APPENDIX 1

Some parameters used in testing and defining the performance of fast NIM modules are briefly reviewed here.

LINEAR INPUTS

Inputs accepting analog d.c. or pulse signals are described by the following parameters (see also Fig. 1).

INPUT IMPEDANCE	must be specified together with its accuracy, the reflection ratio for pulses of specified rise-time, and the signal levels up to which the correct impedance is kept (i.e. the clamping levels of input protection circuit). Reflections must be in the few percent range when good accuracy is required in the instrument performance.
POLARITY	Positive, negative, or bipolar.
COUPLING	d.c. or a.c. with specified time constant.
PROTECTION	against d.c. or transient overvoltages of specified value.
VOLTAGE OFFSET	is the quiescent d.c. voltage at the input. Its dependence on ambient temperature, time, and supply voltages should be specified.
EQUIVALENT INPUT NOISE	is the noise level actually measured at the output divided by the instrument amplification. It compares directly to the input signal.
LINEAR RANGE	Voltage, current, or charge.
OVERLOAD RECOVERY	Time to recover to normal operation after a specified input overload.
CROSS-TALK	Mutual influence between inputs in a multichannel unit.

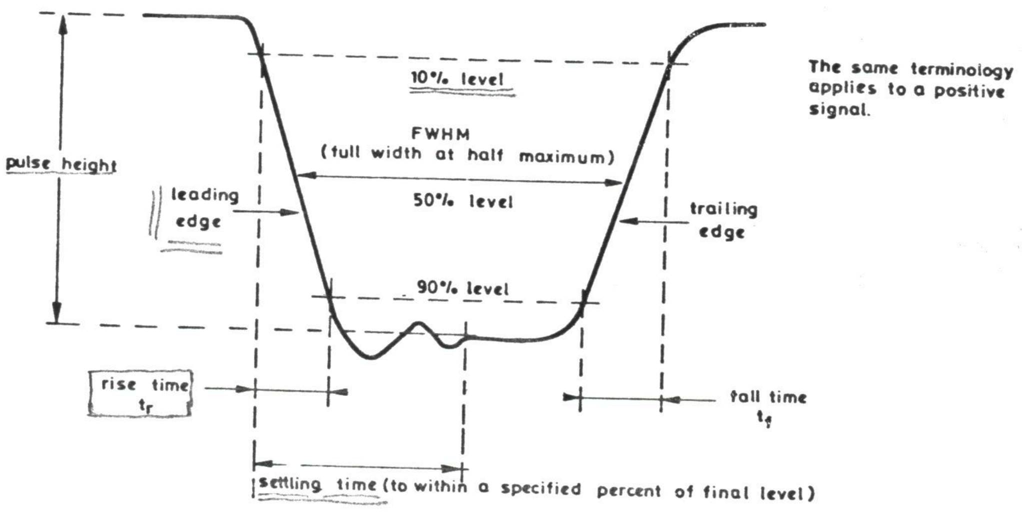


Fig. 1 Analog input or output signal

For instruments such as shapers and discriminators, performing a non-linear operation on analog signals, one should also consider:

THRESHOLD — (voltage or current), its accuracy and dependence upon temperature, time, supply voltages, input pulse width and input pulse rise-time, previous overloads.
The time of threshold crossing is taken as a reference for all timing specifications which refer to a given input.

INPUT OVERDRIVE — or factor by which the signal is over threshold, must be specified in connection with propagation (input to output) delay, and other performance such as maximum working frequency.

LOGIC INPUTS (NIM)

