5v or 9-12V output pulse levels under software control.
- ...can accurately generate varying pulse width and closure width outputs under software control.
- ...can accurately delay **B** output after **A** output under software control effecting a source print delay.
- ...can accurately output on **B** as a function of..... (*see note "c" below*)

- | | |
|--|------------------------------------|
| 1:)- count of external trigger pulses in | (divide by external trigger event) |
| 2:)- fixed delay after A on External trigger | (sync to source with ext event) |
| 3:)- fixed delay after external trig after " <i>n</i> " triggers | (divide+sync external) |
| 4:)- alternate output on A | (toggle fire two sources) |

- ...can accurately delay the first output after a general system timer reset by a fixed delay. (*see note b*)
- ...can accurately effect software de-bounce on any external trigger inputs .

note a:

The system clock is implemented in an 8pin RISC micro which can be hardware reset by the master channel. Each source channel maintains a timer-counter which can be reset also to effect a complete system timing reset when ever the master clock is also reset.

note b:

This delay feature allows the relationship of each channels output to be moved slightly in time with respect to the other channels output.

note c:

All the "FIXED DELAY" periods are user selectable from the PC interface.

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Technical Specifications

Power Consumption	5v Dc @ 98mA (Supplied by external 9-12V DC PSU)
Trigger Input	Pulse or closure inputs for each channel
Trigger Output	4 TTL pulse outputs per channel. 4 Isolated closure outputs per channel, pulse and closure width is selectable
INHIBIT INPUT	Pulse or closure input
INHIBIT MODES	<p><i>Mode 0</i> No Inhibiting of any channel output (INHIBIT OFF)</p> <p><i>Mode 1</i> Strict Busy Period Inhibit <i>In this mode no extra triggers are output during Digital Busy Period</i></p> <p><i>Mode 2</i> Pre-emptive Start Busy Period triggering <i>In this mode only at the start of the busy period is an extra trigger attempted under software control</i></p> <p><i>Mode 3</i> Pre-emptive Start and End Busy period triggering <i>In this mode extra triggers are attempted under software control after the Start and before the End of the digital or master systems busy period</i></p>
SYNCHRONISATION	Each output channel can be synchronised to another channel or to the digital System busy (Inhibit). Each channels output can be moved in time relationship with reference to any other channels output, or to be synchronised on the end of Inhibit with an immediate shot issued at end of Inhibit.
RS232 IN	Accepts data at 19200 8 data No Parity 1 Stop bit
SAFETY CUT OUT	Input normally closed link , when fails it is open circuit as in an emergency stop circuit all channels will stop firing , with a message box alert on the PC user interface.
DTR Triggering (Feb 2014)	By clients request to enable the box to be triggered externally from DTR (Data Terminal Ready Line) pin4 of the serial 9 Way connector Uses a spare input RS232 buffer brings TTL out to new Bnc on rear panel.
SET -UP	By software command via the serial link and the PC interface
TOGGLE FIRE	Ability to alternately fire or "toggle" between print delay and normal fire outputs

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Getting Started

Power Up and Set Up

Connect up the 9-12 V PSU to the DC Jack socket at the rear of the unit. A dc supply extension cable is provided to allow powering of the unit several meters from the AC outlet sockets.

Using the 5m extension serial cable and the USB/serial port convertor unit, connect the female end of the serial extension cable to the male end of the USB/Serial port converter lead, the male end of the extension cable needs to go to a short standard "one to one" wired 9 way serial lead, which is in turn connected to the female serial connector on the rear of the Smart-Trigger unit.

If a USB/Serial port converter has not been used before on the computer in use, then it will be necessary to install the "PROLIFIC" driver for the USB/Serial converter device. Under Windows 7 and where an internet connection is present, the drivers will load automatically on detection of the device, however alternatively the drivers can be found both on the CD that comes with the USB unit, and they are also copied on the Rovtec Software USB memory stick under a directory named "PROLIFIC". The System software memory stick is packed in the system spares kit. (see page XX)

The Serial Com Port number will have been set when the "PROLIFIC" driver was installed and the device plugged into the computer, by using windows Control Panel, and then Device Manager its possible to view the "Com port" number in use.

Under advanced settings here it is also possible to force the port to any free com port number.

Install and run the SmarT-Trigger software version 4:00 and be sure to set the SmarT-Trigger com port to the same number as the prolific device. Also ensure the USB converter has been removed and re-inserted after the port number is changed.

Ensure Safety Cut out link is fitted or that the external safety circuit is closed. A dummy bnc shorting link is fitted as standard to the cut out BNC socket on the rear panel of the Smart-Trigger unit.

Turning on the SmarT-Trigger 4 interface unit will result in the following display on the front panel LED's After an intital display of Extra Led only Ch1 Inhibit Led only Ch2 Fire Led only Ch3 Ext Led only Ch4 after a second all the extra leds will flash in sequence every second on off. If the box has a stored setup and no PC software is connected to the box, it will automatically set its self to all chs firing at 500mS in sequence. (see page xx for LED displays)

If connected, as soon as the PC program has determined the interface unit has powered up, the PC will download a complete set of working parameters, unless the box reports it is already set up. these will be default parameters as supplied by the software installation.

The INTERFACE UNIT should now be showing a **RUN** status for all channels i.e. all the GREEN LED's should be lighting at a rate of 500mSec.

If any of the above sequence does not happen then check TROUBLE SHOOTING section Boot Up.

Stopping Starting Output

Function Keys F1 controls channel one, F2 controls channel two etc. etc..

Pressing F1 once will result in the channel being turned from ON to STANDBY, the GREEN FIRE LED should now be lighting at a slower rate (plus a few seconds of normal rate)

Pressing F1 once more will result in the channel going into STOP mode where 10 seconds will have been added to the output fire rate, the Yellow EXTRA FIRE LED will now flash at a the fire. No Pulses will be output from channel, Extra Led on its own shows the channel is stopped and not outputting pulses

Pressing F1 once more will bring the channel back once again to a RUN condition, the GREEN FIRE led will be flashing at the fire rate of 500mSec. pulses will be output from channel one once more.

Control for the other three channels is affected with Function Keys F2 F3 and F4.

Function Keys F5, F6, and F7 will force all channels to STOP RUN, STANDBY condition in that order.

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This same level of control is also effected with the mouse by clicking on the individual channel buttons on the main status panel as shown below in .Fig1

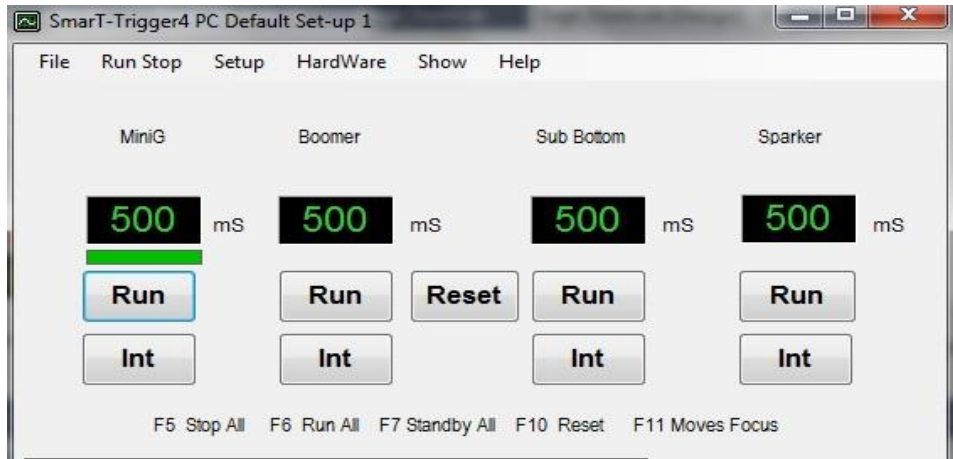


Figure 1: Channel Control and STATUS Panel

The RUN STOP STANDBY buttons have the same effect as function keys F1 F2 F3 F4

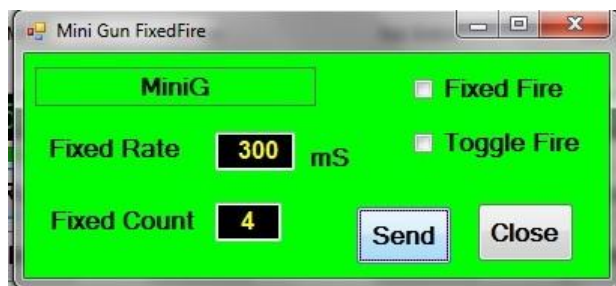
The INT buttons set mode INTERNAL or EXTERNAL , in external the channel will only respond to Input pulses or closures to the channel. The buttons show the current channel status , pressing them will advance the channels condition onto the next condition in a RUN - STDBY - STOP - RUN order.

