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PEAK NDT

Command Reference

MicroPulse Range:
MP6

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1 Introduction

This manual covers the MicroPulse range of instruments. It is written for MicroPulse 6 (MP6) but also covers other instruments in the range including LTPA, MPLT and LT2.

MicroPulse 6 is part of the MicroPulse family of high speed, multi-channel digital flaw detectors, offering phased array capability as well as separate channels for conventional high-performance pulse-echo/TOFD. Up to 256 phased array channels (with an aperture of up to 128 channels) and 12 conventional channels may all be housed in one enclosure. Where more phased array channels are required, then two units can be linked together. The phased array channels and conventional channels are configured and controlled independently to allow the high-speed firing of the transducers at rates of up to 55KHz. With selectable digitisation rates of up to 100MHz (and at a maximum of 16-bit output resolution) data can be reported as RF/AScan or up to 80 peaks. Where lower digitisation rates are selected, then there is no loss of resolution for element delays of phased array focal laws as the 100MHz clock rate is maintained until the final data output. Output data can be synchronised with up to four axes of motor positional data.

Control of the MicroPulse is via 1000BaseT (Gigabit) Ethernet to the host PC. The command language allows the user to configure up to 1024 phased array tests (this limit can be increased to 2048) and 255 conventional ultrasonic tests using any combination of transmit/receive channels that can be executed in sequence or individually. The phased array tests can be grouped together into sweeps to allow the test for example comprising a sector scan to be addressed collectively. Each test can have its ultrasonic parameters configured independently.

On the receiver, the parameters include:

- Amplifier gain
- Filter selection
- Waveform type (r/f, full wave, positive half cycle or negative half cycle)
- Waveform smoothing
- Distance amplitude correction (DAC).

Also, under user control are the transmitter parameters these include:

- Pulser width
- Pulser voltage
- Pulser Damping (conventional channels only)

The resultant data is presented in a number of ways. These include:

- Peak reporting (from 1 to 80 with TimeBase)
- Coupling level
- AScan or RF waveform capture
- Averaged data

Gates are defined relative to the firing of the pulser, but it is also possible to define an ‘inspection gate’ relative to a peak within a ‘search gate’, this is known as echo gate triggering.

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2 The MicroPulse Command Language

The communication interface of MicroPulse 6 is Ethernet. The IP address is normally set to a default of 10.1.1.2. Commands to MicroPulse consist of ASCII characters and are of the general format:

<mnemonic> <parm1> <parm2> … <parm n>

Where <mnemonic> is a 3 or 4 alphabetical command name (upper or lower case) and <parm> is a signed decimal integer or unsigned hexadecimal integer terminated by 'h' (or 'H'). Mnemonics and parameters are terminated by a space character; a command is terminated by either a carriage return character (0x0D) or the mnemonic of the next command. Several commands may appear on one line up to a total length of 1024 characters.

The '#' character is used to allow the use of comments on a line. All characters on the same line after the '#' character will be ignored by the MicroPulse. The use of Horizontal Tab characters (0x09) before '#' is not allowed, they should be replaced with whitespace characters (0x20).

Each test is identified by a number from 1 to 1279 (can be greater if specified in the SRST command). Tests 1 to 255 are used for conventional probes. This ensures backward compatibility with earlier MicroPulse systems. The NUM command defines the number of conventional tests in use at any one time and using test number 0 causes a command to apply to all tests up to the NUM parameter.

The MicroPulse default data output format is 8 bits, and so all data relating to signal amplitude are in the range 0 to 255. This applies to all threshold values (UPL, LWL, GPL, and GLH commands). When another output format is selected (10, 12 or 16 bit) the data relating to signal amplitude alters to match the resolution selected. Gain parameters (GAN, BAL, and auto-CAL commands) are in the range 0 to 280 and represent units of 0.25 dBs. DAC curves are programmed by the DSET and DFIL commands in 0.25dB units and assigned to a test using the CUR command.

By default, the gate commands (GAT, EGT, and IGT) are in machine units. A machine unit is defined by the digitisation rate (i.e. 10nSec for 100MHz digitisation).

Encoder control commands (FLX, FLZ, FLR, and LCP) use axis numbers 1 to 4, set up commands (MPE, SPA and BKL) carry up to 4 parameters, one for each axis. Axis locations can be reported as either signed 24-bit or signed 32-bit values.

Tests numbers of 256 or greater are used for phased array probes. Each one of these tests can be assigned a focal law by utilising the TXN/RXN commands. The TXN/RXN command will interpret that test numbers below 256 are assigned directly to a channel whilst tests 256 and above are assigned to a focal law. These phased array tests can be grouped into a sweep. A sweep is a number of tests that are fired sequentially and are defined by the SWP command. For example, if defined, a sweep could be tests 300 to 349 fired sequentially.

The transmit and receive focal laws are defined by using TXF/RXF commands. From the number of TXF/RXF commands sent relating to a particular law the MicroPulse can determine the number of array elements. After any changes to a focal law the appropriate TXN/RXN command must be sent to reassign the changed focal law to a test. The rx_delay and tx_delay are specified in 1 nanosecond units irrespective of the sample frequency of the system.

Dynamic depth focusing (DDF) is defined in a similar way to a focal law. The DXN command assigns a DDF law to a test whilst the DXF command details the DDF law itself.

To accommodate the fact that when changing a parameter, it is desirable to change that parameter for all tests in a sweep a fourth letter ‘S’ can be added to many of the existing MicroPulse commands. This new command will then alter the parameter for the defined sweep number or all defined sweeps if set to zero.

For example:

CAL 0	fires all tests defined by the NUM command
CAL 1	fires test 1
CALS 1	fires all tests in Sweep 1 as defined by the SWP command.

If the system is configured with parallel conventional channels, then this allows conventional pulse-echo/TOFD tests to parallel fire. To accommodate this certain MicroPulse commands can have an optional fourth letter “G” added. This allows control of the test groups specified by the GRUP command. The configuration of the MicroPulse system should be checked with Peak NDT prior to use of group firing.

3 Command Language Overview

The commands recognised by the MicroPulse can be grouped according to the functions that they perform. There are nine groups discussed in this section, these cover:

3.1 General Control Commands
3.2 Ultrasonic Commands (e.g. gates, gain, etc)
3.3 Test Commands
3.4 Axis Control Commands
3.5 Inspection Commands
3.6 Data Control Commands
3.7 User Interface Commands
3.8 Input/Output Commands
3.9 Multi-gate on a Test Commands

In this section the following abbreviations are used:

< >	These parameters are mandatory
[ ]	These parameters are optional
( )	This is a note for clarity; they do not actually appear in either input or output

3.1 General Control Commands

OUT XXA XXAS XXB XXR XXT RST SRST STA SDS STS ZFL

The STA command is often used as a quick way of testing communications with a host. The response consists of an LLC message, which indicates the current axis positions.

RST performs a full reset of the system and replies with a message identifying the system version number. SRST performs a soft reset clearing only the parameters held in MicroPulse back to the power on state, it also replies with a message identifying the system version. The SDS command allows the user to define the power-on/RST default sample Frequency and data output mode.

The OUT command causes MicroPulse to reply with a defined message, this is useful for recognition of an event such as axis stall (see INE and MSE), or to flag the end of a command sequence containing CAL or STP commands (which may or may not produce data depending on the ultrasonics).

The XXA, XXAS, XXB, XXR, XXT and STS commands are used to query various parameters and settings from the MicroPulse. The ZFL command allows the storing of commands within the MicroPulse that are executed after a power-on/RST.

Format:

OUT	(Send Message)	<Hd><Arg>…[]
RST	(Reset System)	[Frq]
SDS	(Default sample frequency/DOF)	<Sample>[DOF]
SRST	(Software Reset)	[Frq][No. Tst[No. DDF]
STA	(System Status)	[Status]
XXA	(Request Ultrasonic Parameters)	<Tn>
XXAS	(Request Test Numbers in sweep)	<Sweep No.>
XXR	(Request Receive Focal Law Details)	<Law No.>
XXT	(Request Transmit Focal Law Details)	<Law No.>
XXB	(Display Ultrasonic Parameters)	<Tn>
STS	(Request Axis Control Parameters)	<Mode>
ZFL	(Store/Erase Commands)	<Mode>

3.2 Ultrasonic Commands

AAV AWF(S) BAL(S) CUR(S) DDAC DDF DFIL DLY(S), DRTE DSET DTG DXF DXN EGT(S) ETM EUPL EPL(S) FRD(S) FRQ(S) GAN(S) GAT(S) HYS(S) IGT(S) LOF LON PAV PAW PDW PSV RTD RXF RXN TGA(S) TRM(S) TTD TXF TXN UPL(S) VEL

The ultrasonic settings of any test are primarily accessed via the AWF(S), EGT(S), FRQ(S), GAN(S), GAT(S), HYS(S), IGT(S), RXN, TXN, and UPL(S) commands. The parameters of GAT(S), IGT(S) and EGT(S) are in machine units. A machine unit is defined by the digitisation rate (i.e. 10nSec for 100MHz digitisation). Distance units may be used as defined by the VEL command, although this is included only for backward compatibility and is not recommended for use on new software development.

The BAL(S), TGA(S), DLY(S) and TRM(S) commands provide means of relative adjustment of the basic parameters. The DDAC, DSET, DRTE, DFIL and DLIN commands provide interface with the D.A.C. memory to enable user-defined curves that can then be assigned to tests via the CUR command. The D.A.C. is turned on/off using the LON/LOF commands.

DTG allows the D.A.C. to be either triggered from the initial pulse or an interface echo.

AAV only applies to tests enabled with the gain reduction facility (GRE) and sets the amount of gain drop required.

ETM is used for tests using echo trigger facility to enable/disable echo trigger mode or to display the echo trigger gate on the A-scan monitor, this is used in conjunction with EGT(S) and IGT(S).

For conventional channels, PDW allows the adjustment of pulse width and damping, whilst PSV adjusts the pulser voltage. Phased array channels utilised the PAV and PAW commands to adjust the transmit voltage and width respectively.

The RXF and TXF commands are used to define the receive and transmit focal laws whilst the DXF command defines the Dynamic depth focus law which is assigned to a test using the DXN command. The receive and transmit laws can be trimmed using the RTD and TTD commands.

The SGA command can be used to increase the gain on phased array tests by altering the dividing factor for that test.

Format:

AAV	(Amplitude Adjustment Valve)	<Gred>
AWF(S)	(Analogue Waveform)	<Tn><sw>
BAL(S)	(Balance Gain)	<Tn ><Gchange>
CUR(S)	(DAC Curve number)	<Tn><Cn>
DDAC	(Define DAC Memory)	<Cn><Clen><Caddr>[Rate]
DDF	(Restrict DDF)	<Mode>
DFIL	(DAC Memory Fill)	<Cadd1><Cadd2><Cval>
DLIN	(Fill DAC Memory with line)	<Cn><Setting><Count> <Rate of Change><Repeat No.>
DLY(S)	(Delay)	<Tn><Delay>
DRTE	(Set System DAC Rate)	<Rate>
DSET	(DAC Memory Set)	<Cadd><Cval>
DTG	(DAC Trigger Mode)	<Tn><mode>
DXF	(DDF Law Define)	<DDF Law><channel><Count> <law details>
DXN	(DDF Law Assign to a Test)	<Tn><DDF Law>
EGT(S)	(Echo Gate)	<Tn><Gs><Ge>
EPL(S)	(FMC mode interface trigger threshold)	<Tn><Value>

ETM	(Enable Echo Trigger Mode)	<Tn><Mode>
EUPL	(Echo Gate Trigger Threshold)	<Tn><Value>
FRD	(Digital Filter Select)	<Tn><HPF>< LPF >
FRQ(S)	(Frequency Filter Select)	<Tn><Fn><Sn>
GAN(S)	(Gain)	<Tn><Gval>
GAT(S)	(Search Gate)	<Tn><Gs><Ge>
HYS(S)	(Hysteresis)	<Tn><Hys>
IGT(S)	(Echo Inspection Gate)	<Tn><Gs><Ge>
LOF	(DAC Off)	<Value>
LON	(DAC On)	<Value>
PAV	(Adjust Phased array pulse voltage)	<1st channel><last channel><volts>
PAW	(Adjust Phased array pulse width)	<1st channel><last channel><width>
PDW	(Pulser Damping with Width)	<channel><dd><ww>
PSV	(Pulser Voltage)	<channel><voltage>
RTD	(Receive Focal Law Trim)	<Focal Law><Value>
RXF	(Set Receive Focal Law)	<Focal Law><channel> <delay><element gain trim>
RXN	(Receive Channel Connector)	<Tn><Conn>[Vpn]
SGA(S)	(Phased array sum gain)	<Tn><Value>
TGA(S)	(Trim Gain)	<Tn><Gval>
TRM(S)	(Trim a test delay)	<Tn><Value>
TTD	(Transmit Focal Law Trim)	<Focal Law><Value>
TXF	(Set Transmit Focal Law)	<Focal Law><channel><delay> [optional pulser volts]
TXN	(Transmit Channel Connector)	<Tn><Conn>[Vpn]
UPL(S)	(Upper Threshold Level)	<Tn><Value>
VEL	(Velocity)	<Vel><Cn>
VPN	(Define a virtual probe)	<Virtual Probe No.><No. channels> <channel 1><channel n>

3.3 Test Commands

DIS(S) DISG ENA(S) ENAG GRUP NUM(G) PRF SWP

These commands control which tests are enabled for inspection and how fast the tests are repeated.

The NUM command specifies the current length of the test cycle for conventional probes, that is the number of the last test to be executed at any inspection point. ENA(S) and DIS(S) enable and disable specific tests, although disabled tests are still executed in response to STL, STP(S) or CAL(S) with a specific test number.

The SWP command defines the phased arrays tests that are grouped into any of the 32 sweeps.

The PRF command provides a means of setting a maximum pulse repetition rate; this can be useful to ensure that electronic or acoustic limits are not exceeded.

Format:

DIS(S)	(Disable Test)	<Tn>
DISG	(Disable group of Tests)	<Gn>
ENA(S)	(Enable Test)	<Tn>
ENAG	(Enable group of Tests)	<Gn>
GRUP	(specify a group of tests)	<GPn><Tn><Tn><Tn><Tn><Tn>
NUM(G)	(Test Cycle)	<No.>
PRF	(Pulse Repetition Frequency)	<Rate>
SWP	(Define Sweep)	<Swp No><list of tests>

3.4 Axis Control Commands

BKL EMUL, ENCF ENCM ENCO ENCT LCP MPE MSE SPA TERM

These commands set up the data necessary for reading of encoders.

MPE, EMUL, BKL must be set up before any axis move is performed, these specify the number of encoder pulses per user distance unit and backlash timeout.

SPA sets the pitch as which the tests are executed for FLR/FLX/FLZ inspections.

LCP presets axis position and may be used at any time, and so can for example be invoked by an input line to provide an external datum.

MSE provides the user with a means of programming the action to be taken of certain axis conditions.

TERM allows the user to either turn on or off the encoder axis termination.

Format:

BKL	(Backlash)	<Awt1><Awt2><Awt3><Awt4>
EMUL	(Encoder unit multiplier)	<Axis1><Axis2><Axis3><Axis4>
ENCF	(Encoder Filter)	<Axis1><Axis2><Axis3><Axis4>
ENCM	(Encoder Mode)	<Mode>[Input Mode][Filter Count]
ENCT	(Encoder Type)	<Axis1><Axis2><Axis3><Axis4>
JIT	(Encoder Jitter)	<Axis1><Axis2><Axis3><Axis4>
LCP	(Location Preset)	<An><Apos>
MPE	(Millimetre Per Encoder)	<Aep1><Aep2><Aep3><Aep4>
MSE	(Message Status Enable)	<ass><mode>[off]
SPA	(Spacing – Inspection)	<Axis1><Axis2><Axis3><Axis4>
TERM	(Define Encoder Termination)	<An><on/off>

3.5 Inspection Commands

STL STX CAL(S) STP(S) STPF STR(S) STRF FDEF FLM FLR FLX FLZ BUFF

Non-reporting modes

The STX command is used to place MicroPulse into an idle state, while the STL command is used to place MicroPulse into an idle state where a selected test is displayed on the A-scan monitor (where available). No ultrasonic data is sent to the host.

Static Modes

The CAL(S) and STP(S) commands are provided mainly for calibration purposes and can be used as single test commands or with a test number 0 for all tests specified by the NUM command. The CAL(S) command differs from all the other inspection commands in that MicroPulse performs one test or cycle of tests after processing the CAL(S) command and then reverts to whatever mode was previously selected. The other commands set up the required mode but do not execute them directly. MicroPulse first processes all pending commands before entering the most recently selected mode.

Moving inspection mode

Inspection is performed at points separated by a pitch specified via the encoder control command MPE and SPA (these points are referred to as SPA points in the command descriptions). Any data reported is preceded by an LCI message showing to which inspection point the data applies. The ultrasonics proceeds while the axis is moving, and data is continuously buffered. Because of the asynchronous nature of the ultrasonics, axis motion, and host data processing rate, there is a potential problem associated with this kind of inspection. The axis motion may be such that the ultrasonics for one SPA point does not finish before the next point is reached, when this occurs the data for the missed point is lost and this fact is flagged by an LCA message.

FLX, FLZ and FLR set up the inspection mode and rely on axis motion generated externally.

STR(S) can be used in an inspection as it fires tests at the defined PRF reporting the axis location and uses the internal buffer of the system.

The FLM command specifies the type of tests to be carried out at each inspection point. This can be conventional tests, phased array tests or both. FDEF can be used to define a sequence of sweeps to be carried out at inspection points. This can then be utilised by the STRF, STPF, FLX/FLZ and FLR inspection modes.

Format:

CAL(S)	(Calibration)	<Tn>[Amp]
CALG	(Calibration Group)	<Tn>< Gn>[Amp]
FDEF	(Define Sweep Sequence)	<Ena/dis><Mode><No. of sweeps><No. sweeps/tests
FLM	(Inspection Type)	<Mode>
FLR	(Fly Inspection Relative)	<Axis><disp><dir>
FLX	(Fly Inspection Start)	<Axis><start><dir>
FLZ	(Fly Inspection End)	<Axis><end>
STL	(Stopped Non-reporting)	<Tn>
STP(S)	(Stopped and Reporting)	<Tn>
STPF	(FLM Mode Stopped and Reporting)	
STPG	(Stopped and Reporting Groups)	<Gn>
STR(S)	(Stopped and Reporting, using buffer)	<Tn>
STRF	(FLM Mode Stopped and Reporting, using buffer)	
STRG	(Stopped and Reporting Groups, using buffer)	<Gn>
STX	(Enter Idle Mode)	[option]

3.6 Data Control Commands

ACNT AMP(S) DCM(S) ECON LWL(S) GPL(S) GPH(S) GRE(S) OLM(S) PIG SCHK

This group of commands allows the user to define how the ultrasonic data for a particular test is to be reported. The test specific commands AMP(S), LWL(S), GPL(S), GPH(S) and GRE(S) are mutually exclusive. In particular this means that any of these commands overrides any previous command for the same test number. PIG applies to all tests which report multiple peaks and specifies the maximum number of peaks to report. The DCM command allows the reduction of data from a test. ECON allows the activation various extra information. The first of these is Cycle time reporting where a message gives the user the actual cycle time achieved in STR/STP modes. The second is extended error message reporting where more information is given on incorrect commands received.

The OLM command enables the reporting of individual phased array element saturation, whilst SCHK allows the automated ADC and linearity checks on phased array channels.

Format:

ACNT	(Display Ascan Rate)	<Tn><count>[optional count start]
AMP(S)	(Amplitude)	<Tn><mode>[optional count][optional mode]
DCM(S)	(Data compression)	<Tn><mode>[optional count]
ECON	(Enable parameter reporting)	<value1><value2><value3><value3>
GPL(S)	(Grass Coupling Low)	<Tn><Value>
GPH(S)	(Grass Coupling High)	<Tn><Value>
GRE(S)	(Auto Gain Reduction)	<Tn><mode>
LWL(S)	(Lower Threshold Level)	<Tn><Value>
OLM(S)	(Overload reporting mode)	<Tn><Mode><No. elements>
PIG	(Peaks In Gate)	<no.>
SCHK	(System check)	<Mode><Chstrt> <Chend> <Gtstrt><Gtend> <Filter><Pulwidth> <Pulvolt><Pulrep>

3.7 User Interface Commands

BAB DOF IPM MAS SNM SYNC PAKA

The DOF command is provided to allow the user to change between output reporting modes.

MAS is used to determine the primary/secondary configuration when more than one MicroPulse is used in an inspection controlled by a single computer. SYNC is used as a method of synchronising two independently controlled systems to fire tests together.

The IPM and SNM commands can be used to set the IP address and subnet mask for Ethernet communication. This is an alternative method to using the 'PeakIPAssign' utility.

The BAB command is to allow a limited use of the MicroPulse 6 or LTPA Phased Array tests with older versions of the MIPS software (see appendix 6.7).

Format:

BAB	(Output mode)	<Mode>
DOF	(Output mode)	<Mode>[Ascan Mode]
IMF	(Computer Interface Control)	<Mode>
IPM	(Set the Ethernet IP address)	<Value><Value><Value><Value>
MAS	(Primary/Secondary mode)	<Mode>
SNM	(Set the Ethernet subnet mask)	<Value><Value><Value><Value>
SYNC	(System synchronisation)	<Mode><Timeout>

3.8 Input/Output Commands

CPIN INE INEF SCPE

INE and CPIN utilise general purpose hardware input and output lines. These may be used for inspection systems which provide external event data (e.g. axis datum) or require direct control from MicroPulse rather than a host (e.g. to operate a reject indicator). CPIN is used to output signal levels on the external outputs. The INE command has the ability of invoking any sequence of commands on external event; this makes it possible to configure standalone systems to respond to events without the need of an intelligent host. The SCPE command allows the enabling/disabling of the oscilloscope outputs (where available) for specific tests.

Format:

CPIN	(Control Pin)	<pin><sense>
INE	(Input Line Enable)	<pin><sense>[Off]
INEF	(Input Line Enable Filter)	<Filter Count>
SCPE	(Oscilloscope output enable)	<Tn>[mode]

3.9 Multi-gate on a Test Commands

AMM(S) CML GIN(S) GMH(S) GML(S) GMT(S) GTR(S) HMS(S) LML(S) PMG(S) UML(S)

There are a set of commands that control the use of multiple gates on a test. Multiple gate modes are accessed via special AMP modes (31,32 and 33). Up to Four Peak Detection gates can be specified. These commands are the multi-gate equivalent of the standard single gate commands

Format:

AMM(S)	(Multi-gate Amplitude)	<Tn><Gn><mode>
CML	(Multi-gate Calibration)	<Tn> <Gn> <amplitude>
GIN(S)	(Invert gate)	<Tn><Gn> <value>
GMH(S)	(Multi-gate Grass Coupling High)	<Tn><Gn><value>
GML(S)	(Multi-gate Grass Coupling Low)	<Tn><Gn><value>
GMT(S)	(Multi-gate Search Gate)	<Tn> <Gn><Gs><Ge>
GTR(S)	(Multi-gate Gate to Gate Trig)	<Tn><Trig SGate><Trig TGate><Thres> <Delay or Pre-trig>
HMS(S)	(Multi-gate Hysteresis)	<Tn><Gn><Hysteresis Level>
LML(S)	(Multi-gate Lower Threshold Level)	<Tn><Gn><value>
PMG(S)	(Multi-gate Peaks In Gate)	<Tn><Gn><value>

4 MicroPulse Output Messages

All MicroPulse messages are binary and carry a byte count, either explicitly as part of the message or implicitly by virtue of message type. This means that the host can ascertain the length of a message before the whole message has been sent.

To allow existing software to interface with the MicroPulse, different output formats are supported. The output mode is controlled by the DOF command:

DOF 0 Mode: Backward compatible mode for MicroPulse 4. The standard peak mode (peak count in header) of MicroPulse 4 is not supported. Only the newer peak reporting mode that supports up to 80 peaks is implemented (Peak count in the header can be accessed by utilising BAB 1 mode). Reports 8 Bit Data. Details of the command format and output messages can be found in the MicroPulse 4 Manual (PNL1055).

Note in DOF 0:

Test 1 is reported as 0
Test 256 is reported as 0
Test 511 is reported as 0xff

This mode is therefore of limited use as test numbers are duplicated in the output messages.

DOF 1 Mode: The default mode. This allows for all tests and reports 8 Bit Data.

DOF 2 Mode: This mode allows for 10-bit data to be reported. The message format is as per DOF 1 mode except all amplitudes are 10-bit data.

DOF 3 Mode: This mode allows for 12-bit data to be reported. The message format is as per DOF 1 mode except all amplitudes are 12-bit data.

DOF 4 Mode: This mode allows for 16-bit Ascan data to be reported. The message format for all other data is as per DOF 3 (12-bit data).

DOF 5 Mode: This mode allows for 8-bit logarithmic data to be reported. The message format is as per DOF 1 mode except all amplitudes are 8-bit logarithmic data. This is intended for use with rectified data only.

DOF 6 Mode: This mode allows for byte packed 12-bit data to be reported. This gives a 25% reduction in the data transferred. This is only for Ascan data, all other data is as per DOF3 (12-bit data).

A table containing a summary of all the available output messages can be found in Appendix 6.2.

An optional second parameter is available in some DOF modes to allow 8-bit Ascan data while keeping higher resolution with all other messages (Not valid when using FMC data output AMP modes, Ascan data will be in the set DOF mode).

4.1 Standard Data Output Messages

Data Message

<Header> <count lsb><count tsb><count msb>><Sweep No./Test No. lsb><Sweep No./Test No. msb><dof >< channel ><amp 1>….<amp n >

Where:

Header byte:	1A Hex	Ascan
	1C Hex	Normal indications
	1D Hex	Gain reduced indications
	1E Hex	LWL (coupling failure)
Count:	24-bit total data length count	
Sweep/Test No:	16 bits. Bottom 11 bits Test No. Top 5 bits sweep No.	
dof:	Bits 0 – 4 = data format Bits 5 – 7 = 0 except in multi-gate mode where they give the gate number that the data is from (1 – 4). Also in FMC mode used as the most significant 3 bits of the data of the channel number. This allows channels above 255 to be reported correctly.	
channel:	Normally 0, except in full matrix capture tests it is used to indicate the channel number	
amp:	In 8-bit Modes, for Ascan = amplitudes of digitised signal else for peak indications the format of the data is <amp n >TimeBase lstb n><TimeBase mstb n>	

Note in DOF 1 to DOF 6:

Test 1 is reported as 0
Test 255 is reported as 0xFE
Test 256 is reported as 0xFF
Test 511 is reported as 0x1FE

Auto-CAL - 10 Bytes in total:

<26Hex>
<Sweep/Test No. lsb >
<Sweep/Test No. lsb >
<dof>
<amp lsb>
<amp msb>
<TimeBase lsb>
<TimeBase msb>
<gain lsb>
<gain msb>

GPL Grass Coupling –10 Bytes in total:

<25Hex>
<Sweep/Test No. lsb >
<Sweep/Test No. msb >
<dof>
<32-bit waveform integral Byte 0 (lsb)>
<32-bit waveform integral Byte 1>
<32-bit waveform integral Byte 2>
<32-bit waveform integral Byte 3>

<amp lsb>

<amp msb>

GPH Grass Coupling – 10 Bytes in total:

<24Hex>
<Sweep/Test No. lsb >
<Sweep/Test No. msb >
<dof>
<32-bit waveform integral Byte 0 (lsb)>
<32-bit waveform integral Byte 1>
<32-bit waveform integral Byte 2>
<32-bit waveform integral Byte 3>

<amp lsb>
<amp msb>

LWL Coupling failure – 4 Bytes in total:

<28Hex>
<Sweep/Test No. lsb >
<Sweep/Test No. msb >
<dof>

Echo Trigger failure – 4 Bytes in total:

<27Hex>
<Sweep/Test No. lsb >
<Sweep/Test No. msb >
< Channel >

Where:

Channel: Normally 0, except in full matrix capture tests it is used to indicate the channel number

Overload failure (1) – 4 Bytes in total:

<29Hex>
<Sweep/Test No. lsb >
<Sweep/Test No. msb >
<Count of elements saturating during gate>

Overload failure (2)

<2aHex>
<Total message length count (n+4)>
<Sweep/Test No. lsb >
<Sweep/Test No. msb >
<n Bytes containing a bitwise representation of each channels overload status>

4.2 Information Messages

RST

The format of this message is now 32 bytes in total length:

1 Header Byte 23Hex
2 System number
3 LSB of the number of Phased Array channels in system
4 Number of Conventional channels in system
5 System type see below for decode
6 Hardware version most significant byte
7 Hardware version least significant byte
8 Actual data output format
9 Default sample Frequency
10 Actual system sample Frequency
11 Default data output format
12 Bits 0 - 4 = Conventional channels per CUIF ADC
Bits 5 - 6 = Conventional Channel DAC, 0 is 40dB, 1 is 60dB and 3 is 70dB
13 Main processor software version byte 1
14 Main processor software version byte 2
15 Main processor software version byte 3
16 Main processor software version byte 4
17 Master control
18 Bit 0 - 3 = MSB of the number of Phased Array channels in system + 1
Bit 4 - 6 = For future use.
Bit 7 = Bit set indicates extra transmit channels present
19 RF Slot 1
20 RF Slot 2
21 RF Slot 3
22 RF Slot 4
23 RF Slot 5
24 RF Slot 6
25 RF Slot 7
26 RF Slot 8
27 RF Slot 9
28 Spare
29 Ethernet processor software version byte 1
30 Ethernet processor software version byte 2
31 Ethernet processor software version byte 3
32 Ethernet processor software version byte 4

Decode of System type byte is as follows:

Bit 0 - 1:	System Number MSB		
Bit 2 - 3:	For future use		
Bit 4 - 7:	0	=	MicroPulse 5
	1	=	MicroPulse LT1
	2	=	MicroPulse LT2
	3	=	LTPA
	4	=	MPLT
	5	=	MicroPulse 6

Decode of RF slot bytes is as follows:

Bit 4 - 7:	0	=	Nothing expected in slot
	1	=	PAIF expected in slot
	2	=	CPIF expected in slot
Bit 0 - 3:	0/1	=	Slot is empty
	8	=	Slot has PAIF in
	9	=	Slot has a CPIF in

Byte 17 (Master control) A MasCon Pass in indicated by 0xFF

The Conventional Channels per CUIF is used to indicate the number of ADCs on a CUIF PCB for parallel firing of conventional channels. The byte is set to 0 or 16 on standard systems to indicate that the feature is not available. The configuration of the MicroPulse system should be checked with Peak NDT prior to use of group firing.

