

DECUS DIVIDER MODULE FOR LPRO-101 and FRC-C RUBIDIUM SOURCES

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Introduction

This manual describes the design, construction, operation and use of the DECUS Divider Module. The primary use of the module is to condition the 10 MHz signal from a rubidium oscillator source such as the LPRO-101 or FRS-C modules manufactured by EFRATOM Ball, Inc. The module divides the 10 Megahertz output from these units to produce marker signals at various frequencies.

The module also provides buffered 10 MHz outputs that can be used to distribute the conditioned signal to test equipment.

The conditioning circuit and divider chip on the module can also be used for other applications requiring conditioning and dividing of an input signal, but this usage is outside the scope of this manual.

Audience

The intended audience for this manual includes hobbyists, experimenters, Ham radio operators, technicians and engineers. Hence, it assumes that readers have some familiarity with electronic circuitry, schematic diagrams and surface mount technology.

Features and Specifications

For the following, refer to the schematic titled “DECUS DIVIDER BOARD FOR LPRO-101 and FRS-C RUBIDIUM SOURCES”. The latest revision of this schematic is H, reflecting the circuitry on revision 5 of the PC board.

The schematic shows the components, circuitry and some operational restrictions for the module. The Parts List section provides additional information about the components used to assemble the module.

Physical

The module measures 1 ¼” x 7/8.” Signal connections are provided on two 12-pin single row pin headers. Header pins are spaced one tenth inch apart and the header rows are spaced 0.6 inch apart. This allows the module to be used with in-line sockets or wired directly to a perforated board.

Outputs

The module provides nine different divider outputs, ranging from 1 MHz to 1 Hertz. The module also provides three 10 MHz buffered outputs for driving the reference inputs of test equipment. Two buffer gates are uncommitted to allow any two of the outputs to be buffered or to allow buffering of an external signal (e.g., a lock indicator for an LPRO or FRS output).

Divider outputs are driven by microprocessor port pins capable of sourcing or sinking up to 100 milliamperes each. The one Hertz output can directly drive an LED to act as an “active” indicator. These drive capabilities are limited by the choice of input voltage and the current limitations of the regulator, as noted in the Power section below.

Power

An on-board 3.3 Volt regulator provides stable regulated power to the module. A zener diode input option allows the module to be used with higher voltage inputs such as a 19 to 24 Volt source used to power an LPRO or FRS rubidium oscillator.

Module quiescent current draw is approximately 12 milliamperes. Total regulator dissipation is 250 milliwatts. Maximum regulator output is 100 milliamperes. The regulator is both current and temperature limited in the event of output overload (e.g., due to higher input voltage or output loading).

For operation at higher input voltages, total output buffering current is limited to approximately 10 milliamperes. Higher output currents are available when the module is operated at a lower input voltage (e.g., 5.5 Volts). If possible, operation with a lower supply voltage is recommended.

The module may operate at a standard voltage of 5 Volts, but the 5.5 Volt specification is derived from the worst-case dropout specifications from the regulator datasheet.

Revision Summary

<u>REVISION</u>	<u>CHANGES</u>
1 & 2	Original circuit, board layout changes only
3	Added R3,C4 to reset line - improved large transient performance Replaced 74LVC04 with 74HC04 (less ringing) Reduced value of C1 to 100 pF Added 1N4739 to the board (ships installed but shorted) Changed C3 and C2 to use stock parts
4	Not Implemented
5	Added R4 and C5 to provide additional supply filtering for 74HC04, similar to that used in the LPRO manual C3 and C2 can now be either 0805 or 1206 to use stock parts Changed so that there are two uncommitted buffers with outputs at I and Q (no unused pins) – Board shipped with R and G inputs connected to 10 MHz output with short wire-wrap jumpers

Design and Operation

Design

The input conditioning circuit is based on the circuit recommended in the LPRO-101 manual but modified for lower-voltage operation.

The divider outputs are driven by a microprocessor with hardware divider capabilities. Module outputs are not derived from software counting routines (thus eliminating jitter due to looped calculations). Observing the outputs on an oscilloscope shows reliable synchronization on signal edges.

The module is designed so that all pins are on one tenth inch centers so that it can be plugged into a breadboard socket or mounted on a perforated board. When mounted on a breadboard socket, some signals may be degraded due to capacitance between connector rows.