Quick Change of Fire Rate.

To effect a fast change of the firing rate for any channel , simply click on the status panel inside the black box displaying the rate for a given channel ,and enter a new value , assuming the value entered is valid (not shorter than the current PRINT DELAY VALUE for the channel) the new value will be acted on immediately .

Quick Change of Fixed Fire Rate and Toggle features (Ver4:00)

In the screen shot above in Fig1 Under Ch1 time panel can be seen a green bar , it shows Ch1 has the focus for keyboard input using F1 ,clicking on this bar brings up a new (Ver 4:00) control which is called the fixed fire control frame as seen below .



Fixed Fire Rate is the time period that this channel will run at , immediately after inhibit the period ends for a fixed count number of shots , by selecting the fixed fire tick box and toggle tick box it is possible to select toggle firing , With this mode selected the fire outputs toggle between print delay outputs and normal fire outputs with each successive shot , print delay for the channel is turned off with toggle, inhibit is forced to be on when fixed fire is selected .

The rules for fixed fire are as follows , with STRICT inhibit , strictly only the set number of shots (If that number is possible) , prior to the next pre trigger inhibit period are allowed , however extra shots can be allowed with the selection of either “early start” and or “late finish” the rules which apply for these inhibit modes apply to shots beyond the number selected will be attempted, if time allows prior to the next pre trigger inhibit period .

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Changing Print Delays

Each channel provides a trigger to source and a delayed trigger to recorder (PRINT DELAY), the print delay feature can be turned on or off in the channels set up , but once switched on, the user has instant access to the parameter where the current print delay for any channel can be quickly changed by a single key or mouse click action.

Assuming that PRINT DELAY is turned on for a given channel, then that channel will also have a set of LEFT RIGHT arrow buttons for controlling the print delay in 1mSec steps, and also a display panel showing the current print delay value in mSec. These panels appear below the channel status panel on the main screen of the SmarT-Trigger 4 PC program as shown below....



Figure 2: Print Delay control Panel

The PRINT DELAY values are printed in colours that reflect the current Channel STATUS i.e... STOP in **RED** RUN in **GREEN** or STANDBY in **YELLOW**.

Clicking on the LEFT ARROWS will decrease the print delay in 1 mSec steps while clicking on the RIGHT ARROWS will increase the print delay in 1 mSec steps.

The KEYBOARD LEFT ARROW and RIGHT ARROW KEYS will also affect the print delay in a similar manner for the current KEYBOARD ACTIVE channel, The current KEYBOARD ACTIVE channel is indicated by a GREEN STRIP below the period value , as can be seen in the Figure 1 on the previous page, channel number 1 is shown as the current KEYBOARD ACTIVE channel.

It does not matter if a channel is in STOP RUN or STDBY condition , the print delay can be changed with the KEYBOARD or MOUSE and the changes will take affect immediately.

Global Control of System

As mentioned in the previous page , the user can STOP RUN or STDBY all channels together with single KEYBOARD or MOUSE Clicks.

To control all channels, there is a MENU COMMAND for all three actions as shown below



Fig 3:) Run Stop Control Menu's

Alternatively the user may simply press F5 or F6 or F7 to effect the same control over the system.

The print delay , The fire rate, INTERNAL or EXTERNAL mode are the only channel parameters that can be changed quickly on the main screen, in order to affect more detailed changes to any channels set-up , the user must select the CHANNEL SETUP SCREEN , this is achieved by simply pressing F8 or the menu command under the SETUP MENU. As there are many parameters that can be set for each channel, these will be discussed in detail, In the next section of the handbook.

NB* Note All channels will stop automatically as soon as the safety cut out link is removed , or when connected to a safety circuit line such as a "man over board alarm circuit", as soon as the link is broken the channels will all stop firing and a message box will be displayed indicating the alarm condition. , the system will remain shut down until the safety link is restored.

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Setting Up The Channels

To set-up a particular channel the user must either press Function Key F8 or select the SETUP Menu. The user will be presented with a panel with all the current settings for the current channel that has the screen focus (green bar under the period display). The Setup channel form for Version 4:00 has many more settings than previous versions as shown below.



Figure 4:) Channel Set-up Panel

Each channel in SmarT-Trigger 4 is given an IDENT in order to name the channel numbers and give them a more meaningful title such as PROFILER SONAR BOOMER, etc

Name By clicking on the name panel (MiniG) as shown in Figure 4 above it is possible to change the ident for the channel, this ident will be shown in the channel control and status panel. Once saved to disk the channel will keep this IDENT name. Each setup can store settings for separately named channels.

Fire Rate is the firing rate for the channel, clicking on the BLACK BOX where the current time base is displayed it is possible to enter a new value, values greater than 16380 will be set back to 16000, as 16 seconds is the maximum that SmarT-Trigger 4 can time.

Print Delay is the delay applied to the TRIGGER TO RECORDER OUTPUTS on the interface rear panel, it is only used if the PRINT DELAY feature for the channel is turned on (see next page) The value entered can not be greater than the time base value for the channel, and must always be greater than 1 mSec.

Standby is the value in seconds that is added to the time base fire rate for the channel when STDBY mode is selected for the channel. This value can be 1 to 16 (16 seconds maximum) This feature can be used for example to keep a mini gun active on a line turn, firing at intervals up to 16 seconds duration.

Fixed Rate is the rate at which a fixed shot count number of shots when fixed fire mode is selected this mode puts inhibit on for the channel by default and the first shot will be issued the instant inhibit period ends.

Fixed Count is the number of fixed rate shots that will be attempted from end of inhibit to the next pre inhibit period prior to the next external trigger to the master channel. If Strict inhibit mode is selected only the fixed count will be attempted, if not strict inhibit, then if time allows further triggers will be attempted up to the start of the next pre inhibit period. Early Start and late finish will allow triggers to occur before end of Inhibit period or just after inhibit period starts.

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Setting Up The Channels continued.

Reference: [Fig 4:\)](#) [previous page](#)

Pulse Width is the value in milliseconds of the width of the closure and pulse outputs for the channel. This value can be 1 to 16 mSec (16 mSec maximum value)

Inhibit Period is only changed in the Master Channel control panel, this figure displayed in the Inhibit period time display is the full period of the Pre Trigger block period and the normal Inhibit period together.

Early Start is the period that determines when the channel comes out of INHIBIT MODE, this value must be less than the full INHIBIT period defined for the channel. This parameter is only used if the EARLY START feature of the INHIBIT mode for the channel is switched on with the EARLY Tick box.

Late Pull is the period in which the system can output a pulse after the pre inhibit period has started, and this value can be 1 to 255 mSec Max. The parameter is only used if the LATE FINISH feature of the INHIBIT mode for the channel is switched on with the Late Finish Tick box. See Inhibit details for further information.

Mesh Delay is the delay issued before the first pulse is output after a system reset. This parameter is only used if the MESH DELAY feature of the channel is switched on with the Mesh Delay Tick box, the value can be 10 to 255mSec.

CHANNEL FEATURES

PRINT DELAY ON OFF Clicking on this Check Box will turn on or off the print delay feature for the channel. When switched off the user will have no further screen control of PRINT DELAY for the channel. All outputs for the channel (TRIGGER TO SOURCE and TRIGGER TO RECORDER) will be at the fire rate. When switched on the user will have a means of adjusting the delay about the initial value set in the PRINT DELAY value box (see Fig 4 previous pages) TRIGGER TO RECORDER OUTPUTS will be delayed with respect to TRIGGER TO SOURCE OUTPUTS by the PRINT DELAY TIME period.

INHIBIT ON OFF Clicking on this check box will turn on or off the INHIBIT feature for the channel. When turned on the channel will respond to master channel commands at START OF INHIBIT PERIOD and will also affect other actions depending on the INHIBIT MODE set up, See Inhibit details for further information.