To obtain the PA channel count on a system with greater than 255 channels:

count = (BYTE3) + (((BYTE18 & 0x7f) - 1) * 0x100)

XXA <Test No.>

This query message now replies with a 40 Byte message as follows giving full test information:

1 Header Bytes 20Hex
2 Test No lsb
3 Test No msb
4 Tx focal law Number (channel number in conventional test) lsb
5 Tx focal law Number (channel number in conventional test) msb
6 Gain lsb
7 Gain msb
8 Bits 0-3 Filter and bits 4 –7 smoothing
9 Amp / reporting mode Byte 1(lsb)
10 Amp / reporting mode Byte 2
11 Amp / reporting mode Byte 3
12 Amp / reporting mode Byte 4 (msb)
13 Gate start lsb
14 Gate start msb
15 Gate end lsb
16 Gate end msb
17 Delay lsb
18 Delay msb
19 Upl lsb
20 Upl msb
21 Echo gate mode - echo gate start lsb
22 Echo gate mode - echo gate start msb
23 Echo gate mode - echo gate end lsb
24 Echo gate mode - echo gate end msb
25 Echo gate mode - inspection gate start lsb
26 Echo gate mode - inspection gate start msb
27 Echo gate mode - inspection gate end lsb
28 Echo gate mode - inspection gate end msb
29 Hysteresis
30 Test on/off (Bit 7), DAC on/off (Bit 6) and DTG setting (Bit 5)
31 DAC number
32 Sample Frequency
33 Velocity for this test lsb
34 Velocity for this test msb
35 Echo gate EUPL lsb
36 Echo gate EUPL msb
37 Rx focal law Number (channel number in conventional test) lsb
38 Rx focal law Number (channel number in conventional test) msb
39 Spare
40 Spare

Decode of Amp/ reporting mode:

Bit 0 - 7:	Bits 8 - 11	Bits 12 - 15	Bits 16 - 31
0 = Amp mode 0	0 = ETM mode 0	2^n Number of averages	LWL/GPH/GPL level
1 = Amp mode 1	1 = ETM mode 1		
2 = Amp mode 2	2 = ETM mode 2		
3 = Amp mode 3	3 = ETM mode 3/4/5		
4 = GRE mode 1			
5 = GRE mode 2			
6 = GPH mode			
7 = GPL mode			
8 = LWL mode			
13 = FMC Amp13			
30 = Amp mode 30			
31 = Amp mode 31			
32 = Amp mode 32			
33 = Amp mode 33			

XXAS <Sweep No.>

This query message replies with a variable length message giving the test numbers contained in the sweep. The message length is No tests in ((sweep * 2) + 8). If no tests are in the sweep the message length is 8

1	Header Bytes 21Hex
2	Message count lsb
3	Message count msb
4	Sweep No
5	Sweep enabled/ disabled
6	Spare
7	Number of tests in sweep lsb
8	Number of tests in sweep msb
9	First test number in sweep lsb
10	First test number in sweep msb
x	Last test number in sweep lsb
x+1	Last test number in sweep msb

XXT <Tx Focal Law No.> / XXR <Rx Focal Law No.>

These query messages reply with a fixed length message giving the details of 128 channels of focal law. The message length is 520 bytes

1	Header Bytes 22Hex
2	Message count lsb
3	Message count msb
4	1 = Tx focal law, 0 = Rx focal law
5	Focal law No. lsb
6	Focal law No. msb
7	Spare
8	Spare
9	Channel 1 law byte 1 (delay lsb)
10	Channel 1 law byte 2 (delay msb)
11	Channel 1 law byte 3 (enable byte)
12	Channel 1 law byte 4 (gain trim on RX / voltage apodization on TX)
⋮	
517	Channel 128 law byte 1 (delay lsb)
518	Channel 128 law byte 2 (delay msb)
519	Channel 128 law byte 3 (enable byte)
520	Channel 128 law byte 4 (gain trim on RX / voltage apodization on TX)

4.3 Error Messages

Error messages follow two formats, a simple mode (header 6) or an extended mode which provides a much greater level of detail of the error.

<Header 0x6><char>

MicroPulse uses the CER (header 6) message as a general-purpose error message. This message occurs when command input contains a syntax error, and the second byte (char) of the CER is the index of the first input character not to be recognised. Other CER messages will occur if input is syntactically correct but contains invalid parameters. In this case the second byte is greater than 128.

If the extended command error mode has been selected the format is as follows:

<Universal Header 0x2d><count lsb><count tsb><count msb>
<Ext CER Sub-header><type>< error pos lsb><error pos msb><$data^0$…$data^n$)

Where:

Header byte:	Universal Header 0x2d
Count:	24-bit total data length count
Sub-header:	Ext CER Sub-header 0x43
type:	0 = argument conflict 1 = unrecognised command 2 = argument outside standard limits 3 = unrecognised command 4 = System over temperature 5 = EHT supply error 6 = Secondary system error 7 = Parallel channel or Phased array interface trigger mode error 8 = Conventional channel VPN mode error
error pos	16-bit location of error on input line, least significant first
$data^0$…$data^n$	Copy of the input line that contained the error.

Note:

A “System over temperature” warning message will be generated if the system has reached a temperature within 5°C of the “shutdown temperature”.

If the temperature continues to rise, then the system will automatically turn off.

When a warning message is received, then the user should check the system for the cause of the increased temperature.

4.4 Axis Related Messages

For axis information the default mode is 24-bit (standard mode that is compatible with previous MicroPulse systems). A full 32-bit output mode is optional.

LLC message

The LLC message is generated in response to a STA command and gives the current location for all axes.

(24 Bit mode)

<Header 0x15><status><K1><K2><K3><K4><Info>

Where:

Status:	Status Byte (reflection of the optional parameter in STA)
Kn:	Three-byte location of axis n, least significant first.
Info:	Four Bytes normally set to 0xFFFFFFFF, but in moving inspection modes can be configured to give information on the number of Bytes left in the system buffer when the test was fired (Status = 1).

(32 Bit mode)

< Universal Header 0x2d><count lsb><count tsb><count msb>
< LLC Sub-header 0x40><status><K1><K2><K3><K4><Info>

Where:

Header:	Universal header 0x2d
Count:	24-bit total data length count
Sub-header:	The LLC sub-header 0x40
Status:	Status Byte (reflection of the optional parameter in STA)
Kn:	Four-byte location of axis n, least significant first.
Info:	Four Bytes normally set to 0xFFFFFFFF, but in moving inspection modes can be configured to give information on the number of Bytes left in the system buffer when the test was fired (Status = 1).

LCI message

The LCI message is generated during a moving inspection mode. It precedes any data from an inspection point and gives the actual location of that inspection point.

(24 Bit mode)

<Header 0x13><axis><K axis>

Where:

axis:	Axis number n
Kn:	Three-byte location of axis n, least significant first.

(32 Bit mode)

< Universal Header 0x2d ><count lsb><count tsb><count msb>
< LCI Sub-header 0x41><axis><K axis>

Where:

Header:	Universal header 0x2d
Count:	24-bit total data length count
Sub-header:	The LCI sub-header 0x41
axis:	Axis number n
Kn:	Four-byte location of axis n, least significant first.

LCA message

The LCA message is used to indicate a missed inspection point. The format of this message is as shown above, unless the message is generated due to the MicroPulse buffer being full. In this case the LCA has the top bit of the axis byte is set to 1.

(24 Bit mode)

<Header 0x14><axis><K axis>

Where:

axis:	Axis number n
Kn:	Three-byte location of axis n, least significant first.

(32 Bit mode)

< Universal Header 0x2d ><count lsb><count tsb><count msb>
< LCA Sub-header 0x42><axis><K axis>

Where:

Header:	Universal header 0x2d
Count:	24-bit total data length count
Sub-header:	The LCA sub-header 0x42
axis:	Axis number n
Kn:	Four-byte location of axis n, least significant first.

4.5 Extended modes / Special Messages

These messages are used to support newer modes and features implemented in the MicroPulse system. All of these messages now use the Universal header format.

EGT Range message (For ETM Tn 3 in Multi-gate modes and ETM Tn 5)

To support the reporting of the interface echo range for Multi-gate modes:

<Universal Header 0x2d> <count lsb> <count tsb> <count msb> <Sub-header 0x02>
<Sweep/Test No. lsb> <Sweep/Test No. msb> <dof> <Echo Range lsb>
<Echo Range msb> <spare 0> <spare 0>

Where:

Header:	Universal header 0x2d
Count:	24-bit total data length count
Sub-header byte:	0x02 = EGT range
Sweep/Test No:	16 bits. Bottom 11 bits Test No. Top 5 bits sweep No.
DOF:	Data Output Format
Echo Range:	Echo Range is reported at the sample frequency and from the time of the initial pulse
Spare:	Not used and set to 0

Data Message with EGT Range message in FMC

To support FMC mode individual channel echo gate trigger the following messages are used.

< Universal Header 0x2d><count lsb><count tsb><count msb><Sub-header 0x01>
<Sweep No./Test No. lsb> <Sweep No./Test No. msb><dof ><Channel >
<Echo range lsb><Echo range msb><Spare> <amp 1>…<amp n >

Where:

Header:	universal header 0x2d
Count:	24-bit total data length count
Sub-header byte:	0x01= FMC Ascan
Sweep/Test No:	16 bits. Bottom 11 bits Test No. Top 5 bits sweep No.
dof:	Bit 0 – 4 data output format Bit 5 – 7 most significant data of the channel number. This allows channels above 255 to be reported correctly.
Channel:	Normally 0, except in full matrix capture tests it is used to indicate the channel number
Echo Range:	Range of the interface echo from the start of the interface echo gate
Spare:	Not used
Amp:	In 8-bit Modes, for Ascan = amplitudes of digitised signal. In greater than 8-bit modes, the amplitudes are least significant byte first.

Cycle Time Message

To report the achieved test cycle time.

< Universal Header 0x2d ><count lsb><count tsb><count msb>< Sub-header 0x44>
<PRF cycle time lsb>< PRF cycle time tsb>< PRF cycle time msb>

Where:

Header:	universal header 0x2d
Count:	24-bit total data length count = 0x8
Sub-header byte:	0x44 = PRF cycle time
PRF cycle time:	24-bit count of time taken to complete all tests in the cycle (640nsec steps)

STX 1 Completion Message

To indication the completion of a STX 1 buffer clear command.

< Header > <count lsb > <count tsb> <count msb> <Sub-header> <result> <spare>

Where:

Header:	Universal header: 0x2d
Count:	24-bit total data length count: 0x8
Sub-header byte:	STX 1 completion: 0x3
Result:	Zero means successful buffer clear Bit 0 set = failure to clear buffer Bit 1 set = only partial buffer clear
Spare:	Two spare bytes set to zero

SYNC Mode Synchronisation Message

To report a synchronisation error message in SYNC mode.

<Header><count lsb> <count tsb><count msb><Sub-header><System><Spare><Spare>

Where:

Header:	Universal header 0x2d
Count:	24-bit total data length count 0x8
Sub-header byte:	SYNC error 0x4
System:	1 for primary, 2 for a secondary
Spare:	Two spare bytes set to zero

SCHK: Simple Report Message

< Universal Header 0x2d><count lsb ><count tsb><count msb><Sub-header 0x31>
<channel number><result code><spare>

Where:

Header:	universal header 0x2d
Count:	24-bit total data length count = 0x08
Sub-header byte:	0x31 = SCHK simple report
Channel number:	Phased array channel number
Result code:	See detailed message

SCHK: Detailed Report Message

<Universal Header 0x2d><count lsb><count tsb><count msb><Sub-header 0x30>
<channel number><result code><spare><Pulser voltage used lsb>
<Pulser voltage used msb><Reference gain used for 80% lsb>
<Reference gain used for 80% msb>

Then 6 sets of 8 bytes for each of the gain settings
(default 0dB, +2dB, -6dB, -12dB, -18dB, -24dB)

<positive limit 8-bit><spare><negative limit 8-bit><spare><Amplitude obtained 8-bit >
<spare><TimeBase lsb><TimeBase msb>

Where:

Header:	universal header 0x2d
Count:	24-bit total data length count = 0x3c
Sub-header byte:	0x30 = SCHK detailed report
Channel number:	Phased array channel number

Result Code Format:

0	=	pass
1	=	on auto CAL no peak found in gate
2	=	even at minimum pulser volts the reference signal too high
3	=	reference peak too low
4	=	reference peak found but too little gain for linearity checks
5	=	reference peak found but too much gain for linearity checks
6	=	Linearity check outside limits

Error Log Report Message

<Universal Header 0x2d><count lsb><count tsb><count msb><Sub-header 0x45>
<Number of log messages lsb >< Number of log messages msb><Log status>
<Contents of the log with each being 20 bytes long>

Where:

Header:	universal header 0x2d
Count:	24-bit total data length count of whole message
Sub-header byte:	0x45 = SUB_HDR_ELOG
log messages:	16 bits count of the number of log messages
Log status:	0 = disabled 4 = enabled

And each 20-byte log format:

<ERR_LOG_FOUND 0xc8><count lsb><count msb><Type><Value>
<4 bytes Timestamp 1><4 bytes Timestamp 2><4 bytes Timestamp 3>
<spare byte><Signature byte 1><Signature byte 2>

Where:

Header:	ERR_LOG_FOUND 0xc8
Count:	16-bit log length count, always 0x0014
Type:	1 = Error timeout 2 = Remote shutdown occurred 3 = Error over Temperature 4 = Error Temperature shutdown
Value:	Either the temperature of the error in degC (type 3 and 4) or a number indicating exact nature of the timeout (type 1) or 0 (type 2)

Timestamp 1:	4 bytes, LSByte first, of uptime in seconds when log occurred
Timestamp 2:	4 bytes, LSByte first, since RST in seconds when log occurred
Timestamp 3:	4 bytes, LSByte first, since SRST in seconds when log occurred
Spare Byte	Currently set to 0
Signature byte 1:	Always set to 0x5a (if incorrect then this particular log is invalid)
Signature byte 2:	Always set to 0xfe (if incorrect then this particular log is invalid)

Example1 (Log with only one timeout with value 7):

<0x2d><0x1c><0><0><0x45><1><0><4><0xc8><0x14><0><1><7>
<0xb0><0><0><0><0x20><0><0><0><0xb0><0><0><0><0><0x5a><0xfe>

Example2 (An erased log in response to a STS 22 command):

<0x2d><8><0><0>< 0x45><0><0><4>

System Status Message

1 Universal header 0x2d
2 total data length count of whole message lsb
3 total data length count of whole message tsb
4 total data length count of whole message msb
5 Sub-header byte 0x46 (SUB_HDR_INFO)
6 System type where:

0Hex	=	MicroPulse 5
10Hex	=	MicroPulse LT1
20Hex	=	MicroPulse LT2
30Hex	=	MicroPulse LTPA
40Hex	=	MicroPulse MPLT
50Hex	=	MicroPulse 6

7 System number lsb
8 System number msb
9 Number of phased array channels lsb
10 Number of phased array channels msb
11 Number of Conventional channels lsb
12 Number of Conventional channels msb
13 Tx buffer size in Megabytes lsb
14 Tx buffer size in Megabytes msb
15 Hardware version number msb
16 Hardware version number lsb
17 Default sample frequency
18 Actual sample frequency
19 Default Data output format (DOF)
20 Actual Data output format (DOF)
21 Main processor software version byte 1
22 Main processor software version byte 2
23 Main processor software version byte 3
24 Main processor software version byte 4
25 Ethernet processor software version byte 1
26 Ethernet processor software version byte 2
27 Ethernet processor software version byte 3
28 Ethernet processor software version byte 4
29-31 System error code, each bit defines pass/fail of a hardware section (fail bit set):

Bit0	=	System flash fail/re-read
Bit1	=	System flash not configured

Bit2 = System I/O interface fail
Bit3 = System PSU fail
Bit4 = Conventional ADC fail

32-96 16 sets of 4 bytes of voltage data. Arranged as follows:

2-byte voltage setting (signed 16 bit) LSB first - divide by 100 to get 2 decimal places. If 0 then no voltage available so actual reading is not valid
2-byte actual voltage reading (signed 16 bit) LSB first - divide by 100 to get 2 decimal places

97 System Temperature in °C
98 System Processor Temperature in °C
99 Secondary System Temperature in °C
100 Secondary System Processor Temperature in °C
101 Spare
102 Spare
103 Spare
104 Count of number of MAX_No_system_cards (PAIF/CUIF) cards to be reported defined as PAIFCOUNT
105 (12 byte * "PAIFCOUNT") of PAIF Status SLOT 1 first

1 Byte Card Status for slot
1 Byte Card map for map
1 Byte PAIF board temperature in °C
1 Byte PAIF FPGA temperature in °C
4 Bytes PAIF_STATUS as read over the separate serial interface
2 Bytes RF Card ID (Version number)
2 Bytes Spare

Extended Echo Trigger Failure for FMC

< Universal Header 0x2d><count lsb ><count tsb><count msb><Sub-header 0x27> <Sweep/Test No. lsb ><Sweep/Test No. msb ><spare 0 ><channel lsb><channel msb><spare 0><spare 0>

Where:

Header:	universal header 0x2d
Count:	24-bit total data length count = 0x0c
Sub-header byte:	0x27 = SCHK simple report
Sweep/Test No:	16 bits. Bottom 11 bits Test No. Top 5 bits sweep No.
Spare:	Not used and set to 0
Channel	16 bits. FMC channel number
Spare:	Not used and set to 0
Spare:	Not used and set to 0

5 Instruction Set Details

AAV

Purpose: Amplitude Attenuation Value applied to GRE tests.

Format: AAV <Value>

Description: Selects amount of gain reduction applied to tests with GRE modes 1 or 2 selected when amplitudes greater than 200 are detected. When gain reduction occurs the test is fired a second time and the received signals attenuated by the amount <value> specified.

Parameters:

<Value>	:	Integer number between 0 and 80 corresponding to 0.25 dB increments. Default: 24 (6dB)

Example: AAV 24 : Sets gain reduction to 6dB.

ACNT

Purpose: To specify the count for the output an Ascan data every Nth test firing.

Format: ACNT <Tn><count>[optional count start]

Description: For use in AMP 32 and 33 mode to specify the count (N) for the output an Ascan data every Nth test firing. This is useful to reduce the rate of an Ascan that is for display purpose only.

Parameters:

<Tn> : Test number. An integer value from 0 to the maximum number of tests (default maximum is 1279 tests).
Tn = 0 for all tests.

<Count> : Integer 0 between 10000. Where an Ascan will be output every count +1 firing of the test.
0 = (Default every firing)

optional [count start] : When the third parameter is omitted the ACNT command synchronizes the Ascan output cycle count and the next test fired will output an Ascan.
If used, this parameter can offset the count start value for a test. This is used for multiple tests with the ACNT command to offset the firing at which an Ascan is output.

AMM(S)

Purpose: Select amplitude reporting mode in multi-gate modes

Format: AMM <Tn> <Gn> <mode>

Description: Multi-gate version of AMP command. The specified test is set to report amplitude and TimeBase data as follows:

Mode	=	0 First peak in gate.
	=	1 Largest peak in gate.
	=	2 All peaks reported with TimeBase.
	=	10 First Threshold crossing (single Peak).

Parameters:

<Tn>	:	Test number. An integer value from 0 to the maximum number of tests (default maximum is 1279 tests). Tn = 0 for all conventional tests. If the S extension is used it applies to all tests in the sweep number specified: 1-32, 0 = all sweeps.
<Gn>	:	Gate Number, an integer value from 0 to 4. Gn = 0 for all gates in the test
<mode>	:	0 1, 2 and 10

System Compatibility: Valid in Multi-gate Mode only (AMP 31, 32 and 33)

AMP(S)

Purpose: Select amplitude reporting mode.

Format: AMP <Tn><mode> [optional count][optional mode]

Description: The specified test is set to report amplitude and TimeBase data as follows:

Mode
- =0 First peak in gate.
- =1 Largest peak in gate.
- =2 All peaks reported with TimeBase.
- =3 A-scan data reported
  (modes 2, 3 and 13 : if count n is specified the test is repeated 2^n count times and averaged.)
- =10 First Threshold crossing (single Peak)
- =13 Full matrix capture.
  Ascan reported from each channel in the focal law.
  In this mode the gate size is limited to 8000 sample points per channel for each transducer firing.
- =30 A-scan data and all peaks reported with TimeBase reported.
- =31 All peaks reported with TimeBase for up to four hardware gates in multi-gate mode. Gates specified by GMT command.
  Averaging can be specified as a third parameter.
- =32 All peaks reported with TimeBase for up to four hardware gates in multi-gate mode. Gates specified by GMT command. Also an A-scan of the gate that encompasses the enabled peak detection gates for the test is reported.
- =33 As per mode 32 except that the A-scan data is persisted (maximum) across multiple test cycles as specified by the ACNT.
  These A-scans can be compressed using the DCM command. No addition averaging can be specified.
  The gates specified by the GMT command are processed on every firing. Mode 33 is intended to allow peak detection on every test whilst providing A-scans for use for display purposes with persistence. The mode is currently available in continuous inspection modes STR, STRS, STRG, STRF, FLX/FLZ and FLR.
  In this mode only there is a restriction of 32000 total A-scan samples across all tests in a cycle (after compression). This maximum is increased to 64000 samples if 8-bit data output is specified for A-scans via the optional second parameter of the DOF command. Mode 33 is not available in DOF 5 and 6.

Here ‘all peaks’ means the first n peaks as defined by the PIG command.

Parameters:

<Tn>	:	Test number. An integer value from 0 to the maximum number of tests (default maximum is 1279 tests). Tn = 0 for all conventional tests. If the S extension is used it applies to all tests in the sweep number specified: 1-32, 0 = all sweeps.
<mode>	:	0 1,2,3,10,13,30,31,32 and 33
optional [count]	:	Repeat count for Averaging/persistence modes 1 to 8 for 2 to 256 averages 1 to 1000 for maximum/minimum persistence

	optional [mode]	:	0 = normal averaging, with the number of averages n specified by 2n count 1 = persistence maximums of n A-scans where n is specified by the count parameter. Only available in AMP modes 3, 30, 31 and 32. Not available in DOF 5 and 6. 2 = persistence minimums of n A-scans where n is specified by the count parameter. Only available in AMP modes 3, 30, 31 and 32. Not available in DOF 5 and 6.
Examples:	AMP 1 2 3	:	averages 8 firings (2^3)
	AMP 1 3 10 1	:	The test is repeated 10 times and the maximums output as a single A-scan

AWF(S)

Purpose: Rectification select.

Format: AWF <Tn><Value>

Description: Selects for the test specified the rectification mode.

Parameters:

<Tn> : Test number. An integer value from 0 to the maximum number of tests (default maximum is 1279 tests).
Tn = 0 for all conventional tests. If the S extension is used it applies to all tests in the sweep number specified: 1-32, 0 = all sweeps.

<Value> : 0 – display and process rectified signal.
1 – display and process full RF signal.
2 – +ve half wave.
3 – -ve half wave.

Examples:

AWF 5 0 : Set Test 5 to display and process rectified Ultrasonic signal.
AWF 3 1 : Set Test 3 to display and process Full Wave RF Ultrasonic signal.
AWF 0 0 : Set all tests to display and process rectified Ultrasonic signal.

BAL(S)

Purpose: Relative Gain Adjustment (Balance).

Format: BAL <Tn><Value>

Description: Permits a RELATIVE gain adjustment to be applied to the ABSOLUTE value given by the GAN command. This can be useful during calibration and compensating differences in efficiency between transducers of the same type.

Parameters:

<Tn> : Test number. An integer value from 0 to the maximum number of tests (default maximum is 1279 tests).
Tn = 0 for all conventional tests. If the S extension is used it applies to all tests in the sweep number specified: 1-32, 0 = all sweeps.

<Value> : dB change to be applied. Entered in units of 0.25dB.
If the resultant gain exceeds 280 (70.00 dB) or falls below 0 it is set to 280 or 0 respectively.
The value can be positive or negative.

Examples:

BAL 1 100 : Increase gain of test 1 by 25 dB.

BKL

Purpose: Backlash Period.

Format: BKL <Axis><Axis2> <Axis3><Axis4>

Description: This command defines the number of times that the control processor must detect no movement on an axis before a stop condition is recognised. This allows the mechanical system to overcome backlash. The rate at which the controller polls the encoder input is fairly consistent and the BKL Parameters may be set empirically. If a stall is detected then an LLC message is reported, or if MSE has been enabled then the programmed command line is executed at the end of the current test cycle.
If BKL is set too low then a stall will be detected while the axis is still moving, conversely if BKL is too large there will be a delay between the time at which the axis stops and the detection of the stop by MicroPulse.

Parameters: <Axis n> : wait period for axis n: 1 to 20000
Units are 500uSec.

Example: BKL 100 350 100 100 : This sets Axis 1, 2, 3 and 4
Backlash delays.

CAL(S)

Purpose: To perform one test cycle, or to calibrate a test to specific amplitude.

Format: CAL <Tn> [amplitude]

Description: If amplitude is omitted the specified test (or all tests if 0 is used) is performed and the indications (if any) sent to the host. The ultrasonics are performed as part of the CAL command and so several CAL commands may be used in one line of input.
On the completion of a CAL 0 the system will output a two-byte message to indicate its completion The format of this message is header <01> followed by a single <01>.
If <amplitude> is specified then this means auto calibration mode, where the test is repeated for all gain values and the gain which gives a maximum peak closest to the specified amplitude is reported along with the corresponding indication. The test then remains with this gain.
Test 0 or CALS is not allowed in auto calibration mode.
CALS 0 performs all enabled sweeps, by default only sweep 1 is enabled. Use ENAS to enable other sweeps.

Parameters:

<Tn>	:	Test number. An integer value from 0 to the maximum number of tests (default maximum is 1279 tests). Tn = 0 for all conventional tests. If the S extension is used it applies to all tests in the sweep number specified: 1-32, 0 = all sweeps.
optional [amplitude]	:	Target amplitude for auto-calibration 1 to 255 (8-bit modes, 1 to 1023 (10-bit modes) and 1 to 4095 (12-bit modes)

Note:

CAL(G)

Format: CALG <Gn>

A version that is for use with parallel conventional channels only

This is a version of the CAL command for groups. The CALG executes once either a single group or all groups enabled within the NUMG. A number between 0 and 16. As with the CAL 0/CALS 0 on the completion of a CALG 0 the system will output a two-byte message to indicate its completion The format of this message is header <01> followed by a single <01>.

CML

Purpose: To calibrate a test to a specific amplitude in multi-gate modes

Format: CML <Tn> <Gn> <amplitude>

Description: Multi-gate version of CAL auto calibration mode .The test is repeated for all gain values and the gain which gives a maximum peak closest to the specified amplitude in the specified gate is reported along with the corresponding indication. The test then remains with this gain.

Parameters:

<Tn>	:	Test number. An integer value from 0 to the maximum number of tests (default maximum is 1279 tests).
<Gn>	:	Gate Number, an integer value from 1to 4.
<amplitude>	:	Target amplitude for auto-calibration 1 to 255 (8-bit modes, 1 to 1023 (10-bit modes) and 1 to 4095 (12-bit modes)

Note: Valid in Multi-gate Mode only (AMP 31 & 32)

CPIN

Purpose: Set output line sense.

Format: CPIN <pin><sense>

Description: The specified output pin is set to the specified sense.

Parameters:

<pin>	:	Number of output bit(s) 0 to 15 for MP6 0 to 3 for LTPA 0 to 3 for MPLT 0 for LT1 and LT2
<sense>	:	1 = HIGH 0 = LOW

CUR(S)

Purpose: Distance Amplitude Correction Curve Selection

Format: CUR <Tn><Curve No.>

Description: The specified test is set to use the specified DAC curve, Note: If DDAC is used CUR must be sent after DDAC.
Curve 256 is a special curve. It is a flat 0dB curve that can be used to provide DAC off on a test.
Curves 257 to 2304 are for curves defined by the DLIN command.