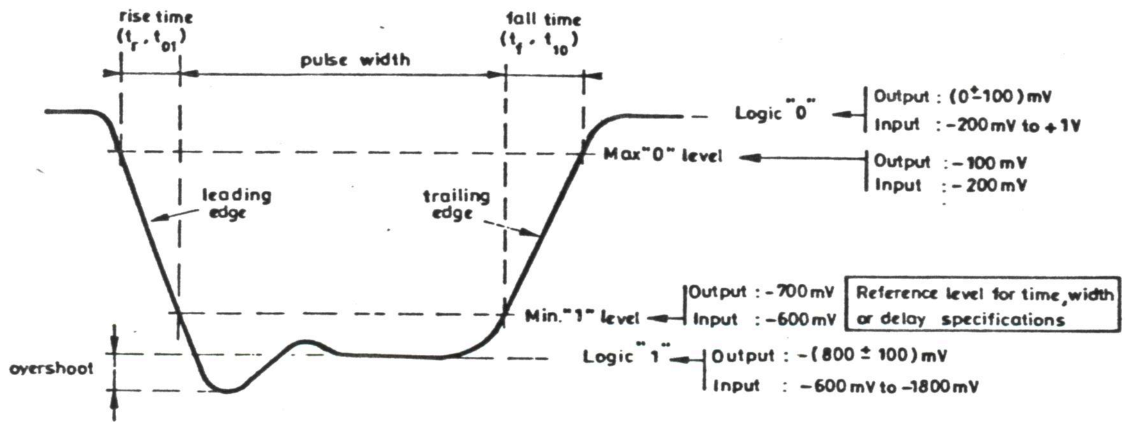
Logic inputs must recognize as a logic "0" any signal of amplitude between +1 V and -200 mV.

They must recognize as a logic "1" any signal of amplitude between -600 mV and -1800 mV (Fig. 2).

-100 mV and -600 mV are also the reference levels for all timing specifications.

A few more parameters can be mentioned:

INPUT IMPEDANCE	is either 50 Ω, or >> 50 Ω for "bridge" inputs by which the signal can be daisy-chained to many units and terminated on the last one.
REFLECTIONS	as high as 12.5% are tolerated in Pool units.
MINIMUM WIDTH OR OVERLAP	is the minimum width of a single signal, or overlap of time-coincident signals, required to produce a valid output signal. Measuring levels are at -600 mV for normal signals and -100 mV for complementary ones.
TERMINATION	of unused inputs is not required, unless otherwise stated.



Complementary logic signal

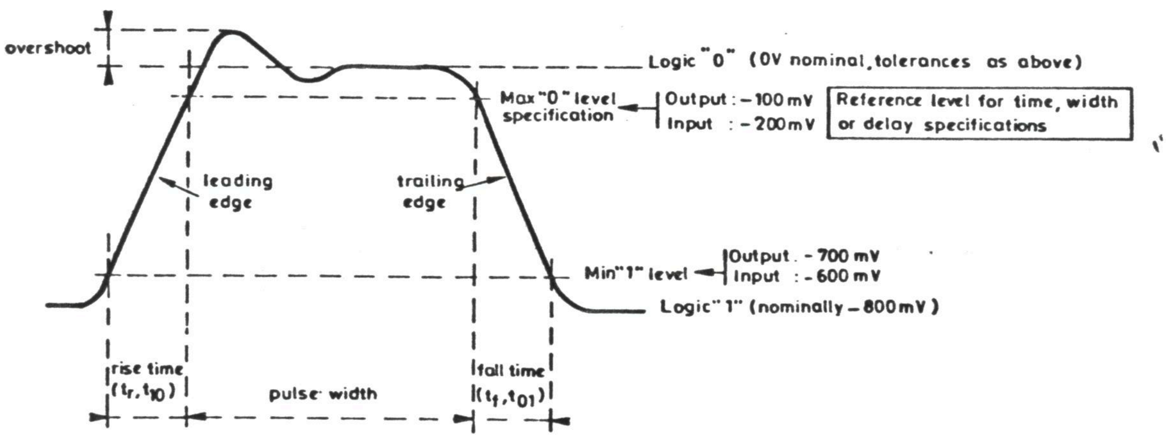


Fig. 2 Logic signal (NIM-AEC standard)

LINEAR OR ANALOG OUTPUTS

Pertinent parameters are:

OUTPUT IMPEDANCE	(voltage source, current source). Effect of loading on accuracy.
d.c. OFFSET	with the same meaning as for linear inputs.
RISE/FALL	usually measured between 10% and 90% of full output.
SETTLING-TIME	i.e. time for signal to settle within some percent to its final amplitude. The settling time and overshoot should be low when the output information is carried by the signal flat top, as in Time-to-Amplitude Converters and some "majority" outputs.
GAIN (GUADAGNO)	must be specified together with its accuracy as a function of temperature, time (long-term) supply voltages, and linearity (integral and differential).
FEEDTHROUGH (Eff. muthinsi attraverso)	is the cause of unwanted output signal from a specific source (adjacent channels or auxiliary signals).
PROPAGATION DELAY	is the time for the signal to go "through" the circuit, measured between specified reference levels.