HV ON OFF Clicking on this check box will turn on or off the HIGH VOLTAGE OUTPUT for the channel. When turned off the channel will output pulses at a normal TTL Level, When turned on the channel will output pulses at a level set by the unregulated DC power supply input to the interface unit. Use this with caution, as this feature is a historic feature where some mini gun controllers in the past required larger than TTL pulse levels to fire them, and is a feature no longer needed for most triggering situations'

EXTERNAL ON OFF Clicking on this check box will change the mode from INTERNAL TO EXTERNAL for the channel, when set to External On, the user will also be presented with an external trigger count set-up as shown below.



Fig 5:) [External Trigger count set-up](#)

The normal input here is every 1 trigger. A "divide by n" feature can be set up here by selecting other greater numbers, 2 would output a fire for every two input external triggers to the channel. The user can enter a value of external trigger count, this value can be set from 1 to 254, giving a divide by "n" function of input triggers. The normal setting for this parameter would be 1. (every trigger)

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Setting Up The Channels continued.

(Refers to Fig 4 on previous pages)

STANDBY ON OFF Clicking on this check box will turn on or off the STDBY feature for the channel , when turned on the time base output for the channel will be increased by the STANDBY TIME (period in seconds) for the channel, when turned off the time base period fire rate will return to the normal rate for the channel.

MESH DELAY ON OFF Clicking on this check box will turn on or off the MESH DELAY feature for the channel, when set to ON , the channel will issue a MESH DELAY to the value of the current setting of the MESH DELAY PERIOD when ever the system does a general reset. General Resets are issued after all channels are forced to a RUN condition , At Boot Up, or after the RESET Button (see Fig 1 channel control status panel) is pressed. When set to off the channel will not issue a MESH DELAY and will commence firing immediately at its normal fire rate after a general reset to the system.

RUN ON OFF Clicking on this check box will turn on or off the RUN feature of the channel , which will either set the channels condition to STOP OR RUN (or STDBY if the standby feature for the channel is also on.)

TEST DROP SHOT Clicking on this check box will turn on or off a test facility for the channel where it is possible to set the drop every "n" shots feature for the channel. This facility is to aid in interference minimisation or finding out which output event is causing the most interference with another channel. Entering for example a figure of 5 will result in that channel dropping (not issuing) every fifth output pulse . The possible range of entries for this parameter is from 2 to 15. A value entry box is provided once this facility is turned on. When turned off the drop shot feature is turned off for the channel and all outputs are restored.

When ever the Interface box is powered up or the PC is booted this feature is turned off for all channels.



Fig 6:) Set-up Panel Control Buttons

SEND BUTTON

As soon as the very first parameter for a channels set-up has been changed , the user will notice that the SEND BUTTON as seen if Fig 6 above, will become visible , indicating that parameters have been changed and in order that these changes be acted on, they must now be SENT to the channel.

Once the SEND button has been pressed the changes made will be SAVED TO DISK and SENT to the channel. The SEND BUTTON will then become invisible once more.

Last Ch /Next Ch BUTTONS

These buttons offer a means of navigating through the four channels set ups. However if a change is made to any channels set up and the SEND BUTTON becomes visible ,

CLOSE BUTTON Closes the panel down regardless of any changes made to parameters.

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Setting Up The Master Channel

To Set up the Master synchronisation channel in the SmarT-Trigger 4 interface unit, the user must press F9 Or select the Set-up Menu as shown below Master Channel....

Figure 7:) Set-up Menu (Master Channel)

Figure 8:) Master Set-up Panel New Features (Ver 4:00)

There are some new features of on the Ver4:00 control that were not present on the previous versions of the software , Version 4:00 firmware has facilities for setting a pre trigger “block period” , which effectively turns on the inhibit a user set period prior to the expected next external trigger applied at the master channel which normally would turn on the inhibit for the normal Inhibit period. In this new approach to inhibiting the system firmware ensures that the actual Inhibit period applied to the slave channels is the combination of the BLOCK PERIOD (user set period where no output fires should occur prior to the next expected digital system trigger) plus the normal inhibit period. (normally set to the digital recorder record length)

Inhibit time and Start of Data time as exactly as before ,with the older versions of smart trigger firmware, the Trigger settings edge detection use SOD and Sync on inhibit function exactly as before , the new features are as follows

Shot point Interval this setting sets the interval of the external triggers to 12.5 6.25 or 3.125 m shot point interval , it is used to determine the speed of the vessel and calculations regarding the expected trigger interval can be made prior to a start of line , when the user enters the vessel speed the value of expected total trigger event is sent to the master channel so as the time calculations for pre trigger period are correct from the first fix at the start of line.

Trigger Filter affects the number of triggers over which the new event period is calculated and this can smooth out erratic triggering by not responding to small changes on each trigger, but rather averaging them out over a number of external triggers (2-6 triggers)

Block Time the user set period which inhibit starts prior to the next expected external event .(Main Guns Fire)

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Setting Up The Master Channel

Vessel Speed this setting allows the user to enter the actual vessel speed just prior to the start of line so the system can calculate and send to the Master channel the expected total event time, given the Shot point interval in use on this survey, this way the system will set the pre inhibit block time correctly from the second shot after the start of the line. Entering a value (in Knots) will calculate the total external trigger event time and also show the expected spare time, given the known full Inhibit period and the shot point interval.

After any parameter is changed the SEND button will become visible and on pressing this button the new settings will be sent to the Master, however this happens automatically after a new speed setting is entered. During shooting the PC calculates and displays the vessel speed based on the total trigger event time and the calculation is based on the shot point interval in use for this survey. It can be clearly seen that if the shot point interval is not set correctly wrong time calculations will be made and the pre trigger block time will not have the correct timing relationship to the next external trigger event.

INHIBIT TIME is the period that all channels set to INHIBIT will be inhibited for (the actual time is this time plus the block period). This period is normally set to the digital systems record length.

SYNC ON INHIBIT is the most important setting in the master set-up and is discussed in the Inhibit section. Turning on or off this parameter changes the way the time bases of the channels that are inhibited react when an Inhibit period ends, if on the time base is reset, a trigger output is issued immediately, if off the time base is unaffected and free runs in relation to the external events. Some inhibit parameters are affected by this setting, for example "Early Start" can not work if this feature is switched on. If on or off its on or all for all channels that are inhibited, it only affects channels that are inhibited.

SOD TIME is the period to wait after the external trigger has been received by the master channel before sending The START INHIBIT Signal to the slave channels in the interface unit. This time is entered in mSec and can be From 1 to 16000 mSec. It is the time from trigger to "Start Of Data" recording for the master or critical recording system that is generating the inhibit signal to SmarT-Trigger 4. If the trigger to the system is as some function of the gun controller receiving a trigger then SOD should be used and if alternatively it is the same trigger that actually fires the guns then it should not, either way there is an allowance for the user to be able to enter a period between when the trigger arrives and when the actual "aim point" of the guns is set for. The Aim point being the expected time the guns are required to go off following an external trigger to the gun controller.

USE SOD determines if the SOD time value is to be used or not, based on where the source of the external trigger, as explained above.

EDGE DETECT determines if the trigger will be detected on a rising or falling edge of input pulse or closure. This can be useful if there is a very long input trigger from the inhibit source.

EXT TRIGGER COUNT for the master channel should normally be set to every 1 trigger but the facility is there to divide input triggers from 2 to 254 can be entered.

The master setup form only works while offline (not shooting) to adjust the expected total trigger event time when the next line is started, the master form can not be used once firing is in progress but the Trigger Filter value as well as the block time as well as any Fixed Fire rate applied to a channel if fixed firing is being used as well as toggle on off can all be controlled while on line.

Normal Operation The control would be set up at the start of a job with shot interval and inhibit and block time these settings would be sent to the master channel by pressing the send button, however just prior to the start of a line the user should open the Master channel form and enter the current value of ships speed as indicated by navigation system and by entering this value new settings will be automatically sent to the master channel, they will also update the various screen displays with expected interval time which is most important for the interface to know this value prior to the arrival of the first trigger. Once shooting is in progress the control is blocked from use. The interface box will adjust the interval time according to the timing of the external trigger events and will inform the PC of these changing values and so the PC will display the vessel speed calculated from the event time, while shooting is in progress.

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Setting Up A Sonar Channel

Setting Up A Channel For Side Scan

It is possible with SmarT-Trigger 4 to define any of the four slave channels as a SONAR or the side scan channel.

In this way its possible to run a Side scan sonar unit from this channel and for the user to work in meters for the range rather than in milliseconds for the time base. The default conversion factor used is 1.333 but the user has a choice of setting it to any desired value in the sonar set up dialog boxes.