Parameters:

<Tn>	:	Test number. An integer value from 0 to the maximum number of tests (default maximum is 1279 tests). Tn = 0 for all conventional tests. If the S extension is used it applies to all tests in the sweep number specified: 1-32, 0 = all sweeps.
<Curve No.>	:	Integer number between 1 and 2304. (257 - 2304 for DLIN curves only)

Example: CUR 1 3 : Test 1 to use curve 3

DCM(S)

Purpose: To select a data compression algorithm

Format: DCM <Tn><mode>[optional count]

Description: The specified test is set to use the compression mode. Averaging prior to compression of the data is still available via the AMP command

Parameters:

<Tn> : Test number. An integer value from 0 to the maximum number of tests (default maximum is 1279 tests).
Tn = 0 for all conventional tests. If the S extension is used it applies to all tests in the sweep number specified: 1-32, 0 = all sweeps.

<mode> : 0 = OFF, this is the default (requires no third parameter)
1 = Sample frequency decimation. 3rd parameter gives compression i.e. Reduce by taking 1 sample out of n points
2 = Maximums, 3rd parameter gives compression i.e. largest out of n points. Where n can be up to 64.

[optional count] : Repeat count. An integer value from 2 to 64.

Example:

```
AMP  1      3
GAT  1  1000  2000
DCM  1      2    10
```

: test 1 will take maximum value of every 10 points, this will result in a 100-point Ascan

Note: DCM modes are not available in logarithmic (DOF5) and byte packing (DOF6) output formats. Persistence AMP modes (apart from AMP 33) also cannot be used with DCM.

DDAC

Purpose: Define memory for DAC curve.

Format: DDAC <Curve No.><length><Base Address>[Rate]

Description: Defines the base address of the specified DAC curve. Note if the DAC length specified does not reach the test end the last value in the curve will be held until the test end.
The base address, length and value may be entered in decimal or hexadecimal formats
The Rate is an optional parameter that sets the clock rate of the DAC curve. If not used, then the system wide clock rate specified by the DRTE is used. If a DAC curve has been previously assigned to a test, then after a DDAC command a CUR must be sent to re-assign the new curve parameters to that test.

Parameters:

<Curve No.>	:	Integer number between 1 and 2304. (257 - 2304 for DLIN curves only)
<Length>	:	Length of the DAC curve.
<Base Address>	:	Base address for curve. 0 to 65530
[Rate]	:	Integer number between 1 and 8: 1 = 25.0MHz 2 = 12.5MHz 3 = 6.25MHz (default at 50/100Mhz digitization rate) 4 = 3.125MHz (default at 25Mhz digitization rate) 5 = 1.5625MHz 6 = 0.78125MHz 7 = 5.0MHz 8 = 1.25MHz (default at 10Mhz digitization rate)

Example: DDAC 2 300 512 : Defines curve number 2 to start at memory location 512 and a length of 300.

Note: For DLIN curves the minimum length of a DAC curve is four (two settings). This is because an initial setting and one line must be specified.

DDF

Purpose: To restrict the number of DDF values used internally within the MicroPulse

Format: DDF <Mode>

Description: Where the user only requires 16 DDF values in their dynamic depth focus law this command sets the MicroPulse to only download 16 values to the appropriate channels. This has the effect of speeding up pulse repetition frequencies where DDF is used.

Parameters: [Mode] : Integer number of wither 16 or 32
16 = 16 value DDF
32 = 32 value DDF

System Compatibility: Valid only for systems with Phased Array channels.

DFIL

Purpose: DAC Memory Fill.

Format: DFIL <addr 1><addr 2><value>

Description: Fills all addresses from address 1 to address 2 with the specified value. The addresses are within the range 0 to 65530 for standard DAC and the range 70000 to 70511 for water path DAC used in FMC echo gate mode. This command is useful for gain gating specific signals at specific ranges.

Parameters:

<Addr 1>	:	Start address from which the specified value is to fill. Integer number between 0 and 65530 or 70000 and 70511
<Addr 2>	:	End address to which the specified value is filled Integer number between 0 and 65530 or 70000 and 70511
<Value>	:	Integer number representing a gain increase in 0.25 dB steps: 0 - 280 (0 - 70dB).

The address and value may be entered in decimal or hexadecimal Formats.

Example:

DFIL 100 200 20	:	Fill from absolute address 100 to absolute address 200 with gain value 5dB.
DFIL 20H C0H 120	:	Fill from HEX address 20 to HEX address C0 with gain value 30.0dB

DIS(S)

Purpose: Disable Test.

Format: DIS <Tn>

Description: Disable test specified by Tn that has been previously enabled by ENA. This means that the test will not be executed during FLR/FLX/FLZ, CAL 0 or STP 0, but the test remains enabled for CAL and STP with specific test number.

Parameters:

<Tn>	:	Test number. An integer value from 0 to the maximum number of tests (default maximum is 1279 tests). Tn = 0 for all conventional tests. If the S extension is used then sweep number specified is disabled: 1-32, 0 = all sweeps.

Example:

ENA 1	:	This enabled test number 1.
DIS 1	:	This disables test number 1.
XXA 1	:	Will show if test disabled.
DISS 1	:	This disables sweep 1

Note:

DISG

Format: DISG <Gn>

A version that is for use with parallel conventional channels only

This is a version of the DIS command for groups. The DISG command disables a group so it will not be executed in a set of groups firing even if it is within the NUMG. Group number is between 0 and 16. Gn = 0 for all Groups

DLIN

Purpose: To allow DAC memory to be filled with DAC line information for use on Phased Array tests.

Format: DLIN <Curve No.><Setting No.><Count><Rate of change><Cycle No.>

Description: Used as an alternative method to DFIL/DSET for entering DAC information to memory. This input method uses less DAC memory for each curve therefore allowing more DAC curves to be specified. The information is entered as a series of settings for each DAC curve. The setting is made up of a count that defines the number of DAC points before the change, then a Rate of change amount followed by the number of times to carry out this change.

Parameters:

<Curve No.>	:	Integer number between 257 and 2304
<Setting No >	:	The setting number of the DLIN DAC curve. Integer number between 1 and 16.
<Count>	:	Integer number between 2 and 255.
<Rate of change >	:	The 1/4 dB change. -2 = -0.5dB -1 = -0.25dB 0 = 0dB 1 = +0.25 2 = +0.5dB
<Cycle No.>	:	The number of times the count then change cycle should be carried before the DAC moves on to the next setting (1 – 32 cycles). Although on the first setting this is not used and so should be set to 0

Note: The first setting differs from the others in that the Rate of change parameter is an absolute DAC gain value (0 to the maximum DAC value in 1/4dB steps) that is applied from the start of the DAC curve. This value is held for Count No of DAC points and the next setting is executed.

The DDAC is still valid with the DLIN as with the DFIL/DSET. The length should be set to twice the amount of settings required for the DAC curve and is therefore limited to 32 (2 x 16 settings). This is because each of the new settings requires 2 DAC memory positions.

For DLIN curves the minimum length of a DAC curve is four (two settings). This is because an initial setting and one line must be specified. To set a flat DAC curve using DLIN commands the first DLIN should contain the gain value required whilst the second DLIN should be a line with 0dB rate of change. See Example 2.

DAC curves of the old format and DAC curves of the new format can be used together in a system configuration.

Examples:

1. Using DLIN for an increasing gain DAC:

DDAC	257 4 100 3	Define DAC 257 to start at 100 with a length of 4 (2 settings). The rate is 6.25Mhz
CUR	256 257	Assign curve 257 to test 256
DLIN	257 1 100 40 0	Define curve 257 point 1. Start gain of 40 (10dB). This DAC gain is held for 100 DAC points.
DLIN	257 2 20 1 10	Define curve 257 point 2. Count for 20 DAC points then increase the DAC gain by 0.25dB. Carry this out this cycle 10 times. By the end the DAC gain will be 12.5dB. The equivalent total length of a non DLIN curve in DAC points would be: 100 + (20 x 10) = 300

2. Using DLIN for a constant gain (Flat DAC curve):

DDAC	257 4 100 3	Define DAC 257 to start at 100 with a length of 4 (2 settings). The rate is 6.25Mhz
CUR	256 257	Assign curve 257 to test 256
DLIN	257 1 2 40 0	Define curve 257 point 1. Start gain of 40 (10dB). This DAC gain is held for 2 DAC points.
DLIN	257 2 2 0 1	Define curve 257 point 2. Count for 2 DAC points then leave the DAC gain the same. Carry out this cycle 1 time.

DLY(S)

Purpose: Delay

Format: DLY <Test No.><Value>

Description: Allows for an offset of all timing measurements to compensate for travel time through the probe shoe. In echo trigger mode delay this must be set to 0.

Parameters:

<Tn>	:	Test number. An integer value from 0 to the maximum number of tests (default maximum is 1279 tests). Tn = 0 for all conventional tests. If the S extension is used it applies to all tests in the sweep number specified: 1-32, 0 = all sweeps.
<Value>	:	Integer number between 0 and 20000 each increment representing 1 TimeBase delay. i.e. a delay may be set between 0 and 0.8 milliseconds when the sample frequency is 25MHz (40nsec TimeBase units)

Example:

DLY 1 100	:	set delay for test 1 to 4µsec (for 25MHz sampling).
DLY 0 200		set delay for all tests to 8µsec (for 25MHz sampling).

DOF

Purpose: Computer Interface Mode Format Select.

Format: DOF < Mode > [Ascan mode]

Description: Seven modes are available

0 Backward compatible mode for MicroPulse 4. The standard peak mode (peak count in header) of MicroPulse 4 is not supported. Only the newer peak reporting mode that supports up to 80 peaks is implemented (Peak count in the header can be accessed by utilising BAB 1 mode). Reports 8 Bit Data. Details of the command format and output messages can be found in the MicroPulse 4 Manual (PNL 1055).

Note in DOF 0 Test 1 is reported as 0.
Test 256 is reported as 0xFF
Test 511 is reported as 0xFFE.

This mode is therefore of limited use as test numbers are duplicated in the output messages. It is for backward compatibility only.

1 This mode is 8-bit data output mode

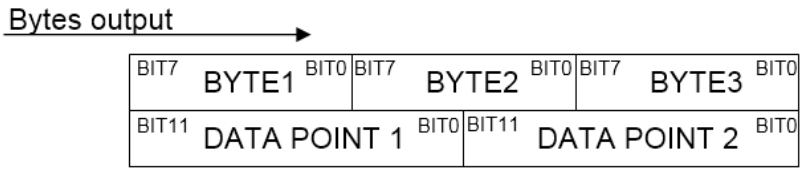
2 This mode is 10-bit data output mode.

3 This mode is 12-bit data output mode.

4 This mode is 16-bit data output mode.

5 This mode is 8-bit logarithmic data mode All data is output in logarithmic format except the integral part of the grass coupling message (GPL and GPH). Input parameters for commands are as per DOF3. This is intended for use with rectified data only.

6 This mode is 12-bit packed data output mode. This gives a reduction of 25% in the number of bytes sent. This only affects Ascan data output, all other data and input parameters for commands are as per DOF3(12bit).



Note in DOF 1 to 6: Test 1 is reported as 0x00.
Test 256 is reported as 0xFF.
Test 511 is reported as 0xFFE

Parameters:

< Mode > : 0, 1, 2, 3, 4, 5, 6

[Ascan mode] : 0,1. This optional second parameter is available in DOF 1,2,3,4 modes and when set to 1 allows 8-bit Ascan data while keeping higher resolution with all other messages (Not valid when using FMC data output AMP modes, data will be in the set DOF mode)

DRTE

Purpose: Define the system wide DAC clock rate.

Format: DRTE < Rate >

Description: Defines the system wide clock rate of the DAC. This parameter can be overridden for individual curves by utilising the extra parameter on the DDAC command.

Parameters: <Rate> : Integer number between 1 and 8:

1 = 25.0MHz
2 = 12.5MHz
3 = 6.25MHz (default at 50/100Mhz digitization rate)
4 = 3.125MHz (default at 25Mhz digitization rate)
5 = 1.5625MHz
6 = 0.78125MHz
7 = 5.0MHz
8 = 1.25MHz (default at 10Mhz digitization rate)

Example: DRTE 2 : Defines the system wide DAC rate to 12.5MHz

DSET

Purpose: DAC Memory Set.

Format: DSET <address><value>

Description: Sets addressed location to the specified value. The address is within the range 0 to 65530 for standard DAC and the range 70000 to 70511 for water path DAC used in FMC mode. This command is used to generate and adjust gain profiles.
The address and value may be entered in decimal or hexadecimal Formats.

Parameters:

<Address>	:	Address at which the specified value is stored. Integer number between 0 and 65530 or 70000 and 70511
<Value>	:	Integer number representing a gain increase in 0.25 dB steps: 0 - 280 (0 - 70dB).

Example:

DDAC 1 10 512	:	Define memory for DAC curve 1.
DSET 512 80	:	Set DAC gain at first byte to 20dB.

DTG(S)

Purpose: To change DAC trigger source.

Format: DTG <Tn><value>

Description: This command allows the user to select the source of the DAC trigger. It can be set to trigger the DAC either on the initial pulse an interface signal as specified by the interface echo gate (EGT)

Parameters:

<Tn>	:	Test number. An integer value from 0 to the maximum number of tests (default maximum is 1279 tests). Tn = 0 for all conventional tests. If the S extension is used it applies to all tests in the sweep number specified: 1-32, 0 = all sweeps.
<Value>	:	0 = trigger DAC on initial pulse (by Default) 1 = trigger DAC on interface echo

DXF

Purpose: To define element dynamic depth focus law.

Format: DXF <DDF Law No><channel><count><values 1 to n>

Description: For each Dynamic Depth Focus Law a number of DXF commands define the focus change for each element used. The delays and change are in 10 nanoseconds steps.

Parameters:

<DDF Law No>	:	Dynamic depth focus law. An integer value from 1 to the maximum number of DDF laws (default maximum is 512 laws).
<channel>	:	MicroPulse phased array channel number. An integer value from 0 to 128. 0 is used with a count of 0 to clear the whole law
<count>	:	Number of DDF values in law. An integer value from 1 to 32. A zero for any element means no DDF is needed for that element.
<values 1 to n>	:	The first value is the number of 10nSec steps to the first focus change. It is an integer value from 1 to 65535. Subsequent values are of a different format. The bottom 12 bits of each number is the number of 10nSec steps until the focus change from the last focus change. It is an integer value from 1 to 4095. The top 4 bits is the number of times this change should be implemented. It is an integer value from 1 to 15. If the top 4 bits are set to 0 then the system will count the value set in the bottom 12 bits one time and then perform no focus change.

Example: DXF 1 0 0

DXF 1 2 2 1000 16394

DDF law number 1 is cleared then element 2 is set with 2 values. The first means go for 1000 10nSec steps to the first 10nSec change. The second 16394 (400A Hex) means go for another 10 10nSec steps then change by 10nSec. This should be repeated 4 times.

System Compatibility: Valid only for systems with Phased Array channels.

DXN

Purpose: To assign a Dynamic Depth Focus (DDF) law to a test.

Format: DXN <Tn><DDF Law No>

Description: Selects a DDF law for a given test number. The DDF law should be defined using DXF commands prior to assigning the law to a test.

Parameters:

<Tn>	:	Test number. An integer value from 256 to the maximum number of laws (default maximum is 1279 tests). 0 can be used to assign to all phased array tests.
<DDF Law No>	:	Dynamic depth focus law. An integer value from 1 to the maximum number of DDF laws (default maximum is 512 laws). 0 clears any DDF law from a test.

Example: DXN 256 1 : Assign DDF Law 1 to test 256.

System Compatibility: Valid only for systems with Phased Array channels.

ECON

Purpose: To enable various parameter reporting

Format: ECON <value1><value2><value3><value4>

Description: To allow the selection of new data output modes. The extended error reporting mode is useful when a large sequence of commands is sent to MicroPulse. If an error is found, the line containing the error is sent back and information on the position in the line where the error occurred. For the format of output messages see the MicroPulse Output Messages section.

Parameters:

<value1>	:	Turn on actual time for a test cycle in STP, STPS, STPG, STR, STRS and STRG modes 0 = OFF (default) 1 = ON
<value2>	:	Turn on extended command error mode. 0 = OFF (default) 1 = ON
<value3>	:	Turn off echo range reporting in ETM 3 and 5 modes 0 = ON (default) 1 = OFF
<value4>	:	Turn on null peak message mode. When enabled and a test is in multi-gate mode (AMP 31/32/33) if no peak is found in a gate then a peak message is issued with a single peak at amplitude 0 and TimeBase of 65535

EGT(S)

Purpose: Echo Gate.

Format: EGT <Tn><Gate Start><Gate End>

Description: Defines the 'Echo Gated' area, i.e. the area in which the specified echo-trigger signal is expected for the specified test. The Parameters are in machine units unless a material velocity is set, even though in reality the acoustic medium usually has a different velocity.
If no signal appears in the echo gate above the UPL/EUPL (or EPL for FMC echo gate mode) then a four-byte message is reported to indicate an echo-gate failure
Calibration is performed during Echo Trigger gate display Mode (ETM mode 1 conventional tests only).

Parameters:

<Tn>	:	Test number. An integer value from 0 to the maximum number of tests (default maximum is 1279 tests). Tn = 0 for all conventional tests. If the S extension is used it applies to all tests in the sweep number specified: 1-32, 0 = all sweeps.
<Gate Start>	:	Distance units
<Gate End>	:	Distance units from 1 to 20000, i.e. each increment representing 0.1mm at the specified ultrasonic velocity

Example:

ETM 3 1	:	Set Test 3 Echo Trigger display Mode.
EGT 3 200 600	:	Set Test 3 Echo gate from 200 to 600 distance units
ETM 3 2	:	Set Test 3 Echo Trigger Mode

EMUL

Purpose: Encoder unit multiplier

Format: EMUL <Axis1><Axis2> <Axis3><Axis4>

Description: This command defines the multiplier for the raw encoder value before it is divided by the MPE. EMUL is intended for use with MPE and SPA to help define inspection pitches of less than 1 millimetre.

NOTE: It MUST be set before any other motor commands are used. It is usual to set this command once only at power-up or after a reset.

Parameters: <Axis n> : Multiplier to be used on axis.
Range is from 1 to 100000. Default of 1

Example: If an encoder is used with a count of 125 per millimetre

MPE	125	125	125	125		
EMUL	1	1	1	1		
SPA	1	1	1	1	:	Inspects every 1 mm
MPE	125	125	125	125		
EMUL	2	2	2	2		
SPA	1	1	1	1	:	Inspects every 1/2 mm
MPE	125	125	125	125		
EMUL	10	10	10	10		
SPA	1	1	1	1	:	Inspects every 1/10 mm

ENA(S)

Purpose: Enable Test.

Format: ENA <Tn>

Description: Enables test specified by test number Tn. Used to enable a test previously disabled by DIS.

Parameters:

<Tn>		:	Test number. An integer value from 0 to the maximum number of tests (default maximum is 1279 tests). Tn = 0 for all conventional tests If the S extension is used then sweep number specified is enabled: 1-32, 0 = all sweeps.

Example:

ENA	1	:	This enables test number 1.
XXA	1	:	Will show if test enabled.
ENAS	1	:	This enables sweep 1

Note:

ENAG

Format: ENAG <Gn>

A version that is for use with parallel conventional channels only

This is a version of the ENA command for groups. The ENAG command enables a group so it will be executed in a set of groups firing. Group number is between 0 and 16. Gn = 0 for all Groups

ENCF

Purpose: Select the input Filter setting for the encoders

Format: ENCF <Axis1><Axis2><Axis3><Axis4>

Description: The Filter for each axis can be separately configured. The Filter count is a parameter that can used to clean up the edges of noisy encoders by time hysteresis. This defines the length of time before a decision is made on any input transitions and can filter out noise spikes and noisy level transitions.

Parameters:

<Axis n>	:	Integer number between 0 and 255 (default 0) 0 = OFF 1 to 255 = approximately 100nSec to 20uSec

Note: This parameter can be set globally by use of an optional parameter on the ECON command. It is recommended that ENCF is used.

ENCM

Purpose: To globally set encoder parameters

Format: ENCM <Mode>[Input Mode][Filter Count] [LLC Freq]

Description: This command allows the global setting of encoder parameters. Mode 0 is the default mode of 24-bit encoders with the standard output message format. Mode 1 is the full 32-bit output mode. In mode 2 the output mode is full 32 bit but also the output message of inspection modes FLR and FLX/FLZ are now a 32-bit LLC message giving all axis positions instead of the normal LCI message that only gave information about a single axis. Further modes are available 3, 4, and 5 that give the same as modes 0, 1 and 2 but also include with the axis data a message that gives the status of the input/output lines. This message is the same as the reply to an STS 6 command.

The input mode and filter count are optional parameters. The input mode sets all axis as either full Quadrature or Step/Direction. In Step/Direction the 'A+' input is the Step whilst the 'B+' is the Direction. Each complete Step pulse is one encoder count. The filter count is a parameter that can used to clean up the edges of noisy encoders by time hysteresis. This defines the length of time before a decision is made on any input transitions and can filter out noise spikes and noisy level transitions.

For individual setting of the Input Mode and Filter Count see the ENCT and ENCF command respectively. It is recommended that these are used.
The optional fourth parameter (LLC Freq) allows the setting of an increased number of LLC messages (as defined by the Mode parameter above). Normally only one LLC is sent at the start of a data set. If this parameter is used then an LLC will be still sent at the start of a data set, but then further LLC messages will be sent during the data set on before every nth test.

Parameters:

<Mode> : Integer value from 0 to 5:

- 0 = 24 Bit output (Default)
- 1 = 32 Bit output
- 2 = 32 Bit output with LLC message for moving inspection modes
- 3 = 24 Bit output with STS 6 message
- 4 = 32 Bit output with STS 6 message
- 5 = 32 Bit output with LLC message for moving inspection modes with STS 6 message

[Input Mode] : Integer 0 or 1:

- 0 = Quadrature (Default)
- 1 = Step/Direction

[Filter Count] : Integer value from 0 to 255:

- 0 = OFF (Default 0)
- 1 to 255 = approximately 100nSec to 20uSec

[LLC Freq] : Integer value "n" from 0 to 100 (default 0).

Note: The 32-bit encoders require longer messages for LLC, LCI and LCA. The format is shown in the MicroPulse Output Messages Section.

ENCT

Purpose: Select the input count mode of the encoders as either Quadrature or Step/Direction. The default count mode of MicroPulse is Quadrature.

Format: ENCT <Axis1><Axis2><Axis3><Axis4>

Description: Each axis can be separately configured as either full Quadrature or Step/Direction. In Step/Direction the 'A+' input is the Step whilst the 'B+' is the Direction. Each complete Step pulse is one encoder count.

Parameters: <Axis n> : Integer 0 or 1:
0 = Quadrature (Default)
1 = Step/Direction

Note: This parameter can be set globally by use of an optional parameter on the ECON command. It is recommended that ENCT is used

EPL(S)

Purpose: Threshold for Phased Array and FMC mode interface echo.

Format: EPL <Tn><value>

Description: Specifies the Threshold that must be exceeded for a valid interface echo in Phased Array and full matrix capture Interface Echo Mode. If no signal appears in the echo gate above the EPL then a four-byte message is reported to indicate an echo-gate failure.

Parameters:

<Tn>	:	Test number. An integer value from 256 to the maximum number of tests (default maximum is 1279 tests). If the S extension is used it applies to all tests in the sweep number specified: 1-32, 0 = all sweeps.
<value>	:	Integer between 10 and 255 (8-bit modes) Integer between 10 and 1023 (10-bit modes) Integer between 10 and 4095 (12-bit modes)

Example: EPL 256 100 : Sets the interface echo threshold of test 256 to 100 machine units.

ETM(S)

Purpose: Echo Trigger Mode.

Format: ETM <Tn><Mode>[Test No/CH]

Description: Selects/deselects Interface Echo Trigger Modes, sometimes referred to as immersion testing with echo start. There several modes, one for calibration in conventional tests, one for echo trigger inspection in conventional/Phased Array tests and one for echo gate inspection in FMC tests. In echo trigger modes the echo gate is specified by the EGT(S) command and the inspection gate by the IGT(S) command. The trigger threshold level of the interface echo is set by the EUPL command for conventional tests and the EPL(S) command for Phased Array tests.

Mode = 0	:	Normal triggering. (Default)
Mode = 1	:	Display mode forms part of the calibration for conventional tests. Only the 'Echo Gate' is displayed allowing precise adjustment via the 'EGT' command.
Mode = 2	:	Echo Trigger Mode for conventional tests. If a signal above the EUPL (is detected within the echo gate (EGT), MicroPulse processes the part of the signal derived from the IGT Parameters taken relative to the point in the echo gate where the signal breaks the EUPL.
Mode = 3	:	For FMC Tests (AMP modes 13): Echo Trigger Mode for FMC tests If a signal above the EPL is detected within the echo gate (EGT), MicroPulse processes the part of the signal derived from the IGT Parameters taken relative to the point in the echo gate where the signal breaks the EPL. This happens independently on each receive channel used in the law. The data messages use a universal header format to accommodate the extra information required in this mode. For details on FMC mode interface echo see Appendix 6.5 For Multi-gate Tests (AMP modes 31 & 32): The system performs interface echo mode and also output an Ascan that is referenced to the initial trigger. The interface echo range is now reported. It is now possible to set up an interface trigger gate, 4 hardware peak detection gates and 1 Ascan data gate on the same test. The interface echo range is output in an EGT range message (see Output Messages section)
Mode = 4	:	Reserved
Mode = 5	:	Echo Trigger Mode for Phased Array tests where a channel a contained within the focal law is specified as the interface trigger channel. The trigger channel must be contained within the focal law of the test. If a new focal law is applied to a test then the ETM mode is set back to 0, so the ETM mode (and therefore the trigger channel) must be resent. The interface echo range is output in an EGT range message (see Output messages section).

Parameters:

<Tn>	:	Test number. An integer value from 0 to the maximum number of tests (default maximum is 1279 tests). Tn = 0 for all conventional tests. If the S extension is used it applies to all tests in the sweep number specified: 1-32, 0 = all sweeps.
<Mode>	:	0 = Echo Trigger Mode 'OFF' (Default). 1 = Use Echo Trigger Gate (Conventional test only). 2 = Echo Trigger Mode 'ON' (Conventional/ Phased Array test). 3 = Echo Trigger Mode 'ON' (FMC test)/ Multi-gate with Ascan. 5 = Echo Trigger Mode 'ON' Phased Array channel trigger
[Test No/CH]	:	Used modes 2 and 5. In mode 2 it specifies a trigger test (256 - max test number), whilst in mode 5 it specifies a trigger channel (1 -128, but within the focal law)

Example 1:

ETM	3	1		Set test 3 to echo trigger display mode.
ETM	3	200	300	Adjust interface echo monitor gate.
ETM	3	2		Set test 3 to echo trigger mode.

Example 2:

AMP	256	32		Set test amp mode to multi-gate
EGT	256	1000	2000	Set the interface trigger gate
EPL	256	100		Set the interface trigger gate threshold
IGT	256	0	5000	Set the interface trigger inspection gate
ETM	256	5	1	Set the test to interface trigger on element 1

Note 1: ETM mode 2 can be used for phased array tests in non-FMC applications. For phased array tests the echo gate functions differently to conventional tests. For a Phased array test the user can specify another test (and therefore possibly another focal law) as the interface echo test. This test then triggers the inspection test relative to an interface echo found. The test to be used as the interface echo test is specified by using a third parameter on the ETM command.
Mode "ETM X 1" is not valid for phased array tests. The interface echo test can simply be displayed if required.
Delay (DLY) and trim (TRM) are still used in echo gate mode for phased array tests. These parameters should normally be set to 0.

Note 2: The selection of an ETM mode for a test will clear any averaging setup on the test.

Note 3: By default, in ETM modes 3 and 5 the range of the interface echo is reported with an EGT Range message. To turn off this reporting use the ECON third parameter.

EUPL

Purpose: Threshold for interface echo in conventional tests.

Format: EUPL <Tn><value>

Description: Specifies the Threshold that must be exceeded for a valid interface echo in Interface Echo Mode.
If no signal appears in the echo gate above the EUPL then a two-byte ING message is reported: 8<Tn>

Parameters:

<Tn>	:	Test number. An integer value from 0 to 255. Tn = 0 for all tests. Not used for phased array tests as echo gate mode is performed in a different manor.
<value>	:	Integer between 10 and 255 (8-bit modes) Integer between 10 and 1023 (10-bit modes) Integer between 10 and 4095 (12-bit modes) (Default = If no EUPL is specified the current UPL is used in the interface echo gate.)

Example: EUPL 10 100 : Sets the interface echo threshold of test 10 to 100 machine units.