LOGIC OUTPUTS (Fig. 2)

OUTPUT IMPEDANCE	is generally high (current source) or low (voltage source) compared to 50 Ω load impedance.
TYPE OF OUTPUT	Normal or complementary, single or dual.
DUAL OUTPUTS	(Fig. 3) consist of -32 mA (nominal) current source, which can be used to drive two 50 Ω loads or in some other ways. For instance a "back termination" can be used to absorb reflections from a load ≠ 50 Ω, for pulse widths lower than the cable propagation time.
SINGLE OUTPUT	A single logic output can either be a -16 mA current source or a -800 mV voltage source, short-circuit proof. Cable OR-ing can only be made on current source outputs.
TERMINATION	of unused outputs is not necessary, apart from the cases shown in Fig. 3.
RISE/FALL	are specified between -100 mV and -700 mV levels.
OVERSHOOT	Some overshoot (≤ 15% in Pool units) is generally accepted both on normal and complementary outputs.
PROPAGATION DELAY	Same as for linear outputs, except that the reference levels are those specified for logic signals (Fig. 2).
TIME JITTER	is determined by the random fluctuations in propagation delay (from pulse to pulse).
TIME SLEWING	is the change in propagation delav with specified changing conditions (e.g. input overdrive, input signal rise-time or number of coincident inputs).
WIDTH	of output pulse must have specified accuracy and dependence on variables such as temperature, time, supply ages, voltages, input width, or overdrive.
PULSE PAIR RESOLUTION	in non-regenerative units (logic fan-in, fan-outs, level adapters) is the minimum time separation between two input pulses (trailing edge of first to leading edge of second, Fig. 4a) for which the output pulses are still logically separated (Fig. 4b). For shorter time distance of the input pulses, the output signals merge into a single pulse. Since the unit does not exhibit dead-time, no logic errors are induced, although counting errors in a subsequent scaler are to be considered.
MAX. RATE	in a non-regenerative unit is determined by the pulse pair resolution above plus the minimum input width required to produce a valid output.