The user must select menu command set-up SONAR UNIT and enter the number for the channel to be used The user will also be asked for a side scan range , however if no range is given the system will default to the last range that was used for a defined sonar unit previously. The user is then asked to confirm the meters to milliseconds conversion factor figure.

Once this action has been completed the selected channel will have its time base period set to the appropriate value for the current sonar range which will be displayed in meters in the channel status panel as shown below.



Figure 9:) Side Scan Sonar Display

The Normal INTERNAL EXTERNAL mode change buttons are removed when the channel is in Sonar Mode. Clciking on the range display will prompt the user for a new range which will set the channel to the correct fire rate in Millisecons in order to achieve that sonar range .

There are only RUN STOP conditions , there is no STDBY condition valid for a sonar unit.

To end the SONAR UNIT definition and return the channel to normal operation , the user must select the same menu command menu SETUP where a new menu will have become enabled since turning on the sonar definition , this menu is called KILL SONAR , clicking on this menu will return the channel to normal operation.

Saving and restoring system setups

Figure 10:) Saving and restoring System setups



In order to save the current set-up to disk for later recall or to load in a previously saved set-up there are two menu commands under the file menu as shown above in Fig 10

SmarT-Trigger 4 Operation Handbook

Saving and restoring system setups

Figure 10:) Load Save Set-up Menu

The system software stores all settings in the windows registry, Effectively there are four system settings setups , these are all stored in the windows registry and each can be saved for particular types of survey , different suites of equipment with different setups etc and can be quickly recalled from the registry for use when required ,its best to give these individual setups meaningful names describing their pupose.

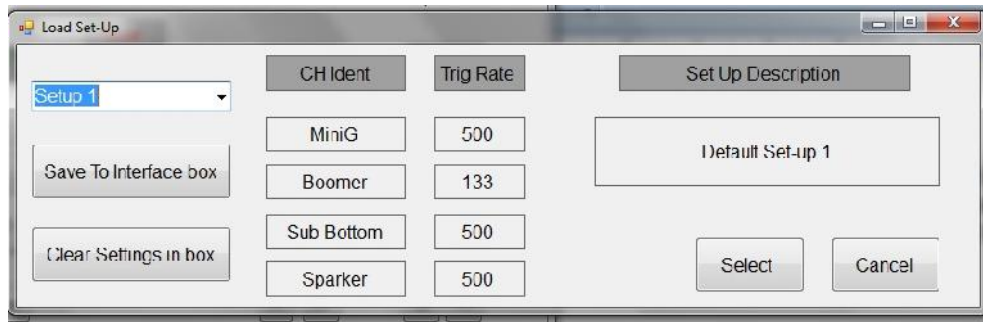


Fig 11 Save and load settings control

The control above shows on selection of the LOAD or SAVE settings menu's , the Drop down box allows selection of four separate setups to be stored on the PC , each one can have four channels all set to different settings and can be used for different survey scenarios .

If the user is happy with a current particular setting the User should select Load Setting and can press the SAVE to Inteface box and the current settings will be written to EEPron in the Interface box , that is the current Ch1-Ch4 and the current settings for the master channel , all will be saved , on box re boot and there is no pc present or the software is not running , the box will automatically load these settings after about five seconds after power up.

When saving a setting to the PC , the user gets the oppotunity to give each setting a particular name Under "Set up Description", this can help to remind users of the particular setups .

If at any time the user stored settings become corrupt for any reason , the user can simply select the REGEDIT facility in Windows taskbar and Start menu and enter the name "Regedit" into the search for Program window as shown below on the left side of Fig12.



Fig 12. Using "regedit.exe"

Search the registry for the setting of "SmarTTrigger" as shown on the right side of Fig12, which will be under VB and VBA program settings , select the key and delete the entire SmarTTrigger key, prior to doing this ensure the PC control program is not running. Close Regedit and run the PC control program.

On program boot, it will warn that no settings were found on the PC and it will set about to create in the windows registry of the PC , an entirely new and default standard set up from scratch.

In Version 4:00 pc software

A new menu command under the EXIT Menu allows this Registry operation to be done progrmatically editing and deleting the entire applications registry entries on exiting the program , under a menu marked Exit Clear Registry. On reboot the program will create a full set of clean new registry settings.

SmarT-Trigger 4 Operation Handbook

Saving and restoring system setups

The interface box can save any of the four possible PC setups that are stored in the Registry to the EEPROM inside the box, thereafter always booting to this setup, provided the PC does not get there first and force the current PC setup (selected by the user) to the box on boot up.

In order to save the settings that are currently in the PC and box to the EEPROM, the user should select LOAD SETUP and on the form shown in Fig11 on the previous page select SAVE TO INTERFACE BOX button. The unit will report the settings are being saved and eventually (it takes about 30 seconds) will report the settings have been saved. The settings for all four slaves and the Current master set up are now saved to the EEPROM memory and will be there until the user decides to use the CLEAR SETTINGS Button, where the entire EEPROM memory is erased. This can be useful where you don't want the box to autoselect on boot, and only ever take its settings from the PC program.

As well as storing the particular settings it also saves the SETUP number, 1 to 4, this is useful if the box reports its set for setting 3 and the PC determines that for example Setup 1 is in use on the PC, then there may be a good case for the user, if finding the box reports it already setup with a different number than the PC. Then forcing the PC setup into the box to ensure the PC and Box settings are the same from the start of the program operation, or alternatively reading back the settings from the box into the PC and when the PC next shuts down it would save those new settings to that particular number set up in the registry.

The master channel contains the version of firmware for itself and the slave, it checks the slaves they are all the same version and reports this to the PC on boot up and the current firmware revision number is displayed in the PC control program just under the Rovtec systems logo panel as shown below in Fig 13.

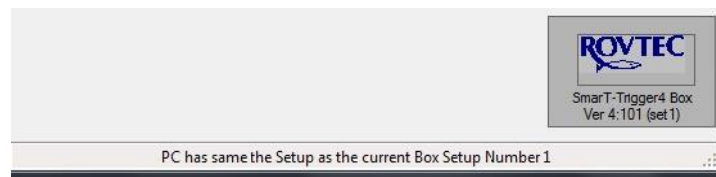


Fig 13 Version label

If the label does not display the version (label has ??) then simply click on the label and the version number and setting number of the box will be updated to the PC control program. Each time the box boots up it should under normal circumstances eventually after set up, report its box version and setting number to the PC, if it has a setting number, it will be enclosed in "()" after the version number, deleting the settings in the Interface unit will mean its setting number will be zero and the PC will always have to set up the box each time it is powered up.

Selecting a different setup in the Load and Save settings control form will effectively force a reboot of the PC software and it will reload the settings of the setup number chosen and force these settings into the interface box, the next time the box boots and the PC software runs there will be a conflict between the autoselected number stored in the box and the current PC setup number, and the user will have to make choices when this happens, the PC will warn of the conflict, the user must decide either to read back the settings from the box into the PC, or accept them, one other way round this problem is to select the LOAD setup menu and select SAVE TO INTERFACE button and this will force the interface unit to store the current PC settings and the autoselected number will be the same as the current PC set up and so there will be no further conflict between settings stored in the box and on the PC, it is worth noting that if many changes are made to the current PC setup, it should be refreshed to the interface box by pressing the SAVE TO INTERFACE button again in order to keep the box and PC settings synchronised. No matter what the actual situation is regarding this issue, taking the choice of reading back the settings from the box into the PC, will always ensure the settings on the screen, accurately represent those currently in use in the interface box.

When selecting the SAVE settings menu the user will be asked to give a name for the setup and it must be stored in a place other than the current setup, so the user having made many changes to master and slave setups will select SAVE settings control select a new setup number and enter a useful name in order that this set up will be remembered for precisely what it is intended for, The Current PC setup number will change to the selection made and the new name will be applied to that set up from then on, In order to synchronise the interface box, the user must then select the Load Settings menu and press the SAVE TO INTERFACE button in order to update the interface with the new settings and the same setup number as the current PC set up number. In future each time the box boots before the PC they will both be using the same setup number.

SmarT-Trigger 4 Operation Handbook

How inhibiting works An Overview

The inhibit feature of the SmarT-Trigger 4 is quite simple in operation, there are a few options and parameters that can be changed in order to affect the way the inhibiting will work on individual channels, but in general the operation is simple. It's important for the user however to fully understand all of the parameters and how they affect the operation of the system.