FDEF

Purpose: To allow the setup of a sequence of sweeps to be executed in STR, STRF, FLR and FLX/FLZ inspection modes

Format: FDEF <Ena/Dis> <Mode> <Number of sweeps n> <number of sweeps/ test at each point> <sweep 1> .... <sweep n>

Description: Used to define a sequence of sweeps that are carried out in inspection modes. Three modes are available. In the first mode a set number of sweeps are carried out at an inspection point and then another different set at each subsequent point until the sequence loops around again. At each point this can be a single sweep or multiple ones. In the second mode at each inspection point all the defined sweeps are executed, but only a set number of tests from each sweep.
The tests executed differ at each point as the sequence moves through the contents of the sweep. The test sequence restarts back at the beginning when the sweep end is reached. If the sweep only contains a single test, then this test will be carried out once at each inspection point. The third mode (2) is to define the parallel firing of both Phased Array sweeps and conventional groups. Another mode (3) utilises the extended parallel firing capability of a primary/secondary system configuration and allows four phased array tests to be parallel fired. These can then be used by the STRF, STPF, FLX/FLZ and FLR command.

Parameters:

< Ena/dis.> : Integer number between 0 and 1
- 1 = enable
- 0 = disable (no further parameters required)

<Mode> : Integer number between 0 and 3
- 0 = Executes all the tests in the number of sweeps specified by the 4th parameter and at the next inspection point executes the next set.
- 1 = Executes all the sweeps in the sequence but executes only the number of tests in the sweep specified by the 4th parameter and at the next inspection point executes the next set.
- 2 = Executes sequence of combined Phased Array and conventional tests.
- 3 = Executes sequence of four Phased Array tests on primary/secondary configuration.
- 4 = Executes a set of sweep sequences as defined as the SSEQ command.
  Up to 2 SSEQ can be executed in parallel fast mode with up to 4 SSEQ in primary/secondary configuration.

<Number of sweeps n> : The number of sweeps used in the definition.
Integer number between 1 and 32
In mode 2 this is defined as 2 = 2 parallel Phased Array sweeps only and 3 = 2 parallel Phased Array sweeps and conventional groups
In mode 3 should be set to 4
In mode 4 this is the number of SSEQ sequences to be executed.

<Number of sweeps/tests at each point >	:	In mode 0 defines the number of sweeps carried out at each point. In mode 1 defines the number of tests carried out at each point. In mode 2/3 this is the first of the parallel sweeps required. In mode 4 this is the SSEQ to be executed.
<sweep 1>...<sweep n>	:	In modes 0 and 1 this is the list of sweeps. In mode 2 there are only two parameters: the second parallel sweep and the conventional group (if required). In mode 3 there are three parameters, which are the second, third and fourth sweeps to be fired in parallel with the first. In mode 4 this is the SSEQ to be executed.

Example 1:

```
SWP    1 301
SWP    2 302
SWP    3 303
SWP    4 304
SWP    5 305
SWP    6 306
SWP   10 310
FDEF   1    0  12    2 1 10   2   10  3   10  4   10  5   10  6   10
STRS   0
```

Inspection Sequence	
Inspection Point	Tests Executed
1	301 to 310
2	302 to 310
3	303 to 310
4	304 to 310
5	305 to 310
6	306 to 310
7	301 to 310
8 … n	Sequence continues

Example 2:

```
SWP    1 301 302 303 304 305 306
SWP   10 310
FDEF   1    1    2    1    1   10
STRS   0
```

Inspection Sequence	
Inspection Point	Tests Executed
1	301 to 310
2	302 to 310
3	303 to 310
4	304 to 310
5	305 to 310
6	306 to 310
7	301 to 310
8 … n	Sequence continues

Example 3:

```
SWP    1 301 302 303 304 305
SWP   10 310
FDEF   1    1    2    2    1   10
STRS   0
```

Inspection Sequence	
Inspection Point	Tests Executed
1	301 302 310
2	303 304 310
3	305 306 310
4	301 302 310
5 .... n	Sequence continues

Example 4:

```
DISS   0
SWP    1 256   257 258
SWP    2 266   267 268
ENAS   1
ENAS   2
DISG   0
GRUP 1   1   5   0   0   0   0   0   0   0   0
GRUP 2   2   6   0   0   0   0   0   0   0   0
GRUP 3   3   7   0   0   0   0   0   0   0   0
GRUP 4   4   8   0   0   0   0   0   0   0   0
ENAG   1
ENAG   2
ENAG   3
ENAG   4
FLM    5
FDEF   1   2   3   1   2   0
STRF
```

The setup executes sweep 1 and sweep 2 with conventional group 0 (all groups).

Inspection Sequence	
Inspection Point	Tests Executed(in parallel)
1	256 266 1 5
2	257 267 2 6
3	258 268 3 7
4	256 266 4 8
5	257 267 1 5
6	258 268 2 6
7	256 266 3 7
8	257 267 4 8
9	258 268 1 5
10	256 266 2 6
11	257 267 3 7
12	258 268 4 8
8 … n	Sequence continues

Note 1: By specifying FLM 5 the same results can be obtained for FLR and FLX/FLZ inspection modes.

Note 2: Examples 1 and 2 demonstrate that the same sequence of tests can be setup using either mode with the difference being that in example 1 the sequencing tests are each in a different sweep while in example 2 the sequencing tests are grouped into one sweep with the constantly fired test in another. These two different modes are to allow for how different software packages to use sweeps in different ways to contain tests.

FEAT

Purpose: To enable/disable various system settings

Format: FEAT <value1> <value2> <value3> <value3>

Description: To allow the setting of various setting and output messages

Parameters:

<value1 set to 1> : This command allows the LTPA/MPLT/MP6 to turn on when power is applied to the system (FEAT 1 0 0 0). Subsequently the LTPA can be turned ON/OFF with the front panel button. FEAT 1 0 0 0 disables this feature so that only the front panel button turns the LTPA on. This setting is stored in non-volatile memory.

<value1 set to 2> : This command allows the LTPA to disable the conventional channels if they are not required (FEAT 2 0 0 0). This minimises the power consumption of the LTPA and is the default state. FEAT 2 1 0 0 enables the conventional channels.

<value1 set to 3> : This command allows the LTPA sleep timer to be configured. If not connected on a TCP connection the LTPA goes into a low power sleep mode. Also, if connected the LTPA will go into a sleep mode if there is no communication (commands sent, or data received) for a defined length time. The default this time is sent to 5 minutes. The values available are:

FEAT 3 0 0 0 = sleep timer disabled
FEAT 3 1 0 0 = sleep timer set to 5 minutes (default)
FEAT 3 2 0 0 = sleep timer set to 10 minutes
FEAT 3 3 0 0 = sleep timer set to 20 minutes
FEAT 3 4 0 0 = sleep timer set to 30 minutes

If the LTPA is in sleep mode, then the first command received over the Ethernet wakes it up to a normal state.

<value1 set to 12> : FEAT 12 X Y 0
X – 1/0 Turns Fast Ascan Mode ON/OFF
Y – 1 Stores the settings into flash

<value1 set to 17> : FEAT 17 X 0 0
X – 1/0 Turns on FMC ING message with extra channel support ON/OFF

FLM

Purpose: Specifies the type of tests to be carried out at each inspection point. This can be conventional tests, phased array tests or both.

Format: FLM <Mode>

Description: Inspections where MicroPulse is monitoring encoders and firing a test sequence on position it is necessary to determine the type of tests to be carried out at each inspection point.

Parameters: <mode> : 0 = Performs convention tests only (CAL 0);

1 = Performs convention tests and then Phased array tests (CAL 0 then CALS 0);

2 = Performs Phased array tests and then Conventional tests (CALS 0 then CAL 0);

3 = Performs Phased array tests only (CALS 0);

4 = Performs all enabled groups within the NUMG (CALG0);

5 = Performs phased array sweep sequence as defined by the FDEF command. Alternatively perform a parallel Phased Array/Conventional test sequence if defined by the FDEF.

Example: FLM 3 : Performs a CALS 0 on each inspection point

FLR

Purpose: To enable FLR mode for a relative displacement.

Format: FLR <axis><displacement><direction>

Description: FLR inspection mode is enabled. Inspection begins at the current location and continues at each subsequent SPA point reached in the specified direction (0 = forwards, 1 = backwards) until the axis has moved the specified displacement. LCP commands may be used during the inspection and will not affect the displacement calculations. At the end of the displacement the MSE command line is invoked.

Parameters:

<axis>	:	axis number 1 to 4
<displacement>	:	Relative displacement in distance units 0 to 1600000000. If a distance of 0 is specified, then the inspection will be performed in the direction specified without an end point. In this instance care should be taken to ensure the 32bit encoders stay below within the valid range.
<direction>	:	0 = Inspect forward 1 = Inspect backwards 2 = Inspect in both directions continually (ignoring any set BKL timeout) until the mode is exited. When 2 is used set the displacement to zero.

Example: FLR 2 100 1 : Inspect on axis 2 for 100 distance units in a negative direction

FLX

Purpose: To perform fly mode from a fixed position.

Format: FLX <axis><start location><direction>

Description: Fly inspection mode is enabled. Inspection begins at the specified start location and continues at each subsequent SPA point reached in the specified direction (0 = forwards, 1 = backwards) until the inspection is terminated by change of mode command or (more usually) until the axis reaches the end location as defined in FLZ command.
In the latter case the MSE command line 1 is invoked.

Parameters:

<axis>	:	axis number 1 to 4
<start location>	:	Location at which inspection is to begin
<direction>	:	0 = inspect forwards 1 = inspect backwards

Example:

```
FLX    2  100   0
FLZ    2  200
```

: Inspect on axis 2 from 100 to 200

FLZ

Purpose: To terminate Fly mode at a specified location.

Format: FLZ <axis><end location>

Description: FLZ is used in conjunction with FLX to define the absolute range of an inspection. See FLX command.

Parameters:

<axis>	:	axis number 1 to 4
<end location>	:	Location at which inspection is to end –800000000 to 800000000 decimal

Example: See FLX Command

FRD(S)

Purpose: Digital Filter Select

Format: FRD <Tn><High pass filter>< Low pass filter >

Description: One of six high pass and six low pass digital filters can be selected. By default the digital filters are disabled. To enable the use, an FRD -1 1 1 command must be sent. This then enables an internal gate extension to ensure the correct operation of the filters for the entire user inspection gate.
To disable the gate extension FRD -1 0 0 should be sent.

Parameters:

<Tn> : Test number. An integer value from 0 to the maximum number of tests (default maximum is 1279 tests).
Tn = 0 for all conventional tests. If the S extension is used it applies to all tests in the sweep number specified: 1-32, 0 = all sweeps.

<High pass filter > :
0 = none
1 = 0.7MHz High-pass
2 = 1.5MHz High-pass
3 = 4.0MHz High-pass
4 = 7.5MHz High-pass
5 = 10.0MHz High-pass
6 = Use defined

<Low pass filter > :
0 = none
1 = 1.8MHz Low-pass
2 = 3.0MHz Low-pass
3 = 6.0MHz Low-pass
4 = 8.0MHz Low-pass
5 = 12MHz Low-pass
6 = Use defined

Example: FRD 1 3 4 : Sets test 1 to a 4 – 8 MHz bandpass filter

System Compatibility: Incompatible for FMC tests (AMP 13 mode)

FRQ(S)

Purpose: Frequency Filter Select

Format: FRQ <Tn><Filter><Smoothing>

Description: For conventional channels this selects one of twelve frequency filters. The frequency filters are preferred probe centres frequencies or various broadband settings. For phased array channels this selects one of four filters. The third parameter defines for each test the level of smoothing on the rectified waveform.

Parameters:

<Tn> : Test number. An integer value from 0 to the maximum number of tests (default maximum is 1279 tests).
Tn = 0 for all conventional tests. If the S extension is used it applies to all tests in the sweep number specified: 1-32, 0 = all sweeps.

<Filter> (Conventional) :

1 =	1 MHz Bandpass	0.75 - 1.7MHz 3dB Typ
2 =	2 MHz Bandpass	1.50 - 3.1MHz 3dB Typ
3 =	4 MHz Bandpass	2.60 - 5.5MHz 3dB Typ
4 =	5 MHz Bandpass	3.70 - 6.4MHz 3dB Typ
5 =	10 MHz Bandpass	8.20 -12.0MHz 3dB Typ
6 =	Broadband	2.50 - 18.0MHz
7 =	Broadband	0.75 - 12.0MHz
8 =	0.5MHz Bandpass	0.30 - 0.8MHz 3dB Typ
9 =	5 MHz 2nd order TOFD	0.80 - 8.0MHz 3dB Typ
10 =	10 MHz 2nd order TOFD	3.00 - 15.0MHz 3dB Typ
11 =	Broadband	3.00 - 22.0MHz
12 =	Broadband	3.00 - 25.0MHz

<Filter> (Phased Array) :

1 =	5.00 MHz to 10.0 MHz
2 =	2.00 MHz to 10.0 MHz
3 =	0.75 MHz to 5.00 MHz
4 =	0.75 MHz to 20.0 MHz

<Smoothing> : Sets the level of smoothing on the rectified waveform for this test.
An integer value from 1 to 11

Example: FRQ 0 2 7 : Sets 2 MHz filter and smoothing setting 7 to all conventional tests within the set NUM.

GAN(S)

Purpose: Gain Control

Format: GAN <Tn><Value>

Description: Sets the absolute gain for the test number specified

Parameters:

<Tn>	:	Test number. An integer value from 0 to the maximum number of tests (default maximum is 1279 tests). Tn = 0 for all conventional tests. If the S extension is used it applies to all tests in the sweep number specified: 1-32, 0 = all sweeps.
<Value>	:	Integer in the range 0 to 280, each increment corresponding to 0.25dB.

Example: GAN 0 80 : Adjusts gain for all tests within the set NUM to 20dB.

GAT(S)

Purpose: Search Gate, alternatively referred to as the Inspection Gate.

Format: GAT <Tn><Gate Start><Gate End>

Description: Defines search gate start and end positions for the specified test. By default, the gate units are in machine units. A machine unit is defined by the digitisation rate (i.e. 10nSec for 100MHz digitisation). If required conversion from TimeBase units to millimetres is controlled by the VEL command, which therefore must be issued prior to the 'GAT' command. The VEL command is not recommended for use on new software development. The probe shoe delay command (DLY) adjusts the effective gate values and may be set at any time.

Parameters:

<Tn>	:	Test number. An integer value from 0 to the maximum number of tests (default maximum is 1279 tests). Tn = 0 for all conventional tests. If the S extension is used it applies to all tests in the sweep number specified: 1-32, 0 = all sweeps.
<Gate Start> <Gate End>	:	Integer in the range 2 to 96000 each increment representing 0.1mm at the specified ultrasonic velocity. (Note: the maximum gate length is 32000 sample points)

Example:

DLY 1 100	:	Sets probe shoe delay to 1usec (at 100MHz sample rate)
GAT 1 1000 2000	:	Sets search gate start gate position to 10usec and the end position to 20usec.

GIN(S)

Purpose: Gate negative peak detect

Format: GIN <Tn><Gn> <value>

Description: To allow the detection of negative peaks in a gate. This function is intended for use with RF signals and the UML value now becomes the threshold for reporting when the signal breaks it in a negative direction

Parameters:

<Tn> : Test number. An integer value from 0 to the maximum number of tests (default maximum is 1279 tests).
Tn = 0 for all conventional tests. If the S extension is used it applies to all tests in the sweep number specified: 1-32, 0 = all sweeps.

<Gn> : Gate Number, an integer value from 0 to 4.

Gn = 0 for all gates in the test

<value> : Integer 0 between 1
0 = normal positive peak detection gate
1 = negative peak detection gate

Example:

```
DOF   1
GAT   1  0  5000
AMP   1 32
AWF   1  1
GMT   1  1  1000   4000
GML   1  2  1000   4000
GIN   1  2     1
AMM   1  0     1
UML   1  1   154
UML   1  2   100
```

In this example gates 1 and 2 are looking at RF data in 8-bit mode (normally 127). In gate 1 the largest positive going signal that breaks the 154 threshold will be reported, while in gate 2 the largest negative going signal that breaks the 100 threshold will be reported.

Note: Valid in Multi-gate Mode only (AMP 31 & 32)
To ensure the correct threshold is set for a gate the UML command should be re-sent after the GIN command.

GMH(S)

Purpose: Grass Coupling Level in multi-gate modes

Format: GMH <Tn> <Gn> <value>

Description: Multi-gate version of GPH command. It provides the same facility as GML except that the test reports only if the average signal height is above the defined threshold. It is useful for setting up the GML level.

Parameters:

<Tn>	:	Test number. An integer value from 0 to the maximum number of tests (default maximum is 1279 tests). Tn = 0 for all conventional tests. If the S extension is used it applies to all tests in the sweep number specified: 1-32, 0 = all sweeps.
<Gn>	:	Gate Number, an integer value from 0 to 4. Gn = 0 for all gates in the test
<value>	:	Integer between 10 and 255 (8-bit modes) Integer between 10 and 1023 (10-bit modes) Integer between 10 and 4095 (12-bit modes)

Note: Valid in Multi-gate Mode only (AMP 31 & 32)

GML(S)

Purpose: Grass Coupling Monitor assignment in multi-gate modes.

Format: GML <Tn> <Gn> <value>

Description: Multi-gate version of GPL command. It provides facility to monitor coupling integrity using the average of amplitude of signals within the specified gated area (GMT). Generally used with high gain to enhance the ultrasonic noise of the material. The reported data indicates the total of all amplitude values in the gate (i.e. the integral of the waveform) and the average signal height.
The average value is used to determine whether the data is reported, if the average is below the level specified in the GML command a message is reported, otherwise there is no message.

Parameters:

<Tn>	:	Test number. An integer value from 0 to the maximum number of tests (default maximum is 1279 tests). Tn = 0 for all conventional tests. If the S extension is used it applies to all tests in the sweep number specified: 1-32, 0 = all sweeps.
<Gn>	:	Gate Number, an integer value from 0 to 4. Gn = 0 for all gates in the test
<value>	:	Integer between 10 and 255 (8-bit modes) Integer between 10 and 1023 (10-bit modes) Integer between 10 and 4095 (12-bit modes)

Note: Valid in Multi-gate Mode only (AMP 31 & 32)

GMT(S)

Purpose: Search gate in multi-gate modes.

Format: GMT <Tn><Gn> <Gate Start><Gate End>

Description: Multi-gate version of GAT command. Defines search (inspection gate start and end positions for the specified test. By default, the gate units are in machine units. A machine unit is defined by the digitisation rate (i.e. 10nSec for 100MHz digitisation). If required conversion from TimeBase units to millimetres is controlled by the VEL command, which therefore must be issued prior to the 'GMT' command. The probe shoe delay command (DLY) adjusts the effective gate values and may be set at any time.

Parameters:

<Tn>	:	Test number. An integer value from 0 to the maximum number of tests (default maximum is 1279 tests). Tn = 0 for all conventional tests. If the S extension is used it applies to all tests in the sweep number specified: 1-32, 0 = all sweeps.
<Gn>	:	Gate Number, an integer value from 0 to 4. Gn = 0 for all gates in the test
<Gate Start> <Gate End>	:	Integer in the range 2 to 96000 each increment representing 0.1mm at the specified ultrasonic velocity. To turn off a gate in multiple gate modes: set the start and end to 0. The maximum gate length is 32000 sample points

Note: Valid in Multi-gate Mode only (AMP 31 & 32)
When using echo gate mode with multiple gates per test then the gates set by GMT are used and triggered by the Echo gate (EGT).

GPH(S)

Purpose: Grass Coupling Level.

Format: GPH <Tn><Value>

Description: Provides the same facility as GPL except that the test reports only if the average signal height is above the defined threshold. It is useful for setting up the GPL level.

Parameters:

<Tn>	:	Test number. An integer value from 0 to the maximum number of tests (default maximum is 1279 tests). Tn = 0 for all conventional tests. If the S extension is used it applies to all tests in the sweep number specified: 1-32, 0 = all sweeps.
<Value>	:	Integer between 10 and 255 (8-bit modes) Integer between 10 and 1023 (10-bit modes) Integer between 10 and 4095 (12-bit modes)

GPL(S)

Purpose: Grass Coupling Monitor.

Format: GPL <Tn><Value>

Description: Provides facility to monitor coupling integrity using the average of amplitude of signals within the specified gated area (GAT). Generally used with high gain to enhance the ultrasonic noise of the material. The reported data indicates the total of all amplitude values in the gate (i.e. the integral of the waveform) and the average signal height. The average value is used to determine whether the data is reported, if the average is below the level specified in the GPL command a message is reported, otherwise there is no message.

Parameters:

<Tn> : Test number. An integer value from 0 to the maximum number of tests (default maximum is 1279 tests).
Tn = 0 for all conventional tests. If the S extension is used it applies to all tests in the sweep number specified: 1-32, 0 = all sweeps.

<Value> : Integer between 10 and 255 (8-bit modes)
Integer between 10 and 1023 (10-bit modes)
Integer between 10 and 4095 (12-bit modes)

GRE(S)

Purpose: Select gain reduction mode.

Format: GRE <Tn><mode>

Description: Gain reduction (modes 1 and 2):

In these modes the test is repeated if the amplitude of any peak in the gate exceeds a threshold of 200 machine units (800 and 3200 in 10bit and 12bit modes respectively). The gain is temporarily reduced by the number of dB defines by the AAV command for the second firing. Modes 1 and 2 differs in that mode 1 does not report the data from the first execution of the test if a re-fire takes place. The data is reported with no adjustment but with the header byte set to indicate that gain reduction has occurred, so that the user may adjust the amplitudes accordingly. Note that this means that the user must maintain a record of the AAV values used.

Parameters:

<Tn> : Test number. An integer value from 0 to the maximum number of tests (default maximum is 1279 tests).
Tn = 0 for all conventional tests. If the S extension is used it applies to all tests in the sweep number specified: 1-32, 0 = all sweeps.

<mode> :
= 0 Default to AMP mode 2
= 1 Re-fire test if signal exceeds threshold and report second
= 2 Re-fire test if signal exceeds threshold and report both firings.

GRUP

Purpose: To define tests in a group firing

Format: GRUP <GPn><Tn><Tn><Tn><Tn><Tn><Tn><Tn><Tn><Tn><Tn>

Description: To allow the specifying of a group firing of conventional tests only. Tests must specify channels that are on different ADC blocks on the CUIF PCB. Only available if the system is configured with parallel conventional channels.

Parameters:

<GPn>	:	Group number. Integer between 1 and 16
<Tn>	:	Test number. An integer value from 0 to 255 Tn = 0 is no test used

Example: GRUP 1 1 5 9 13 0 0 0 0 0 0
This sets up a group firing of 4 channels using tests 1, 5, 9 and 13.

Note 1: If only 4 channels are used, as in the example above the remaining <Tn>'s must be set to 0.

Note 2: If the firing of a single test is required, then a single test can be specified in a group. All other <Tn>'s must be set to 0.

Limitations: Dependent upon the configuration of the system there are limitations on which channels can be specified within a group. If in doubt as to the configuration of a system, please contact Peak NDT. The number of channels per ADC is obtained from the RST message, see section 4.2.
MP6 and MPLT have 1 ADC for every 6 channels. Therefore on a 12-channel system 2 channels can fire in parallel. Systems that report 0 to RST message's ADC bit don't have the parallel firing feature available.

GTR(S)

Purpose: Defines gate to gate trigger setup

Format: GTR <Tn><Trig Source Gate><Trig Target Gate><Threshold>
<Delay or Pre-trig>[Drift Start][Drift]

Description: Defines gate to gate trigger setup. This new mode is currently limited in its implementation to triggering the end of gate 2 by a threshold crossing in gate 1.
The threshold crossing from gate 1 is output as normal peak data except that the gate is reported as gate 5 to distinguish it from the other data. The amplitude of the data is from when it first crosses the threshold crossing specified in the GTR command whilst the TimeBase reported is the range. If the threshold is not crossed, then the MicroPulse will report in gate 5 a single peak of amplitude 0 at time 65535 (0xffff).

The drift parameters are optional. They specify the maximum allowable drift of a trigger from one firing of a test to the next firing of the test. In this way, large changes to the trigger point can be avoided. If omitted or set to 0 no drift will be used. The drift start gives a starting point for the trigger drift and is used for the first firing of the test after the GTR command is sent. If a drift start is specified, then a drift must also be specified. When a trigger drift is used, a no trigger event will report in gate 5 a single peak of amplitude 0 at time of the drifted trigger.

Parameters:

<Tn>	:	Test number. An integer value from 0 to the maximum number of tests (default maximum is 1279 tests). Tn = 0 for all conventional tests. If the S extension is used it applies to all tests in the sweep number specified: 1-32, 0 = all sweeps.
< Trig Source Gate >	:	Trigger source gate (if 0 off) +/- 1 to 4 to allow start (-) and end (+) triggering. (Currently must be 1, meaning gate 1 source for end gate triggering)
< Trig Target Gate >	:	Trigger target gate. (Currently must be 2)
< threshold >	:	Set the threshold for the trigger: Integer between 10 and 255 (8-bit modes) Integer between 10 and 1023 (10-bit modes) Integer between 10 and 4095 (12-bit modes)
< delay or pre-trig >	:	Set the delay after a trigger or the before the trigger for the target gate start or end. Currently a positive number between 1 and 100 (10nsec to 1 usec) which is the time before the trigger in the gate 1 that the target gate 2 gate ends.
[Drift Start]	:	An integer value from 0 to 64000. Sets the starting point for the trigger drift.
[Drift]	:	An integer value from -107 to 107. Setting the maximum drift in either direction of a trigger from one test to the next firing of that test. Where: 0= No Drift ±1= 1/128 ±2= 1/64 ±3= 1/32 ±4= 1/16

±5= 1/8
±6= 1/4
±7= 1/2
±8= 1-point Drift
±9= 2-point Drift
⋮
±107= 100-point Drift

A negative number means that if no trigger is seen the trigger point will drift toward the trigger gate start, whilst a positive number means a no trigger will drift toward the trigger gate end.

Example: GTR 256 1 2 200 50 Sets up the gate 1 to trigger the end of gate 2.

Note 1: To turn off a gate trigger send: GTR(S) <Tn> 0 0 0 0
(e.g. in the above example: GTR 256 0 0 0 0)

Note 2: When an allowable drift is used, the drift start specified should within the trigger gate. If the drift start is less than the trigger gate start, then the drift start will be set to the trigger gate start. If the drift start is greater than the trigger gate end, then the drift start will be set to the trigger gate end.

HMS(S)

Purpose: Hysteresis, peak discrimination control in multi-gate modes

Format: HMS <Tn><Gn><Hysteresis Level>

Description: Multi-gate version of HYS command. The hysteresis function governs whether secondary peaks are reported as separated indications or not and works by assigning a value in dB that the signal must fall before the half cycle is considered as a separate meaningful signal. Conversely, following a peak validation the system tracks and validates the trough using the same value.

Parameters:

<Tn>	:	Test number. An integer value from 0 to the maximum number of tests (default maximum is 1279 tests). Tn = 0 for all conventional tests. If the S extension is used it applies to all tests in the sweep number specified: 1-32, 0 = all sweeps.
<Gn>	:	Gate Number, an integer value from 0 to 4. Gn = 0 for all gates in the test
<Hysteresis level>	:	0 = No Hysteresis 1 = 3dB 2 = 6dB (Default level) 3 = 9dB 4 = 12dB

Note 1: Valid in Multi-gate Mode only (AMP 31 & 32)

HYS(S)

Purpose: Hysteresis, peak discrimination control.

Format: HYS <Tn><Hysteresis Level>

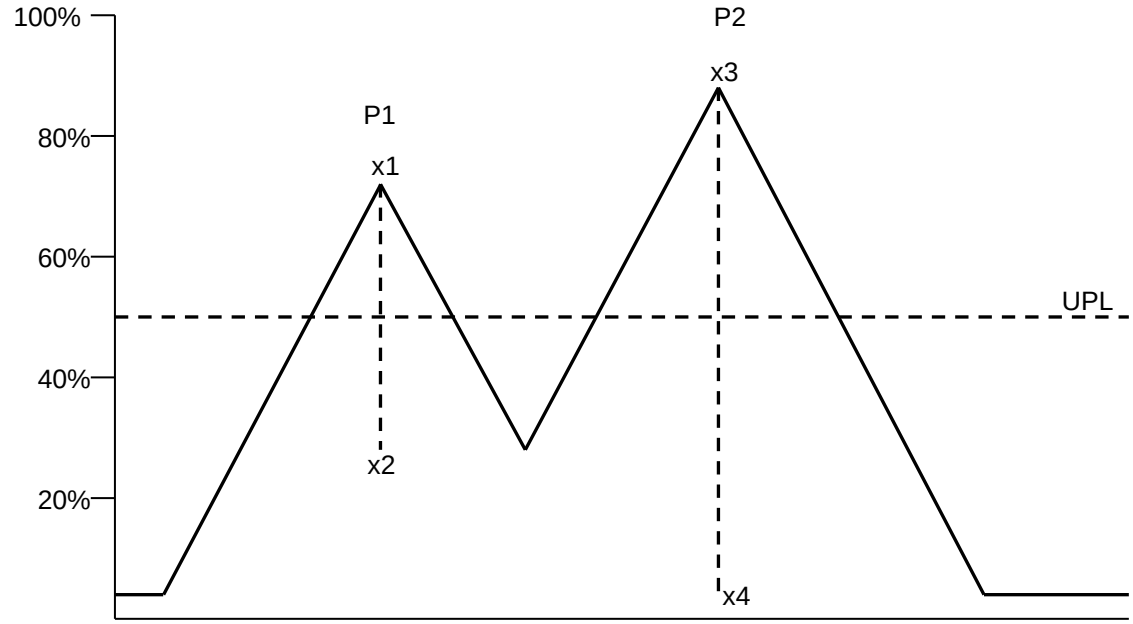
Description: The hysteresis function governs whether secondary peaks are reported as separated indications or not and works by assigning a value in dB that the signal must fall before the half cycle is considered as a separate meaningful signal. Conversely, following a peak validation the system tracks and validates the trough using the same value.