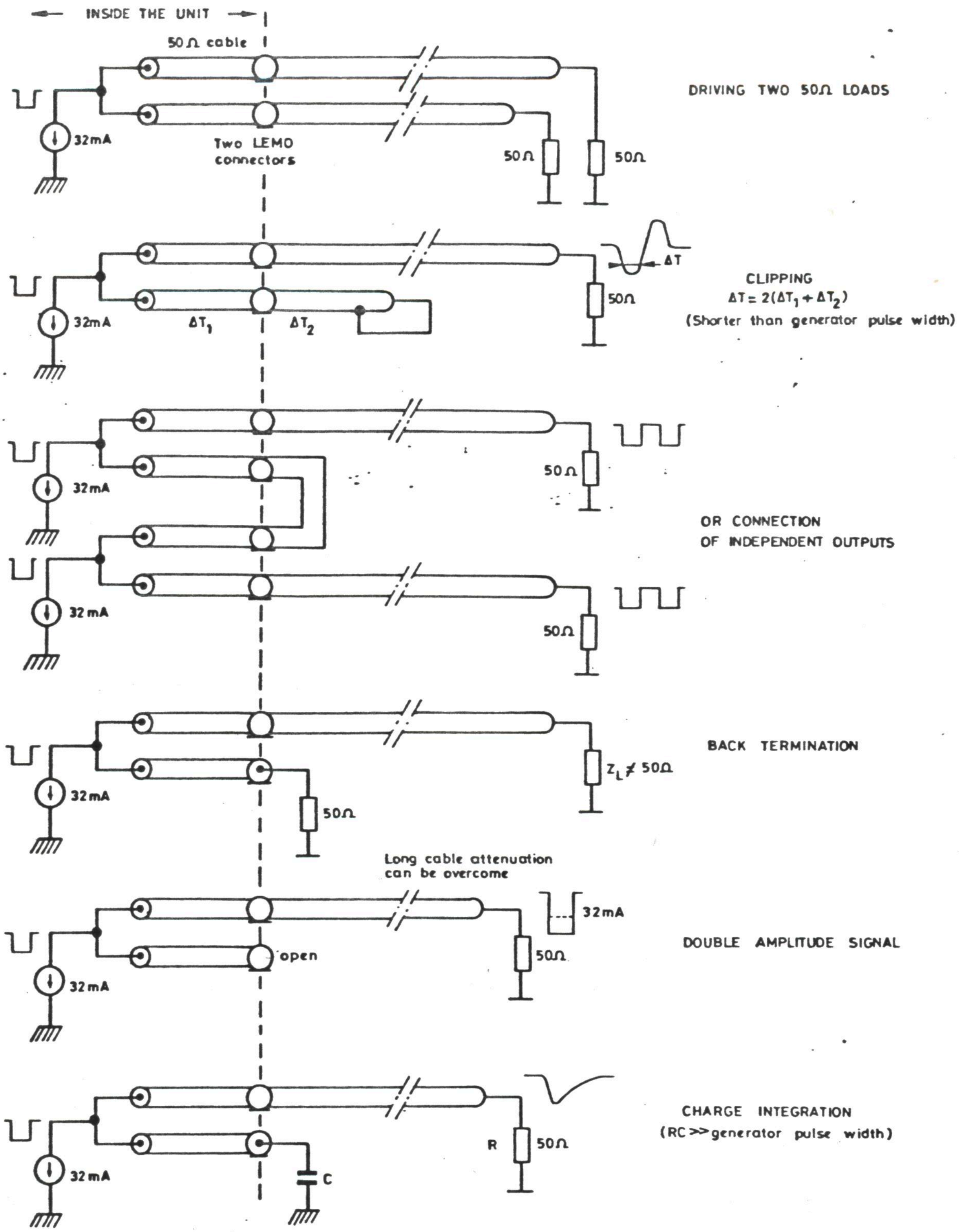


Fig. 3 Some uses of dual logic outputs

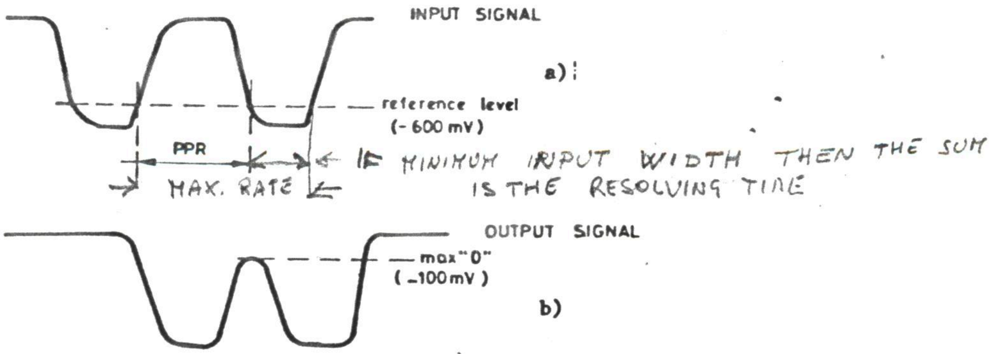


Fig. 4 Pulse pair resolution

RESOLVING TIME

(also double pulse resolution) in regenerative units such as shapers and discriminators is the minimum time separation of two input pulses (between leading edges, Fig. 5) for which two output pulses of the minimum width are still produced. For a shorter separation, the second output pulse is usually lost, and on a high rate input burst only one output pulse is produced, causing both logic and counting errors.
Some discriminators have a d.c. or burst mode to produce a continuous output under high rate conditions. When setting for output widths larger than the minimum, either the resolving time increases correspondingly, or it stays constant if the unit has an updating mode (below).

UPDATING

is the property of a discriminator or gate generator to restart the internal shaping operation even while a timing cycle, triggered by a former input, is still under way; in this case the output pulse becomes wider by an amount related to the time separation between the input pulses (Fig. 6).
This feature permits the information carried by two input pulses to be preserved when their spacing is larger than the resolving time of the unit (5-8 nsec in present units). By choosing an output width > resolving time an apparently dead-time-less operation is possible in logic applications provided the max. input rate does not exceed 1/(resolving time).

MAX. RATE

in a regenerative unit is the maximum rate at which a logically correct output waveshape can be produced. It generally depends on the input overdriving conditions, which are therefore to be specified.