In the old firmware (pre Ver 4:00) When an external trigger is applied to the master or synchronisation channel (A pulse or a closure input) the master channel would send a message across the fast internal data bus to all slave channels that the start of the inhibiting period had occurred and all channels that have their INHIBIT FEATURE turned on, would Inhibit their outputs for INHIBIT PERIOD time, and as soon as this period ends the Master would allow all slaves to once again start issuing fire pulses.

In the new firmware (Rev4:00) the system works in a different way with regard to inhibiting and the operation will be described in the next few pages.

When the first trigger arrives the interface unit has an idea of the ball park figure of the total event time expected given the speed and the shot point interval in use.

The system will always issue a start inhibit period when the first trigger comes in and the timing will look like the time graph below. The accuracy of the first pre trigger period prior to the second shot can not be guaranteed but the third and fourth will be highly accurate and once the system has settled down to a reasonably constant fire period the system will always start inhibit the pre period ahead of the next trigger.

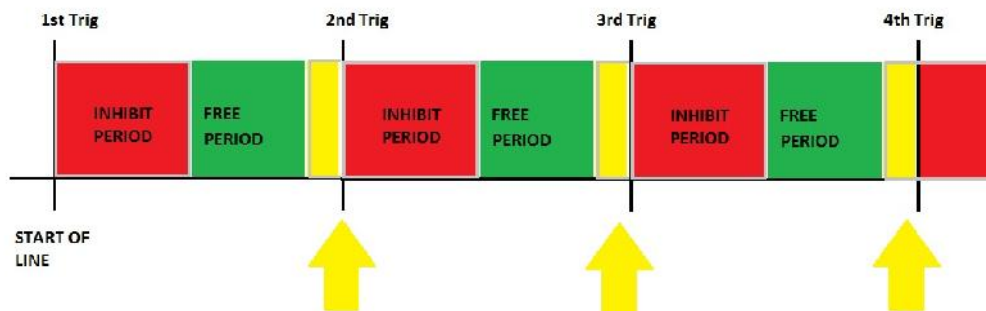


Fig 12 Shooting inhibit sequence from SOL

The yellow periods shown in Fig12 are in fact when the inhibit gets turned on again after the free period. This PRE BLOCK period is user set and ensures the period just prior to the next digital record sequence is not interfered with by the late firing of a mini gun or other source during single pass survey operations. The user can gradually increase this value moving the likelihood of interference away from the digital record period.

Naturally this will also reduce the free time and the number of shots that can be fired during this period.

The user has the ability to infringe on these strict settings by taking off STRICT Inhibit and instead applying criteria such as Early Start, which will allow fires to take place towards the very end of the Inhibit period (near the end of the digital record) bearing in mind that the inhibit period for the first shot is shorter than the inhibit periods applied from shot 2 onwards down the line. Late finish will allow triggers to be output into the Yellow periods of pre trigger block and the user must determine how much into this region a shot may occur depending on the value of the Late finish one applies.

Each time an extra shot (either early start or late finish meets the criteria and is allowed to fire) the extra led will light as well as the fire light and the INHIBT led will also be lit. This enables the user to quickly see if extra shots are managing to squeeze into the time windows, as and when the timing of the period of the channel being inhibited, corresponds with the occurrence of the Inhibit period starting and ending. If the setting of SYNCH on inhibit has been set on the Master channel then each time the inhibit period ends the time base of the inhibited channel is fully reset and a fire will be issued immediately upon inhibit start, it would not be possible therefore to ever issue an early start for this condition as the time base is being synchronised on the external event of the inhibit ending.

However a late finish could be achieved at the end of the free period and into the early stages of inhibit start for the next expected trigger.

SmarT-Trigger 4 Operation Handbook

Inhibit Detailed operation

Once the system is on line the user has several means of adjusting the system so the chance of interference is minimized on line , once shooting commences a new control and information display (shooting panel) will appear following the receipt of the first shot and the interface box will report this event .

The shooting panel shows the vessel speed (calculated from the event time) the trigger filter and the block period , its possible to change both the trigger filter and the block period on the fly during recording. But the system is designed to be unattended and without the need for PC control the system is capable of tracking the varying event time and ensure the inhibit is being applied at the designated Pre Block time ahead of the next expected external event, it is designed to autocompensate down the line with rapidly varying periods of external interval. It may get out of sequence for one or maybe two shots with wildly varying external shot times , but the system will very quickly get itself back into the correct sequence of always starting inhibit prior to the next actual external trigger event as soon as triggers return to a more regular interval.

Where noisy or erratic navigation is expected a lower number of trigger filter may be better and where it is stable and constant a higher value is better . No matter at the start of a line shot point interval may be erratic for the first one or two shots but no matter the system should have the inhibit starting correctly ahead of the second trigger , or at worst case ahead of the third trigger of any line.

Firstly the most crucial setting for the master channel is SYNC ON INHIBIT setting and this determines how the slaves interpret the inhibit END events.

LATE FINISH and PULL

Late finish is the ability of any slave channel to decide on outputting an extra fire pulse after the actual start of Inhibiting has taken place. Late finish can only happen when the user has supplied a suitable value of PULL parameter. The PULL parameter is the time in milliseconds after INHIBIT START that an extra shot can be allowed for that channel. Bear in mind that when Inhibit starts with Ver 4:00 firmware the actual start of the next digital record is still the pre trigger block period away.

EARLY START

This mode is not compatible with Sync on Inhibit turned on

This will attempt to fire a shot once the early start figure of time has been reached into the inhibit period towards the end of the inhibit period , the end of the digital shot record time . In deeper water it may be possible to get a shot into the water column before the digital record ends , this is when one would normally use Early Start.

STRICT INHIBIT

When a slave channel has STRICT inhibit set on , then LATE and EARLY are overridden, with STRICT Inhibit The channel will not issue a shot at or after inhibit start, The channel will only allow logical outputs after Inhibit end. The period of STRICT Inhibit is set by the INHIBIT PERIOD for each individual channel.

Toggle fire has been added for Ver4:00 firmware , where 6.25m shot point interval is concerned the use of twin mini air guns can be considered to improve mini gun performance on single pass survey , if two mini guns are used and the SmarT-Triggee toggle fire feature is used along with fixed fire , it would be possible to achieve far greater results than would be possible with a single mini gun giving the timing of the situation.

Keeping the speed below or at 3.9knots (at 3.9 kts) the event time is 3115mS with 2100 for inhibit and a 100mS pre trigger block period .

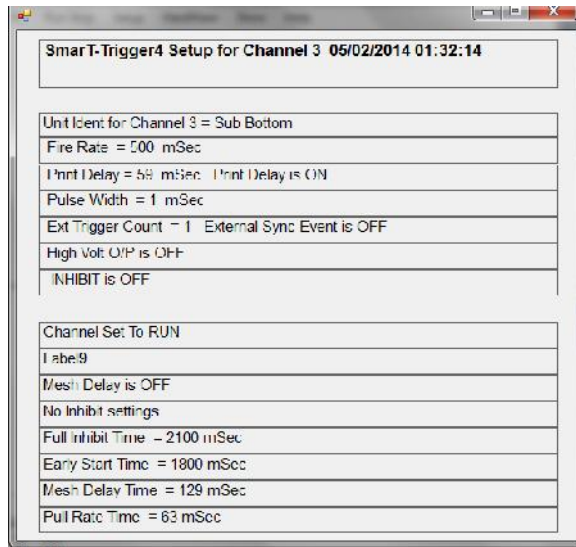
A free time of 1015mS remains , if two guns are fired at 500mS in toggle mode one would get three shots off between digital shots in this mode (each gun fires at 1000mS)

SmarT-Trigger 4 Operation Handbook

Show set up menu command

Figure 11:) Show setup menu Command

This simple menus shows a page with the full channel set up parmeters than can be snet to the printer for later reference .



System installation.