Parameters:

<Tn> : Test number. An integer value from 0 to the maximum number of tests (default maximum is 1279 tests).
Tn = 0 for all conventional tests. If the S extension is used it applies to all tests in the sweep number specified: 1-32, 0 = all sweeps.

<Hysteresis level> :
0 = No Hysteresis
1 = 3dB
2 = 6dB (Default level)
3 = 9dB
4 = 12dB

Example: HYS 0 1 : Assigns 3dB hysteresis for all conventional tests



With a 6dB threshold set, each trough after a peak above the UPL level must be at least 6dB below the corresponding peak to produce an indication. Thus if x1 to x2 and x3 to x4 are above the 6dB threshold then peaks P1 and P2 will be reported.

IGT(S)

Purpose: Defines inspection gate in echo trigger mode.

Format: IGT <Tn><Gate Start><Gate End>

Description: Defines the 'inspection gate' area. The actual gated data is derived from the IGT Parameters taken relative to the point in the echo gate (as defined by the EGT command) where the signal breaks the EUPL (EPL in FMC tests). By default, the gate units are in machine units. A machine unit is defined by the digitisation rate (i.e. 10nSec for 100MHz digitisation). If required conversion from TimeBase units to millimetres is controlled by the VEL command, which therefore must be issued prior to the 'IGT' command. IGT is not used by phased array tests except when in FMC and element trigger interface mode (ETM5). In FMC tests MicroPulse has the ability process inspection gates that start before the trigger peak, i.e. IGT may have negative parameters.

Parameters:

<Tn>	:	Test number. An integer value from 0 to the maximum number of tests (default maximum is 1279 tests). Tn = 0 for all conventional tests. If the S extension is used it applies to all tests in the sweep number specified: 1-32, 0 = all sweeps.
<Gate Start> <Gate End>	:	Distance units from 0 to 20000 (in FMC the gate start may be negative, but the total gate length cannot exceed 3000 Bytes)

Example:

```
ETM  3   2          :  Sets test 3 to echo trigger mode.
EGT  3   200   600  :  Sets test 3 with echo gate from 200 to 600 distance units
IGT  3   0     200  :  Sets inspection gate to 100 units after the trigger.
```

INPUT/OUTPUT COMMANDS

INE

Purpose: Sensor Input Line Configuration.

Format: INE <Pin><Sense> [Off]

Description: Eight input sensor lines can be programmed to initiate any line of command entered immediately after the INE command. This means that any action can be taken on any sense of any line.

Parameters:

<Pin>	:	Number of input bit(s) 0 to 15 for MP6 0 to 3 for LTPA 0 to 3 for MPLT 0 for LT1 and LT2.
<Sense>	:	Low to High or High to Low electrical sense: 1 = Low to High 0 = High to Low
<Off>	:	Optional. If this parameter is omitted the function is enabled. 0 = Disable

Example:

INE 6 1	:	Initiate the following line of commands on input to line 6 on a low to high transition. As the option parameter is omitted the function is enabled.
CAL 1 CAL 6 LCP 1 0	:	Inspects on Tests 1 and 6 then sets axis 1 to 0

Note: The INE command must be terminated with a carriage return before the entering of the commands to be executed on the INE event.

INEF

Purpose: Sensor Input Line Configuration.

Format: INEF <Filter Count> [Off]

Description: The filter for the INE inputs can be configured. The filter count is a parameter that can be used to clean up the edges of noisy signals by time hysteresis. This defines the length of time before a decision is made on any input transitions and can filter out noise spikes and noisy level transitions. An integer number between 0 and 255.

Parameters: <Filter Count> : 0 - 255

IPM

Purpose: To set the IP address for Ethernet communication

Format: IPM <Value><Value><Value><Value>

Description: This command allows the changing of the IP address of MicroPulse. The value is stored in flash memory and so is retained when the MicroPulse is turned off. To use the new IP address the MicroPulse must be turned off after sending the command (wait for 10 seconds before turning off to allow the flash to be written to). Caution should be used when using this command as setting the MicroPulse to an unknown IP address will cause problems with communication. Alternatively, the Peak NDT software utility 'PeakIPAssign' can be used to program the IP address.

Parameters:

<Value.>	:	1 to 255
<Value.>	:	1 to 255
<Value.>	:	1 to 255
<Value.>	:	1 to 255

Example: IPM 10 1 1 2 : Sets the MicroPulse to IP address 10.1.1.2

JIT

Purpose: To define the maximum amount of axis jitter allowed.

Format: JIT <Axis1><Axis2><Axis3><Axis4>

Description: To define the maximum amount of axis jitter allowed while still recognising that an axis is stationary, and movement has ended. The user should use this command prior to moving any axis.

Parameters: <Axis n> : Range 0 – 100 raw axis units

Example: JIT 1 1 1 1 : Sets the jitter on all four axis to 1 axis unit

LCP

Purpose: Location Preset.

Format: LCP <Axis No.><Value>

Description: This command presets the current axis position to be the value specified. This may be used in conjunction with MSE to set up a datum switch for example.

Parameters:

	<Axis No>	:	Axis number 1 to 4
	<value>	:	-8000000 to +8000000

Example:

	LCP 2 -33	:	Sets motor 2's current position to –33
	INE 0 1	:	Enable the input line 0 for Low to High transition
	LCP 2 0	:	This command is stored and on the input change axis 2 will be set to 0.

LOF

Purpose: Sets output line Off.

Format: LOF <pin>

Description: LOF is provided for downward compatibility with earlier systems. The only valid parameter is 11

Example: LOF 11 : Switches DAC off.

LON

Purpose: Sets output line On.

Format: LOF <pin>

Description: LON if provided for downward compatibility with earlier systems. The only valid parameter is 11

Example: LON 11 : Switches DAC On.

LML(S)

Purpose: Lower Threshold Level assignment in multi-gate modes

Format: LML <Tn> <Gn> <value>

Description: Multi-gate version of LWL Defines a LOWER threshold level BELOW which an indication is to be reported. Can be used to detect low coupling conditions or, when in through transmission mode, the presence of defects. When the maximum signal within the gated area falls below the Lower Threshold Level (LML) an 'INC' message is sent indicating the TimeBase and amplitudes of the signal lying within the gated region. On setting an LML threshold, MicroPulse automatically adjusts the UML threshold to 1/3 of the LML value. If the signal falls below this threshold, and 'coupling failure' message is reported.

LML mode is disabled by sending any overriding mode control command for the specified test (AMM, GML, GMH).

NOTE. If the operator requires to set a different UML for an LML test, the UML command must be issued after the LML command.

Parameters:

<Tn>	:	Test number. An integer value from 0 to the maximum number of tests (default maximum is 1279 tests). Tn = 0 for all conventional tests. If the S extension is used it applies to all tests in the sweep number specified: 1-32, 0 = all sweeps
<Gn>	:	Gate Number, an integer value from 0 to 4. Gn = 0 for all gates in the test
<Value>	:	Integer between 10 and 255 (8-bit modes) Integer between 10 and 1023 (10-bit modes) Integer between 10 and 4095 (12-bit modes)

Note: Valid in Multi-gate Mode only (AMP 31 & 32)

LWL(S)

Purpose: Lower Threshold Level.

Format: LWL <Tn> <Value>

Description: Defines a LOWER threshold level BELOW which an indication is to be reported. Can be used to detect low coupling conditions or, when in through transmission mode, the presence of defects. When the maximum signal within the gated area falls below the Lower Threshold Level (LWL) an 'INC' message is sent indicating the TimeBase and amplitudes of the signal lying within the gated region. On setting an LWL threshold, MicroPulse automatically adjusts the UPL threshold to 1/3 of the LWL value. If the signal falls below this threshold, and 'coupling failure' message is reported.

LWL mode is disabled by sending any overriding mode control command for the specified test (AMP, GPL, GPH, GRE).

NOTE. If the operator requires to set a different UPL for an LWL test, the UPL command must be issued after the LWL command.

Parameters:

<Tn>	:	Test number. An integer value from 0 to the maximum number of tests (default maximum is 1279 tests). Tn = 0 for all conventional tests. If the S extension is used it applies to all tests in the sweep number specified: 1-32, 0 = all sweeps
<Value>	:	Integer between 10 and 255 (8-bit modes) Integer between 10 and 1023 (10-bit modes) Integer between 10 and 4095 (12-bit modes) 0 = return to default reporting mode (AMP mode 2)

MAS

Purpose: To set the primary/secondary configuration to achieve system configurations of up to 256 phased array channels.

Format: MAS <Mode>[store]

Description: When two MicroPulse 6 or LTPA systems are connected together using the primary/secondary intersystem link cable, the MAS command should be used. The MAS command should be sent to one MicroPulse which then becomes the primary system. The primary then begins the sequence required to enter the primary/secondary mode. The primary system performs a complete reset of the secondary and synchronises the clocks between the two systems. Upon completion the primary system responds with a 'RST message' that indicates the new overall system configuration.

Parameters:

<Mode> : 0 = Revert primary/secondary mode to independent.
1 = Primary/Secondary mode
2 = Primary/Secondary mode extended for FMC where the Ethernet interface of both systems are used to output data. This increases the available bandwidth for data output.

[store] : If set to 1 then the mode is stored in non-volatile memory. This allows the user to define the system as a primary on power-on.

Notes: When a primary/secondary combination is used the secondary will not communicate over the Ethernet communication link (except in mode 2). All communication is via the primary system and the secondary acts as extra pulser/receiver channels. So, unless in mode 2 the Ethernet should be connected to the primary system only.
The digital I/O is only active on the primary system, so the secondary digital I/O should be left unconnected.
The encoders only need connecting to the primary system as all data passes through the primary system and so is position stamped by the primary system. The secondary encoder inputs should be left unconnected.
The systems should be connected via the intersystem link cable prior to power on of the systems.
Care should be taken whilst plugging in the intersystem link cable to ensure that it is aligned correctly and fully plugged in. The retaining screws should be finger tightened to ensure the plug is secure.
The primary system will try three times in total to synchronise with the secondary system. A successful synchronisation is indicated by the number of channels being reported in the reset message not as 128 but as 256.
Once the systems are linked both RST and SRST should be used to reset the systems. It is not recommended to use MAS 0/MAS 1 as a means of resetting the system due to the time taken to complete the system synchronisation process.

MPE

Purpose: Encoder unit divider.

Format: MPE <Axis1><Axis2> <Axis3><Axis4>

Description: This command defines the divider for the raw encoder value. The raw encoder value is divided by the MPE after being first multiplied by the EMUL value. So, as well as setting up the encoder units to be in millimetre the user can realise fraction of millimetre inspection pitches.

NOTE : It MUST be set before any other motor commands are used. It is usual to set this command once only at power-up.

Parameters: <Axis n> : Divider to be used on axis.
Range is from 1 to 100000.

Example: MPE 200 1000 10 10 : This sets axis 1 to 200 and axis 2 to 1000 encoder divider, whilst setting axis 3 and 4 to a divider of 10.

MSE

Purpose: To program action on axis condition.

Format: MSE <axis> <mode> [off]

Description: This command works in the same way as INE in that the command line following the MSE command is stored and invoked when the specified condition occurs. There are four such conditions corresponding to different events at the end of the axis move or inspection commands. In particular the programmed command line may redefine the MSE setting. If MSE is disabled, then MicroPulse defaults to its normal mode of sending LLC message to host on any axis stop.

NOTE : It MUST be set before any other motor commands are used. It is usual to set this command once only at power-up.

Parameters:

<axis> : Axis number 1 to 4

<mode> : 1 end of FLR or FLZ
2 stall

[off] : Optional.
If this parameter is omitted the function is enabled.

Example:

```
MSE  2    2
OUT  6    10
```

: Causes CER 10 message when axis 2 stalls

Note: Modes 0, 3 and 4 are only used by earlier systems.

NUM

Purpose: Test Cycle.

Format: NUM <No.>

Description: This command specifies the number of conventional tests through which MicroPulse multiplexes when in the CAL 0, STP 0, STR 0 and fly modes.
In addition, the NUM command specifies the number of conventional tests to which commands using 0 test number apply.

Parameters:

<No.>	:	Number of tests used. 1 to 255	

Example:

NUM 50		Sets a test sequence from 1 to 50 All enabled tests from 1 to 50 will be performed.
NUM 10 GAN 0 40		Tests 1 to 10 gain 10dB.
NUM 5 GAN 0 80	:	Tests 1 to 5 gain 20dB.

Note:

NUMG

Format: NUMG <No>

A version that is for use with parallel conventional channels only

This is a version of the NUM command for groups. The NUMG command specifies the number of conventional test groups which are executed in a set of group firings. A number between 1 and 16.

OLM(S)

Purpose: To set the overload reporting mode on a Phased Array Test.

Format: OLM <Tn><Mode><No. elements>

Description: MicroPulse can be set to report the saturation of individual phased array elements. As element saturation can affect the results, the user can then determine the action to be taken.

Parameters:

<Tn> : Test number.
An integer value from 256 to the maximum number of tests (default maximum is 1279 tests).
If the S extension is used it applies to all tests in the sweep number specified: 1-32, 0 = all sweeps.

<Mode> : Integer value from 0 to 2.
0 = turns off element overload reporting
1 = reports the count of the saturated elements
2 = reports the details of the saturated elements

<No. elements> : Integer value from 0 to 128 that is the number of elements that need to be saturated before the warning message is generated by MicroPulse (0 always reports)

OUT

Purpose: To cause a message to be sent to host.

Format: OUT <header><parm1> … <parm>

Description: The message defined is sent to the host. The header byte must be a valid header code and the corresponding number of parameters should be supplied, although the message will be truncated or padded with 0's.
OUT can be useful when used in conjunction with the INE command to output messages upon the change of an input.

Parameters:

<header>	:	Any valid header code
<parm>	:	0 – 255

Example:

```
INE  1  1
OUT  6  123
```

: Will cause 6 123 to be sent to the host when the input INE 1 changes to 1

PAV

Purpose: To change the phased array channels Pulser Voltage.

Format: PAV <channel start><channel end ><value>

Description: Selects the voltage required for the phased array pulsers. The default is all channels set to 100 volts. This new generation of Micropulse systems, where a global supply is used, a channel pulser value is applied to all channels so <channel start> and <channel end > command parameters are only provided for backward compatibility with earlier versions of MicroPulse where independent control of each channel's pulser voltage was available.

Parameters:

<channel start>	:	Provided only for backward compatibility with earlier versions of MicroPulse.
<channel end>	:	Provided only for backward compatibility with earlier versions of MicroPulse.
<value>	:	Pulser voltage required, settings are: 50 to 200volts in 25-volt steps

Example: PAV 1 16 200 : Sets all channels to a 200-volt pulser.

PAW

Purpose: To change a phased array channel Pulser Width.

Format: PAW <channel start><channel end ><value>

Description: Selects the pulse width required for the phased array pulsers. The default is all channels set to 100nsec.

Parameters:

<channel start>	:	Start Micropulse channel number to be set.
<channel end>	:	End Micropulse channel number to be set.
<value>	:	Pulser width required, settings are: 20 to 500nsec in 2nsec steps.

Example: PAW 1 16 200 : Sets channel 1 to 16 to a 200nsec pulse width.

PDW

Purpose: Define pulse width and damping for conventional channels.

Format: PDW <channel><damping><width>

Description: Selects the damping and pulser width for a given channel (or all channels if <channel> is 0). The settings will apply to all tests using the specified channel as RXN or TXN parameters. There are 8 standard pulse widths (for compatibility with earlier systems) and pulse widths between 16nSec and 1010nSec in 2nSec steps.

Parameters: <channel> : Integer value from 0 to 24 (0 for all channels).

<damping> :

	LTPA/MPLT/MP6	LT2
0 =	733 Ω	4.7 kΩ
1 =	492 Ω	1137 kΩ
2 =	228 Ω	308 Ω
3 =	152 Ω	184 Ω
4 =	104 Ω	118 Ω
5 =	88 Ω	92 Ω
6 =	66 Ω	68 Ω
7 =	51 Ω	54 Ω

<width> :
0 = 50 nSec
1 = 100 nSec
2 = 150 nSec
3 = 200 nSec
4 = 250 nSec
5 = 300 nSec
6 = 350 nSec
7 = 225 nSec
16 – 1010 = Specifies the pulse width in nanoseconds i.e. 30 = 30nSec. Valid every 2nSec step.

Default: PDW 0 4 3

Example: PDW 1 7 4 : Set pulser/receiver channel 1 to 51ohm (MP6) damping and 250nSec pulse width.

PIG

Purpose: Peaks in gate.

Format: PIG <Value>

Description: Used to define how many peaks are reported in AMP mode 2. The first n-1 plus the largest of the remaining peaks are reported.

Parameters: <Value> : Integer value n from 1 to 80

PMG(S)

Purpose: Peaks in gate in multi-gate modes

Format: PMG <Tn> <Gn> <value>

Description: Multi-gate version of PIG command Used to define how many peaks are reported in AMM mode 2. The first n-1 plus the largest of the remaining peaks are reported.

Parameters:

<Tn>	:	Test number. An integer value from 0 to the maximum number of tests (default maximum is 1279 tests). Tn = 0 for all conventional tests. If the S extension is used it applies to all tests in the sweep number specified: 1-32, 0 = all sweeps
<Gn>	:	Gate Number, an integer value from 0 to 4. Gn = 0 for all gates in the test
<Value>	:	Integer value n from 1 to 80

Note: Valid in Multi-gate Mode only (AMP 31 & 32)

PRF

Purpose: Pulse Repetition Frequency.

Format: PRF <rate>

Description: The <rate> parameter specifies the maximum rate in firings per second. The time period is derived from a timer device and so is accurate provided that the rate specified is not greater than that which MicroPulse can achieve or the ultrasonics will allow.

Parameters:

<rate>	:	Test repetition rate in Hz, between 1 Hz and 55 kHz in 1 Hz steps.

Example:

PRF 1000	:	Sets PRF. of 1000 Hz. This ensures that firings will be at least 1 millisecond apart.

Note: The LT2 system is limited to a maximum of 20 kHz repetition rate.

PSV

Purpose: To change a conventional channel Pulser Voltage.

Format: PSV <channel><value>

Description: Selects the voltage required for the conventional pulsers. The default is all channels set to 200 volts for MicroPulse 6/LT2 and 100 volts for LTPA/MPLT. This new generation of Micropulse systems, where a global supply is used, a channel pulser value is applied to all channels so <channel> command parameter is only provided for backward compatibility with earlier versions of MicroPulse where independent control of each channel's pulser voltage was available.

Parameters:

<channel>	:	Sets all channels to 0. Provided only for backward compatibility with earlier versions of MicroPulse.
<value>		Pulser voltage required settings are from 50V to 300V in 25V steps.

Example: PSV 4 200 : Sets all channels to a 200-volt pulser.

RST

Purpose: To reset MicroPulse and optionally change its sample frequency.

Format: RST [sample freq]

Description: The RST command completely resets the MicroPulse. On a power on reset the MicroPulse will go to its default sample frequency set by the SDS command. If an RST command is sent with no other parameters, the MicroPulse will reset to its default sample frequency. If the user sends a valid second parameter with the RST, then the system sample frequency will be changed. Subsequent to a reset command completion the system responds with a 'RST message' that indicates the system configuration.

Parameters: [sample freq] : If omitted the system sample frequency is set to the system default otherwise:

10 =	10 MHz	(Default DAC rate 1/8th sample freq)
25 =	25 MHz	(Default DAC rate 1/8th sample freq)
40 =	40 MHz	(Default DAC rate 1/8th sample freq)
50 =	50 MHz	(Default DAC rate 1/8th sample freq)
80 =	80 MHz	(Default DAC rate 1/16th sample freq)
100 =	100 MHz	(Default DAC rate 1/16th sample freq)

Note: 40Mhz and 80Mhz are provided for backward compatibility with earlier versions of MicroPulse only.

Note: LT2 has 200MHz sampling available

RTD

Purpose: To trim the receive focal law.

Format: RTD <focal law No.>< value>

Description: To correct the receive focal law delay to make the reference point as the array centre.

Parameters:

<focal law No.>	:	Focal law number, an integer value from 0 to the maximum number of focal laws (default 1024).
<value>	:	Receive trim delay value in nanoseconds. Integer in the range 0 to 25000

System Compatibility: Valid only for Phased Array systems.

RXF

Purpose: To define the element delay for a receive focal law.

Format: RXF <focal law No.><channel><delay><elt gain trim>

Description: For each focal law a number of RXF commands define the receive delays for each individual element used. The gain of an individual element can also be trimmed.

Parameters:

<focal law No.>	:	Focal law number, an integer value from 0 to the maximum number of focal laws (default 1024).
<channel>	:	MicroPulse phased array channel number. An integer in the range 0 to the maximum number of phased array channels available. 0 is used with a delay of -1 to clear the whole law. Where a secondary system is present the range of channels is increased to allow for the secondary channels.
<delay>	:	Receive delay value in nanoseconds. An integer in the range -1 to 25000. -1 is used to clear the whole law or individual elements.
<elt gain trim>	:	From -64 to +64 that corresponds to -16 to +16dB in 0.25dB steps

Example:

RXF 1 0 -1 0	:	Clears receive focal law 1
RXF 1 1 0 0	:	Adds MicroPulse channel 1 to law 1 with 0 delay and 0 gain trim.
RXF 1 2 100 4	:	Add MicroPulse channel 2 to law 1 with 100nsec and 1dB of additional gain trim.

System Compatibility: Valid only for Phased Array systems.

RXN

Purpose: Receiver Channel Select

Format: RXN <Tn><Channel>[Vpn]

Description: Selects the receiver probe connection for a given test number (Tn).

Parameters:

<Tn>	:	Test number. An integer value from 0 to the maximum number of tests (default maximum is 1279 tests). Tn = 0 for all tests.
<Channel>	:	Integer in the range of 1 to the maximum number of focal laws (default 1024). When the <Tn> is 256 or greater, this parameter refers to a phased array focal law and not an actual MicroPulse channel.
[Vpn]	:	Optional probe number. If channel is set to 0 then this integer value from 1 to 16 specifies a virtual probe consisting of conventional channels.

Example:

RXN 7 4	:	Assigns pulser/receiver channel 4 as receiver for Test Number 7.
RXN 256 1	:	Assigns receive phased array focal law 1 to test 256.

SCHK

Purpose: To allow automated ADC and linearity checks on MicroPulse PA channels

Format: SCHK <Mode> <Chstrt> <Chend> <Gtstrt> <Gtend> <Filter> <Pulwidth> <Pulvolt> <Pulrep>

Description: To allow automated checking of the gain and ADC linearity using a probe coupled to a test block. The MicroPulse performs an auto calibration on each of the specified channels to achieve an 80% FSH reference signal. The gain is then adjusted to pre-set levels and the amplitudes checked against stored limits. The results of the checks are then reported for each channel. There are 6 gain levels used. The default gain values are +2dB, 0dB, -6dB, -12dB, -18dB and -24dB.

Parameters:

<Mode> : Reporting mode. An integer value from 0 to 1
0 = simple report (see Output Message format)
1 = detailed report (see Output Message format)

<Chstrt> : The start channel number.
An integer between 1 and the <Chend> parameter

<Chend> : The end channel number.
An integer between the <Chstrt> parameter and the maximum number of PA channels.

<Gtstrt> : The inspection gate start.
An integer in the range 0 to 64000. Units are the sample frequency of the system (100MHz = 10nSec)

<Gtend> : The inspection gate end. An integer in the range <Gtstrt> to 64000 (Note: the maximum gate length is 32000 sample points). Units are the sample frequency of the system (100MHz = 10nSec)

<Filter> :
1 = 5.00 MHz to 10.0 MHz
2 = 2.00 MHz to 10.0 MHz
3 = 0.75 MHz to 5.0 MHz
4 = 0.75 MHz to 20.0 MHz

<Pulwidth> : Pulser width required, settings are: 20 to 500nsec in 2nsec steps.

<Pulvolt> : The maximum Pulser voltage to be used. The settings are 50 to 200 volts in 25-volt steps. The system will reduce the pulse voltage if the signal received is too large.

<Pulrep> : Test repetition rate in Hz. Between 1 Hz and 20 kHz in 1 Hz steps.

Default Settings for Checks:

Settings	Gain	Positive Limit	Negative Limit
1	0 (0dB)	166 (83%)	154 (77%)
2	8 (+2dB)	214 (107%)	190 (95%)
3	-24 (-6dB)	86 (43%)	74 (37%)
4	-48 (-12dB)	46 (23%)	34 (17%)
5	-72 (-18dB)	24 (12%)	16 (8%)
6	-96 (-24dB)	14 (7%)	6 (3%)

Note: The SCHK command utilises various tests within the system and clears any previous settings. After use an RST (or SRST) should be sent to the system.

SCPE

Purpose: Oscilloscope output enable

Format: SCPE <Tn>[mode]

Description: To allow the oscilloscope output to be enabled for a specific test. Default is enabled for all tests

Parameters:

<Tn>	:	Test number. An integer value from 0 to the maximum number of tests (default maximum is 1279 tests). Tn = 0 for all tests.
[mode]	:	Where mode is omitted (or set to 0) then only the test specified by <Tn> is enabled. If set to 1 then if <Tn> is 0 then all tests are disabled. Also, if set to 1 and a <Tn> is set to a test, then this test will be enabled without clearing any previously enabled tests. In this way multiple tests can be enabled.

Example:

SCPE	256		:	The oscilloscope is enabled for test 256 only
SCPE	257		:	The oscilloscope is enabled for test 257 only
SCPE	0		:	The oscilloscope is enabled for all tests
SCPE	0	1	:	The oscilloscope is disabled for all tests
SCPE	256	1	:	The oscilloscope is enabled for test 256 only
SCPE	257	1	:	The oscilloscope is enabled for tests 256 and 257

System Compatibility: Valid only for MicroPulse 6.

SDS

Purpose: To set the default sample frequency.

Format: SDS <sample> [dof]

Description: Sets into non-volatile memory the power-on sample frequency of the system. The MicroPulse will also default to this sample frequency after an RST command that has no sample parameter. The SDS value is reported as part of the RST message. An optional parameter also allows the setting of the default data output format for the system.

Parameters:

<sample> : System sampling frequency:

10	=	10 MHz sample frequency
25	=	25 MHz sample frequency
40	=	40 MHz sample frequency
50	=	50 MHz sample frequency
80	=	80 MHz sample frequency
100	=	100 MHz sample frequency

[dof] : 0, 1, 2, 3, 4, 5, 6 Details of the modes can be found in the DOF command. This parameter is optional.

Note: 40Mhz and 80Mhz are provided for backward compatibility with earlier versions of MicroPulse only.

SGA(S)

Purpose: Control of the Phased Array Channel Summing Gain.

Format: SGA <Tn><Value>

Description: This sets the value of the summing gain for a test. On a phased array test the Micropulse system divides the summed signal by the number of elements in the focal law. For example: in a 128-element focal law, 128 elements are added together and then divided by 128. The sum gain parameter can be used to alter this division and therefore give more effective gain to a test.

Parameters:

<Tn> : Test number. An integer value from 0 to the maximum number of tests (default maximum is 1279 tests).
Tn = 0 is not supported.
If the S extension is used it applies to all tests in the sweep number specified: 1-32, 0 = all sweeps.

<Value> : Integer in the range 0 to 6, where:

0 = sum gain 0dB (default off)
1 = 6dB
2 = 12dB
3 = 18dB
4 = 24dB
5 = 30dB
6 = 36dB

Example:

SGA 256 1 : Sets the summing gain for test 256 to 6dB
SGAS 1 2 : Sets the summing gain for all tests in sweep 1 to 12dB

Note: Although summing gain can be useful in giving more gain to a test that utilises a number of elements, care should be taken with its use. It is not intended for use on a single element law. For the best performance summing gain should only be utilised where high gains are already required, and additional gain is needed.

SNM

Purpose: To set the subnet mask for Ethernet communication

Format: SNM <Value><Value><Value><Value>

Description: This command allows the changing of the subnet mask of the MicroPulse. The value is stored in flash memory and so is retained when the MicroPulse is turned off. To use the new subnet mask the MicroPulse must be turned off after sending the command (wait for 10 seconds before turning off to allow the flash to be written to). Caution should be used when using this command as setting the MicroPulse to an unknown subnet mask can cause problems with communication. Alternatively, the Peak NDT software utility 'PeakIPAssign' can be used to program the subnet mask.