Operation

To set up the module for operation, it is necessary only to supply it with power and an input signal. Once set up for operation, outputs are continuously available at lettered output pins, as shown on the schematic (also see the PIN/PORT MAPPING table on the schematic).

The following sections describe power and signal requirements, connections and verification procedures.

Test

All module outputs are verified before shipment. Modules are tested with an LPRO-101 or FRS input source. Outputs are checked for waveform integrity, level and frequency with a Tektronix TDS 2014 oscilloscope.

Power

A 3.3 Volt regulator supplies power to the module. As shipped, the regulator accepts power inputs from 5 to 20 Volts.

The module can operate from the 19 to 24 Volt rubidium oscillator supply if a 9.1 Volt zener diode is connected in series with the regulator's input. The addition of the zener drops the input voltage to the regulator to approximately 15 Volts. Note that operating the module at higher input voltages (e.g., above 10 Volts) may significantly limit divider output currents, as noted above.

The zener can be wired into the circuit by removing the small shorting jumper wired across the zener on the bottom of the module (also see the schematic). When using the zener, the input voltage should be a minimum of 15 Volts.

For direct operation at lower voltages, such as 5.5 Volts, the shorting jumper should be left in place.

Once the proper input voltage has been selected and configured, the operation of the regulator can be verified by measuring the voltage between ground and the power pins of the ICs (e.g., pin 14 of the hex inverter or pin 7 of the microprocessor). The measured voltage should be close to 3.3 Volts.

Input

The input signal is applied between the module pins labeled “K” and “L” (ground), as shown in the schematic. The conditioning circuit is designed to be compatible with the LPRO-101 specifications with a typical input signal of 0.55 Volts RMS (approximately 1.5 Volts peak to peak).

The input may not operate reliably for signal inputs under one Volt peak to peak. Inputs as high as 6 Volts peak to peak have been used but are not recommended for routine use.

To verify the correct operation of the conditioning circuit, use an oscilloscope to observe the input signal between ground and pin 1 of the hex inverter. If the input voltage is within the range specified above, a 10 MHz square wave can be observed at pins “H”, “T” and “V.” Buffered versions of the conditioned signal appear at pins “J”, “O” and “P”, as shown in the schematic.

Outputs

The DECUS output frequencies and module pins are:

<u>PINS</u>	<u>OUTPUT FREQUENCY</u>
C, F	1 Megahertz
D,E	100 Kilohertz
U, S	25 Kilohertz
V, T, H	10 Megahertz (unbuffered)
W	10 Kilohertz
X	1 Kilohertz
A	100 Hertz
B	1 Hertz
J, O, P	10 Megahertz (buffered)
I, Q	uncommitted buffer outputs

The above data and microprocessor port/pin mapping also appears on the schematic in the “PIN/PORT MAPPING” table.

Parts List

ID	QTY	Description	Vendor.	Part Number
RESISTORS				
R1,2	1	RES, 51.1K, 1/8W, 1%, 0805	Digikey	541-51.1KCCT-ND
R3	1	RES, 1K, 1/8W, 1%, 0805	Digikey	541-1.00KCCT-ND
R4	1	RES, 51 Ohm, 1/8W, 1%, 0805	Digikey	541-51.0CCT-ND
CAPACITORS				
C1	1	CAP, 100pF/200V, NPO, 0805	Digikey	PCC1977CT-ND
C2,5	1	CAP, 10uF/6.3V, X5R, 0805	Digikey	PCC2225CT-ND
C3,4	2	CAP, 1uF/25V, X5R, 0805	Digikey	PCC2319CT-ND
SEMICONDUCTORS				
D1	1	zener diode, 1N4739, 9.1 Volt, 1 Watt, DO-41	Digikey	1N4739ADICT-ND
U1	1	voltage regulator, 3.3 Volt, TO-92, 100 mA, 250 mW		L78L33
ICs				
IC1	1	uP, C8051T602-GS OTP, programmed by BOBZ	Digikey	336-1655-5-ND
IC2	1	inverter, hex, 74LVC04ADR	Digikey	296-1218-1-ND
PCB				
PCB1	1	printed circuit board by BOBZ		
MISCELLANEOUS				
PHD1	2	12-pin header, SIL, breakaway	FRYS	PLS-40S-P5