There is a separate document can be downloaded from the software downloads page of the Rovtec Systems web site covering the installation of version 4:00 Pc software , replacement of PCB's and in field programming of the new firmware

<http://www.rovtec-systems.com>

SmarT-Trigger 4 Operation Handbook

19 inch Rack Mount Unit

SmarT-Trigger System Block Diagram

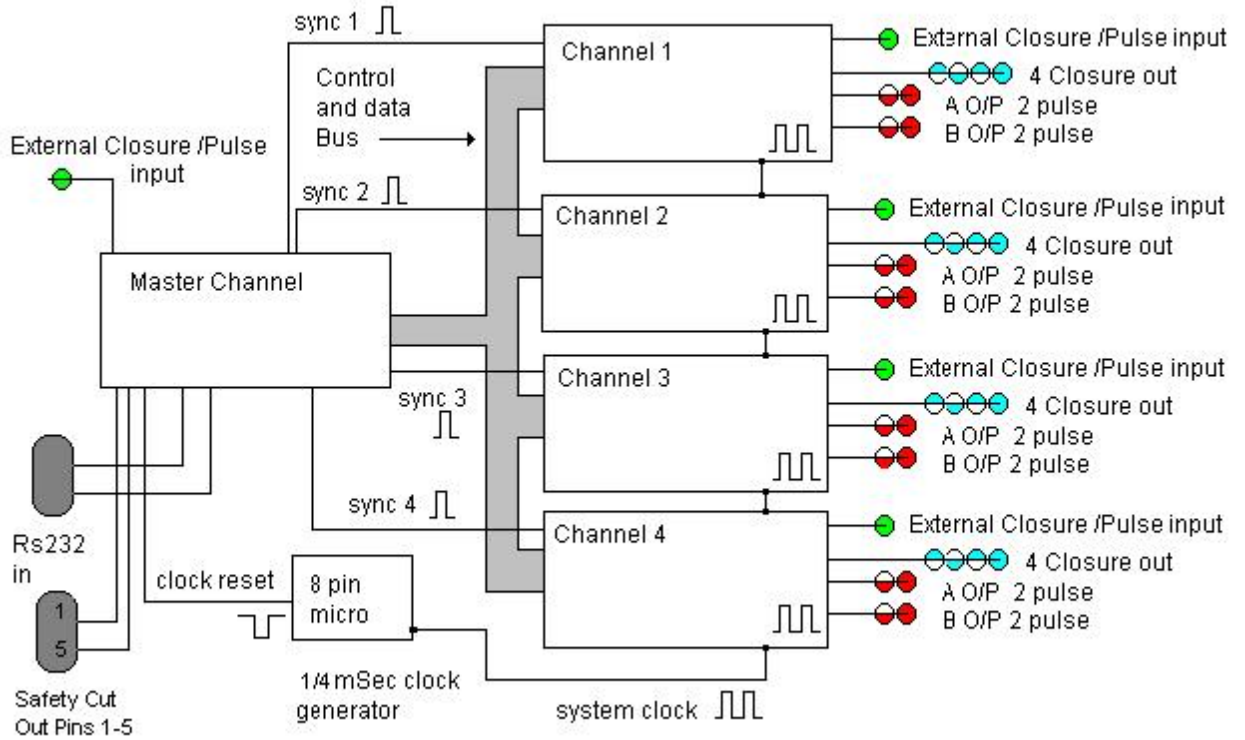


Fig 14:) System Block Diagram

Above is the System BLOCK DIAGRAM , it shows the outputs of each slave channel and the control and data lines used by the master channel to control the slave channels

Prior to May 2012 units with serial numbers below 12-101 have five boards located inside the units
 A master channel control board and four slave cards linked by ribbon cable ,
 After May 2012 serial numbers from 12-101 and above - the smart trigger units have a single pcb where the master channel control all one board with a single 5V regulator for all channels

From 2014 Hardware remains the same as 2012 but new firmware ver 4:00 has more capabilities for saving its own settings and autsetting itself on power up as well as being field reprogrammable.

Smart-Trigger 4 Operation Handbook

The Rear Panel Connections

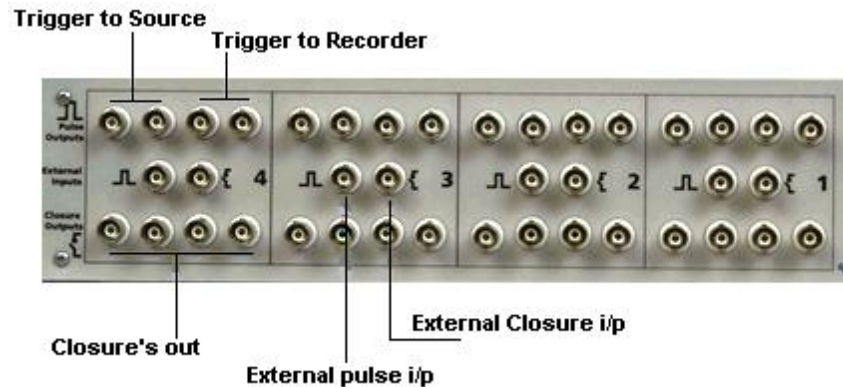


Fig 15:) Rear Panel channel connections

Each channel has four output pulses at the Top

Trigger to Source Top Left Two BNC Sockets
 Trigger to Recorder Top Right Two BNC Sockets

Each Channel has two input trigger connections

External Pulse Middle Left BNC socket
 External Closure Middle Right BNC Socket

Each Channel has four output closures

Bottom four BNC Sockets

MASTER CONTROL POWER AND SERIAL CONNECTIONS

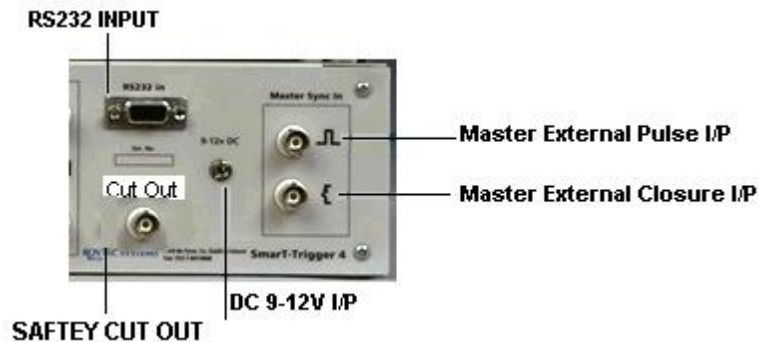


Fig 16:) Master Control connections

RS232 Input is the serial Link to the PC.

9-12VDC Input power jack , Any DC Supply less than 19V can be used (At least 100mA capability)

High voltage pulse outputs are at the DC supply Voltage. On the 2.1mm connector the centre tip is positive the main printed circuit board is diode protected in case of reverse polarity being applied.

Feb 2014 DTR triggering Extra Bnc connector feeding TTL output located to left of Safety cut out on new Units built in 2014, requires a short BNC lead to be connected from the DTR out to Ext pulse in on master.

The master channel has an external PULSE or Closure input BNC Socket, connected to trigger from the master system to indicate the start of the Inhibit period.

The safety cut out requires a normally closed line between the two pins on the safety cut out connector
 When the safety line goes open circuit, all units stop firing immediately .
 The box will not respond to any PC commands until the link is restored.

Smart-Trigger 4 Operation handbook

Front Panel LED Display

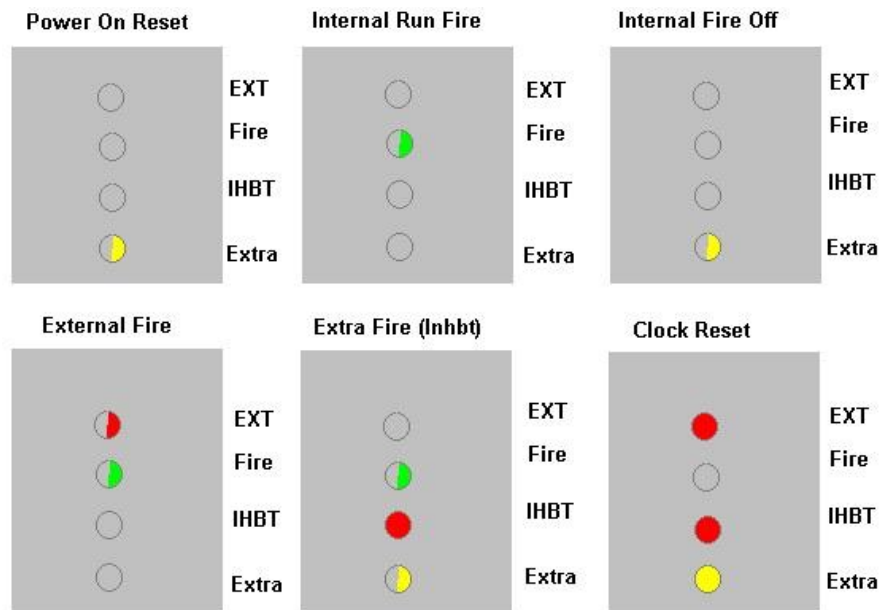


Fig 17:) Front Panel LED Display Sequence

There are four LED's per channel ,

External LED RED

indicates the system is in external mode and is being fired by external pulse or closure inputs to that channel. When the channel is being triggered the EXTERNAL Led should flash with the FIRE LED

When the EXTERNAL LED is on all the time on its own indicates the system is in external mode and waiting for its first external trigger.