Parameters:

<Value>	:	0 to 255
<Value>	:	0 to 255
<Value>	:	0 to 255
<Value>	:	0 to 255

Example: SNM 255 0 0 0 : Sets the MicroPulse to subnet mask 255.0.0.0

SPA

Purpose: Spacing of inspection locations.

Format: SPA <Axis1><Axis2><Axis3><Axis4>

Description: This command sets the distance between inspection points to the required pitch for each axis, in axis units as defined by MPE/EMUL, this is used for fly inspection modes.

Parameters:

<Axis n>	:	Number of axis units between inspection points for axis n. Range 1 to 100000.

Example:

SPA 5 5 5 5	:	Sets pitch to 5 on Axes 1, 2, 3 and 4.
SPA 2 5 10 10	:	Sets pitch to 2, 5, 10 and 10 on axes 1, 2, 3 and 4 respectively.

SRST

Purpose: To reset the control parameters within MicroPulse and optionally change its sample frequency.

Format: SRST [sample freq] [No. PA tests] [No. PA DDF Laws]

Description: Unlike the RST command the SRST command does not completely reset the MicroPulse. The SRST command performs a quick reset that bypasses self-test and only clears all parameters back to the power on state. If a SRST command is sent with no other parameters, the MicroPulse will reset to its default sample frequency. If the user sends a valid second parameter with the SRST then the system sample frequency will be changed. Further optional parameters allow the number of available phased array tests/focal laws and the number of Dynamic Depth Focusing (DDF) laws to be specified. Subsequent to a SRST command completion the system responds with a 'RST message' that indicates the system configuration.

Parameters:

[sample freq] : If omitted the system sample frequency is set to the system default otherwise:

- 0 = No change to the current sample frequency
- 10 = 10 MHz (Default DAC rate 1/8th sample freq)
- 25 = 25 MHz (Default DAC rate 1/8th sample freq)
- 50 = 50 MHz (Default DAC rate 1/8th sample freq)
- 100 = 100 MHz (Default DAC rate 1/16th sample freq)

[No. PA tests] : If omitted the system uses the default number of phased array tests and focal laws (1024), but the number can be specified:

- 0 = 512 phased array tests and focal laws available
- 1 = 1024 phased array tests and focal laws available
- 2 = 2048 phased array tests and focal laws available

[No. PA DDF Laws] : If omitted the system uses the default number of phased array Dynamic Depth Focusing (DDF) laws (512), but the number can be specified:

- 0 = 256 Dynamic Depth Focusing (DDF) laws
- 1 = 512 Dynamic Depth Focusing (DDF) laws
- 2 = 1024 Dynamic Depth Focusing (DDF) laws

Note: The default number of tests/focal laws is 1024 and DDF laws is 512. The increase or decrease in these parameters is optional to allow the power on default of the system to be consistent with previous systems. When more tests/focal laws or DDF laws are used the time for the system to initialise is increased and commands that require changes to all of the available tests/focal laws or DDF laws will take longer. The user should only define greater numbers if required. This will ensure that configuration time is kept to a minimum.

Note: LT2 has 200MHz sampling available

SSEQ

Purpose: To define a sequence of sweeps

Format: SSEQ <SSEQ No.> <Number of swps n> < swp 1.>……< swp n.>

Description: Phased array sweeps can be grouped together to form a sequence that can be executed as a single sequence or multiple parallel sequences as defined by the FDEF command. The mode is used by STRF and executes tests in a much faster sequence. If required sequences can contain only 1 sweep and 1 sequence can be fired. In this way the fast test mode can be accessed for single sweeps.

Parameters:

< SSEQ No.>	:	Integer value from 1 to 16
< Number of swps n >	:	The number of sweeps used in the definition. Integer number between 1 and 2.
< swp n >	:	List of Sweeps in the sequence

Example:

```
SWP 1 310 - 313     # sweep on probe 1
SWP 2 320 - 323     # sweep on probe 1
SWP 3 330 - 333     # sweep on probe 2
SWP 4 340 - 343     # sweep on probe 2
SWP 5 350 - 353     # sweep on probe 3
SWP 6 360 - 363     # sweep on probe 3
SWP 7 370 - 373     # sweep on probe 4
SWP 8 380 - 383     # sweep on probe 4

SSEQ 1 2 1 2
SSEQ 2 2 3 4
SSEQ 3 2 5 6
SSEQ 4 2 7 8

FDEF 1 4 4 1 2 3 4
```

This will result in the following parallel firing on a primary/secondary configuration:

Probe 1	Probe 2	Probe 3	Probe 4
Swp 1, test 310	Swp 3, test 330	Swp 5, test 350	Swp 7, test 370
Swp 2, test 320	Swp 4, test 340	Swp 6, test 360	Swp 8, test 380
Swp 1, test 311	Swp 3, test 331	Swp 5, test 351	Swp 7, test 371
Swp 2, test 321	Swp 4, test 341	Swp 6, test 361	Swp 8, test 381
Swp 1, test 312	Swp 3, test 332	Swp 5, test 352	Swp 7, test 372
Swp 2, test 322	Swp 4, test 342	Swp 6, test 362	Swp 8, test 382
Swp 1, test 313	Swp 3, test 333	Swp 5, test 353	Swp 7, test 373
Swp 2, test 323	Swp 4, test 343	Swp 6, test 363	Swp 8, test 383
Swp 1, test 310	Swp 3, test 330	Swp 5, test 350	Swp 7, test 370
Swp 2, test 320	Swp 4, test 340	Swp 6, test 360	Swp 8, test 380

STA

Purpose: User Request for MicroPulse status and axis locations.

Format: STA [Status]

Description: Interrogates MicroPulse for current system status and axis location. In 24-bit mode the reply is a single message:

15H (LLC) nnH aaaaaaH bbbbbbH ccccccH dddddddH eeeeH

Where aaaaaa to dddddd are the 3-byte locations of axes 1 to 4. nn is the optional status parameter (reflection of the optional status parameter). Here eeeeee represents 4 spare bytes. See section 4.4 (Axis Related Messages) for the full description of both 24-bit and 32-bit messages

STL

Purpose: To perform specified test without data output.

Format: STL <Tn>

Description: Any previously selected inspection mode is terminated, and any driven axis is stopped. The requested test is displayed on the A-scan monitor (if available)

Parameters:

<Tn>	:	Number of the test to be performed. An Integer value from 1 to the maximum number of tests (default maximum is 1279)

STP(S)

Purpose: To perform tests continuously.

Format: STP <Tn>

Description: The specified test(s) is repeated until a new mode (for example: STL or STX) is requested. The data is buffered for each cycle, i.e. if a single test is requested then data is output between each test, if all tests requested then data for each cycle of tests is buffered and output. The tests within a cycle are fired at the requested PRF (subject to gates set not being longer than the PRF). The next cycle will not start until this data has been output.

Parameters:

<Tn>	:	Test number. An integer value from 0 to the maximum number of tests (default maximum is 1279 tests). Tn = 0 for all conventional tests. If the S extension is used it applies to all tests in the sweep number specified: 1-32, 0 = all sweeps

Example:

NUM 100		
STP 0	:	MicroPulse sends data for tests 1 to 100 repeatedly
STL 1	:	After completing the reporting of the data from the last test cycle, the MicroPulse enters STL mode on test 1.

Note:

STPG

Format: STPG <Gn>

A version that is for use with parallel conventional channels only

This is a version of the STP command for groups. The STPG executes continuously either a single group or all groups enabled within the NUMG. A number between 0 and 16.

Note:

STPF

Format: STPF

A version of STP that performs the test cycles/sweeps defined by the current FLM mode. This can be conventional tests, phased array tests or both, either sequentially or in parallel.

STR(S)

Purpose: To perform tests continuously using the system buffer.

Format: STR <Tn>

Description: The purpose of this command is to output tests continuously. The internal buffer of the system is utilised. The specified test(s) is repeated at the PRF requested (restricted if the gate length is actually greater than the specified PRF) until a new mode (STL, STP or STX) is requested or the system buffer is full.

Data is reported in format specified by the current DOF. From each complete data set the system also outputs an LLC message giving four axis locations. In the LLC message the status byte is set to 1 and the last four bytes of the data report is the number of bytes available in the system buffer when the test was fired. If the LLC message is required more often, then the ENCM command can be used to specify this.

Parameters:

<Tn>	:	Test number. An integer value from 0 to the maximum number of tests (default maximum is 1279 tests). Tn = 0 for all conventional tests. If the S extension is used it applies to all tests in the sweep number specified: 1-32, 0 = all sweeps

Example:

```
NUM  100
STR    0
```

: MicroPulse sends data for tests 1 to 100 repeatedly.

Note: If a FDEF command is setup to define a sequence of sweeps, then STRS 0 will execute the defined sequence rather than all enabled sweeps. This mode is cancelled by FDEF 0.

Note:

STRG

Format: STRG <Gn>

A version that is for use with parallel conventional channels only

This is a version of the STR command for groups. The STRG executes continuously either a single group or all groups enabled within the NUMG. A number between 0 and 16.

Note:

STRF

Format: STRF

A version of STR that performs the test cycles/sweeps defined by the current FLM mode. This can be conventional tests, phased array tests or both, either sequentially or in parallel.

STS

Purpose: Request Parameters.

Format: STS <mode>

Description: For backward compatibility STS -1 can be used to find out the information contained in an RST message without resetting the MicroPulse. Other modes can be used to request various parameters from the MicroPulse.
The STS 20 for system temperature readings has been expanded to report the temperatures of each 16-channel line card within the system. The command also reports the temperatures of any secondary system if fitted (If no secondary then values are 0).

Parameters: <mode> : = 0 → axis locations
= 1 → MPE settings
= 2 → BKL settings
= 5 → SPA settings
= 6 → Read status of input and output lines
= 7 → Time in seconds since last power-on, RST and SRST
= 8 → System information (see section 4.5)
= 20 → System temperature readings
= 21 → Output system log (see section 4.5)
= 22 → Erase system log (see section 4.5)
= -1 → RST message
= -2 → Copy of primary system RST message when in primary/secondary mode
= -3 → Copy of secondary system RST message when in primary/secondary mode

Reply from MicroPulse:

Modes 0 – 5 : (hex) 15 Fn a a a b b b c c c d d d 0 0 0 0
n = <mode>
aaa = 24-bit data for axis 1 (least significant byte first)
bbb = 24-bit data for axis 2
ccc = 24-bit data for axis 3
ddd = 24-bit data for axis 4

Mode 6 : (0x15) (0xf6) (input line 15...8 level) (input line 7...0 level)
(output line 15...8 level) (output line 7...0 level)
(0) (0) (0) (0) (0) (0) (0) (0) (0) (0) (0)

Mode 7 : (0x15) (0xf7) (0) (0)
(4 bytes, LSByte first, of uptime in seconds)
(4 bytes, LSByte first, since RST in seconds)
(4 bytes, LSByte first, since SRST in seconds)
(0) (0)

Mode 20 : The LTPA/MPLT decode is as follows:

(0x15) (0xF4) (TEMP in Deg C of system) (0)
(TEMP in Deg C of processor) (0)
(TEMP in Deg C of any secondary system) (0)
(TEMP in Deg C of any secondary processor)

(TEMP in Deg C of line card 1)
(TEMP in Deg C of line card 2)
(TEMP in Deg C of line card 3)
(TEMP in Deg C of line card 4)
(TEMP in Deg C of secondary line card 1)
(TEMP in Deg C of secondary line card 2)
(TEMP in Deg C of secondary line card 3)
(TEMP in Deg C of secondary line card 4)

The MP6 decode is as follows:

(0x15) (0xF4) (TEMP in Deg C of system) (0)
(TEMP in Deg C of processor) (0)
(TEMP in Deg C of any secondary system) (0)
(TEMP in Deg C of any secondary processor)
(TEMP in Deg C of line card 1)
(TEMP in Deg C of line card 2)
(TEMP in Deg C of line card 3)
(TEMP in Deg C of line card 4)
(TEMP in Deg C of line card 5)
(TEMP in Deg C of line card 6)
(TEMP in Deg C of line card 7)
(TEMP in Deg C of line card 8)

Mode -1/-2/-3 : As per RST message

STX

Purpose: To enter idle mode with no test displayed.

Format: STX [option]

Description: This command is useful for suspending pulser activity.

Parameters: [option] : If omitted all test activity is stopped and any remaining test data is sent to the host.

= 1 All test activity is stopped, the contents of the data buffer are erased, and a message is sent to indicate completion. For the format of the output message see the MicroPulse Output Messages section. Prior to the STX 1 complete message, MicroPulse may also send a series of header 0 messages (single byte). This is to ensure that the last data set has been completed prior to the STX 1 complete message. This maintains message synchronisation with the host. Header 0 messages should be discarded.

SWP

Purpose: To define a group of focal laws.

Format: SWP<sweep No.><start Tn><-><end Tn>

Description: Phased array tests can be grouped together to form sweeps. Thereafter most ultrasonic settings can be set for the whole sweep by adding an 'S' to the appropriate command.
Sweep 1 is enabled by default. If more than one sweep is used, the rest of sweeps must be enabled before use.

Parameters:

< sweep No. >	:	Integer value from 1 to 32
<start Tn>	:	Integer value from 256 to the maximum number of tests (default maximum is 1279 tests) that is the start test number for the sweep
<->	:	A space is required on either side of the Dash. If the Dash is not used, then a list of individual tests can be used.
<end Tn>	:	Integer value from 256 to the maximum number of tests (default maximum is 1279 tests) that is the end test number for the sweep

Example:

SWP 1 501 - 532	:	Set sweep 1 to contain tests 501 to 532
SWP 2 301 302 303 304	:	Set sweep 2 to contain tests 301, 302, 303, 304

SYNC

Purpose: To allow firing of the tests to be synchronised between multiple independently controlled MicroPulse systems in continuous inspection modes.

Format: SYNC <Mode><Timeout>

Description: This command can be used when the optional SYNC connector is fitted to MicroPulse systems. They then can be connected and configured using the SYNC command to fire their tests together. This feature is for use on systems that are independently controlled but require some level of synchronisation. The synchronisation jitter between systems is less than 20nSec. A timeout can be specified where a system waiting for acknowledgement will timeout and issue a synchronisation failure message.
One system is designated the sync primary and should be sent the SYNC 5 <timeout>, whilst all other systems are then to be defined as the sync secondaries and sent SYNC 6 <timeout>. For the format of the output message see the MicroPulse Output Messages section.

Parameters:

< Mode >	:	Integer number between 0 and 2. 0 = Mode off (default) 5 = Trigger sync primary 6 = Trigger sync secondary 7 = Secondary static acknowledgement (unused secondary system permanently acknowledges a primary system)
< Timeout >	:	Integer number between 1 and 10000 Timeout in 100uSec units

Example: SYNC 5 100 : Set a primary with a timeout of 10mSec

System Compatibility: Valid only for MicroPulse 6 and LTPA.

TERM

Purpose: Encoder axis termination

Format: TERM <Axis No.><Value>

Description: This command sets the termination on each encoder axis. The default is encoder termination on

Parameters:

<Axis no.>	:	0 to 4, where 0 indicates all available axis
<Value>	:	0 or 1, where 0 is axis termination on

TGA(S)

Purpose: Test Gain Adjust.

Format: TGA <Tn><Value>

Description: Sets the gain trim that is applied in addition to the GAN for the test number specified. The TGA allows the adjustment gain of a test whilst specifying an overall gain for a sweep or number of tests using the GAN(S) command. The value of TGA set for a test is maintained even when a new GAN is applied.

Parameters:

<Tn>	:	Test number. An integer value from 0 to the maximum number of tests (default maximum is 1279 tests). Tn = 0 for all conventional tests. If the S extension is used it applies to all tests in the sweep number specified: 1-32, 0 = all sweeps.
<Value>	:	dB change to be applied. Entered in units of 0.25dB. If the resultant gain exceeds 280 (70.00 dB) or falls below 0 it is set to 280 or 0 respectively. The value can be positive or negative.

Example:

SWP	1	256	-	270	: Setup sweep 1
GAN(S)	1	80			: Set gain for all tests to 20dB.
TGA	260	4			: Trim test 260 by +1dB to a total gain of 21dB
TGA	270	-4			: Trim test 270 by -1dB to a total gain of 19dB

TRM(S)

Purpose: To trim the test delay

Format: TRM<Tn><value>

Description: To trim the specified delay (DLY) on a test basis to correct for transit time in the wedge when different angles are generated.

Parameters:

<Tn>	:	Test number. An integer value from 0 to the maximum number of tests (default maximum is 1279 tests). Tn = 0 for all conventional tests. If the S extension is used it applies to all tests in the sweep number specified: 1-32, 0 = all sweeps.
<Value>	:	Integer number between -20000 and 20000 each increment representing 1 TimeBase delay.

TTD

Purpose: To trim the transmit focal law.

Format: TTD <focal law No.>< value>

Description: To correct the transmit focal law delay to make the reference point as the array centre.

Parameters:

<focal law No.>	:	Focal law number, an integer value from 0 to the maximum number of focal laws (default 1024).
<value>	:	Transmit trim delay value in nanoseconds. Integer in the range 0 to 25000

System Compatibility: Valid only for Phased Array systems.

TXF

Purpose: To define the element delay for a transmit focal law.

Format: TXF <focal law No.><channel><delay>[optional pulser volts]

Description: For each focal law a number of TXF commands define the transmit delays for each individual element used. A TXF command can be used to specify the extra transmit channels where there are available.

Parameters:

<focal law No.>	:	Focal law number, an integer value from 0 to the maximum number of focal laws (default 1024).
<channel>	:	MicroPulse phased array channel number. An integer in the range 0 to the maximum number of phased array channels available. 0 is used with a delay of –1 to clear the whole law. Where a secondary system is present the range of channels is increased to allow for the secondary channels. On systems where addition pulser channels are available the channel number can also be appended with a T to indicate these channels.
<delay>	:	Receive delay value in nanoseconds. An integer in the range -1 to 25000. -1 is used to clear the whole law or individual elements.
[optional pulser volts]	:	Allowed for backword compatibility only.

Example 1:

TXF 1 0 -1	:	Clear transmit focal law 1
TXF 1 1 0	:	Add MicroPulse channel 1 to law 1 with 0 delay.
TXF 1 2 100	:	Add MicroPulse channel 2 to law 1 with 100nsec delay.

System Compatibility: Valid only for Phased Array systems.

TXN

Purpose: Transmit Channel Select.

Format: TXN <Tn> <Channel>[Vpn]

Description: Selects the transmit probe connection for a given Test Number (Tn)

Parameters:

<Tn>	:	Test number. An integer value from 0 to the maximum number of tests (default maximum is 1279 tests). Tn = 0 for all tests.
<Channel>	:	Integer in the range of 0 to the maximum number of focal laws (default 1024). When the <Tn> is 256 or greater this parameter refers to a phased array focal law and not an actual MicroPulse channel.
[Vpn]	:	Optional probe number. If channel is set to 0 then this integer value from 1 to 16 specifies a virtual probe consisting of conventional channels

Example:

TXN 7 2	:	Assign pulser/receiver channel 2 as transmitter for Test Number 7
TXN 256 1	:	Assign transmit phased array focal law 1 to test 256.

UML(S)

Purpose: Upper Threshold Level Assignment in multi-gate modes

Format: UML <Tn> <Gn> <value>

Description: Multi-gate version of UPL command. Specifies the UPPER reporting threshold for the specified Test Number (Tn) and Gate Number (Gn). Any signals ABOVE the UML threshold level value and within the search gate area will be recognised by the signal processor as possible valid peaks, depending on HMS.

Parameters:

<Tn>	:	Test number. An integer value from 0 to the maximum number of tests (default maximum is 1279 tests). Tn = 0 for all conventional tests. If the S extension is used it applies to all tests in the sweep number specified: 1-32, 0 = all sweeps
<Gn>	:	Gate Number, an integer value from 0 to 4. Gn = 0 for all gates in the test
<Value>	:	Integer between 10 and 255 (8-bit modes) Integer between 10 and 1023 (10-bit modes) Integer between 10 and 4095 (12-bit modes)

Note: Valid in Multi-gate Mode only (AMP 31 & 32)

UPL(S)

Purpose: Upper Threshold Level Assignment.

Format: UPL <Tn><Value>

Description: Specifies the UPPER reporting threshold for the specified Test Number (Tn). Any signals ABOVE the UPL threshold level value and within the search gate area will be recognised by the signal processor as possible valid peaks, depending on HYS. If no EUPL is specified, then the UPL is used in the interface gate in echo gate mode.

Parameters:

<Tn>	:	Test number. An integer value from 0 to the maximum number of tests (default maximum is 1279 tests). Tn = 0 for all conventional tests. If the S extension is used it applies to all tests in the sweep number specified: 1-32, 0 = all sweeps
<Value>	:	Integer between 10 and 255 (8-bit modes) Integer between 10 and 1023 (10-bit modes) Integer between 10 and 4095 (12-bit modes)

Example: UPL 6 80 : Assign a reporting threshold of 80 machine units to Test Number 6.

VEL

Purpose: Set Ultrasonic Velocity

Format: VEL <Velocity><DAC Curve No.>

Description: Allows the Ultrasonic Velocity to be specified. With or without the DAC option, velocities are assigned to a test via one of the DAC curve numbers. This form retains downward compatibility with earlier MicroPulse systems but is not recommended for use on new software development.

The velocity value is used by the system to translate search gate values from millimetres into machine units (i.e. 10 nSec for sample rate of 100 MHz).

Parameters:

<Velocity>	:	Permitted range between 250 to 10000 $msec^{-1}$
<DAC Curve No.>	:	Integer in the range 1 to 256

Example: Test Number 1 is a pulse echo shear wave inspection requiring the use of DAC curve 2. The shear wave velocity in steel is 3230 metres per second.

VEL 1615 2	:	note half shear wave velocity used and linked with DAC curve No. 2.
CUR 1 2	:	links curve No. 2 and hence shear wave velocity to Test number 1.

Note: For Pulse Echo inspections the velocity is entered as HALF the material velocity, whilst for tandem and through transmission techniques the ACTUAL velocity is used.

VPN

Purpose: Define a virtual probe consisting of two conventional channels.

Format: VPN <Virtual Probe No.><No. channels><channel 1><channel n>

Description: Allows a virtual probe consisting of combined conventional channels. Currently the maximum number of channels is two, but the capability of adding more channels may be added in the future. Once a virtual probe has been defined it can be assigned to a test by using the TXN and RXN command with the 2nd parameter set to 0.

Parameters:

<Virtual Probe No.>	:	The virtual probe number. Integer in the range 1 to 16.
<No. channels>	:	The number of channels in the virtual probe. An integer in the range 1 to 2.
<channel 1>	:	The first channel in the virtual probe. An integer in the range 1 to 16.
<channel n>	:	Further channel. An integer in the range 1 to 16.

Example:

VPN 1 2 1 5	:	Virtual probe 1 using channels 1 and 5
TXN 1 0 1	:	Test 1 transmit on virtual probe 1
RXN 1 0 1	:	Test 1 receive on virtual probe 1

Note: The channels specified in the virtual probe must be on different ADC blocks on the conventional PCB (CUIF). On MPLT or MicroPulse 6 systems an ADC block is 6 channels, therefore a 24 conventional channel system has 4.

XXA

Purpose: Request ultrasonic Parameters.

Format: XXA <Tn>

Description: Allows the operator to interrogate current ultrasonic Parameters for the test specified.

Parameters: <Tn> : Test number. An integer value from 1 to the maximum number of tests (default maximum is 1279 tests).

Example: XXA 33 : Request ultrasonic Parameters currently assigned to Test Number 33.

XXAS

Purpose: Request Sweep Parameters.

Format: XXA <Sweep No.>

Description: Allows the operator to interrogate current test numbers contained in the sweep specified. Replies with a XXAS message.

Parameters: < Sweep No.> : Integer number from 1 to 32.

System Compatibility: Valid only for Phased Array systems.

XXB

Purpose: Display on MicroPulse screen ultrasonic Parameters.

Format: XXB <Tn>

Description: Allows the operator to interrogate current ultrasonic Parameters for the test specified.

Parameters:

<Tn>	:	Test number. An integer value from 1 to the maximum number of tests (default maximum is 1279 tests). 0 displays the system information

Example:

XXB 33	:	Request ultrasonic Parameters currently assigned to Test Number 33 on L.C.D. screen.

System Compatibility: Valid only for systems where an LCD is provided (MicroPulse 6).

XXR/XXT

Purpose: Request list of tests in a focal law.

Format: XXT<Tx focal law No.>
XXR<Rx focal law No.>

Description: Allows the operator to interrogate current channels used in a transmit or receive focal law. Replies with an XXR/XXT message.

Parameters: < Tx/Rx focal law No > : Integer number from 1 to the maximum number of focal laws available.

System Compatibility: Valid only for Phased Array systems.

ZFL

Purpose: To allow commands to be stored in flash memory

Format: ZFL<value>

Description: Allows the operator to store a set of commands in the flash memory of MicroPulse. These commands will be executed on power-on or reset.

Parameters:

<value>	: 0 =	erase command file
	1 =	begin list of commands
	2 =	end list of commands

Example:

ZFL 0	:	Delete file
ZFL 1	:	Begin file
⋮	:	List of commands
ZFL 2	:	End of file

6 Appendix

6.1 Commands

Command Name **Page**

6.2 Summary of Output Messages

This appendix lists the complete set of output headers available in a MicroPulse. Messages generated in DOF 0 are not listed as they are not MicroPulse messages and are only supported as a backward compatibility mode for MicroPulse 4. Some non MicroPulse messages are still listed as they are available through the OUT command.

Standard Headers

Name	*Header (HEX)*	*Length (Bytes)*	*Description*
HDR_ZERO	0x00	1	To be discarded. Used to maintain synchronisation after a buffer clear and before a STX 1 complete message.
HDR_INX	0x01	2	Used to indicate end of data for CAL(S) 0. See "CAL(S)" in section 5. Available in the OUT command.
HDR_DRW	0x02	10	Not used for standard MP5 output. Available in the OUT command.
HDR_FOR	0x04	4	Not used for standard MP5 output. Available in the OUT command.
HDR_FIV	0x05	3	Not used for standard MP5 output. Available in the OUT command.
HDR_CER	0x06	2	Standard command error message. See section 4.3. Available in the OUT command.
HDR_STS	0x07	2	Not used for standard MP5 output. Available in the OUT command.
HDR_ING	0x08	2	Not used for standard MP5 output. Available in the OUT command.
HDR_LCI	0x13	5	Single Axis location message generated during moving inspection modes for an inspection point (24 Bit mode). See section 4.4. Available in the OUT command.
HDR_LCA	0x14	5	Single Axis location message generated during moving inspection modes for a missed inspection point (24-Bit mode). See section 4.4. Available in the OUT command.
HDR_LLC	0x15	18	Multi-axis location message (24-Bit mode). See section 4.4. Available in the OUT command.
HDR_ASNX	0x1A	Variable*	Test Data Message: ASCAN/RF. See section 4.1.
HDR_NPKX	0x1C	Variable*	Test Data Message: Peaks / TimeBase. See section 4.1.
HDR_GPKX	0x1D	Variable*	Test Data Message: Gain Reduced peaks / TimeBase. See section 4.1.
HDR_LPKX	0x1E	Variable*	Test Data Message: Loss of coupling/Grass Coupling peaks / TimeBase. See section 4.1.

* for the message length see the detailed description in section 4.

Name	*Header (HEX)*	*Length (Bytes)*	*Description*
HDR_XXA	0x20	40	Test information query message. See section 4.2. Available in the OUT command.
HDR_XXAS	0x21	Variable*	Sweep information query message. See section 4.2.
HDR_XXT	0x22	520	Focal law information query message. See section 4.2.
HDR_RST	0x23	32	Message generated in response to a RST or SRST. See section 4.2.
HDR_GPHX	0x24	10	Test Data Message: Grass coupling high. See section 4.1. Available in the OUT command.
HDR_GPLX	0x25	10	Test Data Message: Grass coupling low. See section 4.1. Available in the OUT command.
HDR_ACAL	0x26	10	Test Data Message: Response to an auto cal. See section 4.1. Available in the OUT command.
HDR_INGX	0x27	4	Test Data Message: Interface echo trigger failure. Available in the OUT command.
HDR_LWLX	0x28	4	Test Data Message: Coupling test Failure. Available in the OUT command.
HDR_OVD	0x29	4	Test Data Message: Phased Array Element overload. See section 4.1.
HDR_OVDD	0x2a	Variable*	Test Data Message: Phased Array Element overload (detailed). See section 4.1.
HDR_GEN	0x2d	Variable*	Universal header (see Sub-Header section).
HDR_MXE	0x36	2	Not used for standard MP5 output. Available in the OUT command.
HDR_LWL	0x42	2	Not used for standard MP5 output. Available in the OUT command.
HDR_GPL	0x46	6	Not used for standard MP5 output. Available in the OUT command.
HDR_GPH	0x86	6	Not used for standard MP5 output. Available in the OUT command.

* for the message length see the detailed description in section 4.