Fire LED GREEN

Indicates the channel is firing at the time base rate for that channel

Inhibit LED RED

Indicates the channel is in INHIBIT period

Extra LED YELLOW

Indicates the channel is in the OFF condition when flashing on its own and no triggers Are output from the channel.

Also when flashes with the FIRE led and the INHIBIT light is on that the channel has issued an EXTRA Shot.

Note Power on Reset is slow flashing EXTRA Led for one second on one second off and is preceded by an individual led per channel indicating its address

1 = Extra 2 = Inhibit 3 = fire 4 = External displayed for about one second duration

SmarT-Trigger 4 Operation Handbook Trouble shooting

Bootup

The SmarT-Trigger 4 Interface unit sends two attention request characters at boot to the PC system. The system should then have its entire set-up downloaded to the interface unit by the PC. If this does not happen for any reason. Its best to first test the communications link with the control program itself.

Under the menu command **HARDWARE** there are two test menu commands **TEST SLAVE** channels And **TEST MASTER** channel, with the **TEST MASTER** menu command , a small extra test panel will become available where its possible to send an interrogation character to the Interface unit to test the serial link Between the PC and the interface unit . This test should result in the Unit reporting a SMART-TRIGGER RESET condition in the PC program , when a floating message box will appear with this status displayed. The unit shows RESET from power up or if the unit is initialised with a full set up the unit should respond with “SmarT-Trigger is Initialised”



Fig :18) Master Channel Test Hardware

The BAD CHAR Button will always reply with a floating message display indicating that a UNKNOWN CHARACTER was received by the the Interface unit. This tests the serial link with the Interface unit. Clicking On the menu HARDWARE TEST MASTER CHANNEL will remove this extra test panel.

The cable between the PC and the SmarT-Trigger unit should be wired as a standard 1 to 1 cable. Pins 2 – 3 and 5 only being used. Where DTR triggering is used pin 4 is also used (Data Terminal Ready)

There is an extra button on the test master panel for toggling the hardware lines on the internal units control bus and is for internal test purposes only.

Slave channel outputs and LED's

Under the HARDWARE menu mentioned above , the user should click on the **TEST SLAVE CHANNELS** menu command and another small test panel will become available for testing the slave channels I/O. For these tests communication is established, and the channel with which there appears to be a problem with, Is made the current active channel , by clicking on its Function Key **F1 F2 F3** or **F4** to force it to a **RUN STOP** Or **STANDBY** condition.

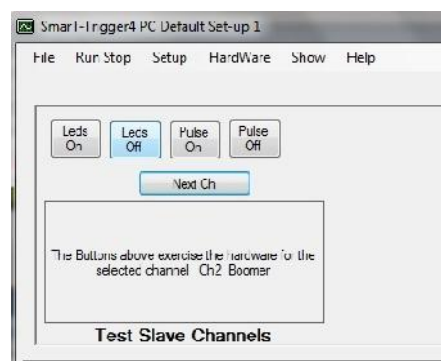


Fig 19. Test Slave hardware

SmarT-Trigger 4 Operation Handbook Trouble shooting

Fig: 19) Slave Test Hardware

(See fig 19 previous page)

The LEDS ON LEDS OFF buttons will turn on and off all the front panel LED's for the current active channel , enabling a confidence check to be made on all that channels front panel LED's.

When there is concern regarding the PULSE or CLOSURE I/O from a particular channel then the PULSE ON PULSE OFF buttons will toggle the A and B pulse outputs as well as the four closures for the channel so confidence checks can be made with an AVO connected to the relevant outputs at the rear panel.

OutPut Failure

If for any reason an output from a particular channel fails , changing the output driver chip is a simple task. Remove the top cover of the interface unit , locate the channel concerned (The master channel is beside the DC Power connector) next to it is located channel 4 , then moving across the board Channel 1 is located at the other side of the board. See Fig 20 below.

OutPut Failure Changing out a Driver Chip

Locate the 20 Way Ribbon connector which connects the particular channels rear panel BNC's to the main control board as seen below in Fig 20

The four driver chips highlighted in the figure below, are the closure output driver chips (IC101-IC 401) and the pulse driver chips are hidden under the respective channels ribbon cable , remove the ribbon to gain access to the chips IC102 –IC402 which deliver the pulse outputs.

The driver chips are 16pin DIL quad optically isolated transistor circuits and there are two spare chips located in the system spare kit. (Note the closure chips are oriented opposite direction to the pulse output chips)

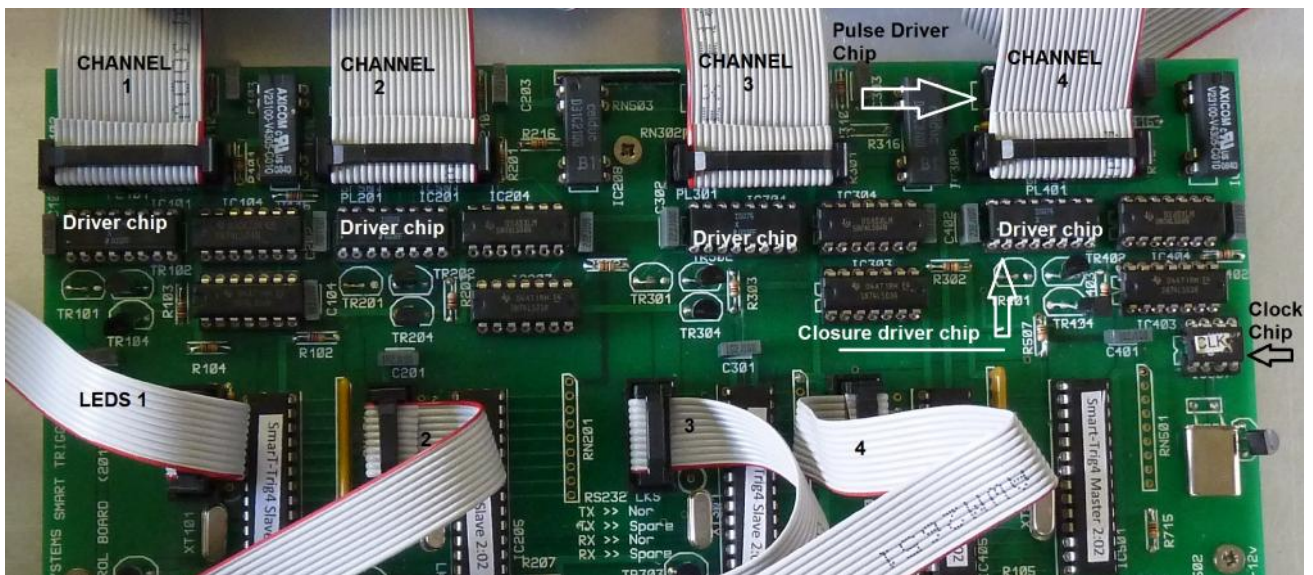


Fig :20) Main Control PCB Layout

System Clock Failure

In the event of a system clock failure , the symptoms of which will be as follows , The system powers up and is downloaded with the parameters , but immediately after this action the PC warns of a system CLOCK FAILURE with a floating message box display. All LED's will go out and stay out, The main system clock is generated by an 8 Pin RISC Micro device which is located on the far right hand side of the main control board as shown above in figure 20.

SmarT-Trigger 4 Operation Handbook Trouble shooting

The system spares kit contains a replacement 1/4 mSec clock generator (PIC I2C508)
 The symptoms of failed clock would be each channel would go into external and the red light would come on
 And the channel would respond to external triggers but would not run on any internal time base.