Sub-Header Used by the Universal Header

To allow for newer messages a general-purpose Universal Header is utilised (0x2d). This message is always the following format

<Universal Header 0x2d> <count lsb> <count tsb> <count msb> <Sub-header 0x01> <Data>

Count: 24-bit total data length count
Sub-Header: The appropriate sub-header from the table below
Data: Data of length Count - 5

Name	*Header (HEX)*	*Length (Bytes)*	*Description*
SUB_HDR_ASN	0x01	Variable*	Test Data Message: FMC data with EGT range embedded. See section 4.5.
SUB_HDR_EGT	0x02	12	Test Data Message: EGT range message from ETM 3 and 5. See section 4.5.
SUB_HDR_STX	0x03	8	Response to a STX 1 buffer clear command. See section 4.5.
SUB_HDR_SYNC	0x04	8	Two independently controlled MicroPulse 6/LTPA systems are synchronised, a synchronisation error has occurred.See section 4.5.
SUB_HDR_CALIB	0x05	8	For Peak NDT use only
SUB_HDR_INGX	0X27	12	Extended echo trigger failure message used for FMC to support channels above 255. See section 4.5
SUB_HDR_SCHK	0x30	60	Results of SCHK command: Detailed. See section 4.5.
SUB_HDR_SCHKD	0x31	8	Results of SCHK command: Summary. See section 4.5.
SUB_HDR_LLC	0x40	26	Multi-axis location message (32 Bit mode). See section 4.4.
SUB_HDR_LCI	0x41	10	Single Axis location message generated during moving inspection modes for an inspection point (32 Bit mode). See section 4.4.
SUB_HDR_LCA	0x42	10	Single Axis location message generated during moving inspection modes for a missed inspection point (32 Bit mode). See section 4.4.
SUB_HDR_XERR	0x43	Variable*	Extended error reporting mode error message. Contains copy of the input line that contained the error. Enabled by FEAT command See section 4.3.
SUB_HDR_CYC	0x44	8	Data Message: Total test cycle time. See section 4.4.
SUB_HDR_ELOG	0x45	Variable*	Report the contents of the stored error log in response to an STS command. See section 4.5
SUB_HDR_INFO	0x46	Variable*	Report the system status in response to an STS command. See section 4.5
SUB_HDR_ASN	0x01	Variable*	Test Data Message: FMC data with EGT range embedded. See section 4.5.

* for the message length see the detailed description in section 4.

6.3 Introduction to Programming MicroPulse

The following are a set of simple examples that show various ways of configuring MicroPulse tests. Each example follows on from the previous to build up a sequence of tests. The examples given are for conventional tests but can be easily applied to phased array tests.

Example 1: Simple Ascan Test

Example setup of single conventional test (system set to 100MHz).

```
DOF 1                   # set data output to 8 bits
NUM 1                   # set number of tests to 1
PSV 0 300               # set all channels to 300Volt pulsers
TXN 1 4                 # transmit test 1 on channel 4
RXN 1 4                 # receive test 1 on channel 4
PDW 4 0 100             # set channel 4 damping to 660Ω and 100nsec pulse width
GAN 1 110               # set test 1 gain to 110 (27.5dB)
FRQ 1 3 7               # set test 1 to filter to 4Mhz with smoothing 7
AWF 1 0                 # set test 1 to rectified data
GAT 1 0 10000           # set test 1 gate from 0 to 100uSec
DLY 1 0                 # set test 1 delay to 0
AMP 1 3                 # set test 1 to output full Ascan data
ETM 1 0                 # set test 1 to not interface echo
PRF 1000                # set pulser repletion to 1000Hz
```

The above setup can be executed once by sending a CAL 1 command. A 10000 sample Ascan of 8-bit data will be output. As the NUM is set to 1, CAL 0 will also output the same result.

Continuous execution can be obtained by using STP 0 or STR 0 commands. STR also reports the current encoder position with each complete test cycle.

Example 2: Peak Detection Test

More tests can be added to the cycle by increasing the NUM. These tests can be enabled or disabled by using the ENA / DIS commands respectively.

```
NUM 2                   # set number of tests to 2
TXN 2 4                 # transmit test 2 on channel 4
RXN 2 4                 # receive test 2 on channel 4
GAN 2 110               # set test 2 gain to 110 (27.5dB)
FRQ 2 3 7               # set test 2 to filter to 4Mhz with smoothing 7
AWF 2 0                 # set test 2 to rectified data
GAT 2 5000 10000        # set test 2 gate from 50uSec to 100uSec
DLY 2 0                 # set test 2 delay to 0
AMP 2 2                 # set test 2 to output n peaks
UPL 2 100               # set the peak threshold to 100 units
ETM 2 0                 # set test 2 to not interface echo
HYS 2 2                 # set test 2 to 6dB hysteresis
PIG 8                   # set the maximum number of peaks to 8
```

Now on CAL 0 will output:
Test 1 - A 10000 sample Ascan of 8-bit data
Test 2 - The amplitude and time of any peaks (up to 8) above the UPL from 50uSec to 100uSec.

Example 3: Time Varying Gain (TVG)

TVG can be applied to tests by defining a curve in memory and specifying the tests that it is to be used on. The example shows a single curve, but up to 255 can be defined that utilise up to 65550 points of memory.

```
DTG    0    0          # set all tests to TVG trigger on initial pulse
DRTE   3               # set the TVG rate to 6.25MHz
DDAC   1  625    0     # define curve 1 start in memory as 0 and length 625
DFIL   0  125    0     # set TVG point to 0dB
DFIL 126  175   10     # set TVG point to 2.5dB
DFIL 176  225   20     # set TVG point to 5dB
DFIL 226  275   24     # set TVG point to 6dB
DFIL 276  325   28     # set TVG point to 7dB
DFIL 326  375   36     # set TVG point to 9dB
DFIL 376  425   45     # set TVG point to 11.25dB
DFIL 426  475   54     # set TVG point to 13.5dB
DFIL 476  525   63     # set TVG point to 15.75dB
DFIL 526  575   66     # set TVG point to 16.5dB
DFIL 576  625   68     # set TVG point to 17dB
CUR    1    1          # set test 1 to use curve 1
CUR    2    1          # set test 2 to use curve 1
LON   11               # turns on TVG
```

Example 4: Interface Echo

A third test can be added that uses the interface echo capabilities. Here we will report peaks from the gate but an Ascan can also be reported.

```
NUM  3                 # set number of tests to 3
TXN  3  1              # transmit test 2 on channel 1
RXN  3  1              # receive test 3 on channel 1
EGT  3  1000  2000     # set test 3 interface echo gate from 10uSec to 20uSec
EUPL 3  200            # set test 3 interface threshold to 200 units
IGT  3  2000  3000     # set test 3 interface echo inspection gate from 20uSec to 30uSec
ETM  3  2              # set test 3 to interface echo mode
AMP  3  2              # set test 3 to output n peaks
GAN  3  110            # set test 3 gain to 110 (27.5dB)
FRQ  3  3  7           # set test 3 to filter to 4Mhz with smoothing 7
AWF  3  0              # set test 3 to rectified data
HYS  3  2              # set test 3 to 6dB hysteresis
UPL  3  100            # set the peak threshold to 100 units
CUR  3  256            # as TVG is on, but is not required for this test, set to the 0dB curve 256
```

Now on CAL 0 will output:

Test 1 - A 10000 sample Ascan of 8-bit data
Test 2 - The amplitude and time of any peaks (up to 8) above the UPL from 50uSec to 100uSec.
Test 3 - If an interface echo is found between 10uSec and 20uSec then any peaks above the UPL in the inspection gate that is set 20usec to 30usec from the interface echo will be reported.

Example 5: Multiple Gates

Instead of a single hardware gate on a test a test can be configured to have multiple hardware gates.

```
NUM 4                       # set number of tests to 4
TXN 4 2                     # transmit test 4 on channel 2
RXN 4 2                     # receive test 4 on channel 2
GAN 4 110                   # set test 4 gain to 110 (27.5dB)
FRQ 4 3 7                   # set test 4 to filter to 4Mhz with smoothing 7
AWF 4 1                     # set test 4 to RF data
GAT 4 0 10000               # set test 4 gate from 0uSec to 100uSec
AMP 4 32                    # set test 4 to multi-gate and Ascan
GMT 4 1 5000 6000           # set test 4 gate 1 from 50uSec to 60uSec
GMT 4 2 5000 6000           # set test 4 gate 2 from 50uSec to 60uSec
GMT 4 3 8000 9000           # set test 4 gate 3 from 80uSec to 90uSec
GMT 4 4 8000 9000           # set test 4 gate 4 from 80uSec to 90uSec
GIN 4 2 1                   # invert test 4 gate 2
GIN 4 4 1                   # invert test 4 gate 4
HMS 4 0 1                   # set test 4 all gates to 3dB hysteresis
PMG 4 0 8                   # set test 4 all gates to 8 peaks maximum
UML 4 0 130                 # set test 4 all gates to peak threshold to 130 units
AMM 4 0 2                   # set test 4 all gates to output n peaks
```

Now on CAL 0 will output:

Test 1 - A 10000 sample Ascan of 8-bit data
Test 2 - The amplitude and time of any peaks (up to 8) above the UPL from 50uSec to 100uSec.
Test 3 - If an interface echo is found between 10uSec and 20uSec then any peaks above the UPL in the inspection gate that is set 20usec to 30usec from the interface echo will be reported.
Test 4 - The amplitude and time of any peaks or troughs from 50uSec to 60uSec and 80uSec to 90uSec.

Example 6: Inspection Control

If desired the encoder inputs can be configured to trigger inspection points as shown below:

```
ENCM 1                      # set encoders to 32-bit output
ENCT 0 0 0 0                # set all encoder modes to Quadrature
ENCF 0 0 0 0                # set all encoders to no filter
MPE  1000 1000 1000 1000    # set the encoder input ratio as 1000 per mm
BKL  2000 2000 2000 2000    # set the stall detection to 1 second
SPA  1 1 1 1                # set the inspection pitch to 1 mm
LCP  1 0                    # zero axis 1
LCP  2 0                    # zero axis 2
LCP  3 0                    # zero axis 3
LCP  4 0                    # zero axis 4
FLM  0                      # carry out CAL 0 at each inspection point
FLX  1 100 0                # set inspection to start from 100mm in a positive direction
FLZ  1 200                  # set inspection to end at 200mm
```

As each inspection point is reached a CAL 0 is carried out and the data is output with a LCI message that gives the actual location of that inspection point.

6.4 Introduction to Programming Focal Laws with MicroPulse

Definitions

Focal Law - a set of delays, one for each element, required to focus/steer the beam at a given angle/range/depth/point

Sweep - a group of focal laws

Snell Ray - the central ray from the group of elements for a given law that satisfies Snell's law at the boundary between a wedge and a component under test.

Programming Element Delays for Focal Laws

Focal laws are programmed in MicroPulse using the TXF (transmit focal law) and RXF (receive focal law) commands to set the delay for each element to be used in the focal law. (For further details on the format of these commands refer the Micropulse Range Command Reference Manual).

Format : TXF <focal law no> <MP pin no> <delay>
RXF <focal law no> <MP pin no> <delay> <elt trim gain>

The delay value to be applied is in nanoseconds. There will be one TXF and one RXF command for each element that is used.

Notes:

(1) MicroPulse adopts the standard policy of setting the minimum delay value to be programmed as zero, but this does have implications as to where TimeBase zero is. For a single law this is not an issue as the resulting offsets get taken out during calibration by adjusting the probe/wedge delay. However, for a sweep this offset will be different for every law. To avoid having a different probe/wedge delay for every law in a sweep, various offsets are programmed with the result that the probe/wedge delay can be a constant for that probe/wedge, irrespective of the laws specified. This is important for future integration with MIPS.

(2) Before programming a focal law, TXF and RXF commands with the element delay set to '-1', should be sent to MicroPulse to ensure that all element delays previously programmed are cancelled.

e.g. TXF 1 0 -1 : the <-1> clears previously stored values
RXF 1 0 -1 0

Focal Law Delay Offsets

Consider the case in transmit for a linear array in contact focusing as shown in Figure 6.4.1. In order to achieve a focus, the edge elements are fired **before** the centre elements. The delays applied to each element might look something like the graphic in Figure 6.4.2.

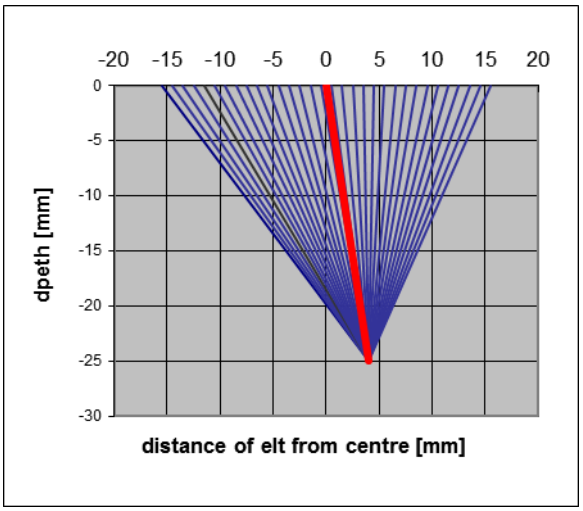


Figure 6.4 1 32 element array focusing at 25mm below the surface with no wedge

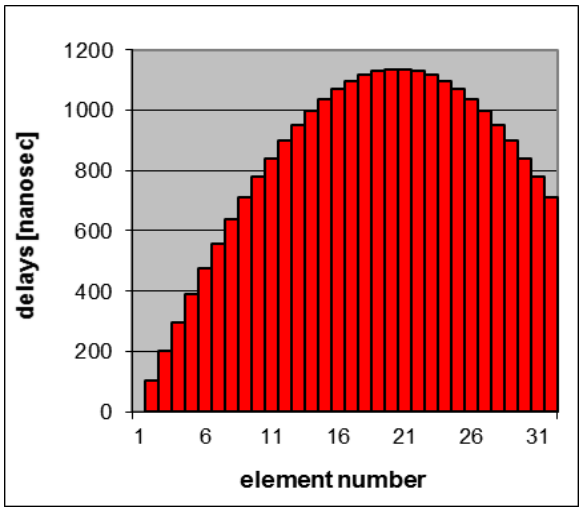


Figure 6.4 2 Element Delays

The clock starts counting with the first element is fired, but the range to an indication is measured from the centre of the array. So, there will need to be on offset applied at some point, which is equal to the difference in transit time to the focus between the element with the longest transit time to the focus and a ray emanating from the centre of the array. (To a reasonable approximation this can be considered as the delay that would be applied to an element at the centre of the array (odd number of elements), or the average delay at the central elements). In MicroPulse this value is called the Transmit Trim Delay. It is programmed by the TTD command and there will be one for every law.

Format : TTD <focal law no> <transmit trim delay value>

The transmit trim delay value is in nanoseconds. The value is always positive.

In receive; a signal from the focus arrives first at the element closest to it (i.e. with the shortest path length). MicroPulse then must **wait** the appropriate time for the signal to arrive at elements further away before summing the signals. This is apparently contrary to the graphic shown in Figure 6.4.2. In fact, what happens is that when MicroPulse gets the receive delays, programmed by the RXF commands, it finds the maximum delay for that law and then subtracts the delay for each element from this maximum value. This result is represented by the graphic in Figure 6.4.3.

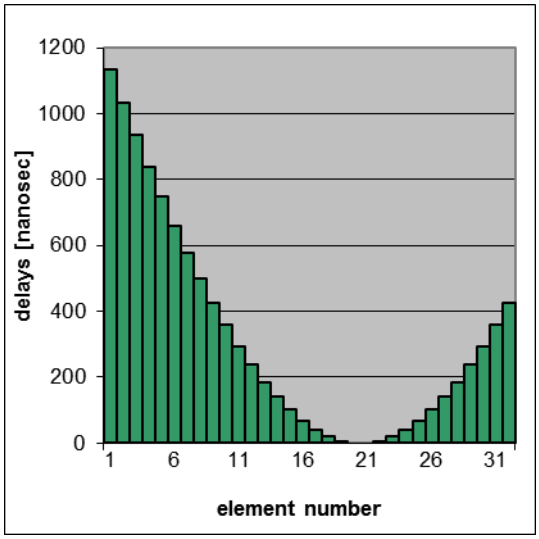


Figure 6.4 3 Element delays applied by MicroPulse on Receive

So in receive, the reference time is taken as when the signal from the focus arrives at the closest element not at the centre of the array, but range is measured from the centre of the array. Another delay correction is required. The value equates to the difference in transmit time between a ray from the focus received at the centre of the array and the closest element. In MicroPulse this is termed the Receive Trim Delay. It is programmed by the RTD command and there will be one for every law.

Format : RTD <focal law no> <receive trim delay value>

The receive trim delay value is in nanoseconds. The value is always positive and must always less than or equal to the transmit trim delay. If the same delay law is used for receiving as was used to transmit, then the <RTD value> equals the maximum delay (see figure 6.4.2) minus the <TTD value>.

Using Focal Laws

To actually use a focal law, it must first be assigned to a MicroPulse <test> via the TXN and RXN commands.

Format : TXN <test no> <law no>
RXN <test no> <law no>

Notes:

(1) For phased array tests, test numbers start at 256, allowing MicroPulse to differentiate between conventional tests and phased array tests.

(2) The focal laws to be used (TXF's, TTD's, RXF's, RTD's) must be sent to MicroPulse before the TXN's and then the RXN's

Different laws may be used in transmit and receive and the same law maybe used in more than one law combination.

Tests may be grouped together to form sweeps via the SWP command.

Format: SWP <sweep no> <start test no> <–> <end test no>

Thereafter, for many common ultrasonic settings, the whole sweep may be addressed rather than each test individually. Most MicroPulse commands allow an 'S' to be added, by which MicroPulse recognises it as a sweep command

e.g. GANS 1 40: set the gain on all tests in sweep 1 to 10dB

Wedge Delay Offsets

The same approach for TXF's, RXF's, TTD's and RTD's is extended to the case of a probe with a wedge. Here, however, a further delay trim value is required. An extension of the MicroPulse DLY command, DLYS, sets the wedge delay for the whole sweep. Its units are in MicroPulse units i.e. the <dlys value> is dependent on the sample frequency.

Format : DLYS <sweep number> <delay in MPunits>

DLYS takes care of the time for the sound in the wedge (at the natural angle of the wedge). There are two contributions to this, on the way out and on the way back. MicroPulse is programmed with the sum of these values (rather than twice the wedge delay) in order to take account of the fact that different probes may be used in transmit and receive. The controlling software must manage the construction and keep track of the DLYS values.
In addition to the DLYS a delay trim value (TRM) is required in order correct the transit time in the wedge when different angles are being generated or different element groups are being used. The TRM value is programmed on a per test basis.
Format : TRM <test_no> <delay trim value in MPunits>

The <trm value> is the difference between the time at the natural angle of the wedge and the time along the so-called Snell ray at the centre of the selected group of elements at the incident angle to give the specified refracted angle (figure 6.4.4). The
<trm value> is made up from a part associated with the transmit focal law and a part associated with the receive focal law. The controlling software must manage the construction and keep track of the TRM value, assigning it to the correct test.

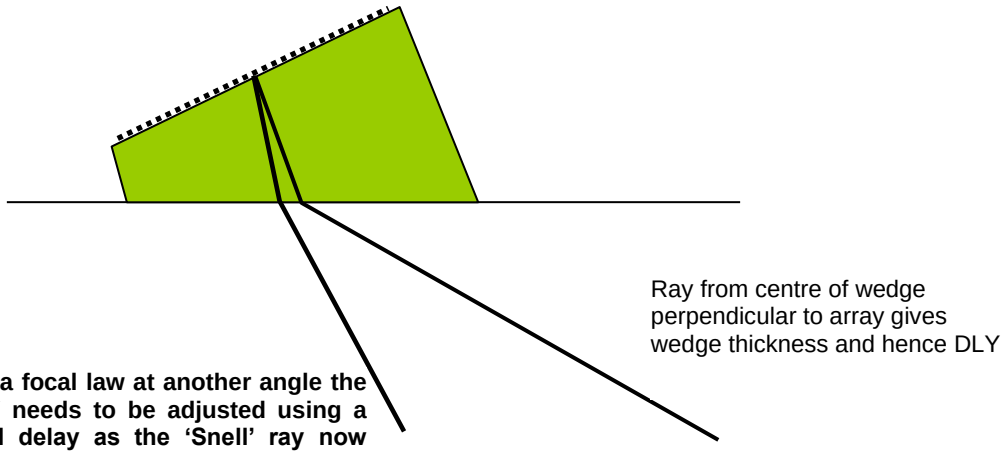


Figure 6.4 4

6.5 Full Matrix Capture (FMC) and FMC individual Channel Echo Gate Trigger Mode

Full Matrix Capture (FMC) is a feature available in MicroPulse phased array systems which allows the capture of A-scans prior to summation. The FMC process involves transmitting on element one of an array, receiving all the A-scans individually for each element of the array, then transmitting on element 2, 3 etc until all elements have been used for transmitting. Where n is the number of elements in the array, then the FMC process will result in the collection of n^2 waveforms. Having acquired the waveforms, the user can apply any focussing algorithms retrospectively to the received data. FMC is of potential benefit in an R&D environment where new focusing methodologies are being developed such as the Total Focusing Method (TFM) being developed by Bristol University. The FMC data output is available in AMP mode '13'.

To programme the MicroPulse to collect the FMC data the focal law programming commands are used with delays set to zero. The laws are then assigned to tests. For example, for a 16-element array:

```
TXF  1    0  -1              :  Clear out any previous Tx laws
TXF  1    0   0              :  Transmit on element one
TXN  256    1                :  The Tx for test number 256 uses Tx law no 1

RXF  1    0  -1  0           :  Clear out any previous Rx laws
RXF  1    1   0  0           :  Receive on element 1
RXF  1    2   0  0           :  Receive on element 2
RXF  1    3   0  0           :  Receive on element 3
  ⋮                              ⋮
RXF  1  16   0  0           :  Receive on element 16
RXN  256    1                :  The Rx for test number 256 uses Rx law no 1

TXF  2   0   -1
TXF  2   0    0
TXN  257  2

RXF  2   0   -1  0
RXF  2   1    0  0
RXF  2   2    0  0
RXF  2   3    0  0
  ⋮
RXF 2 16 0 0
RXN 257 2
  ⋮
  ⋮
RXF 16 16 0 0
RXN 271 16

SWP 1 256 - 271             :  Define a sweep representing these tests
AMPS 1 13                   :  Set to output FMC data.
```

Notes:

- On LTPA or MicroPulse 6 systems the maximum lengths of gates is 8000 samples per element.
- Not available in DOF mode 0.
- Caution PRF achievable may become limited by data transfer rates.
- RXF delays can be non-zero, to, for example, 'line-up' interface signals for use with FMC individual channel echo gate trigger, see below. This means the size of the interface gate can be smaller, reducing the risk of extraneous signals triggering the gate.

FMC Mode Individual Channel Echo Gate Trigger

When in Full Matrix Capture (FMC) the user can specify an interface echo gate that is used by each receive channel to independently set its inspection gate relative to an interface echo.

The Distance amplitude correction (DAC) can also be configured to be triggered by the interface echo. There is now an additional water path DAC that will run from the initial pulse to the interface echo. This DAC stops at the interface echo on each channel and holds its value on that channel. The standard DAC that is triggered on the interface is then applied on top of this. The total cannot exceed the maximum DAC gain of 40dB. The water path DAC has no associated CUR number as it is applied to all tests that have the standard DAC configured to trigger on the interface echo.

Note: that in this mode the standard DAC requires some value between the test start and the interface echo. The first value in the standard DAC curve is used for this and is held until the interface echo is seen. This value would normally be set to zero.

ETM(S)	:	Used to enter the FMC echo trigger mode
EGT(S)	:	Used to specify the interface echo gate
IGT(S)	:	Used to specify the inspection gate relative to the interface echo. The start of the inspection gate (IGT) can be negative if required to allow the capture of the actual interface echo. The maximum gate length is 3000 bytes.
EPL(S)	:	Used to specify the threshold amplitude within the interface echo gate that will trigger the channel.
DTG(S)	:	Used to specify the trigger source for the standard DAC
DFIL / DSET	:	The water path DAC uses the range 70000 to 70512. The water path DAC will be clocked out at the same rate as specified for the standard DAC.

To support FMC mode individual channel echo gate trigger the following new/amended messages are used.

Data Message

<Universal Header 0x2d> <count lsb> <count tsb> <count msb>
<Sub-header 0x01> < Sweep No./Test No. lsb > <Sweep No./Test No. msb>
<dof > <Channel> <Echo range lsb> <Echo range msb> <Spare> <amp 1>…. <amp n >

Where:

Header:	universal header 0x2D
Count:	24-bit total data length count
Sub-header byte:	0x01 = FMC Ascan
Sweep/Test No:	16 bits. Bottom 11 bits Test No. Top 5 bits sweep No.
dof:	Data Output Format
Channel:	Normally 0, except in full matrix capture tests it is used to indicate the channel number
Echo Range:	Range of the interface echo from the start of the interface echo gate.
Spare	Not used.
amp:	In 8-bit Modes, for Ascan = amplitudes of digitised signal. In greater than 8-bit modes, the amplitudes are least significant byte first.

Echo Trigger failure

This message is 4 Bytes in total. If no interface echo is seen on a channel the following is sent to indicate the failure.

<27Hex> <Sweep/Test No. lsb> <Sweep/Test No. msb> <Channel>

Where:

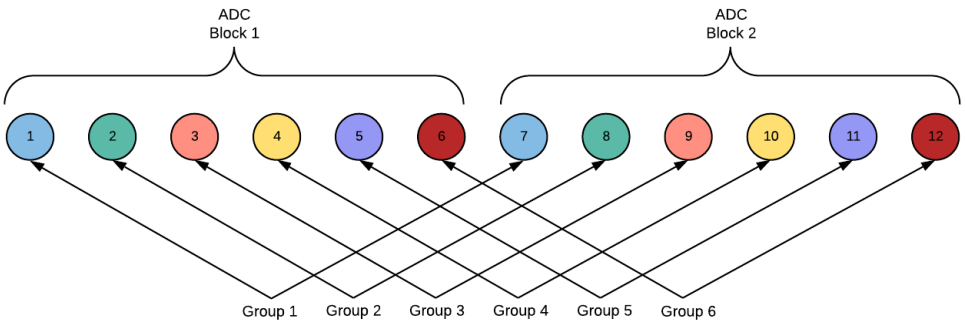
Channel:	Normally 0, except in full matrix capture tests it is used to indicate the channel number

6.6 Introduction to Programming Parallel Groups with MicroPulse 6

MicroPulse systems that are configured for the parallel firing of their conventional channels can use the group (GRUP) feature. This mode requires the systems to have multiple ADC blocks (Micropulse 6 or MPLT). Below is an example setup of a 12-channel system fitted with 2 ADC blocks (one on every 6 channels) thus allowing 2 channels from different ADC block to be fired concurrently (see GRUP command).

```
DOF 6
DISG 0
ENAG 0
NUM 12
NUMG 6
TXN  1  1
RXN  1  1
TXN  2  2
RXN  2  2
TXN  3  3
RXN  3  3
TXN  4  4
RXN  4  4
TXN  5  5
RXN  5  5
TXN  6  6
RXN  6  6
TXN  7  7
RXN  7  7
TXN  8  8
RXN  8  8
TXN  9  9
RXN  9  9
TXN  10  10
RXN  10  10
TXN  11  11
RXN  11  11
TXN  12  12
RXN  12  12
ENA 1
ENA 2
ENA 3
ENA 4
ENA 5
ENA 6
ENA 7
ENA 8
ENA 9
ENA 10
ENA 11
ENA 12
PSV 0 100
PDW 0 7 20
PRF 12000
GAT 0 0 1700
GAN 0 120
FRQ 0 2 7
AMP 0 3
AWF 0 0
GRUP 1 1 7 0 0 0 0 0 0 0 0
GRUP 2 2 8 0 0 0 0 0 0 0 0
GRUP 3 3 9 0 0 0 0 0 0 0 0
GRUP 4 4 10 0 0 0 0 0 0 0 0
GRUP 5 5 11 0 0 0 0 0 0 0 0
GRUP 6 6 12 0 0 0 0 0 0 0 0
ECON 1 0 0 0
```

The setup above requires CALG 0, STPG 0 or STRG 0 command to be sent to the system in order to start firing the channels in parallel. The example sets up 12 tests and then fires them in 6 groups of 2. The order of the channels fired is represented by the schematic below:



There are limitations on the group command:

- Dependent upon the configuration of the system there are limitations on which channels can be specified within a group. If in doubt as to the configuration of a system, please contact Peak NDT. The number of channels per ADC is obtained from the RST message.
- Each conventional ultrasonic (CPIF) PCB within the Micropulse has 12 pulse/receiver channels with 2 ADC's per PCB, the wiring of the system can mean different configurations. For example, a 24-channel system can have 4 CPIF PCB's wired to have 3 channels per ADC.
- The first test in a group has no limitations as to gate length or reporting modes etc., but the other tests in the group MUST be Amp 3 mode (Ascan or RF). These other parallel tests can be compressed (DCM) or uncompressed but the output data of the tests is limited to 16000 data points (16000 bytes in 8 bit or 32000 in 16 bit). For example: Gate of 8000 points with compression ratio of 2 gives a 4000 bytes output in 8-bit mode (8000 in 16 bit).