Locate channel four on the far right hand side of the main control board and see the 8 pin DIL RISC microprocessor (PIC I2C508) as shown in Fig 20 on previous page (clock Chip)

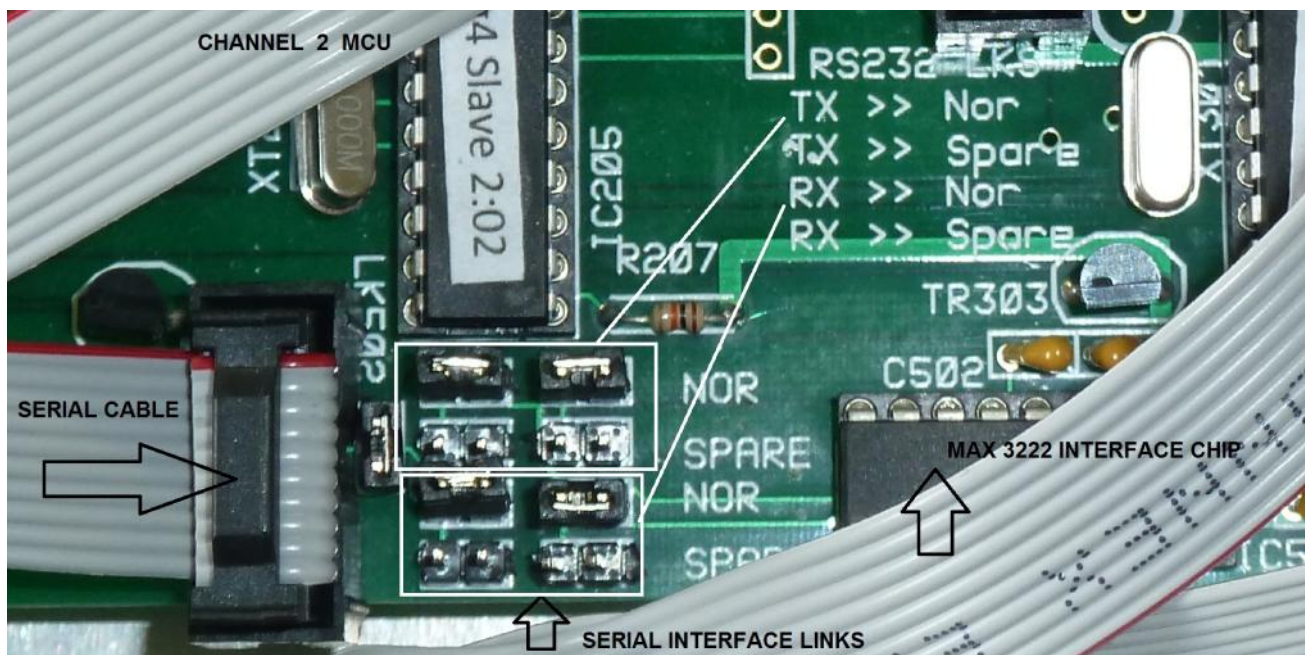
Power Supply

The system is powered from a standard AC wall adapter type DC power supply , the entire system is diode protected with a single 1N4001 Diode fitted on the control PCB and all the channels are powered from a single 1amp 5v regulator.

Serial Connection Problems

The unit is controlled by a standard serial cable , the connections inside the box are simply transmit receive and ground , these inputs are routed to the main board via a 10 way IDC ribbon connector , there follows a series of PCB links which allow the user to swap buffers in the interface chip in the event of not having a spare chip to hand , see fig 21 below , A spare MAX3222 interface chip is supplied in the system spares kit , but in the event of there being no spare available, the user can swap the links over to use the spare TX and RX buffers within the interface chip in the event of one or other buffer becoming damaged.
 The links operate in sets of two, both need to be set , one for the input and one for the output of the chip.

Fig 21 Serial links



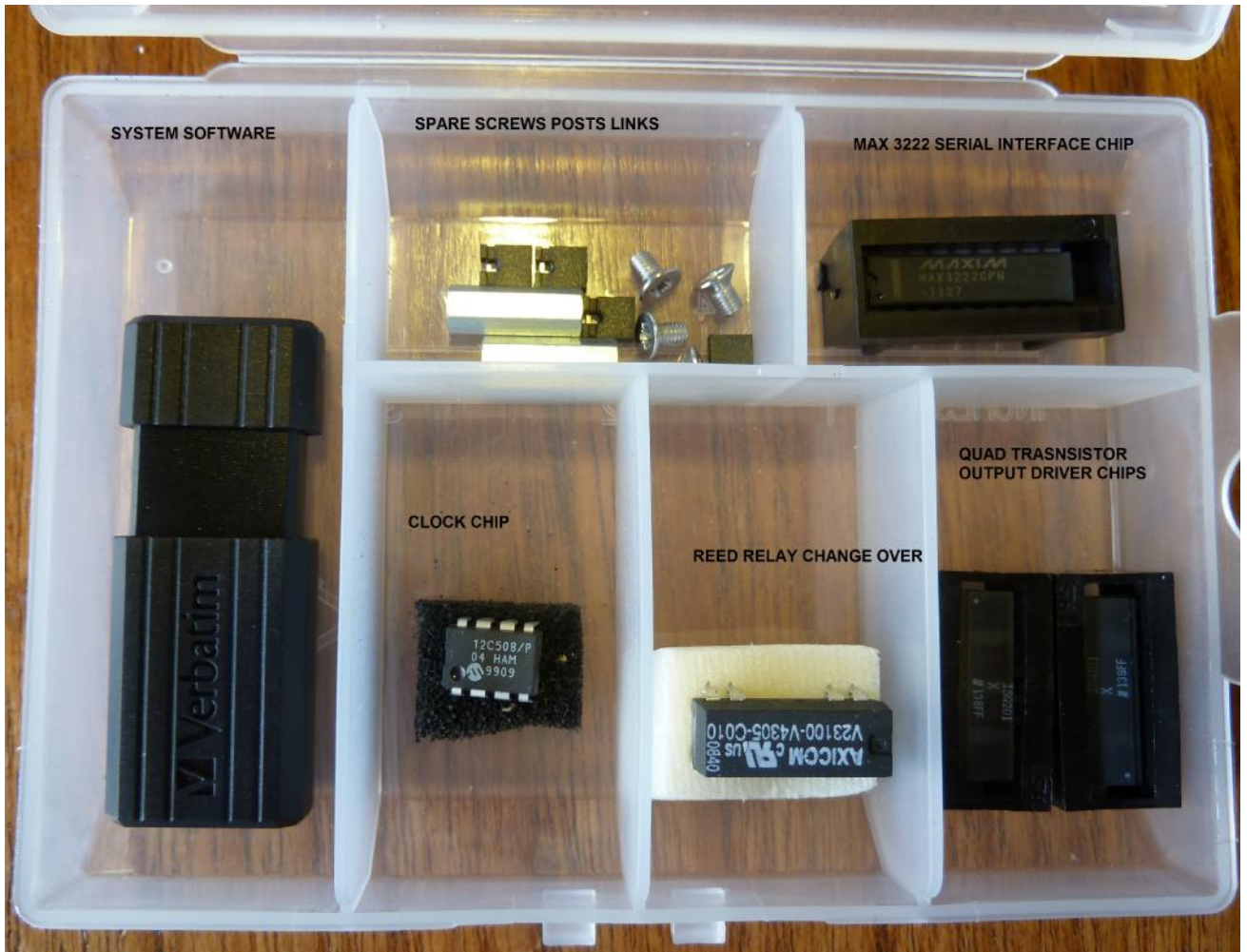
Serial Links

The serial links are for using the spare buffers in the RS232 interface chip MAX3222 but when DTR triggering one of the spare buffers is used to couple pin4 of the 9 way serial plug to an extra BNC TTL output trigger on the rear panel

Safety Cut Out

If the safety cut out circuit goes open circuit during normal operation of the system, All the slave channels Will immediately go into the STOP condition , No output triggers will be issued by the system, The user is alerted to the alarm condition and the circuit must be made before outputs from the system can be restored.

SmarT-Trigger 4 Operation Handbook Systems Spares Kit



The Systems Spares kit contains the system software on a single USB Stick the spare chips Serial Interface chip , a Reed Relay 5V change over for High voltage output, and Quad transistor driver chips.

Shipping check list Each system should contain the following items

- 1x Smart-Trigger4 Interface unit
- 1x 9v PSU with 2.1mm jack plug
- 1x DC extension cable with 2.1mm plug and 2.1mm jack socket
- 1x 5m Serial Extension Cable (wired one to one)
- 1x short serial lead wired one to one (for use at SmarT-Trigger end of extension cable)
- 1x Laminated handbook hard copy
- 1x System spares kit (Containing System software on a USB memory stick)
- 1x USB serial Converter kit Complete with CD and documentation