The number of CUIF PCB's fitted to a system can be obtained from the RST (or STS -1) message. The data is obtained from the number of Conventional channels in system byte and the bottom 5 bits of the channels per CUIF ADC byte (see MicroPulse Output Messages section).

So the CUIF boards = Conventional channels in system / (2 * (channels per ADC & 0x1F))

For example, on a 48-channel system if:

Channels per CUIF = 6 then 48/(2*6) = 4 CUIF cards (each card having 2 ADC blocks)

Or on a 24 Channel system if:

Channels per CUIF = 6 then 24/(2*6) = 2 CUIF cards (each card having 2 ADC blocks).

Note on older system the channels per CUIF byte is set to 0. This would indicate that parallel firing is not available on that system.

Also implemented in this example is the ECON command to allow the output of the cycle time.

To explain the effect of groups on PRF / cycle time refer to the example from earlier in this section.

If in STR 0 mode:

The MicroPulse would fire tests at ~83usec apart (PRF 12000). This would give an overall cycle time of ~1 msec (1000Hz) as there are 12 tests.

So Theoretical Cycle Time = (1 / PRF entered) x (number of enabled tests in NUM)

If in STRG 0 mode:

The MicroPulse would fire the parallel group at ~83usec apart (PRF 12000). As there are 6 groups this would give an overall cycle time of 0.5 msec (2000Hz). But in that time 12 tests are fired in 6 groups of 2, so the effective PRF is 24KHz.

So Theoretical PRF = (PRF entered) x (number of tests in group)

So Theoretical Group Cycle Time= (1 / PRF entered) x (number of enabled groups in NUMG)

6.7 MicroPulse LT2 Command differences

RST Command

Sample frequencies of 200MHz,100MHz, 50MHz, 25MHz and 10MHz are available. while 40MHz and 80MHz are not available

PSV Command

Format: PSV <channel> <value>

The high voltage pulser has a maximum value of 200Volts. Values can be entered up to 500Volts without an error being generated, but they will be clipped to 200Volts.The EHT supply is common to all channels. Any value set will apply to all channels.

GAN Command

Format: GAN <Tn> <Value>

Up to 6db of attenuation is available. The value can be set between -24 and 280 which corresponds to gains of -6dB to +70dB in 0.25dB steps. As the gain can be set in the range of

DFIL/DSET Commands

Format: DFIL <addr 1> <addr 2> <value>
Format: DSET <address> <value>

Up to 70dB of DAC is available. The value can be set between 0 and 280 which corresponds to DAC values of -0dB to +70dB in 0.25dB steps. The maximum combination of main gain and DAC is 110dB. Valid DAC addresses are within the range 0 to 32760.

CENA Command

Format: CENA <mode>

This command allows the user to set the function of pin 8 of the encoder interface connector to INE or CPIN. The mode is either 0 or 1. Mode 0 is for INE functionality and 1 for CPIN functionality.
The default is 0, i.e. INE functionality.

LTE Command

Format: LTE <mode>

Where mode 0 is the default and mode 1 allows the LT2 to report itself as a LT unit (in the RST message). This is useful to allow existing software developed for the LT unit to recognise and work with LT2. This command can be stored in non-volatile memory using the ZFL commands to allow the unit to report as a LT from power on.

Unsupported Commands

STS 20, FLM and any command relating to phased array channels.

6.8 MicroPulse LTPA/MPLT Command differences

RST Command

Sample frequencies of 100MHz, 50MHz, 25MHz and 10MHz are available while 40MHz and 80MHz are not available.

PSV Command and PAV Command

Format: PSV <channel> <value>
Format: PAV <channel start> <channel end> <value>

The high voltage pulser has a maximum value of 200Volts. The high voltage is a single supply common to all phased array and conventional channels. Both commands are maintained for compatibility, but a value applied to any channel from either command will set the current pulser supply voltage for all channels. The available settings are 50, 75 ,100, 125, 150, 175 and 200 Volts. Values sent between these values will be rounded down to the nearest setting. The default 100 volts.

LTE Command

Format: LTE <mode>

Where mode 0 is the default and mode 1 allows the LTPA/MP6 to report itself as a Micropulse 5 PA system (in the RST message). This is useful to allow existing software developed for the Micropulse 5 PA system to recognise and work with LTPA. This command can be stored in non-volatile memory using the ZFL commands to allow the unit to report as a Micropulse 5 PA from power on.

TXN/RXN Command

On LTPA the conventional channel numbering is as follows:

Channel 1 and 2 are TX/RX channels

Channel 3 and 4 are TX only channels

6.9 User/Safety Instructions and Declaration of CE Conformity

- For continued protection against fire hazard, always fit MicroPulse 6 with the same type and rating of fuse. This is a 20mm, 3.15Amp anti-surge fuse (RS:488-8393).

- MicroPulse 6 has an auto-sensing voltage circuit that detects the correct operating voltage. MicroPulse 5 can operate from a supply of 90 to 260 VAC at 45 to 100 Hz.

- To help prevent electric shock, plug the MicroPulse 6 and device power cables into properly grounded electrical outlets. These cables are equipped with 3-prong plugs to help ensure proper grounding. Do not use adapter plugs or remove the grounding prong from the cable. If extension cables must be used, use a 3-wire cable with properly grounded plugs.

- MicroPulse units contain no user serviceable parts. Always refer to qualified service personnel.

- Do not remove the covers as MicroPulse units contain high voltages that could cause electric shock.

- Due to the nature of ultrasonic pulsers, the centre pin of front panel LEMO connectors and Hypertronic connector may have a high voltage pulse on during use. Care should be taken when plugging in connectors to the front panel not to touch the centre pins.

- On LTPA and MPLT the use of category 6a (shielded) Ethernet cables is recommended to help ensure the reliability of the Ethernet communication. For further information on the specification of Ethernet cable please contact Peak NDT.

Declaration of CE Conformity

Name of Manufacturer:	**Peak NDT Limited** Unit 1 Enterprise Way, Jubilee Business Park Derby, DE21 4BB
herewith declare that:	
Products description:	Ultrasonic flaw detector with phased array channels and/or channels for conventional ultrasonics (pulse-echo & TOFD)
Model numbers:	MicroPulse 6, MicroPulse LT/LT2, MicroPulse LTPA/MPLT

are in conformity with provisions of the EMC Directive (2004/108/EC) and the LVD Directive (2006/95/EC), and we declare compliance with the following standards:

EMC

High Frequency Emission:	CENELEC EN 55011:2009+A1:2010 Group 2 Class A Industrial, scientific and medical (ISM) radio-frequency equipment – Electromagnetic disturbance characteristics – Limits and methods of measurement
Immunity:	EN61326-1:2013 Electrical equipment for measurement, control and laboratory use – EMC requirements

LVD

Electrical Safety:	EN61010-1:2010 Safety requirements for electrical equipment for measurement, control and laboratory use
Issued by:	Peak NDT Limited
Date:	June 2020
Signature:	
Position:	QAR

6.10 Conventional Ultrasonic Connectors

On MicroPulse LT2, LTPA, MPLT and MicroPulse 6 the conventional ultrasonic connections are different from the previous MicroPulse generation (MicroPulse 5). LEMO coax 00 (LEMO part number PSA.00.250.CTLC31) are used.

An example of a possible mating connector is LEMO part number:

FFC.00.250.CTAxxx

Where xxx = the collet size and an example is

C31 = 2.8-3.1mm diameter (suitable for RG174 coaxial cable)

Care should be taken when terminating either triaxial or coaxial connectors to ensure that there are no short circuits between the inner conductor and any screens. Prolonged use of the pulser set to a high voltage into a short circuit can cause damage to the pulser circuit.

6.11 Hypertronic Connector Pinout

The pin out details for the Hypertronic connector is shown in Figures 6.13.1 and 6.13.2.

	1	2	3	4	5	6	7	8		12	13	14	15	16	17	18	19
A	PR128	PR124	PR120	PR116	PR112	PR108	PR104	PR100		PR96	PR92	PR88	PR84	PR80	PR76	PR72	PR68
B	PR127	PR123	PR119	PR115	PR111	PR107	PR103	PR99		PR95	PR91	PR87	PR83	PR79	PR75	PR71	PR67
C	PR126	PR122	PR118	PR114	PR110	PR106	PR102	PR98		PR94	PR90	PR86	PR82	PR78	PR74	PR70	PR66
D	PR125	PR121	PR117	PR113	PR109	PR105	PR101	PR97		PR93	PR89	PR85	PR81	PR77	PR73	PR69	PR65
E	GND	GND	GND	GND	GND	GND	GND	GND		GND	GND	GND	GND	GND	GND	GND	GND
F	GND	GND	GND	GND	GND	GND	GND	GND		GND	GND	GND	GND	GND	GND	GND	GND
G	PR61	PR57	PR53	PR49	PR45	PR41	PR37	PR33		PR29	PR25	PR21	PR17	PR13	PR9	PR5	PR1
H	PR62	PR58	PR54	PR50	PR46	PR42	PR38	PR34		PR30	PR26	PR22	PR18	PR14	PR10	PR6	PR2
J	PR63	PR59	PR55	PR51	PR47	PR43	PR39	PR35		PR31	PR27	PR23	PR19	PR15	PR11	PR7	PR3
K	PR64	PR60	PR56	PR52	PR48	PR44	PR40	PR36		PR32	PR28	PR24	PR20	PR16	PR12	PR8	PR4

Figure 6.11 1 Signals of the Pulser/Receiver Connector

The pin out details for the Hypertronic connector is shown in Figures 6.13.1 and 6.13.2.

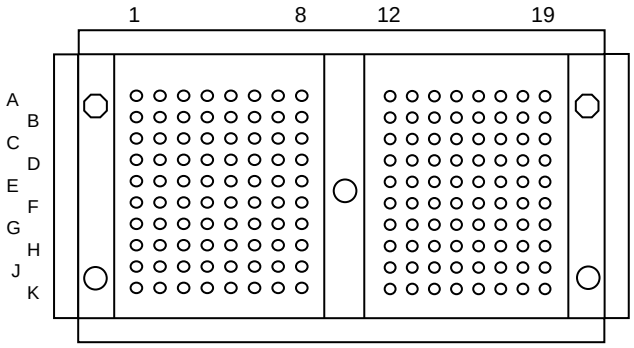


Figure 6.11 2 View on Pulser / Receiver Connector in Front Panel

Pulser Receiver Connector Details

Description: 160-pin connector, female

Manufacturer Part Number: Hypertronics™ HLMYJPAPF16000/NEBV19/16PFD/T

Suggested Cable Connector: HypertronicsTM HLMXJCASM16000/NEPJ19/16PMS/T

On MP6 with 256 channels, the second connector runs from 129 to 256 following the same pattern as above.

On LTPA systems where an additional 64 phased array pulser channels are available, two Hypertronic connectors are used. The top Hypertronic connector is the pulser/receiver connector as shown in Figures 6.13.1 and 6.13.2 while the bottom Hypertronic connector is pulser only channels. The pin out of this connector is the same as the pulser/receiver connector except that the channels are pulsers only.

6.12 MicroPulse LT2 Connector Details

MicroPulse LT2 is an upgraded version of the MicroPulse LT with increased buffer memory and 1000BaseT (Gigabit) Ethernet. The connector details are as follows:

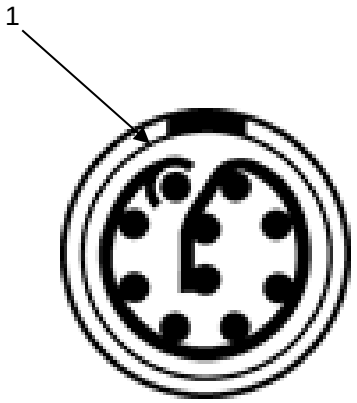
Ethernet Connector

Standard RJ 45 style connector. The status of the Ethernet connection is indicated by an LED labelled LINK adjacent to the connector

LINK LED	Function
Off	No power to the LT2
Red	Power to the LT2 with no Ethernet link
Green	Ethernet linked
Orange	Ethernet linked with activity
Flashing Red	Fault

Multifunction Connector A (wire colour on Peak NDT supplied cable)

10 Way LEMO Plug Pin No.	**Function**	**Colour**
1	+5V Out	Orange
2	Enc 1 A+	Blue
3	Enc 1 A-	Green
4	Enc 1 B+	Yellow
5	Enc 1 B-	White
6	INE0/CPIN0	Brown
7	0V	Black
8	Aux Pwr: 0V	Pink or Red
9	Aux Pwr: +48V(±10%)	Violet
10	Analog I/P 1	-
Screen	0V screen	Green/Yellow



View on cable side of Cable Connector
(Pin 1 indicated, then pins go anti-clockwise)

Connector Details: LEMO EXG.1B.310.HLN

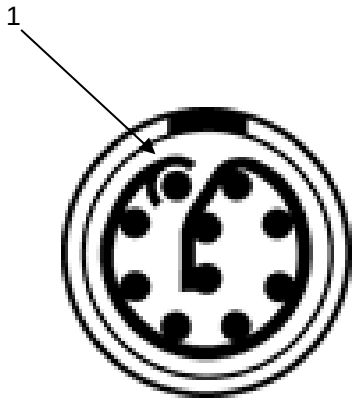
Suggested Cable Connectors: LEMO FGG.1B.310.CYCD62 (crimp contacts)
LEMO FGG.1B.310.CLAD62 (solder contacts)

Note: The connector collet size used is dependent on the cable diameter and should be checked for suitability.

Figure 6.12.1 Encoder Axis 1 Interface Connector (wire colour on Peak NDT supplied cable)

Multifunction Connector B (wire colour on Peak NDT supplied cable)

10 Way LEMO Plug Pin No.	Function	Colour
1	+5V Out	Orange
2	Enc 2 A+	Blue
3	Enc 2 A-	Green
4	Enc 2 B+	Yellow
5	Enc 2 B-	White
6	DO NOT USE	Brown
7	0V	Black
8	Aux Pwr: 0V	Pink or Red
9	Aux Pwr: +48V(±10%)	Violet
10	Analog I/P 2	-
Screen	0V screen	Green/Yellow



View on cable side of Cable Connector
(Pin 1 indicated, then pins go anti-clockwise)

Connector Details: LEMO EXG.1B.310.HLN

Suggested Cable Connectors: LEMO FGG.1B.310.CYCD62 (crimp contacts)
LEMO FGG.1B.310.CLAD62 (solder contacts)

Note: The connector collet size used is dependent on the cable diameter and should be checked for suitability.

Figure 6.12.2 Encoder Axis 2 Interface Connector (wire colour on Peak NDT supplied cable)

Notes:

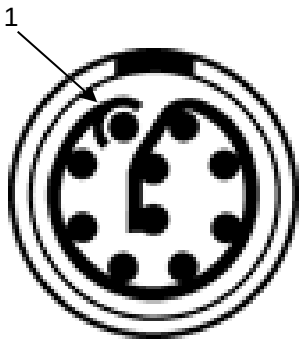
- If required, the Auxiliary Power connection can be used instead of the Power over Ethernet (POE). The recommended supply is +48Volts @300mA, although due to the POE compatibility the LT2 can operate between +37Volts and +57Volts.
- The LT2 encoder input signal voltage is 5 Volts. In differential connection, both + and – inputs are connected, whilst in single ended use the complementary (-) input should be left unconnected. Termination for each axis can be turned on/off using the TERM command.
  Note: The default is termination turned on.
- The +5V output is rated at 200mA maximum current.

6.13 MicroPulse LTPA/MPLT Connector Details

Ethernet Connector

Standard RJ 45 style connector. The status of the Ethernet connection is indicated by a green LED that indicates a link has been established whilst an amber LED indicates activity.

Two Encoder Connectors (wire colour on Peak NDT supplied cable)



View on cable side of Cable Connector (Pin 1 indicated, then pins go anti-clockwise)

10 Way LEMO Plug Pin No.	Axis 1 Function	Axis 2 Function	Colour
1	+5V Out	+5V Out	Orange
2	Enc 1 A+	Enc 2 A+	Blue
3	Enc 1 A-	Enc 2 A-	Green
4	Enc 1 B+	Enc 2 B+	Yellow
5	Enc 1 B-	Enc 2 B-	White
6	Ext Trig In	Ext Trig Out	Brown
7	0V	0V	Black
8	-	-	-
9	-	-	-
10	-	-	-
Screen	0V screen	0V screen	Green/Yellow

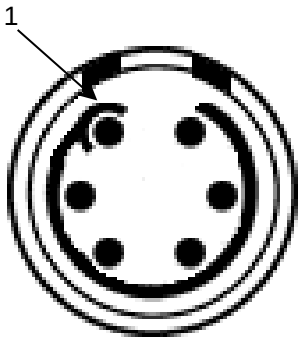
Connector Details: LEMO EXG.1B.310.HLN

Suggested Cable Connectors: LEMO FGG.1B.310.CYCD62 (crimp contacts)
LEMO FGG.1B.310.CLAD62 (solder contacts)

Note: The connector collet size used is dependent on the cable diameter and should be checked for suitability.

Figure 6.13.1 Encoder Axis 1 Interface Connector (wire colour on Peak NDT supplied cable)

Two Input/output Connectors (wire colour on Peak NDT supplied cable)



View on cable side of Cable Connector (Pin 1 indicated, then pins go anti-clockwise)

6 Way LEMO Plug Pin No.	Axis 1 Function	Axis 2 Function	Colour
1	+5V Out	+5V Out	Orange
2	INE 0	INE 2	Blue
3	INE 1	INE 3	Green
4	CPIN 0	CPIN 2	Yellow
5	CPIN 1	CPIN 3	White
6	0V	0V	Black
Screen	0V screen	0V screen	Green/Yellow

Connector Details: LEMO EXA.0B.306.HLN

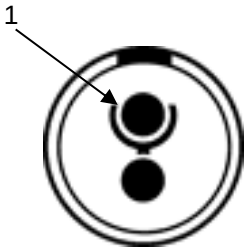
Suggested Cable Connectors: LEMO FGA.0B.306.CYCD52 (crimp contacts)
LEMO FGA.0B.306.CLAD52 (solder contacts)

Note: The connector collet size used is dependent on the cable diameter and should be checked for suitability.

Figure 6.13.2 Encoder Axis 1 Interface Connector (wire colour on Peak NDT supplied cable)

Auxiliary power Connector

2 Way LEMO Plug Pin No.	Function
1	+48V (±10%) in
2	0V



View on cable side of Cable Connector
(Pin 1 indicated)

Connector Details: LEMO EXG.0B.302.HLN

Suggested Cable Connectors: LEMO FGG.0B.302.CYCD62 (crimp contacts)
LEMO FGG.0B.302.CLAD62 (solder contacts)

Note: The connector collet size used is dependent on the cable diameter and should be checked for suitability.

Figure 6.13.3 Auxiliary Power Connector

Notes:

- If required, the Auxiliary Power connection can be used instead of the Power over Ethernet (POE). The recommended supply is +48Volts @1.5A, although due to the POE compatibility the LTPA can operate between +37Volts and +57Volts.
- The LTPA encoder input signal voltage is 5 Volts. In differential connection, both + and – inputs are connected, whilst in single ended use the complementary (-) input should be left unconnected. Termination for each axis can be turned on/off using the TERM command.
  Note: The default is termination turned on.
- The +5V output is rated at 200mA maximum current.

6.14 MicroPulse 6 Rear Connector Details

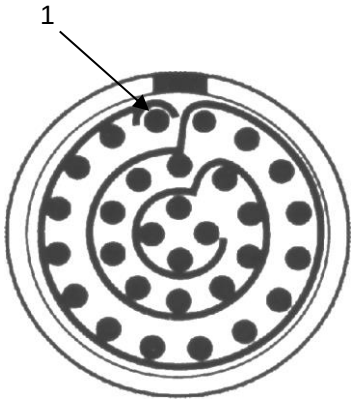
Ethernet Connector

Standard RJ 45 style connector. The status of the Ethernet connection is indicated by a green LED that indicates a link has been established whilst an amber LED indicates activity.

Encoder Connector (ENCODER)

The pinout details are shown in Figure 6.14.1.

30 Way LEMO Plug Pin No.	Function
1	Enc 1 0v
2	Enc 1 A+
3	Enc 1 B+
4	N/C
5	Enc 4 0v
6	Enc 4 A+
7	Enc 4 B+
8	N/C
9	Enc 3 0v
10	Enc 3 A+
11	Enc 3 B+
12	N/C
13	Enc 2 0v
14	Enc 2 A+
15	Enc 2 B+
16	N/C
17	N/C
18	Enc 1 A-
19	Enc 1 B-
20	Enc 4 A-
21	Enc 4 B-
22	N/C
23	Enc 3 A-
24	Enc 3 B-
25	Enc 2 A-
26	Enc 2 B-
27	Enc 1 +5V Out
28	Enc 4 +5V Out
29	Enc 3 +5V Out
30	Enc 2 +5V Out



View on cable side of Cable Connector
(Pin 1 indicated, then pins go anti-clockwise)

Connector Details:

Socket (MP5 back panel):
LEMO ECG.4B.330.CLN

Suggested Cable Connector:

LEMO FGG.4B.330.CYCD10Z

Note: The connector collet size used is dependent on the cable diameter and should be checked for suitability.

Figure 6.14 1 Encoder Connector Pin Out Details

Typical encoders provide two channels in quadrature, known as channel A and channel B. Quadrature encoders can be either be single-ended (channel A and channel B), or differential (channel A+, channel A- and channel B+, channel B-). The maximum frequency of encoders that can be applied to MicroPulse 6 is 700,000 full encoder cycles/second (2,800,000 quadrature counts/second).

The 5Volt outputs can supply a maximum of 200mA. The standard input signal voltage is 5 Volts. In differential connection, both + and – inputs are connected, whilst in single ended use the complementary (-) input should be left unconnected. The encoder input circuit within MicroPulse 6 is shown in Figure 6.11.2. Termination for each axis can be turned on/off using the TERM command. Note: The default is termination turned on.

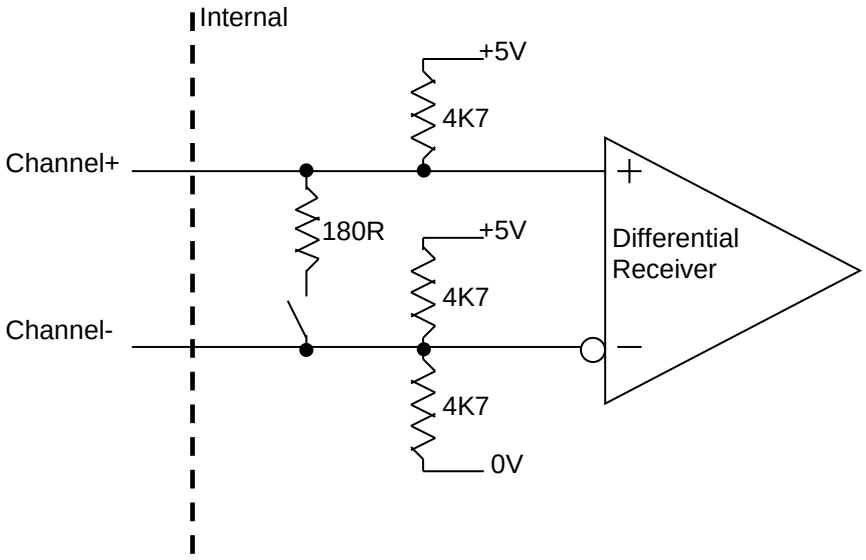
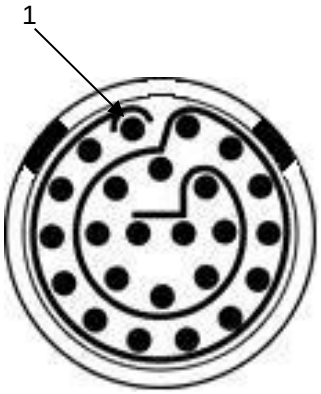


Figure 6.14 2 Encoder Input Circuit

Input/Output Connector (I/O)

The pinout details are shown in Figure 6.14.3.

24 Way LEMO Plug Pin No.	Function
1	+5V Out
2	INE 0
3	INE 1
4	INE 2
5	INE 3
6	INE 4
7	INE 5
8	INE 6
9	INE 7
10	DO NOT USE
11	DO NOT USE
12	DO NOT USE
13	DO NOT USE
14	+5V Out
15	CPIN 0
16	CPIN 1
17	CPIN 2
18	CPIN 3
19	CPIN 4
20	CPIN 5
21	CPIN 6
22	CPIN 7
23	0v
24	0v



View on cable side of Cable Connector
(Pin 1 indicated, then pins go anti-clockwise)

Connector Details:

Socket (MP5 back panel):
LEMO ECC.4B.324.CLN

Suggested Cable Connector:
LEMO FGC.4B.324.CYCD10Z

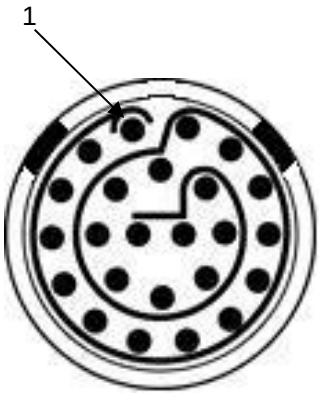
Note: The connector collet size used is dependent on the cable diameter and should be checked for suitability.

Figure 6.14 3 Input/Output First Connector Pin Out Details

Input/Output Connector (EXT I/O)

The pinout details are shown in Figure 6.14.4.

24 Way LEMO Plug Pin No.	Function
1	+5V Out
2	INE 8
3	INE 9
4	INE 10
5	INE 11
6	INE 12
7	INE 13
8	INE 14
9	INE 15
10	DO NOT USE
11	DO NOT USE
12	DO NOT USE
13	DO NOT USE
14	+5V Out
15	CPIN 8
16	CPIN 9
17	CPIN 10
18	CPIN 11
19	CPIN 12
20	CPIN 13
21	CPIN 14
22	CPIN 15
23	0v
24	0v



View on cable side of Cable Connector
(Pin 1 indicated, then pins go anti-clockwise)

Connector Details:

Socket (MP5 back panel):
LEMO ECC.4B.324.CLN

Suggested Cable Connector:
LEMO FGC.4B.324.CYCD10Z

Note: The connector collet size used is dependent on the cable diameter and should be checked for suitability.

Figure 6.14 4 Input/Output Second Connector Pin Out Details

6.15 Debug And Special Commands

The following are commands that be sent to the MicroPulse systems as part of test and debug when interfacing to a host PC software. They are not listed in the instruction set section as they are not fully supported commands.

TST

Purpose: To output a steady stream of data to the host PC to test data rates. This data is in the format of simulated A-scan data in the DOF mode required.

Format: TST <gate length><DOF mode required><number of A-scans>

Description: Allows the operator to interrogate current ultrasonic Parameters for the test specified.

Parameters:

< gate length >	:	Integer value from 4 to 32000
< DOF mode required>	:	Integer value from 1 to 3. DOF modes 1,2 and 3 are supported.
<number of A-scans>	:	Integer value from 0 to 1000000 where 0 is continuous A-scans to be sent.

XXB

Purpose: To display system information on the LCD of MicroPulse 6.

Format: XXB <data1>

Description: Allows the operator to interrogate current ultrasonic Parameters for the test specified.

Parameters: <data1> : Integer value from 10000 to 10010 where

10000	System information with FPGA versions
10001	Encoder settings for axis 1
10002	Encoder settings for axis 2
10003	Encoder settings for axis 3
10004	Encoder settings for axis 4
10005	Further system information
10006	Error log
10007	Temperature warning
10008	Motor Interface (MIF) information
10009	FMC Data receiver (DRIF) information
10010	Phased array interface (PAIF) information

ZFL

Purpose: To enable and disable error logging on latest MicroPulse systems.

Format: ZFL<3> <1 / 0>

Description: Allows the operator enable or disable the error logging features within the Micropulse system. ZFL 3 1 enables the logging whilst ZFL 3 0 disables logging. The system log can be output using the STS command in the format shown in section 4.5.
LTPA/MPLT permanently have this feature enabled,

LCDB

Purpose: On MicroPulse 6 systems write display data directly to the LCD (16 lines, 40 characters per line).

Format: LCDB <data1> [data2] [data3]

Description: Allows the operator to interrogate current ultrasonic Parameters for the test specified.

Parameters: <data1> : 0 = clear LCD
1 = set curser to position, this is then followed by two more parameters:
[data2] = line, integer from 1 to 16.
[data3] = character on line, integer from 1 – 41.
2 = write ASCII data characters to LCD, this is then followed by [data2] which is the line of ASCII characters to be written to the LCD.
3 = write blank characters to LCD, this is then followed by [data2] which number of blanks to be written to the LCD.
4 = write the Peak NDT logo to the LCD
>4= write the contrast to the LCD (stored in flash for future use).

System Compatibility: Valid only for MicroPulse 6.

6.16 Document Revision History

Date and Document Revision	Changes Made
March 2020 V1.01	• MicroPulse 6 Reference Manual created
June 2020 V1.02	• Renamed intersystem connected units to primary/secondary • Various pre-issue changes to previously created manual